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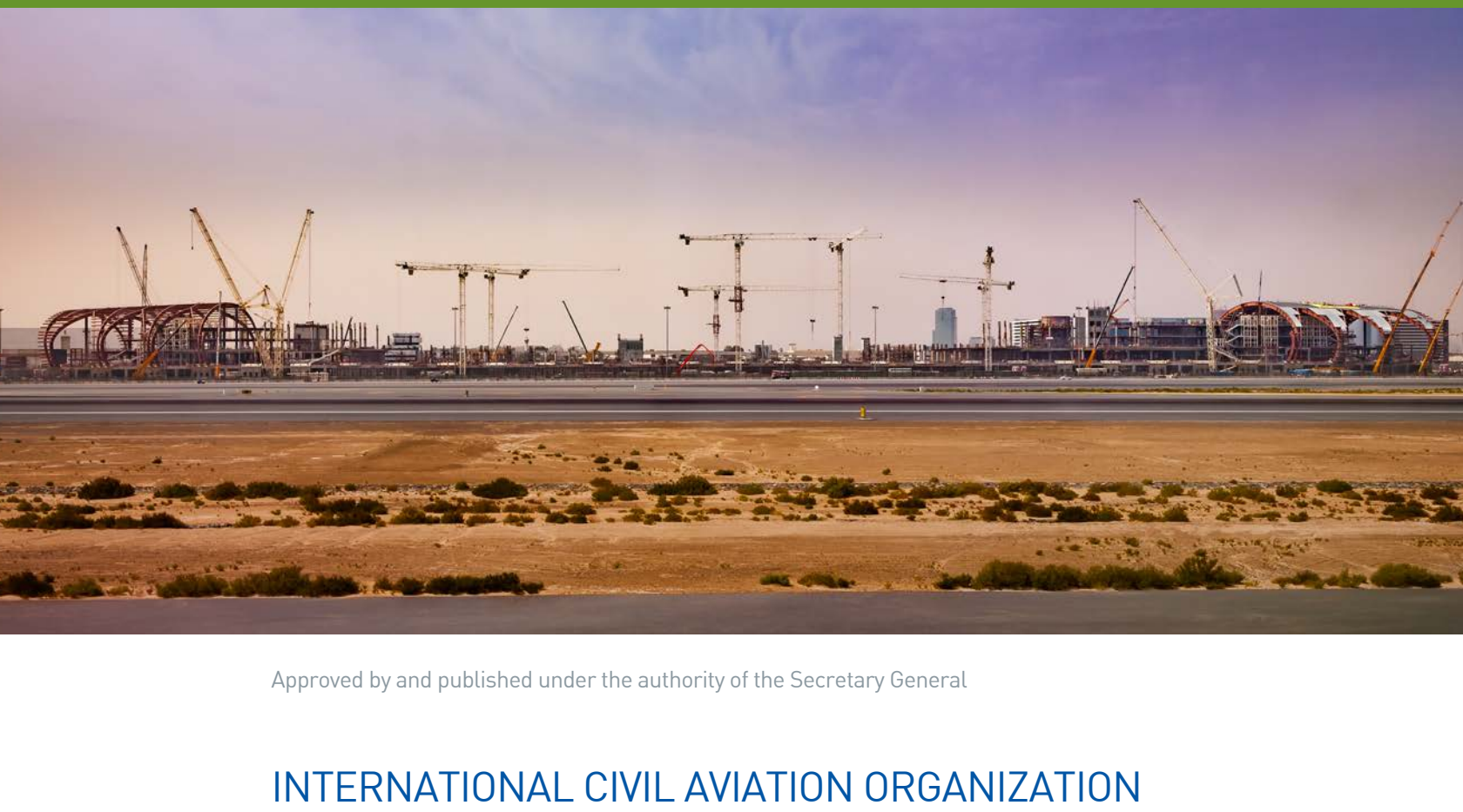
Doc 9184

Airport Planning Manual
Part II — Land Use and Environmental Management

Fourth Edition, 2018



Approved by and published under the authority of the Secretary General

INTERNATIONAL CIVIL AVIATION ORGANIZATION

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AMENDMENTS

Amendments are announced in the supplements to the *Products and Services Catalogue;* the Catalogue and its supplements are available on the ICAO website at www.icao.int. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS		
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FOREWORD

The purpose of this part of the manual is to provide guidance material on land-use planning in the vicinity of airports and on environmental management regarding airport development and operations. It 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.

“Land-use Planning” and “Environmental Management” are terms of relevance used by airport planners for planning the airport and its environs with a view to ensuring the safety of aircraft operations. Since these issues have evolved considerably in recent years, it was necessary to update the information included in previous editions of the manual and to reflect in the title the evolution of the environmental activities at and around airports.

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.

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.

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Chapter 1

GENERAL

1.1 THE AIRPORT AND ITS ENVIRONS

1.1.1 The compatibility of an airport with its environs is an ideal that can be achieved by proper planning of the airport, management of pollution-generating sources, and land-use planning of the area surrounding the airport. The aim is to provide the best possible conditions for the needs of the airport, the community in the surrounding area and the ecology of the environment.

1.1.2 Airport planning is an integral part of an area-wide comprehensive planning programme. The location, size and configuration of the airport needs to be coordinated with patterns of residential, industrial, commercial, agricultural and other land uses of the area, taking into account the effects of the airport on people, flora, fauna, the atmosphere, water courses, air quality, soil pollution, rural areas (such as deserts) and other facets of the environment.

1.1.3 Within the comprehensive planning framework, airport development and operations should be coordinated with the planning, policies and programmes for the area where the airport is located and vice versa. In this way, the social and economic impact, along with the environmental effects of the airport, can be evaluated to ensure to the greatest extent possible that the airport environs are compatible with the airport and, conversely, that the physical development and use of the airport is compatible with the existing and proposed patterns of land use.

1.1.4 To the extent that safety and operational considerations permit a choice, decisions on runway alignment and other airport development should take into account their potential effects on the environment in order to prevent or minimize environmental conflicts. In effect, “land-use control” is a term which describes only a portion of the total planning process, and even highly innovative controls can have little impact unless they are imposed within the context of sound policies and careful planning. “Land-use planning” or “planning for compatible land uses which takes into account the needs of airport development” more adequately describes the process of achieving an optimum relationship between an airport and its environs.

1.2 THE NEED FOR ENVIRONMENTAL MANAGEMENT

1.2.1 In recent years there has been increased public concern regarding the protection of the natural environment from the impact of transportation, and consequently, a growing emphasis on the need to employ effective measures to minimize such impacts. Since pollution may be generated within an airport as well as within the area surrounding it, environmental management practices should be applied at the airport and its environs.

1.2.2 The natural environment has been defined as including:

a) air, land and water;

b) all layers of the atmosphere;

c) all living organisms, including both plants and animals; and

d) the interacting natural systems referred to in a) to c).

These components interact in an ecosystem, and disruption to one may have a profound effect on the entire system. To lessen local and global impacts, it is important that the civil aviation industry endeavours to control harmful environmental impacts. This includes operational impacts like emissions and noise, as well as the management of solid and hazardous wastes emanating from paints, lubrication oils, sludge, solvents, toxic chemicals, etc., handled at airports.

1.2.3 Pollution occurring in and around the airport can have an effect on human health and the ecology of a broad area surrounding an airport. Efforts should be made towards pollution prevention in the first instance and impact management in the second instance. Environmental management thus provides a means of either decreasing pollution at the source or reducing the potential for negative environmental impacts. Environmental management controls may include items such as air and water quality guidelines, aircraft engine or ground-sourced noise limits, waste management plans, environmental emergency plans, and environmental management plans.

1.2.4 Airport operators can reduce the environmental impact of their operations by incorporating environmental management plans and procedures with land-use planning. There are several important components of environmental management at an airport, such as noise mitigation, emissions reduction and pollution prevention. A certain amount of emissions and noise are inevitable from aircraft operations, but can be minimized. Pollution prevention can be defined as “the use of materials, processes or practices that reduce or eliminate the creation of pollutants and wastes at the source.” It includes practices that reduce the use of hazardous and non-hazardous materials, energy, water or other resources. Adequate pollution prevention pre-empts the need for remedial or clean-up actions later.

1.2.5 Appropriate planning and infrastructure decisions at airports help to facilitate good environmental management. By planning for intended growth and development, estimations can be made about the type and extent of potential future environmental impacts to allow for a more integrated approach to environmental management. Refer to Chapter 4.

1.2.6 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. APM Part 1 is focused on master planning at airports and is primarily focused on operational safety and efficiency. The recommendations and considerations for airport planning from APM Part 1 should be considered in conjunction with the information provided in APM Part 2 to minimize environmental impacts.

1.3 THE NEED FOR LAND-USE PLANNING

1.3.1 The need for land-use planning in the vicinity of an airport was recognized in the early history of civil aviation and focused on use and control of land. This has included height control of possible hazards or obstacles to flight into or out of airports. The objectives of these measures was to ensure the safety of people in the air and on the ground, to maintain efficient airport operations, and to limit environmental impacts to local communities.

1.3.2 Though land-use planning continues to focus on possible hazards or obstacles to flight, modern land-use planning includes several additional considerations;

a) land-use zoning that encourages compatible land-uses in the vicinity of an airport;

b) reducing the environmental impact from aviation activities, including noise exposure to the local communities;

c) managing habitat and accumulated solid waste on which wildlife may feed and thus could cause a hazard to approaching or departing aircraft (ref. *Airport Services Manual*, Part 3 — *Wildlife Control and Reduction* (Doc 9137));

d) eliminating light pollution or glint/glare effects that might affect a pilot's interpretation of navigational aids, or air traffic control tower personnel's ability to visually monitor aircraft; and

e) monitoring activities that could compromise the safe flight of aircraft such as electrical interference with radio communications and navigation aids; and

f) minimizing the impact of wind turbulence from obstacles in the vicinity of the runway, etc.

1.3.3 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.

1.3.4 Compatible land-uses in noise-affected areas near airports can include commercial, industrial and agricultural activities. Incompatible land-uses include noise-sensitive areas such as residential homes, schools, hospitals and libraries.

Chapter 2

ENVIRONMENTAL IMPACTS ASSOCIATED WITH AVIATION ACTIVITIES

2.1 GENERAL

This chapter deals with environmental issues related to airport and aircraft operations. It identifies most of the major environmental issues that may be directly associated with air transport and civil aviation in particular. However, this does not necessarily mean that all of the subjects are suitable for consideration in this manual. Excluded are issues concerning the conditions for passengers and crew (such as the effects of smoking, ozone, high altitude radiation, or noise and vibration within the cabin) and issues concerning the working conditions of airline or airport employees. These are defined as occupational health and safety issues. For each environmental issue presented, a brief description is provided, including a summary of past and present ICAO activities aimed at mitigating the issue, as well as comments on the relevant activities of other organizations, whenever pertinent.

2.2 AIRCRAFT NOISE

2.2.1 Since the introduction of jet aircraft, noise has been considered to be perhaps the most important local environmental impact associated with civil aviation. Noise levels in the vicinity of airports are affected by two opposing trends: the replacement of noisy aircraft by quieter ones and the increasing number of aircraft movements. As a result, the level of impact from aircraft noise may decline at some airports but increase at others. In some cases, the level of impact from noise related to aviation activities has prevented the expansion of airport capacity, thereby limiting airport growth and contributing to airport congestion. Because of this and other environmental concerns, some States limit aircraft operations at airports based on environmental considerations, rather than on airport capacity. In other words, the standard “operational airport capacity” has been replaced by capacity restrictions based on environmental parameters such as noise exposure.

2.2.2 Other noise sources that occur on and around airports may include (but not be limited to) aircraft engine testing, auxiliary power units (APUs) used during ground operations, other equipment such as ground power units (GPUs) and ground support vehicles and equipment (GSE).

2.2.4 Annex 16 — *Environmental Protection*, Volume I — *Aircraft Noise* sets the International Standards and provides Recommended Practices for noise certification of subsonic jet and large propeller-driven aircraft, small propeller-driven aircraft, helicopters and tilt-rotor aircraft. The ICAO Committee on Aviation Environmental Protection (CAEP) maintains and reviews Annex 16, Volume I, and develops new noise Standards and Recommended Practices as technology advances. Annex 16, Volume I, also includes guidelines for noise certification of auxiliary power unit (APU) installations and associated systems, as well as recommendations for noise monitoring and assessment around airports.

2.2.5 A worldwide policy has been developed, at ICAO, to define and implement operating restrictions on aircraft that are either non-noise-certificated or only meet the requirements of Annex 16, Volume I, Chapter 2. These were adopted in 1990 with Resolution A28-3[1] and nearly all States now prohibit the operation of these aircraft in their territories.

1. Superseded by Resolution A33-7.

2.2.6 In 2001, the ICAO Assembly unanimously endorsed the concept of the balanced approach to aircraft noise management and in 2007, the 36th ICAO Assembly reaffirmed the balanced approach principle in Resolution A36-22: "Consolidated statement of continuing ICAO policies and practices related to environmental protection". The balanced approach to noise management developed by ICAO consists of identifying the noise problem at an airport and then analysing the various measures available to reduce noise through the exploration of principal elements, namely reduction at source, 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. The recommended practices to assist States in implementing the balanced approach are included in the *Guidance on the Balanced Approach to Aircraft Noise Management* (Doc 9829).

2.3 AIR QUALITY IN THE VICINITY OF AIRPORTS

2.3.1 Air quality in the vicinity of airports can vary greatly depending on local climatic conditions and can be impacted by sources such as road traffic, aircraft engine emissions, emissions from airport motor vehicles and emissions from other sources (e.g. heating/power plants incinerators and construction).

2.3.2 Air pollution refers to a condition of the air quality marked by the presence therein of one or more air contaminants that can:

— degrade the air quality from its normal state;

— endanger the health, safety or welfare of persons;

— interfere with normal enjoyment of life or property;

— endanger the health of animal life; or

— cause damage to plant life or to property.

2.3.3 Air pollution is an environmental problem in many countries, especially in urban areas, and is generally recognized to contain:

— **Carbon dioxide (CO_2)** which is produced by the combustion of hydrocarbon fuels;

— **Carbon monoxide (CO)** is a product originating from the incomplete combustion of hydrocarbon fuels;

— **Oxides of nitrogen (NOx)** result from high-temperature oxidation of atmospheric nitrogen and is composed of a mixture of NO and NO_2. This takes place in the high temperatures and pressures of aircraft engines, road vehicles and other internal combustion sources, and to a lesser extent in other combustion and natural sources (such as lightning);

— **Volatile organic compounds (VOC)** are low boiling point organic chemicals which can be both man-made and naturally occurring. Fugitive emissions and odours from aircraft fuel tanks, oil tanks and other fuel storage facilities can release VOCs into the local area with some recognized as carcinogens. Chronic exposure to some VOCs can cause health problems;

— **Hydrocarbons (HC)** cover a wide range of pure hydrocarbons that consist of only carbon and hydrogen (alkanes paraffins), alkenes (olefins), alkynes (acetylenes), terpenes, etc.) whose sources include fuelling activities and also arise from the incomplete combustion of fuels in vehicle engines, etc.;

— **Particulate matter (PM)** consists of liquid or solid substances that are suspended in the atmosphere and can be generated during jet fuel combustion, ground-based combustion sources (ground power units, power stations, ground transport), tyre and brake wear, and runway, taxiway and road surface erosion;

— **Sulphur oxides (SO_x)** are produced by the oxidation of the sulphur in road vehicle and aircraft fuels during the combustion process. It is the main cause of "acid rain" and has an impact on human health as well as being detrimental to ecosystems;

— **Ozone (O_3)** is a secondary pollutant formed when NOx, CO and VOCs react in the atmosphere in the presence of sunlight. It is a component of photochemical smog and is an irritant gas which can cause health problems, such as irritation to the nose, eyes and throat, as well as respiratory problems, and has damaging effects on plant and animal life; and

— **Lead (Pb)** is a pollutant resulting from the use of leaded fuels in piston-engine aircraft. It impacts local-scale air quality, human health and the local ecosystem.

2.3.4 Common sources of pollution at airports include:

a) aircraft engine emissions, in which the principal pollutant is CO_2, while other pollutants are NOx, CO, unburned hydrocarbons and PM;

b) engine emissions from airport motor vehicles used by airport operators, air carriers and other businesses based at an airport;

c) engine emissions from surface access traffic comprising of passengers' and visitors' motor vehicles, cargo and delivery trucks, service and public transport vehicles;

d) engine emissions from railways and maritime sources, as appropriate;

e) particulate emissions from vehicle tyre and brake wear;

f) emissions from heating/power plants, backup power generators, and incinerators, such as fires set for the purpose of training rescue and firefighting crews;

g) fuel handling and storage tanks;

h) particulates arising from surface erosion of runways, taxiways, airport and surface access roads;

i) natural sources; and

j) construction emissions.

2.3.5 Annex 16 — *Environmental Protection*, Volume II — *Aircraft Engine Emissions* contains the Standards for the control of gaseous emissions through engine certification schemes. It establishes the limits for the emission of NOx, CO, unburned hydrocarbons, and smoke from new turbojet and turbofan engines. These are measured in an engine isolated in a test cell at power levels following a specific reference landing and take-off (LTO) cycle, for the purpose of

technology comparison. The emissions certification values are provided in the ICAO Engine Emissions Databank (EEDB), and are publicly available. Sulphur levels in aviation and road traffic fuels are controlled by the specification of those fuels.

2.3.6 The operational flight cycle is much more complex than the simplified reference LTO cycle used for ICAO certification purposes, hence in 2007, ICAO published a preliminary version of the *Airport Air Quality Manual* (Doc 9889), which was further developed and published in 2011 (available from www.icao.int). Doc 9889 provides details on how to estimate emissions affecting air quality in the vicinity of airports, as well as examples of measurement methods, mitigation options and interrelationships associated with methods for mitigating environmental impacts.

2.3.7 The need to reduce air pollution emanating from emissions of airport motor vehicles, surface access traffic and other sources has attracted the attention of most governments and some intergovernmental organizations. However, the extent of any air pollution problem will vary from one airport to another depending on a number of factors, but, in particular, on the location of the airport and the availability of public transport facilities serving the airport.

2.4 GLOBAL ENVIRONMENTAL ISSUES ARISING FROM AIRPORT USE

2.4.1 Greenhouse gas (GHG) emissions are gases which persist in the atmosphere, can trap heat and cause an increase in global temperatures, and which have the ability to affect the climate and sea levels. GHGs were defined by the Kyoto Protocol to include CO_2, methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6). GHGs are primarily generated by fuel combustion. Of the six GHGs, only CO_2 and N_2O are direct products of jet fuel combustion. GHGs can also be emitted in an airport environment indirectly from other sources, such as electrical power generation and ground access vehicles.

2.4.2 The ozone layer protects the earth from harmful ultraviolet radiation and is being depleted as a result of complex chemical reactions involving man-made gases. The leading causes of ozone depletion are chlorofluorocarbons (CFCs) and halons, foams, solvents and man-made chemicals that are commonly used in air conditioners and refrigerators.

2.4.3 Airlines and airports use CFCs and other ozone-depleting substances (such as chlorinated solvents and oxides of nitrogen) in air-conditioning and chilling systems, degreasers in heavy maintenance operations, cleaning of avionics circuit boards, fumigation operations, and fire extinguishers on aircraft and in computer rooms. The Montreal Protocol on Substances that Deplete the Ozone Layer was signed in 1987; it commits signatories to reduce the production and consumption of ozone depleting substances.

2.5 ENVIRONMENTAL ISSUES ARISING FROM CONSTRUCTION AND EXPANSION OF AIRPORTS OR ASSOCIATED INFRASTRUCTURE

2.5.1 The environmental issues described in this section are mainly concerned with land use, soil erosion, impacts on surface and subsurface water drainage, and the impact on flora and fauna.

2.5.2 Environmental issues arise not only when new airports are being developed but also when existing airport facilities are expanded or redeveloped. The nature of the issues varies from one airport to another.

2.5.3 As a consequence of vegetation clearing and interference with watershed patterns, land on an airport or within its vicinity may be vulnerable to soil erosion by natural elements and, to a limited degree, by aircraft jet blast. This problem can mostly be prevented by replanting, ideally, with endemic species that are less attractive to birds; however, in arid areas it may be necessary to take artificial erosion protection measures, such as facing of escarpments, paving of taxiway shoulders and lining of drains.

2.5.4 Particular consideration should be given to possible water pollution during the construction phases of airports. Construction activities with the potential to cause stream pollution include clearing, grubbing and pest control. For instance, the clearing of vegetation generally results in greater soil erosion into streams. Pest control, particularly the use of sprays, can introduce long-life toxic chemicals into the water. Fuel spillages from equipment and chemicals used in building and pavement construction work can disrupt the hydrological balance of waterways in the area. Changes to the natural drainage patterns of an area due to the construction of an airport can overload certain streams and give rise to flooding. Diversion of flow may cause streams to dry up.

2.5.5 The siting of some airports may require the modification of the shorelines of rivers, lakes and the sea. In planning such airports, careful consideration should be given to possible environmental problems associated with water currents, silt deposits, impacts on marine or fresh water life and marine or stream erosion.

2.5.6 The utilization of land for airport purposes can also cause disturbances to flora and fauna. Airport development work frequently entails clearing and cutting back of trees and other vegetation, changes to the topography of the area, and interference with watershed patterns. Thus airports may destroy the natural habitat and feeding grounds of wildlife and may deplete certain flora that are vital to the ecological balance of the area.

2.5.7 There are also potential impacts on human populations. For example, airport construction may destroy sources of food, water or firewood, or may cause agricultural land loss, a major concern in certain areas of the world.

2.5.8 An important consideration related to airport operational safety is the prevalence and habits of birds in the area and the associated risk of aircraft bird strikes. Bird hazards at proposed new airports can be minimized by careful selection of the site to avoid established bird migration routes and areas naturally attractive to birds and by using the land surrounding the airport for purposes which will not attract concentrations of birds to the area. At existing airports, the bird problem may be controlled by scaring techniques and by making the airport and its environment unattractive to birds. The subject of bird strike reduction is covered in detail in the *Airport Services Manual* (Doc 9137), Part 3 — *Wildlife Control and Reduction*.

2.5.9 As far as these environmental issues are concerned, airport construction is not significantly different from any large construction site. In many countries, the issue is governed by general legislation on planning and development of construction sites.

2.6 WATER AND SOIL POLLUTION IN THE VICINITY OF AIRPORTS

2.6.1 Water pollution can result from direct or indirect discharge of substances into the aquatic environment, leading to alterations in the properties of the natural ecosystems and water chemistry and having subsequent effects on human health. Surface water is most often affected, as pollutants run off the airport pavements and enter into the streams, rivers, lakes, etc. However, subsurface water may also become contaminated when leaks or spills of fluids seep through the soil into the groundwater.

2.6.2 Airports use a variety of chemicals in their day-to-day operations. If not properly controlled, these contaminants may have harmful effects on nearby surface and/or subsurface (ground) water. Water contaminants at airports and their sources include:

a) glycol, from de-icing/anti-icing of aircraft;

b) pavement de-icers, from de-icing/anti-icing of runways, aprons, and taxiways;

c) fuel, from spills during refuelling and leaks from pipes or tanks;

d) fire suppressant chemicals and foams dispersed in firefighting exercises;

e) dust, dirt and hydrocarbons from paved surfaces; and

f) herbicides and pesticides.

2.6.3 The servicing of aircraft and ground vehicles can result in the discharge of industrial effluents, e.g. paint stripping, metal coating, detergents from aircraft, and vehicle and pavement washing.

2.6.4 The discharge of chemical pollutants can disturb aquatic life and diminish water quality in three primary ways:

a) *Toxic effect*: Even a small amount of certain contaminants can be toxic to plants and animals as it can cause either short- or long-term (acute or chronic toxicity) consequences;

b) *Eutrophication*: Excessive levels of nutrients can result in prolific algae and plant growth which, in turn, can choke up water bodies, causing long-term degradation in water quality; and

c) *Oxygen depletion*: The release of certain chemicals in water bodies can lead to the consumption of large quantities of oxygen, causing the water to become oxygen-deficient which is detrimental to aquatic life.

2.6.5 Attention should be given to any change in the ecosystem of desert areas. Deserts are particularly fragile ecosystems. Specific attention should be directed to the loss of natural plants upon which animals feed.

2.6.6 If the airport has a water desalination plant the concentrated saline solution generated should be treated as waste matter. The treatment and disposal of this waste should be considered during the planning phase of the airport facilities.

2.7 WASTE AT AIRPORTS

2.7.1 The disposal of environmentally harmful materials used in aircraft servicing and maintenance (e.g. oils, cleaning fluids and paints) and of waste from the airport and incoming aircraft should be managed effectively.

2.7.2 Although airports are not usually considered as industrial complexes, daily activities, such as movement of aircraft and ground vehicles, fuelling operations, aircraft maintenance and repair work (including painting and metalwork), engine test cell operations, and ground vehicle maintenance, are all sources of airport industrial waste.

2.7.3 Waste management at an airport may require permits and registration due to State and local requirements.

2.7.4 Waste from terminal buildings can be one of the single largest waste streams on an airport site. Waste management practices should include the provision for segregation at site or co-mingling of compatible recyclable material depending on the recycling service providers in the vicinity of the airport.

2.8 ENVIRONMENTAL EMERGENCIES ARISING FROM ACCIDENTS/INCIDENTS INVOLVING DANGEROUS GOODS AND HAZARDOUS MATERIALS

2.8.1 In order to ensure that responses to environmental emergencies are implemented quickly, it is important to establish an environmental emergency plan. The types of environmental emergencies at airports include, but are not limited to, fuel and chemical spills and incidents involving dangerous goods or hazardous materials that may affect the environment. The objective of the environmental emergency plan is to provide a complete and immediate response to an environmental incident.

2.8.2 Many aircraft are not structurally able to withstand a landing at maximum take-off mass. In the event of an emergency requiring an overweight landing, it is sometimes necessary to burn excess fuel, and in rare circumstances dumping fuel for safety reasons, to evaporate into the atmosphere. Air traffic control (ATC) establishes specific areas where fuel can be dumped in case of such an emergency.

2.8.3 Environmental remediation activities must be considered after any emergency release, to ensure that the environment is protected. Environmental site assessments may be performed to determine the extent, if any, of the impact caused by the emergency.

Chapter 3

ENVIRONMENTAL MANAGEMENT MEASURES AND CONSEQUENCES

3.1 GENERAL

3.1.1 Implementation of environmental management measures at airports and surrounding areas is in the best interest of the airport operators, the community and the natural environment. These measures may include compliance with international standards and national and/or local regulations. They are implemented by airports, often in collaboration with airport stakeholders. When planning infrastructure development, an airport operator should consider how environmental management should be integrated to minimize the impact on operations.

3.1.2 Some measures limit pollution at its source while others reduce its effect on communities and ecosystems. An environmental management system (EMS) is seen as the best method to incorporate environmental management into all levels of corporate operations and decision-making processes. This is discussed further in 3.9.2 of this chapter. A well-planned EMS at an airport can help manage environmental impacts. Chapter 4 provides more guidance on the infrastructure that can be planned and built to enable and enhance the environmental management of an airport.

3.2 ENVIRONMENTAL MANAGEMENT

3.2.1 The environmental management activities of an airport can be divided into four basic categories:

a) planning;

b) operations and monitoring;

c) mitigation and remedial measures; and

d) environmental awareness.

3.2.2 Most of the environmental activities at airports involve planning and monitoring, including:

a) environmental assessments;

b) monitoring and compliance;

c) environmental audits, where necessary; and

d) environmental emergency contingency plans.

3.2.3 The environmental assessment process has proven to be an important part of any airport development project. Potential environmental impacts can be identified before they occur and before irrevocable decisions on the design of a project are made. Mitigation of environmental impacts can and should be made an integral part of the planning process. In this regard, reference is made to *Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes* (Doc 10031).

3.2.4 Monitoring and compliance programmes assess air quality, water quality, soil and groundwater quality, noise levels, etc. These programmes are designed to detect developing problems in the early stage before environmental impacts become significant and to identify the source of the problem.

3.2.5 Periodic inspections should be undertaken in order to provide a thorough assessment of the environmental implications of operations and management practices at a given point in time, and to determine the degree of compliance with applicable regulations, guidelines and codes of practice. The inspections are used to assess whether the monitoring and compliance programmes are functioning properly and to identify any problems not previously detected. They also provide a basis for action plans, and are valuable tools for identifying opportunities for enhancing environmental management practices as a whole.

3.2.6 The ultimate goal of a proactive environmental strategy is to prevent the creation of environmental impacts, but there may be a need for *mitigation* and *remedial measures* to correct situations resulting from material handling and management practices of the past.

3.2.7 The objective of an *environmental awareness* programme is to promote increased environmental consciousness and to make individuals aware of their own environmental protection responsibilities, both in decision-making and in the day-to-day work of the airport. This is accomplished primarily through employee education, training and incentives.

3.3 ENVIRONMENTAL MANAGEMENT SYSTEMS

3.3.1 Achieving and demonstrating sound environmental performance require managing the impacts of activities, products and/or services on the environment, taking into account environmental policies and objectives. Legislation is becoming more stringent, with economic policies aiming to foster environmental protection, and there is a growing awareness of environmental issues among society at large.

3.3.2 Many organizations carry out environmental reviews or audits to assess their environmental performance. Organizations can use a series of standards[1] for environmental management, which can be integrated with other management requirements, to assist them in achieving their environmental goals.

3.3.3 The *Report on Environmental Management System Practices in the Aviation Sector* (Doc 9968), published in 2012[2], describes the function of an EMS and presents case studies from the aviation industry where EMS principles were used to manage environmental impacts. Airports, for example, reported that they were using EMS to manage: hazardous and solid waste, water, national environmental regulations, air emissions and noise. Many of these airports had integrated their EMS with other airport management systems, including safety or quality management systems.

3.3.4 There are a number of benefits of implementing an EMS. Doc 9968 cited the top three benefits as:

1) enhance reputation and image among stakeholders, including local communities, customers, and regulators;

2) enhance compliance or mitigate risk of environmental impacts and regulatory violations resulting from airport activities, products, and services; and

3) environmental improvements, enabling organizations to better achieve organizational goals and vision.

1. Such as ISO 14001, Guidance on Implementation of Environmental Management Systems (EMS).
2. http://www.icao.int/environmental-protection/Pages/environment-publications.aspx

Other organizations have identified the following benefits of EMS implementation, including:

a) improved management efficiency by consolidating all environmental programmes into one system;

b) reduced costs by adopting proven, well-developed approaches to environmental management; and

c) increased flexibility to meet changes in legislation and stakeholder concerns.

3.3.5 Airports in general have an obligation to protect the physical environment by evaluating the impacts of their policies and regulatory decisions on the environment, and by promoting and meeting environmental standards while serving the public to optimal satisfaction and safety. EMS provides airports with efficient and effective methods for achieving environmental standards and objectives while also establishing credibility and strengthening public perceptions.

3.4 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) OF AIRPORT DEVELOPMENT PROJECTS

3.4.1 An environmental impact assessment is part of the planning and approval process that identifies the environmental effects of a proposed project. This approach allows for the environmental impacts of the proposed projects to be identified in order to allow for, where necessary, the modification of plans and incorporation of measures to minimize or eliminate any potential adverse effects on the environment.

3.4.2 Preparatory work should start with determining what environmental regulations apply in terms of both the environmental impact assessment itself, and also those related to the impacts that are to be assessed. It would also be prudent to identify relevant stakeholders at an early stage and continually engage with them throughout the process, regardless of the size of the project.

3.4.3 The environmental impact assessment report should contain the details that are needed to make informed decisions with respect to the environment. Gathering information on the current situation and the development of project(s) should begin as early as possible.

This can be achieved by:

a) identifying all project components for the purpose of refining the scope of the project and the scope of the environmental assessment;

b) evaluating alternatives to the project that may achieve the airport development objective with fewer adverse environmental impacts;

c) defining the “do nothing” scenario to provide the “base case” against which the impacts of the project(s) can be assessed; and

d) identify core context assumptions of the project:

1) the proposed date the development will come into service;

2) the expected life-time of the development;

3) agreed “milestone” dates that need to be assessed as part of the EIA;

4) key impact influencers for these milestone years, such as traffic forecasts, etc.;

5) the legislation, regulations and agreements that apply.

3.4.4 A vital part of any assessment is the effective documentation, communication and reporting of the assessment process and the results, and this should be constantly reviewed during all phases of the EIA process.

3.4.5 The environmental assessment process should include:

a) a detailed project description;

b) details of alternatives that are being considered or not and the rationale;

c) an environmental description, including:

1) a list of the environmental regulations and agreements that are applicable;

2) a project environment interaction analysis and all associated impact; and

3) mitigation measures.

A final report should be prepared which details all the phases and results of the environmental assessment. The environmental impact assessment report must be clear, concise and suitable for public scrutiny, if required.

3.4.6 The next stage should be to carry out a detailed and organized environmental screening of the project based on specific terms of reference and any approved modifications/additions. A report should be drafted presenting the process and results in a screening report suitable for public scrutiny and decision-making.

3.4.7 For the environmental assessment process, it is necessary to develop a description of both the physical and social environments, within which the project will be situated. This should include:

a) context, study area, and site plan;

b) definition of the types of environmental and social impacts that are expected and their relative magnitude, including any cumulative effects that need to be considered in the assessment;

c) physical environment:

1) physiography and local topography;

2) soil;

3) landscaping;

4) surface water/drainage basins;

5) groundwater/aquifer;

6) air quality and emissions;

7) atmosphere/weather/climate;

8) vegetation/crops;

9) terrestrial species/habitat;

10) aquatic species/habitat;

11) avifauna migration routes; and

12) ecological systems.

d) social environment:

1) land use;

2) light emissions;

3) impact on the community;

4) recreational uses;

5) aesthetics;

6) employment;

7) economic;

8) municipal services;

9) noise;

10) archaeological, cultural, heritage and historical factors; and

11) planning framework.

3.4.8 Project-environment interaction analyses require identification of the environmental components listed which may be affected by both the project construction and/or operational activities. A matrix should be used to identify the interaction between activities and general categories of environmental components involved.

3.4.9 The identification of possible impact points is followed by an impact analysis. This will require a general description of each potential impact, the determination of valued ecosystem components, and the prediction and evaluation of impacts.

3.4.10 Specifically, the potential impacts of the proposed activities on the environmental components should be described. Any particular concerns of the public or extraordinary circumstances regarding environmental or social impacts should be noted. Through further detailed analysis and consideration of mitigation measures, impact predictions regarding specific project-environment interactions should be developed.

3.4.11 Ultimately, the environmental assessment should provide clear and realistic projections regarding the type and extent of the impact. The assessment should conclude by summarizing decisions regarding the environmental impacts of the project, the specific mitigating measures and monitoring requirements. A recommended environmental assessment decision should be provided, reflecting the options selected among those presented.

3.4.12 The environmental assessment report should be organized in such a manner that information (procedures, findings, etc.) for each of the key stages of the assessment is presented. A table of contents with major headings similar to the following would be appropriate:

— Name of the proposal

— Description of project activities

— Description of the environment

— Environmental impacts (including any cumulative environmental impacts)

— Proposed mitigation measures

— Determination of significance

— Expert government agencies consulted (expert help, if required)

— Public consultation (including methods and results, if required)

— Approximate date of implementation

— Decision and rationale

— Consultant/expert contact (name, title, and address)

3.4.13 An ongoing environmental management programme should detail individual monitoring processes required to evaluate the effectiveness of the mitigation measures, as well as determine the accuracy of the environmental assessment. This programme is not always required for every project. The decision-maker should identify and implement a follow-up programme if one of the following situations occurs:

a) the project involves new or unproven technology;

b) the project involves new or unproven mitigation measures;

c) the assessment was based on a new assessment technique or model, or there is some uncertainty about the assessment's conclusion.

3.4.14 Communication with stakeholders is an essential aspect to finalizing the assessment process, and the final report and supporting documentation may be used to inform them of the outcome and to highlight the process and gain their support for the process. Active engagement with stakeholders and public groups about the process reduces the chance of questions and concerns at a later date.

3.5 NOISE MANAGEMENT

3.5.1 Noise emissions generated on or in the vicinity of airports are unavoidable due to the nature of aircraft and ground operations. In 2001, the ICAO Assembly endorsed the concept of a "balanced approach" to aircraft noise management (Appendix C of Assembly Resolution A35-5) and subsequent ICAO Assembly Resolutions[3]. This consists

3. http://www.icao.int/about-icao/Pages/Assembly.aspx.

of identifying the noise problem at an airport and then analysing 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.

3.5.2 To reduce noise at source (quieter aircraft), States, manufacturers and research institutions have undertaken research which has led to considerable aircraft engine and airframe performance improvements and reduction of aircraft engine source noise. As a result, modern aircraft are significantly quieter than earlier generations of aircraft. With this in mind, before an aircraft is permitted to operate, it must receive noise certification to required standards granted by the State of Registry. Aircraft noise certification provisions are detailed in Annex 16 — *Environmental Protection*, Volume I — *Aircraft Noise* and the *Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft* (Doc 9501, Volume I), which provides practical guidance to certificating authorities on the implementation of the technical procedures of Annex 16.

3.5.3 Land-use planning and management is an effective means to ensure that the activities nearby airports are compatible with aviation. Its main goal is to minimize the population affected by aircraft noise by introducing land-use zoning around airports. Compatible land-use planning and management is also a vital instrument in ensuring that the gains achieved by reduced noise of the latest generation of quiet aircraft are not offset by encroachment and further residential development closer to the airports. In addition, 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). This is discussed in more detail in Chapters 5 to 7 of this manual.

3.5.4 Noise abatement procedures, to further reduce the population adversely affected by aircraft noise, have been employed to reduce noise levels around airports. Noise abatement procedures enable reduction of perceived noise during aircraft operations and can be achieved at comparatively low cost. There are several methods, including preferential runways and routes, as well as noise abatement procedures for take-off, approach and landing. The appropriateness of any of these measures depends on the physical layout of the airport and its surroundings, but in all cases, the procedure must give priority to safety considerations. ICAO's noise abatement procedures are contained in the *Procedures for Air Navigation Services — Aircraft Operations* (PANS-OPS, Doc 8168), Volume I — *Light Procedures,* Part V. In addition to noise abatement procedures, operating restrictions are discussed in 3.2.9.

3.5.5 Acoustical barriers can only provide a benefit in a fairly limited number of situations. A wall or berm between residences and an airport will only be effective against ground-based noise sources such as aircraft taxiing and apron vehicles, and will generally not shield residences from the noise during aircraft take-off, landing and flyover. Furthermore, a wall needs to be placed very close to the residences (within about 20 m) and needs to be built sufficiently high to block the line-of-sight between the noise source and receiver.

3.5.6 If the airport has a large buffer area between it and areas affected by ground-based noise, a forested area can provide better noise mitigation than bare land. The forest buffer would need to be at least 100 m deep and care would need to be taken not to create a wildlife hazard for aviation.

3.5.7 The use of a noise barrier or enclosure to reduce the noise from aircraft engine run-ups is discussed in 4.6.2 of this manual.

3.5.8 Sound insulation can be used to improve the aircraft noise intrusion levels within buildings affected by aircraft noise. Whether retrofitted to existing buildings or required a part of a building code for new constructions, sound insulation clearly can only improve the internal noise levels of a residence, hospital or school. Furthermore, as the benefits of sound insulation are negated if a building occupant opens external windows or doors, in many climates, sound insulation will need to be accompanied by the provision of alternative ventilation for habitable spaces. Further discussion on sound insulation can be found in the land-use planning sections of this manual in Chapter 7.

3.5.9 Operational restrictions on aircraft have been responsible for the introduction of night curfews and restriction of operations of certain aircraft types due to noise considerations. States, guided by the ICAO Assembly Resolutions, have also phased out or banned operations of noisier aircraft types (for example, the phase-out of Chapter 2 aircraft), mentioned as well in *Guidance on the Balanced Approach to Aircraft Noise Management* (Doc 9829).

3.6 AIR QUALITY MANAGEMENT

3.6.1 Some degree of air pollution associated with an airport may be unavoidable, and this can be managed with proper pre-development planning, environmental impact assessment and mitigation measures.

3.6.2 Detailed guidance on the management of air quality at airports is provided in the *Airport Air Quality Guidance Manual* (Doc 9889), which should be consulted if more specialized information is required. A brief overview is provided in this section and more detail on infrastructure for air quality management is provided in Chapter 4.

3.6.3 Airport-related emissions sources that affect airport air quality (AAQ) can be divided into four groups — aircraft, aircraft handling and support vehicles, infrastructure and stationary sources, and landside access traffic. An overview of each of these is provided below covering regulation, technology and infrastructure, and operational measures.

Aircraft

3.6.4 The aircraft's main engines and to a lesser degree the auxiliary power unit (APU) are the primary sources of gaseous emissions from aircraft, though particulate emission sources include brakes and tyres, as well as the engines and APU.

3.6.5 Most aircraft emissions that affect AAQ are subject to the Standards contained in Annex 16, Volume II, which provides SARPs on instruments and methods used for measuring aircraft engine emissions from a range of engine types. Over the past decades, engine technology has continued to improve and ICAO's Standards are continuing to evolve, in particular, NOx Standards have become increasingly more stringent. ICAO continues to develop new Standards for other emissions.

3.6.6 Operational procedures that reduce aircraft emissions are addressed in detail in the manual on *Operational Opportunities to Reduce Fuel Burn and Emissions* (Doc 10013). These procedures are generally under control of the aircraft operator and air navigation service providers (ANSP), but are subject to the aircraft performance and airport runway characteristics and the prevailing meteorological conditions.

3.6.7 Airport facilities and operations can facilitate efficient aircraft operations, such as:

a) providing an efficient runway and taxiway layout;

b) providing fixed electrical ground power (FEGP) and preconditioned air (PCA) installed at terminal gates, while remote stands can enable a parked aircraft's auxiliary power unit (APU) to be switched off; and

c) using towing operations to delay the start-up of the aircraft engines, provided this does not create delays which could contribute to congestion.

3.6.8 Air pollution originating from aircraft engine testing and maintenance facilities may be controlled through the use of test cells equipped with afterburners and catalytic converters.

Aircraft handling and support vehicles

3.6.9 Aircraft handling can include towing vehicles while GSE covers all vehicles providing services to aircraft, such as fuelling, baggage, catering and stairs. A number of steps can be taken to decrease emissions from aircraft handling and GSE, and increase the fuel efficiency of these vehicles. These include:

a) maintaining the vehicles and conducting regular emissions tests;

b) avoiding unnecessary idling by shutting off engines when operation is stopped for periods of more than one minute;

c) reducing driving distances by planning routes;

d) accelerating smoothly;

e) driving at optimum speeds;

f) using alternative low-sulphur diesel fuels;

g) converting vehicles to natural gas, propane, hybrid-electric or electric power;

h) using oxidation catalysts and particulate traps which can reduce hydrocarbon and particulate mass emissions up to 95 per cent; and

i) encouraging purchase of fuel-efficient vehicles, the use of alternative energy sources, such as ethanol and propane, or electric vehicles, and providing the infrastructure to refuel or recharge them.

3.6.10 Environmental impacts should be considered when selecting vehicles. A common mitigation measure is conversion of airport vehicles with internal combustion engines to vehicles utilizing alternative fuels. Alternatives include hybrid-electric (vehicles that partially utilize electric motors) and electric vehicles. The environmental benefits of these options depend on the ultimate source of electricity.

Infrastructure and stationary sources

3.6.11 These sources include incinerators, heating and air-conditioning plants, firefighting training, and certain construction or maintenance works (e.g. smoke from asphalt paving plant or refuse burning).

3.6.12 The main ways to reduce AAQ emissions from these sources include the modernizing of equipment and optimizing the energy efficiency of operations and building use. The latter is addressed in more detail in 3.7 below.

Landside access traffic

3.6.13 The transport of people (and cargo) to and from (and within) an airport area presents another source of emissions that impact AAQ. In certain situations, rail transport, “people movers” and careful design of an airport layout can all contribute significantly to the minimization of the environmental impacts and operating costs arising from such transport needs.

3.6.14 The provision of an excellent public transport system may be outside the scope of the airport authority, but there is the possibility of encouraging airport employees to use public transport. Provision can be made for intermodal interchange facilities in the layout, planning and design of new airports and in the extensions of existing infrastructure,

particularly terminals. Passengers may be provided linkage to light, conventional or high-speed rail systems as well as regional and local bus facilities, the latter being particularly appropriate for employee access. The provision of such facilities should go hand-in-hand with the development of an airport public transport strategy appropriate to local conditions and consistent with a policy of cooperation with transport providers. Airports should coordinate with municipalities to ensure convenient intermodal transport is considered in municipal plans.

Ambient air quality regulation

3.6.15 In most jurisdictions, regional or national authorities provide regulations on ambient air quality for the protection of human health and the environment which are usually based upon the guidelines of the World Health Organization. Ambient air quality regulations provide indications of levels of pollutant concentrations considered acceptable in occupied locations and usually include NO_2, CO, O_3, SO_2, some organic compounds (e.g. benzene (C_6H_6), and PM.

3.6.16 Note that, in contrast to the ambient air quality regulations, emissions certification applies to individual sources such as road vehicles or aircraft, etc. Furthermore, emissions and ambient air quality regulations do not always target exactly the same pollutants — for instance, ICAO engine certification provides limits to NOx emissions (including NO and NO_2 — though reported as if it were all NO_2), whereas most State ambient air quality standards specify maximum concentrations of NO_2. Similarly, the ICAO smoke number (SN)[4] Standard is not consistent with PM_{10} and $PM_{2.5}$ concentrations regulated for ambient air.

3.6.17 To achieve compliance with ambient air quality regulations, an airport operator will normally have an “air quality management” plan in place. Air quality management involves measuring ground level pollutant levels and assessing compliance with the relevant regulation. If limits are exceeded, it is then necessary to identify and, where possible, quantify the emissions sources that are impacting air quality in the area where the exceedance is occurring. This involves developing an inventory of sources and then carrying out a modelling exercise of the likely dispersion to estimate the expected pollutant concentrations. In most cases, this modelling will be a complex and involved process, as the contributions from local roads and industry will also need to be considered as well as the variable nature of some emission sources. As a result, air quality modelling is normally carried out by specialists.

3.6.18 The results of the modelling should indicate those emissions sources that have the greatest impact on the air quality in the area of concern, allowing the airport operator to prioritize and target these areas for mitigation action.

3.7 GREENHOUSE GAS EMISSIONS MANAGEMENT

Drivers

3.7.1 In some States, airports are subject to GHG emissions regulation. In those States, applicable airports must inventory and report emissions, and a few are subject to GHG emissions caps. In the European Union, for example, some airports with large ground based emissions sources such as power stations, are subject to the local Emissions Trading Scheme.

3.7.2 Many airports address GHG emissions on an unregulated or voluntary basis. Drivers for such action might include company policy on environmental stewardship, corporate social responsibility or proactive steps to curtail government regulation.

4. This Standard is currently under review by ICAO.

Inventory

3.7.3 An airport GHG inventory is a report of the sources and amounts of GHG emissions at an airport. An airport GHG inventory should be divided according to the ownership and control of emissions sources. The World Resources Institute GHG Protocol provides three categories for emissions management:

— Scope 1 emissions are from sources that are owned or controlled by the airport operator, such as airport power or heating plants, airport fleet vehicles, construction, and firefighting training.

— Scope 2 emissions are those from the off-site generation of electrical power (and heating or cooling) purchased by the airport operator.

— Scope 3 emissions are those from airport-related activities from sources not owned or controlled by the airport operator, including aircraft, most ground support equipment and most ground access vehicles.

3.7.4 Under most jurisdictions, an airport operator may only be responsible for Scopes 1 and 2 emissions. If unregulated, an airport operator may choose which Scope 3 emissions to include. Some, for example, might exclude aircraft emissions or only include those during the take-off and landing cycle (usually below 3 000 ft).

Mitigation

3.7.5 The GHG emissions at airports are dominated by the CO_2 emitted from burning fossil fuels, thus airports should be developed and operated to minimize these emissions. Most of the mitigation measures to address local air quality in 3.3 above and those to improve energy management in 3.7 below, will also benefit the total GHG emissions associated with an airport.

3.8 WATER MANAGEMENT

3.8.1 Airports are usually subject to State or local environmental regulations or operational permits, which may include both water quantity and quality discharge limits. Waste water, including sewage, may be treated on site before being discharged or directed to non-potable uses, such as landscape irrigation. Alternatively, untreated waste water may be delivered to the local municipal treatment system.

Storm water

3.8.2 Airport storm water run-off will generally need to be collected and treated before being discharged so as not to pollute groundwater or nearby bodies of water. The primary products which can be found in untreated storm water include suspended solids, fuel, oil and greases, heavy metals and de-icing chemicals. Settling ponds can be used to control discharge flow rates and for the removal of solids. Further treatment may be required depending on the types and levels of contaminants. The nature of airport operations will influence the type and extent of waste water treatment required.

3.8.3 When planning water management facilities, the following issues need to be considered:

a) oils and fuel should be contained and segregated at their source;

b) the use of desalinated water can cause piping system corrosion so the aggression index for the water should be monitored;

c) where and how to discharge into natural water systems;

d) water quality monitoring of airport surface run-off, as water could be stored for long periods in underground or elevated reservoirs not frequently cleaned or liable to contamination; and

e) water conservation practices to reduce the use of potable water and harvest rain water.

3.8.4 In order to determine the type of practices to be incorporated in a water management programme, the airport developer and operator should conduct a review of the site conditions. This review should include the following:

a) topography;

b) presence of bodies of water;

c) storm water discharge points, including infrastructure and natural bodies of water;

d) drains, culverts and catch basins;

e) paved areas and buildings;

f) aircraft and vehicle service areas; and

g) operational areas and activities, e.g. fuelling, de-icing and maintenance areas.

Petroleum and chemical management

3.8.5 Large quantities of petroleum and chemical products, which are potential sources of water pollution are stored and handled at airports. The following paragraphs outline management practices that may be employed in maintenance areas, aprons, fuel farms, and de-icing areas.

3.8.6 Aircraft maintenance areas, as well as automotive and equipment service areas, should be provided with oil-water separators which are, in turn, connected to sanitary sewers leading to the municipal waste treatment plant serving the airport.

3.8.7 It is important to manage water originating from aprons as it is likely to contain many contaminants including hydrocarbons from spills. Grease and suspended solids from various sources such as aircraft, service vehicles and minor aircraft maintenance may also be present. The airport pollution control programme should therefore focus on:

a) strict enforcement of storage regulations to control pollution at its source and to minimize hazards that could result in spills;

b) removal of spilled oil and fuel through immediate containment and spill recovery;

c) maintenance activities in hangars, where possible, that are protected by oil-water separators and to reduce aircraft maintenance on the aprons;

d) washing of equipment in dedicated areas; and

e) immediate cleaning of all spills of fuel, oil, or other dangerous goods by using environmentally sound absorbents, which are subsequently removed from the airport by handlers who are licensed and trained disposers.

3.8.8 Airport personnel must regularly check all relevant access pits and sumps, monitor the removal of any fuel or oil found therein, and always respond to spill reports, analysing them for common causes in order to prevent future spills. Trucks used for fuelling operations should be inspected every six months and hydrant pits used for transferring fuel from the underground piping systems should be checked on a routine basis for any accumulation of fuel.

3.8.9 Another water pollution problem can be the presence of underground oil-saturated soils at fuel farms. Several potential sources of oil contributing to the oil-saturated soil beneath a fuel farm:

a) leakage from storage tanks;

b) leakage from distribution lines;

c) leakage from mechanical equipment which penetrates cracks and joints in the slabs beneath the equipment; and

d) leakage through the joints in the storm water drainage pipe used to transport condensate from the fuel storage tanks to the oil-water separator system.

3.8.10 A number of steps can be taken to solve the problem of underground oil-saturated soils. It may be necessary to consult a specialist in this area.

De-icing management

3.8.11 Aircraft de-icing fluids, if released into receiving waters, can be a potential pollution problem as well as a potential hazard to aquatic life due to its toxicity and biochemical oxygen demand (BOD). This is primarily due to the ethylene or propylene glycol chemicals which are widely used in current de-icing fluids, although less toxic, non-glycol based alternatives are under development. Excess de/anti-icing fluid running off an aircraft, if allowed to mix with other surface run-off, poses the risk of contaminating the groundwater. Furthermore, the fluids can also have an adverse effect on the pavement surface friction characteristics. Therefore, it is imperative that only an optimum quantity of the fluids be used. All excess fluids must be properly collected to prevent groundwater contamination. To prevent contamination of water courses, all surface run-off from de-icing areas and sometimes taxiways and runways must be adequately treated before being discharged into storm water drains. For further information on aircraft de-icing, including environmental considerations, please refer to the *Aerodrome Design Manual* (Doc 9157), Part 2 — *Taxiways, Aprons and Holding Bays*, Chapter 3.

3.8.12 To minimize the effects of the spent fluids, the following precautions should be exercised:

a) reduce chemical usage by:

1) centralizing spray operations;

2) using designated de-icing pads; and

3) recapturing, filtering, and/or recycling glycol in leak-free tanks;

b) proper drainage on the apron and sweepers to clean up residual fluids;

c) create spill response plans and ensure that all users are properly trained on chemicals and procedures; and

d) maintain the facility in good order, including:

1) pavement conditions;

2) storage area; and

3) run-off control.

3.8.13 Winter operations management plans should be filed at the beginning of the season and should include the following areas:

a) site responsibilities;

b) site specifications;

c) glycol storage and handling;

d) glycol application;

e) containment;

f) collection and storage of effluent;

g) means of disposal; and

h) reporting plan.

Further information on de-icing is available in the *Manual of Aircraft Ground De-icing/Anti-icing Operations* (Doc 9640).

3.9 WASTE MANAGEMENT

3.9.1 Waste management is concerned with the reduction of both hazardous and non-hazardous wastes. Some countries have legal provisions for how to deal with different waste streams. Waste management at airports is often a service performed by a contractor, and in accordance with the local regulations.

3.9.2 In general, the 4Rs — reduce, reuse, recycle and recover — are good practices for any workplace. Airport waste can be divided into nine general categories of waste, including (1) municipal solid waste (MSW); (2) construction and demolition waste (C&D); (3) green waste (e.g. from landscape management); (4) food waste (domestic); (5) waste from aircraft flights (i.e. deplaned waste); (6) lavatory waste; (7) spill clean-up and remediation waste; (8) hazardous material; and (9) International Catering Waste (ICW). A waste management programme should include three practices: planning, procedures and special provisions.

3.9.3 ***Planning.*** Airports should establish a dedicated plan and programme for the management of waste. This plan should consist of the following:

a) a description of design intent, as well as anticipated wastes, their volumes, and disposal or treatment methods;

b) construction details for new infrastructure such as incinerators or landfills, including an overall landfill development plan, and a site closure plan;

c) a clear description of the chain of authority, organizational structure, job descriptions and job responsibilities for all personnel;

d) an itemized list of mandatory regulatory reporting requirements;

e) an itemized list of internal, written reporting requirements and record-keeping;

f) a waste minimization, reuse and recycling plan (i.e. reduce or eliminate operations/processes that generate solid waste, redesign processes to minimize waste, substitute products for waste reduction), as well as a plan to either maximize municipal recycling capacity for airport and deplaned waste, or develop that capacity at the airport;

g) a description of health and environmental monitoring programmes and related reporting requirements;

h) a description of routine landfill, composting, or incineration operational procedures;

i) a description of health and environmental monitoring programmes and related reporting requirements;

j) a hazardous materials and emergency procedure plan; and

h) training of all employees in waste management concepts, including day-to-day procedures, equipment operating instructions, safe practices and emergency procedures.

3.9.4 ***Procedures.*** It is important that the waste management plan incorporate the following procedural elements:

a) describe procedures for the reduction, reuse and recycling of airport and deplaned waste;

b) choose sustainable products and services;

c) compost organic wastes;

d) provide training for proper material handling to reduce waste and spills, and equip waste transport vehicles with anti-spill equipment;

e) centralize responsibility for waste management and establish written procedures for loading/unloading and transfer operations;

f) track waste to allow for better management (this applies to all utilities); create a spreadsheet or tracking system that does the following, especially for wastes that leave airport property:

1) identifies waste streams;

2) evaluates the process generating the waste;

3) prioritizes waste streams;

4) prepares inventory reports; and

5) maintains records on waste production and disposal costs;

g) isolate hazardous wastes by containment and prevent mixing of hazardous and non-hazardous wastes;

h) isolate liquid waste from solid waste;

i) separate biomedical wastes with infection potential for special treatment and disposal; and

j) segregate incompatible materials/wastes to avoid dangerous reactions in the event of a spill.

3.9.5 ***Special provisions.*** It should be noted that in the management of hazardous wastes, special provisions may be required. These provisions can include the following:

a) perimeter security fence;

b) security alarms on the gate and security fence;

c) designated vehicle wash-off area;

d) a dedicated building or storage sheds for materials storage;

e) safety control devices such as fire and gas alarms;

f) installation of ventilation systems, non-spark electrical controls and fire extinguishers;

g) specialized training of personnel; and

h) implementation of a wildlife hazard management programme including location of airport waste storage and facilities.

3.9.6 An effective waste management programme can be enhanced by employee awareness of the three waste management practices. An awareness programme can include training, participation in special events, information sessions and informative newsletters. Employees should stay current on changes and new information to ensure adherence to policies and procedures. The concept of segregation of recyclable solid waste components should be communicated to all parties. It is possible to recycle and remanufacture both solid and hazardous wastes into other products. Segregation and recycling policies should be mandatory.

3.10 ENERGY MANAGEMENT

3.10.1 The majority of energy used at an airport is associated with the provision of heating, ventilation, air conditioning and lighting. The essential services such as airfield lighting and instrumentation actually use a relatively small amount of energy. It has been estimated that energy costs account for about five per cent of the operating costs of a modern airport . These costs can be reduced through energy efficient design of new airport facilities.

3.10.2 To assess energy and environmental performance in existing facilities, suitable indicators are required. The actual choice of the indicators will depend on the size of the airport, but suitable indicators may include:

a) energy consumption per:

— 1 000 passengers;

— air transport movement;

— tonne of cargo movement;

— traffic unit (TU)[5];

b) pollutants released:

— directly per 1 000 passengers/TU; and

— indirectly per 1 000 passengers/TU.

3.10.3 Actual energy consumption, or the best available estimate, separated by energy source should be recorded. This data should be reported annually so that performance improvements can be demonstrated and compared to other indicators, such as traffic, finance and employment. Indicators based on measures of consumption and pollutants are essential for reports on environmental effects. In addition, indicators based on cost are essential from a financial management viewpoint.

3.10.4 An airport energy audit or assessment may be conducted by qualified airport personnel, outside consultants, or through coordination with an energy provider. Audits typically analyse energy use and building characteristics for multiple airport facilities, and result in a list of measures that can increase energy efficiency. Often, the cost of the audit and implementing measures can be offset by the cost savings from reduced energy usage, or through coordination with energy providers. Energy audits can also identify opportunities to increase an airport's use of renewable energy sources, or pursue more substantial programmes to increase energy efficiency and energy security (e.g. micro grids and smart grids). To be effective, energy audits should be carried out at regular intervals as per international standards[6].

3.10.5 In order to heighten awareness of energy efficiency within the airport and interested communities, some airports adopt an energy policy guidance statement. Turning these statements into effective action requires a clear definition of responsibility for energy efficiency. Ideally, each operational manager will have this responsibility, with expert knowledge being provided by engineering and energy specialists. Examples of policy statements are as follows:

a) "This airport aims to use energy as effectively as possible in the pursuit of its corporate objectives."

b) "This airport will always consider the environmental impact of its direct and indirect energy consumption."

c) "This airport is committed to the efficient use of energy in all its activities."

3.10.6 An effective energy strategy will include a statement of objectives to make all personnel aware of what the organization is committed to achieve. It should integrate environmental performance as well as financial considerations. An energy strategy should consider the following:

a) ***Choice of energy source***: in the context of an effective energy management plan, the choice of energy source will result from a range of different factors (e.g. resilience, energy security, costs, mandates, available resources, environmental impact, and legislation). It is up to each organization to consider these factors when deciding which energy mix best meets its needs. When making decisions, it is important to consider both the direct and indirect environmental effects. For example, using

5. A traffic unit (TU) is either an enplaned passenger, a deplaned passenger, or 100 kg of enplaned or deplaned cargo.
6. Such as ISO 50001.

electricity may have a negligible environmental effect locally, but its effect may be significant elsewhere if the power is generated by the combustion of fossil fuels.

b) ***Effective utilization and management of energy***: A key aim must be to conserve energy and still meet the operational objectives of the airport. The focus of an energy strategy should be to improve energy efficiency. To do this, it is necessary to understand where, how and why energy is used. This is one of the objectives of the energy audit.

3.10.7 All control points related to heating and air conditioning systems should be checked, including the heating and cooling temperatures, control of humidity, and boiler adjustments. While such actions are simple, the combined effect of incorrect settings could mean the use of ten per cent more energy than is necessary. Other simple procedures include checking the insulation of pipework, duct work and buildings themselves (building envelope, ventilation, etc.). All these measures can optimize the performance of the system. Where a comprehensive building management system is installed, many checks and adjustments can be carried out from a central control room. Once the existing plant is operating efficiently and as much waste is eliminated as possible, further capital investment may be considered, including investments in additional sophisticated control systems, variable speed drives for fans and pumps, heat recovery systems, and new boiler plants.

3.10.8 The lighting of buildings accounts for a major part of the energy consumption at an airport. Sometimes it is possible to reduce the requirement for artificial lighting by the introduction of more natural lighting — providing this does not add significantly to heat or cooling loads. Smart meters on individual buildings can have similar effects on a smaller scale.

3.10.9 Where artificial lighting is installed, it should be appropriately controlled and should use the most efficient, suitable light source. Paying close attention to the location of lighting and operating on the basis of time, ambient light levels, occupancy, etc., can lead to very worthwhile savings and can be self-financing. Since most light fittings produce heat, recovering this heat ensures that it does not add to the air conditioning loads of the building.

3.11 ENVIRONMENTAL EMERGENCIES[7]

3.11.1 Emergencies include fuel and chemical spills, and incidents involving dangerous goods or hazardous materials that may affect the environment. In order to respond effectively to environmental emergencies, the airport emergency plan and environmental emergency plan should include specific procedures to deal with such emergencies. These plans and procedures should be coordinated, and must clearly identify a predetermined sequence of communication and actions to deal with the various types of environmental emergencies. The plans and procedures must incorporate the elements of command, communication and coordination.

3.11.2 Environmental emergency planning should include the following:

a) General:

— Table of contents;

— Record of agreements;

— Purpose of the plan;

7. Also see the *Airport Services Manual* (Doc 9137), Part 7 — *Airport Emergency Planning*.

— Geographic location of airport;

— Environmentally sensitive areas;

— Emergency telephone list; and

— Grid and reference maps.

b) Actions:

— Persons of authority — site roles;

— Major types of airport environmental emergencies;

— Site management/spill clean-up and restoration and remediation;

— Site hazardous materials inventory;

— Emergency equipment on site;

— Spill clean-up contractors, agencies and specialists;

— Monitoring, reporting and follow-up procedures;

— Media relation guidelines; and

— Training protocol.

3.11.3 Environmental emergency planning should incorporate the following steps for emergency response:

a) ***Secure***: Establish a hazard zone that will keep non-emergency response personnel out of danger.

b) ***Approach***: Approach from upwind to avoid coming in contact with vapours.

c) ***Identify***: Utilize placards and labels on containers to provide information on the product involved. The United Nations Product Identification Number (PIN) will provide information for personnel protection and spill response information. The exact identity of the products involved can also be found by examining the shipping documents.

d) ***Assess***: The following points should be considered:

— Is there a fire?

— Is there a spill or a leak?

— What are the weather conditions?

— What is the terrain like?

— What is at risk: people, property or the environment?

e) ***Respond****:*

— Respond in an appropriate manner.

— Establish lines of communication.

— Establish line of command.

— Ensure coordination.

3.11.4 It is important that the airport emergency plan be tested on a regular basis and that corrective measures be taken immediately after an exercise or real incident where deficiencies in procedures are identified.

Chapter 4

INFRASTRUCTURE FOR ENVIRONMENTAL MANAGEMENT

4.1 GENERAL

Introductory comments

4.1.1 This chapter provides high-level guidance material on the infrastructure that can be included in an airport design which can enable and facilitate environmental management by the airport operator. The focus of this chapter is on facilities and infrastructure usually included in an Airport Master Plan.

4.1.2 While some consider airspace and its design to be airside "infrastructure", those subjects lie outside the scope of this manual. Additionally, operational concepts are discussed in detail within the *Operational Opportunities to Reduce Fuel Burn and Emissions* (Doc 10013).

4.1.3 It should be noted that aviation safety is of paramount importance when considering airport infrastructure changes. For further information on ICAO aviation safety requirements, please refer to Annex 14 — *Aerodromes*. Risk management approach can be used to assess infrastructure and environmental management options. For further information on ICAO's guidance on using a risk management approach, see the *Safety Management Manual (SMM)* (Doc 9859).

4.1.4 At the national and regional levels, airport system planning can aid environmental management by accommodating future demand and distributing operations in a manner that reduces adverse environmental effects at individual airports. this also ensures that expected demand and capacity are addressed and overcapacity is avoided, which could result in unnecessary environmental impacts. The potential for impact reduction is particularly high at airports that are capacity-constrained or attempting to reduce a local environmental impact. The primary purpose of airport system planning is to study the performance and interaction of an entire aviation system to understand the interrelationship of the member airports. The "system" can be the airports of a metropolitan area, a State, or several bordering States. System planning involves examining the interaction of the airports with the aviation user requirements, economy, population, and surface transportation within a specific geographic area.

Overarching considerations

4.1.5 Some issues need consideration regardless of the infrastructure being developed. Airport planners and infrastructure designers should consider the ecosystem services of the existing environment when considering projects. Ecosystem services are the provision of services by the ecosystem itself, such as treatment of storm- water through wetlands. These services can be economically valued and incorporated into infrastructure planning.

4.1.6 Another overarching consideration is the life cycle cost and management of infrastructure being planned and designed. This will assist with better decision-making with regard to costs and best practices for long-term asset management.

Chapter structure

4.1.7 This chapter is organized into five subsections: Airport-wide, Airside, Passenger Terminal Facilities, Airline/Airport Support Buildings, Landside, and Environmental Aspects. The first four subsections present guidance on the infrastructure that can be included in an airport design, which can enable and facilitate environmental management organized by airport component (e.g. runway layout, terminal building, and landside facilities). Within each component, infrastructure options are discussed and the environmental benefits of the options are highlighted. The fifth subsection (Environmental Aspects) is environmental aspect-focused and re-emphasizes the prior information in terms of the environmental aspect that the infrastructure option benefits the most.

Airport siting

4.1.8 Appropriate siting of new airports is of vital importance to ensure that future environmental impacts can be avoided or mitigated. When considering a new airport site, many environmental and land-use planning-related considerations should be taken into account, including (but not limited to):

— meteorological conditions (e.g. prevailing wind direction);

— required space for airfield operations;

— required space for off-airfield impacts;

— geological conditions;

— potential natural or artificial obstacles;

— airfield layout;

— runway / taxiway layout;

— apron layout;

— ground transport access to the airport;

— location and design of terminals;

— locations of hangars and related installations;

— access to and reliability of utilities and services — e.g. waste water treatment;

— value of existing ecosystem services at proposed site; and

— existing and planned land uses in the vicinity of the site.

4.1.9 For new and existing airports, many of the above considerations, including managing the expected future requirements of an airport, can also be performed through the master planning process, as per the *Airport Planning Manual* (Doc 9184), Part 1 — *Master Planning*.

4.2 AIRPORT-WIDE

4.2.1 Landscaping

Plant species selection

4.2.1.1 Grass and other plant species should be selected taking into account the following considerations:

— Plants and landscape should not create a wildlife hazard.

— Type and extent of irrigation should be considered when determining the type of plants to include. Landscaping that requires little or no irrigation (xeriscaping) should be considered. Endemic or native plant species are usually best adapted to local climate and may require the least maintenance and watering. Temporary irrigation may be required to establish plants.

— Some plantings, such as trees that provide shade, can reduce local temperatures or solar heat loading during hot weather; however, care must be taken with regard to tree height to avoid penetrating protected airspace surfaces.

Wildlife hazard management

4.2.1.2 Wildlife at airports can be a hazard to safe aircraft operations. Though the airport operator is usually responsible for managing the hazard, wildlife management coordination with airport neighbours should be considered. An airport operator should develop a management plan to reduce the attraction of animals and prevent them from crossing the aerodrome perimeter. The *Airport Services Manual* (Doc 9137), Part 3 — *Wildlife Control and Reduction* should be taken into account during airport design in order to optimize future operational wildlife management actions. Some documents, such as the Airports Council International's *"Wildlife Hazard Management Handbook* (second edition, 2013) can also provide useful information.

4.2.1.3 Items of particular importance regarding wildlife hazard management and the avoidance of providing water, food and shelter, include the following:

— water bodies, wetlands and drainage systems;

— plant species selection;

— structures or land forms;

— landfills and waste management; and

— activities on and off the site of the airport.

4.2.2 Storm water management infrastructure

Surface water quantity and quality control

4.2.2.1 To ensure a normal surface water discharge flow rate (hydrograph) is maintained, site drainage needs to be considered prior to all developments taking place. In some instances, settling ponds or vegetated swale drains can be installed to slow the rate of surface waters flowing off the site to a rate closer to the "natural" or predevelopment hydrograph.

4.2.2.2 Water quantity management also has the added benefit of collecting natural and artificial litter thereby allowing time for suspended sediments and pollutants to drop out of the water improving water quality. Pollution management systems designed to address the pollutants anticipated from airport operations should be installed in such a way as to be easily accessed and maintained. These systems typically include: oil/water separators, sediment traps, and de-icing facility drainage and recovery systems. Pollution management systems that mimic natural processes can be most effective and easier to maintain.

4.2.2.3 Systems should be designed for future conditions including potential for increased intensity of storms due to climate change.

4.2.2.4 For occupied buildings, waste water or sanitary drainage systems should be kept separate from storm water and surface water systems.

4.2.2.5 Settling ponds should be designed and located so as to not attract birds and wildlife, as discussed in 4.2.1.

Groundwater management

4.2.2.6 Attention should be paid to subsurface, groundwater (aquifer) management. Management of groundwater should aim to ensure that normal subsurface flows are maintained and the risk of contamination to the subsurface water bodies is reduced. For more information, please see the *Airport Services Manual* (Doc 9137), Part 2 —*Pavement Surface Conditions*.

4.2.2.7 Due to the large volumes of aviation fuel and other potentially hazardous products stored in and around airports, special attention should be given to ensure that the integrity of fuel storage and delivery systems are maintained. The use of oil/water separators and pavement sealer can be used to reduce the risks of contaminated surface waters from effecting groundwater. If the groundwater bodies are contaminated, then remediation works should be conducted to reduce pollutant levels to what is legally accepted.

4.2.2.8 Subsurface flow disruptions could include utility tunnels, trenches, dewatering activities and borrow pits. Activities such as these can interrupt the natural movement of the subsurface waters resulting in the interruption of subsurface water bodies' downslope. The placement of aviation facilities that have the potential to contaminate the aquifer may render downslope water supplies unstable.

4.2.2.9 Instances of groundwater rising to the surface as springs or as vernal or ephemeral ponds can be very important to the endemic biota and should be preserved where possible. This may also provide a water resource for the airport but should be monitored to ensure that it does not develop into a wildlife attractant.

4.2.2.10 In conjunction with construction activities where the ability for surface water to naturally percolate through the ground's surface is removed, natural groundwater recharge can be established. Through careful planning and design of features such as swale drains, groundwater recharge can be re-established with the added benefit of natural surface water hydrographs, also maintained post-construction activities. New landscape features, such as swale drains, should be monitored to ensure they do not develop into a wildlife attractant.

4.2.3 Pavement materials

Consideration should be given to the types of materials used for pavements, including runways, taxiways and aprons. The use of recycled materials in pavements, and recently developed techniques using warm-mix asphalt, can reduce the cost and impact of building pavements. The *Aerodrome Design Manual* (Doc 9157), Part 3 — *Pavements*, provides guidance on airport pavements.

4.3 AIRSIDE

4.3.1 Airfield layout

4.3.1.1 The layout of an airfield has a strong correlation with environmental management of an airport and its environs. Specifically included in the airfield layout context is runway layout, taxiway layout, airport capacity, hold pads/parking positions, and airfield lighting, each addressed below.

Runway layout

4.3.1.2 Runway characteristics such as orientation, length, placement, and threshold location can affect where the off-airport areas of high noise and emissions concentrations will be, as well as on-airport operational efficiency and the associated emissions. For more information, please see the *Aerodrome Design Manual* (Doc 9157), Part 1 — *Runways*. The following issues should be taken into account when designing the runway layout:

- prevailing wind direction;
- minimizing the distance of the runway(s) to the terminal(s) and cargo areas to reduce taxi fuel consumption;
- off-airport geographical features such as water bodies and elevated areas;
- off-airport land use (both existing and planned) such as residential and other noise-sensitive areas;
- allowing space for appropriately sized surface water drainage; and
- sensitive ecosystems such as wetlands, where impacts should be avoided.

Taxiway layout

4.3.1.3 An efficient taxiway layout can reduce aircraft fuel burn and emissions. Simulation modelling can be used to test possible taxiway layouts for efficiency and identify potential bottlenecks that can be mitigated during planning. Additionally, planning for possible future infrastructure needs while designing for current requirements should facilitate future development without the need for reconstruction or less than ideal geometry (e.g. plan for dual parallel taxiway separation if there is an expectation it may be needed in the future). Taxiway features to consider can include:

— dual taxiways that provide additional direct routes, which can help avoid holds or rerouting due to aircraft taxiing in an opposite direction;

— additional taxiways at runway entrances can provide space for intersection departures and optimal queuing and sequencing of aircraft, minimizing ground delay and idling;

— intersections and connections that allow efficient access from terminal and cargo areas to runway threshold;

— high speed exits or rapid exit taxiways (RET) can reduce runway occupancy time and allow landing aircraft to exit at higher speeds over more traditional perpendicular exits. More information on siting RETs can be found in the *Aerodrome Design Manual* (Doc 9157), Part 2 — *Taxiways, Aprons and Holding Bays*;

— placing RET and traditional taxiway exits at locations which minimize runway occupancy time for a large component of the current and planned fleet;

— end-around taxiways that can eliminate runway crossings, reduce taxi times and improve safety during peak periods; and

— Siting taxiways to avoid noise exposure to nearby noise-sensitive areas.

Airport capacity

4.3.1.4 An airport should be designed and built with sufficient capacity to meet demand, otherwise operational inefficiencies and delays can impact fuel burn and emissions. A general planning rule of thumb is that when an airport reaches 60 per cent of its capacity, planning for additional capacity should commence and when it reaches 80 per cent, design work for additional capacity should begin.

4.3.1.5 While runway, apron, and terminal capacity are fundamental, some airports could be limited by other issues such as ground transport access. In addition to the above suggested practice, additional lead time should be considered for surrounding infrastructure to support the airport, e.g. roads, water mains, and clearance of sites.

Hold bays/parking positions and related infrastructure

4.3.1.6 Aircraft holding bays and parking positions can be placed in the most appropriate position to increase efficiency and to reduce the need for long-distance aircraft relocation. See the *Aerodrome Design Manual* (Doc 9157), Part 2 — *Taxiways, Aprons and Holding Bays*.

4.3.1.7 New technologies for aircraft taxiing could have the potential to reduce fuel burn and emissions. Provisions may need to be made to include additional airside infrastructure for deployment of such vehicles.

Airfield lighting

4.3.1.8 Airfield lighting is an area where recent technological improvements can reduce environmental impacts. Use of new lighting technology applications (e.g. light emitting diodes or LEDs) can reduce energy consumption and maintenance costs as these technologies generally provide a longer service life than traditional technologies. See the *Aerodrome Design Manual* (Doc 9157), Part 4 — *Visual Aids* and Part 5 — *Electrical Systems*.

4.3.1.9 Care must be taken to ensure that new lighting technologies produce the same result as traditional technologies. For example, LED taxiway light replacement can reduce energy consumption; however, in cold climates, an additional heating element on a separate circuit may be needed to provide the "snow-melting" benefit of traditional incandescent lighting. Furthermore, lighting needs to produce the appropriate spectrum to accommodate enhanced flight vision systems (EFVS) or night vision imagery technology. Traditional LED lights do not emit infrared light, which is required for EFVS and heads up display systems. Therefore, LED lights could be used in all airfield lighting installations except obstruction lighting, approach lighting, and high-intensity runway lighting.

4.3.1.10 Pilot-activated approach, runway, and taxiway lights at small airfields can reduce electricity use, as well as insect and wildlife attraction.

4.3.1.11 Solar autonomous lights (each light is individually powered) are a secure system which can be an alternative source of lighting at an airfield where electricity is either nonexistent or unreliable. Electricity consumption can be reduced by installing new technologies.

Apron

4.3.1.12 A properly planned apron should allow for efficient aircraft movement throughout the apron area and enable access to all gates and alleyways for the largest aeroplane design group operating on the apron.

Fixed electrical ground power and preconditioned air

4.3.1.13 Sufficient FEGP and PCA installed at terminal gates (and remote stands) can enable a parked aircraft's APU to be switched off. This will reduce fuel burn, lowering emissions as well as noise levels on the ground. The FEGP and PCA need to be appropriate for the aircraft type at a gate or hard stand.

Fuel supply, storage and delivery

4.3.1.14 Fuel is generally regulated by States, and there are processes and standards for fuel storage, handling, and dispensing designed to ensure safety. General principles for minimizing environmental impacts from fuelling systems include maximizing containment of the fuel, as well as minimizing use of vehicle fuel delivery. For more information, see the *Manual on Civil Aviation Jet Fuel Supply* (Doc 9977).

4.3.1.15 There are numerous sources of information on aviation fuels and fuelling systems. The primary consideration for fuel supply, storage, and delivery should be safety. Fuelling system designs that prevent fumes, leaks, and spills are safer *and* prevent environmental contamination. In designing airport fuelling systems, the United States Federal Aviation Administration (FAA) uses the standards contained in the National Fire Prevention Association (NFPA) 407, *Standard for Aircraft Fuel Servicing*[1]. ASTM International provides petroleum standards for aviation fuels, and ASTM Manual 5, *Aviation Fuel Quality Control Procedures*, provides a complete explanation of several common

1. (9) (http://www.nfpa.org/aboutthecodes/AboutTheCodes.asp?DocNum=407).

procedures used by fuel handlers[2]. Fuelling system, pipelines, tanks, hoses, and other equipment should be constructed of the appropriate materials, and tested and maintained regularly.

4.3.1.16 Fixed hydrant refuelling systems can reduce the need for fuel trucks to access the apron, lowering airport vehicle fuel consumption and emissions. While these systems usually require piping, the reduction of GSE movements in the terminal area can provide additional safety benefits.

4.3.1.17 Fuelling is often a contracted service operation at airports. Consultation with fuel service agents on the design of fuelling systems may result in a more efficient airport fuelling system. Some States have very specific training requirements for fuelling agents which can cover fire and explosions, safe handling and storage of fuels and lubricants, handling of hazardous materials, use of personal protective equipment (PPE), prohibition of smoking, and first aid for responding to accidents.

Infrastructure for deplaned sewage and waste water.

4.3.1.18 Deplaned waste water needs to be pumped from the aeroplanes into either a self-powered truck or a cart pulled by a tug and transferred to a triturator facility, generally located airside, for pre-treatment prior to discharge to the sanitary sewage system. The deplaned waste water contains chemicals which present risks to the environment and human health and needs to be handled properly.

Aircraft maintenance facilities

4.3.1.19 Aircraft maintenance is a vital aspect of the smooth running of the aviation system. Airline scheduling and a need to maximize the utilization of fleets can result in the need to carry out aircraft maintenance at night-time. There are a myriad of noise sources produced during aircraft maintenance such as engine testing, aircraft washing and noise from maintenance infrastructure. A well-planned aircraft maintenance facility will site these noisy activities away from noise-sensitive land uses. This will maximize the number of hours a day that the facility can be used.

4.3.1.20 Aircraft run-up pads are usually used to do a post-maintenance engine test prior to operation and are often required in the night period. The main environmental considerations for designing the pad location are minimizing the taxiing required to reach the pad and the proximity to noise-sensitive neighbours. Planners should therefore consider the possible user(s) of the aircraft run-up pad(s) when choosing its location as well as any noise-sensitive receivers nearby.

4.3.1.21 At an airport with particularly high demand for aircraft run-ups at night or with nearby noise-sensitive neighbours, an acoustic enclosure might be built. Such a structure should be designed to shield noise-sensitive areas from engine noise while providing sufficient ventilation to allow the engine test. A U-shaped semi-enclosure might be a cost-effective facility or a fully insulated and ventilated dedicated building or hangar might be required.

Aircraft de-icing facilities

4.3.1.22 The most efficient design for aircraft de-icing facilities will depend on several factors such as the typical duration and severity of winter weather, the airport layout and operational issues such as whether the airlines or a dedicated contractor conducts the de-icing. For more information, see the *Manual of Aircraft Ground De-icing/Anti-icing Operations* (Doc 9640).

2. (10) (http://www.astm.org/).

4.3.1.22.1 The main environment management issues to consider include the following:

— **Operational efficiency** in order that the extra taxiing for aircraft to be de-iced is minimized and that holdover times are sufficient for the distance to departure thresholds.

— **Facilities** in order that spent de-icing fluid can be recovered, stored, processed, or recycled.

— **Storm water management** in order that de-icing fluid does not pollute water out-flows from the airport. At some airports, contaminated storm water might be sent off-site to municipal sewerage treatment plants.

— **Environmental requirements** or **permits** pertaining to storm water run-off.

4.3.1.22.2 The main alternatives for the development of de-icing facilities are as follows:

— No dedicated facility. Aircraft are de-iced at the terminal gates or remote stands and glycol recovery equipment is used. This might be suitable for small airports or those that have infrequent need for aircraft de-icing.

— A central de-icing facility. This might suit an airport with a relatively compact layout or one with a single de-icing service provider. A central facility can enable underground drainage for glycol recovery and is kept separate from the airport's main storm water drainage system.

— Multiple satellite de-icing pads. This option might suit a large spread-out airport and could also include a central facility.

Fire and rescue

4.3.1.23 The main environmental considerations for airport fire and rescue activities are the training areas for simulated fire training and the recovery of related storm water run-off. The infrastructure for these activities should include a fire training area with road access as well as facilities for handling the fuels used, and for the collection and containment of run-off water. For more information, see the *Airport Services Manual* (Doc 9137), Part 1 — *Rescue and Firefighting*.

4.4 PASSENGER TERMINAL FACILITIES AND AIRLINE/AIRPORT SUPPORT BUILDINGS

4.4.1 This section addresses the passenger terminal building and support buildings such as the control tower, hangars, provisioning, maintenance and cargo areas. For information and guidance on the development of airport master plans, see the *Airport Planning Manual* (Doc 9184), Part 1 — *Master Planning*.

4.4.2 The main environmental impact associated with existing buildings is the use of energy, for purposes including electricity, lighting, and heating, ventilation and air-conditioning (HVAC). Increasing energy efficiency and choosing lower emissions or renewable power sources reduces the impacts associated with power generation. The use and management of water and waste water is the another environmental impact associated with buildings.

4.4.3 Buildings

Overall design

4.4.3.1 Key architectural decisions at the early planning or design stage can greatly influence subsequent opportunities to reduce building energy use. These include building form, orientation, shading, height-to-floor-area ratio and decisions affecting the opportunities for and effectiveness of passive ventilation and cooling.

4.4.3.2 Attention should be given to the local environment, for example, local climate, types of surrounding buildings, types of vegetation, and modes of transportation that will be accessing the building, in order to assess how these may impact on the energy efficiency of the building. Where possible, the building orientation should take advantage of natural sunlight for heating, lighting, and snow melt. New buildings should consider the latest energy efficiency certification processes and green building codes and practices.

4.4.3.3 Terminal and other buildings can be designed and built to energy efficiency standards and guidelines, such as Leadership in Energy and Environmental Design (LEED) and Building Research Establishment Environmental Assessment Methodology (BREEAM) certification.

4.4.3.4 “Smart” building technologies such as computer controls, sensors and whole-building automation (such as building automation systems (BAS)/building energy management (BEM) systems) enable an integrated design approach to energy management which considers the functioning of the building as a system, rather than focusing on individual energy-using devices. Building recommissioning provides a check that building systems are still functioning as originally planned, constructed, and delivered, and to identify where opportunities for improvement exist. These systems and approaches enable HVAC and lighting systems to react automatically to the operating environment to optimize energy efficiency. Features include moving external shades or louvres that track ambient sunlight and heat load to maximize light and control solar heat loads. Planting, such as green roofs, can be used to lower ambient temperatures.

4.4.3.5 Furthermore, if the heating, cooling and electricity needs of a collection of buildings can be linked together in an integrated system without major distribution losses, then significant savings in primary energy use are possible — beyond that which can be achieved by optimizing the design of a single building.

Heating

4.4.3.6 The energy requirements to heat a building can be reduced through a number of building features and considerations. These can include the following:

— Careful consideration of the design and properties of the thermal envelope or shell of the building to prevent unwanted heat or air transfer between the interior and exterior. The effectiveness of the thermal envelope depends on factors such as the insulation level of the walls, the thermal properties of the windows and doors, the air-tightness of the building, driving forces such as wind, and inside and outside temperature differences.

— The use of multiply-glazed windows — double or triple glazing — for improved thermal performance.

— Location of heating vents to maximize effectiveness and avoid heating unoccupied spaces where heat is not needed.

— The use of natural solar heating through appropriate orientation of the building or windows to be sun-facing.

— The incorporation of a water vapour condensing system to improve the efficiency of boilers or furnaces.

— The use of hydronic (piped water) heating systems can be more efficient than forced air systems.

— The use of heat pumps drawing heat from the ground using a geological, geothermal or aquifer heat sink rather than outside air (can also use the ground for cooling).

Cooling

4.4.3.7 The energy requirements to cool a building can be reduced through a number of building features and considerations. These can include the following:

— Reducing the solar cooling load on a building through orienting the building to reduce east and west facing walls, clustering buildings to provide shading, using high reflectivity building surfaces.

Note.— When adding reflective surfaces, consideration must be given to the potential adverse effects of glare and reflected light on the control tower and pilots operating aircraft.

— Increasing thermal insulation, including using multiply-glazed windows.

— Using landscaping such as planting trees to provide shade for buildings.

— Location of cooling vents to maximize effectiveness for human activity and to avoid cooling unoccupied spaces where cooling is not needed.

— Using passive cooling techniques to meet some or all of the load, such as natural ventilation, evaporative cooling and channelling in-take air through underground pipes.

— Selecting the most efficient modern cooling equipment and thermal distribution systems, such as hydronic cooling systems.

— Designing so that cooling is not wasted on unoccupied areas. Thermal stratification can allow high spaces to remain uncooled.

Lighting

4.4.3.8 Energy usage from lighting can be significantly reduced through the various designs and equipment including the following:

— Natural light as much as possible, for example, through the use of skylights, atriums and smart choices for the shape, size and position of windows.

— Sensors and zone switches to dim or switch off electric lighting when not needed.

— More efficient lighting devices, such as LEDs.

— A relatively low background lighting level with local levels of greater illumination at individual workstations, referred to as task/ambient lighting.

Other electricity use

4.4.3.9 Other than heating, cooling and lighting, the main uses of electricity in airport buildings include motors for conveyor belts, escalators and lifts, and energy used by concessionaires for food preparation and storage, as follows:

— Escalator and walkways that slow down or shut off when unoccupied or not in use.

— Installation of metering systems for utility use including, water, sewer, gas, and electricity are important to allow for managing and creating appropriate business models to promote conservation.

— Design that promotes human locomotion such as stairs over electric locomotion such as escalators. This can be accomplished by providing convenient access to the alternative for human locomotion that equals or exceeds the powered locomotion.

— BEM systems are central energy control systems for individual buildings or groups of buildings that use computers for monitoring, data storage and communication. With energy meters and temperature, occupancy and lighting sensors connected to a BEMS, energy consumption can be better managed to reduce wastage, and equipment faults can be quickly detected either manually or using automated fault detection. BEMs enable ongoing monitoring and evaluation of operating efficiency for some hot water heating, BEMs may have hardware for using off-peak power which may not be available from suppliers at a lower price.

— Electricity consumption can be reduced by switching to more efficient office equipment, consumer electronics, entertainment and communication systems, heating and cooling equipment and ventilation.

4.4.3.10 Most other factors for reducing energy use will be operational in nature. These can include the following:

— implement building commissioning and improve operations and maintenance;

— deploy continuous commissioning;

— establish energy conservation teams;

— use and reporting of metered data and information; and

— change of behaviour in occupants towards more conservative use of energy.

Plumbing

4.4.3.11 The use of potable water can be minimized, through the use, when practical, of low-flow and no-flow plumbing fixtures that are commonly available. Drainage piping should be compatible with and designed for low-flow and waterless fixtures.

4.4.3.12 Recycled water or other non-potable water can be used for toilet flushing. The use of “grey water” for toilet use should be considered where necessary and or economically viable. In some areas, seawater can be used for toilet flushing. Grey water systems should be considered when designing new buildings. An option for waterless or dry urinals is also available.

Rainwater harvesting

4.4.3.13 Rainwater can be harvested from building rooftops and runway and airside rainwater run-off. The rainwater can be used for non-potable functions such as air conditioning cooling towers, landscape irrigation, washing of paved areas and aircraft, fire control, and toilet flushing.

Waste water management

4.4.3.14 Waste water including sewerage and grey water can be treated at an on-site waste water treatment plant or sent to a local waste water treatment plant. Benefits of on-site waste water treatment include the ability to recycle the waste water for a number of non-potable functions.

4.4.4 Passenger Terminal/Cargo/Hangar Area

Support vehicles refuelling facilities

4.4.4.1 Vehicle refuelling facilities can provide airport operations and tenants efficient access to fuel needed to operate support vehicles. Additionally, alternative fuels, such as compressed natural gas (CNG), can be provided to encourage adoption of alternative fuel vehicles.

Recharging facilities

4.4.4.2 Consideration should be given to providing recharging facilities to ground support equipment, as well as passenger electric vehicles parked in terminal area parking. These facilities can encourage adoption of electric vehicles.

Spill containment

4.4.4.3 Most States have an organization, such as a Department of Environment, that regulate fuels and fuel storage, and also sets regulations for spill prevention and clean-up. Most require that an airport have a plan for spills, such as a spill prevention control and countermeasures (SPCC) plan. In some cases, different regulations apply depending on the quantity of fuels and other hazardous materials stored on site. New absorption materials are being used for spill clean-up that can better absorb fuels and oils, can be easily separated from fuels after clean-up (to reuse the fuel), and can be recycled instead of sent to a landfill. Primary environmental goals of spill containment include (please refer to 3.8 for more information):

— have a good spill containment plan;

— prevent discharge of fuels to waters; and

— have properly engineered storm water containment and settling ponds to contain run-off.

Hazardous materials management

4.4.4.4 For any hazardous material, safe handling is the primary environmental consideration. Measures for handling, containment, and clean-up of hazardous materials should be described in a spill prevention plan, and the correct personal protective equipment should be maintained on site to adequately carry out the clean-up procedures. Some basic features of safe handling of hazardous materials include:

— clear identification of hazardous chemicals;

— identification, training, and certification of those involved in handling hazardous goods;

— safe storage of hazardous material;

— plans for disposal of hazardous materials; and

— ensuring airport tenants that handle or transport hazardous cargo have proper training, certifications, and safety procedures.

4.4.4.5 A hazardous materials plan should include recovery or neutralization of the hazardous materials, as well as disposal procedures. Most of these materials will need to be sent to a specific disposal facility, and some hazardous materials should be transported by a certified waste transporter. Large spills of some of these hazardous materials, such as mercury, can have air quality impacts, and plans should be made to monitor for fumes if such a spill occurs. Materials such as batteries should be kept in closed containers compatible with the contents. Specialized plastic containers can be purchased from commercial distributors such as Lab Safety Supply.

4.4.4.6 Hazardous materials found at airports can include the following:

— potassium hydroxide (for hydrogen generators);

— mercury (in barometers, thermostats, mercury switches, rotary joints);

— lead acid, mercury-oxide, and other batteries;

— ethylene glycol;

— dielectric oil;

— solvents and degreasers;

— fuel (diesel, jet, AVGAS, etc.) ;

— paints; and

— cleaners.

4.5 LANDSIDE

4.5.1 Airport support elements

Power Generation

4.5.1.1 Airports can be high electricity consumers with demand for power at multiple facilities. Power for airport support facilities can be drawn from a variety of energy sources. Airports can rely on local electrical grids, or combine power from a utility provider with on-site power generation.

4.5.1.2 As a large airport can be the size of a small city, some include facilities to generate electricity. Maximizing use of on-airport renewable energy sources, such as solar, geothermal and wind power, can provide a large portion of an airport's energy needs while reducing environmental impacts, and reliance on electricity grids. Power generation from wind turbines at, near or close to airports must consider obstacle limit surfaces (OLS) and the effects on aircraft and radar operations.

Renewable sources for power generation

— Airports surrounded by open landscapes may be particularly suited to large solar photovoltaic installations for electricity generation; these installations can be located on vacant airport land, or mounted on the rooftops of airport terminals, parking facilities, and other buildings. Evaluation of an airport's geographic location, climate, and weather patterns can determine its solar energy potential.

— Consideration of a large solar array should be accompanied by an ocular analysis of glint (a brief flash of light) and glare (a continuous source of bright light). This would help identify solar panel orientations that maximize system performance while eliminating risk of glint and glare which could be hazardous to air traffic controllers and pilots.

— The use of wind power can be limited as large turbines may disrupt aircraft operations. An analysis of obstructions and potential wake effects can help airports determine the potential for wind power.

— Solar hot water systems can provide airports with a renewable energy source for heating water for bathrooms and other uses.

— Some types of waste can be incinerated to generate heat and electricity.

Heating and cooling plants

4.5.1.3 Modern electricity and heating plants tend to use cleaner burning and more efficient natural gas rather than coal. Further efficiencies can be gained using various technology options, such as:

— Cogeneration systems improve the efficiency of electricity production by harnessing the waste heat to heat buildings and generate hot water. Trigeneration uses the waste heat from the generation of electricity for both direct heating and the generation of cooling using absorption cycle refrigeration.

— Fuel from renewable sources and forestry industry by-products, including wood pellets, can be used to generate heat.

— Heat pumps use the same refrigeration equipment used for providing cooling (air-conditioning) and are substantially more efficient than heating with electricity.

— Refrigeration and heat pumps can also use underground, geothermal or aquifer heat sinks to further improve efficiency.

— Snow storage and snow melt usage can be used to enhance cooling efficiency.

Solid waste management

4.5.1.4 Solid waste management infrastructure will depend on the waste management programmes adopted by the airport operator and tenants. A waste management programme can include a wide variety of options such as source separation, separation within a designated terminal area, separation off-site, and composting. Each of these and their related infrastructure is examined below.

4.5.1.5 Waste reduction and reuse requires dedicated storage rooms complete with compactors, loading docks and parking facilities at the terminal in addition to a storage area for incoming supplies. A dedicated on-site or off-site cargo and supplies logistics centre can reduce the amount of packaging, pallets and wasteful material entering the terminal areas (refer to 3.6 for more information).

4.5.1.6 Waste minimization might be an operator's overall goal: reduce, reuse and recycle are the methods to accomplish this. Installations could include filling stations for reusable water bottles to reduce the amount of disposable water bottle waste, combined with traditional drinking fountains. Integration with waste management programmes of the surrounding community should also be considered.

4.5.1.7 Recycling may require source separation facilities in dedicated tenant spaces or, for whole building separation, large centralized collection and separation sites. Off-site processing may require an in-house transportation or piping system and off-site separation and storage.

4.5.1.8 Composting facilities will need to address both wildlife and pest control. Organic material can be either degraded into a soil additive or used to generate energy through incineration or anaerobic digestion and methane capture in a specialized bio reactor. Organic waste disposal may be accomplished using a water-based slurry system requiring tanks or conventional container disposal.

4.5.1.9 In some jurisdictions, agricultural security concerns can mean that local regulation requires that waste from international flights is subject to special segregation and handling rules and may or may not be allowed to be recycled. Separate handling facilities may be necessary. Facilities for the consolidation of waste from international flights to a single terminal or pier should be considered.

4.5.1.10 Incineration may be mandatory for international waste disposal. Design considerations regarding an incinerator could include:

— airport obstacle limitation zoning;

— options to combine municipal waste to make it practical;

— the recovery of useful heat from the incinerator; and

— the minimization of emissions.

4.5.1.11 Programmes to use demolition and excavated materials on-site may require a crushing and processing plant, as well as facilities for stockpiling, dust control and sediment management.

4.5.2 Ground transport, parking and internal airport circulation

Roadway layout

4.5.2.1 Airport roads will normally link the airport to both the regional arterial road system and the local road network. Most access for passengers, staff and deliveries will usually use the regional arterial road system, but many local services and activities in the areas adjacent to the airport will use the local road network. In addition to passengers and staff, road traffic that must be considered includes air freight arriving or departing the airport by road and deliveries of goods to the airport terminal and nearby industries.

4.5.2.2 A logical and efficient layout for both local and arterial traffic will be needed to maximize throughput for arrival and departure areas and other activities on and near the airport. Minimizing driving, congestion and idling time on the airport access roads will also benefit the local air quality in the vicinity of the airport.

Parking and car rental facilities

4.5.2.3 Even with well-developed local transit infrastructure, an airport will need parking facilities for passengers, greeters, staff and deliveries. Ideally, such parking should be close to landside egress, if possible, within walking distance from landside to reduce requirements for airport transport.

4.5.2.4 Facilities could be provided to encourage the use of alternative-fuelled vehicles, such as priority assigned spaces for hybrid and electric vehicles (EV) and EV charging stations. Since EV charging technologies are evolving, airports can pursue demonstration projects with start-ups.

4.5.2.5 Technology such as green lights above vacant parking spaces can be used to assist parking and reduce traffic circulating in search of spaces.

4.5.2.6 Car rental facilities are also ideally located within walking distance of the terminals. For larger airports with many car rental companies consolidated rental car and general or long-term parking facilities can facilitate passenger access using consolidated shuttles buses or light rail.

Inter-terminal transport

4.5.2.7 For large, multi-terminal airports, inter-terminal transport design can reduce airport emissions and minimize energy use:

— use of aero trains or pods (driverless electric vehicles that follow a specific track) instead of airport shuttle buses — either integrated into new buildings or as stand-alone projects at existing airports;

— maximum utilization of low- or zero-emissions vehicles when shuttles are the key to inter-terminal transport; and

— minimization of gate-to-aircraft vehicle shuttles.

Intermodal transport facilities

4.5.2.8 Intermodal public transport links can include local and regional bus stations, local and regional (light and heavy) rail stations and ferry terminals built to allow easy transfers for airport passengers. Such facilities are important for emissions reduction, and the long-term sustainability of an airport and the areas they serve. During the planning stages of an airport development, the airport developer needs to participate in regional planning to ensure that the airport is integrated into the regional (and national) transport plan.

4.6 ENVIRONMENTAL ASPECTS

4.6.1 General

This section analyses the use of airport infrastructure for environmental management. Adverse environmental effects from noise, emissions, and water hazards may be mitigated with optimal uses of airport infrastructure. Those environmental aspects, along with the most appropriate type and use of airport infrastructure to combat those negative effects are discussed below.

4.6.2 Noise

Aircraft noise

4.6.2.1 At the airport, runway placement and layout is the main infrastructure that will assist with managing aircraft noise. In particular, approach and departure tracks can be placed over non-noise-sensitive areas (e.g. water bodies) or the least populated regions in order to mitigate noise (see 4.3.1.2 — Runway layout and 4.3.1.3 — Taxiway layout).

4.6.2.2 Similarly, off the airport site, land-use planning to avoid incompatible land use in noise-affected areas near the airport is also crucial. This is discussed in Chapter 6.

4.6.2.3 The noise from aircraft auxiliary power units (APU) occurs mainly at terminal gates and normally will not be very close to residential areas. Noise screening could also be partly provided by terminal buildings. Moreover, the installation of fixed electrical ground power (FEGP) and preconditioned air (PCA) at aircraft gates can allow APU switch-off. Most of the benefit from the reduction of noise (and emissions) will be derived by the ground support staff on the apron (see 4.3.1.12 — Fixed electrical ground power and preconditioned air).

4.6.2.4 Aircraft run-up noise can be controlled by locating the run-up pad as far as possible from all neighbouring residential sites or the construction of an acoustic enclosure — either a semi-open U-shape or a fully ventilated run-up hangar see 4.3.1.18 — Aircraft maintenance facilities).

4.6.2.5 Noise screening for ground activity, such as from aircraft taxiing, can include barriers and earthen berms. To be effective acoustically, such screens should be placed either near the noise source or near the receiver, and should be sufficiently high to remove the direct line-of-sight between the source and receiver. To screen neighbours immediately adjacent to the airport, a boundary fence could be used.

Other noise sources

4.6.2.6 Other airport noise sources include stationary mechanical plant and mobile equipment used for ground maintenance or cargo handling. If near a residential boundary, mechanical plant equipment can be acoustically treated by traditional means, such as ventilation attenuators, screens, and acoustic enclosures. Mobile equipment could be screened, or their operational area located indoors (e.g. within a cargo handling building) to reduce noise.

4.6.2.7 The noise from ground access vehicles (GAV), including road and rail transport, on the landside of the airport property can also impact neighbouring residential areas. Acoustic screening and the use of low noise generating, porous road surfaces are ways of reducing these effects.

4.6.3 Emissions

4.6.3.1 Infrastructure that reduces emissions can benefit either local air quality (LAQ) or greenhouse gas (GHG) emissions that affect climate change or both. The discussion below is divided according to the emissions sources. For more information, please see the *Airport Air Quality Manual* (Doc 9889). The use of airport air quality studies and modelling can help define priority areas for action.

Aircraft emissions

4.6.3.2 Aircraft in the vicinity of airports are a large source of emissions and are dominated by landing and take-off (LTO) cycles. The capacity of the infrastructure (runway, taxiway, airspace, terminal, etc.) needs to be sufficient to avoid congestion and to reduce holding before landing and queuing before departure (see 4.3.1.4 — Airport capacity)

4.6.3.3 Taxiing emissions can be minimized with an efficient overall airport layout of the runways and terminals. When the aircraft is not taxiing and parked at the gate, emissions can be reduced by installing sufficient FEGP and PCA to allow the aircraft to switch off their APUs. (See 4.3.1.12 — Fixed electrical ground power and preconditioned air and 4.3.1.3 — Taxiway Layout). Additional emissions reductions from taxiing emissions can be achieved by incorporating new technologies.

Airside vehicles and ground support equipment (GSE)

4.6.3.4 Minimizing the distance travelled by airside vehicles is the main way to minimize their emissions. This can be achieved with an efficient apron and terminal layout (see 4.3.1.2 — Runway layout and 4.3.1.3 — Taxiway layout)

4.6.3.5 Additionally, airport infrastructure (airside and landside) can help reduce various emissions by promoting the use of non-diesel and non-petrol vehicles (see 4.4.2.2 — Recharging facilities) This can include:

— recharging facilities for electric vehicles; and

— refuelling facilities for compressed natural gas (CNG), liquid petroleum gas (LPG), hydrogen, and even compressed air.

Ground access vehicles (GAV)

4.6.3.6 GAV can be an important contributor to an airport's LAQ and GHG overall emissions inventories. These can be reduced with the following:

— an efficient roadway layout with well-planned city to airport access;

— intermodal facilities including train, light rail, regional and local bus, and ferry; and

— inter-terminal transport such as an automated people mover (APM).

Energy management

4.6.3.7 In most regions, the generation of electricity (and heat) is dominated by the use of fossil fuels. Therefore, managing energy use and promoting efficiency can indirectly reduce emissions. If a power or heating plant is built at the airport, effective energy management can benefit LAQ as well. Energy management includes reducing the use of electricity, heating and cooling, and generating electricity from renewable sources.

4.6.3.8 Planning infrastructure for promoting energy management involves designing terminals and other buildings (including the control tower, offices, and cargo and maintenance areas) (see 4.4.1 — Buildings). Terminal and other building energy efficiency can be improved using:

— lighting (natural lights, use of sensors, LED lights);

— use of solar energy (e.g. solar heating, solar hot water);

— electric motors that slow down or shut off when unoccupied or not in use (escalators, baggage belts);

— LEED/BREEAM certification;

— smart building technology (such as BAS/BEM systems) for lights, HVAC;

— heating and cooling using geological heat sink;

— green roofs.

Lighting — runway, aprons, car parks

4.6.3.9 Energy usage which will lower emissions from lighting in runways, aprons and car parks can be significantly reduced through the use of:

— energy from renewable sources such as photovoltaic and wind turbines (see 4.5.1.2 — Considerations for on-airport power generation).

— more efficient lighting devices such as LED (see 4.3.1.8 — Airfield Lighting and 4.4.1.9 — Terminal Lighting).

— sensors and zone switches to dim or switch off electric lighting when not needed (where appropriate) (see 4.4.1.9 — Terminal Lighting).

4.6.4 Water management

(see 3.5, 4.4.1.12 — Plumbing, 4.4.1.14 — Rainwater harvesting, and 4.4.1.15 — Waste water management)

4.6.4.1 Infrastructure to enable the management of water resources at an airport involves the consideration of multiple facets, including the following:

— minimizing the use of potable water;

— treating waste water;

— processing contaminated storm water; and

— handling de-icing run-off.

All of these efforts contribute to conserving precious water resources, including the quality of surface and underground aquifer water bodies downstream of the airport.

Water use (see 4.4.1.12 — Plumbing)

4.6.4.2 The use of potable water, whether from municipal supply, on-site purification or groundwater sources, can be minimized with the following techniques:

— plumbing fittings for low flow taps and showers;

— toilet flushing and cooling tower supply with recycled or other non-potable water, such as seawater;

— waterless urinals; and

— landscaping with plants that require little or no watering.

Waste water (see 4.4.1.15 — Waste water management)

4.6.4.3 Waste water, such as sewerage and grey water, can be transferred to municipal processing plants. Alternatively, an on-site treatment plant can be used to produce non-potable water for uses such as cleaning or irrigation.

Storm water (see 4.4.1.14 — Rainwater harvesting)

4.6.4.4 Storm water can be collected from the roofs of buildings and stored for non-potable usage. However, water and snow melt drained from the airfield, especially the tarmac and apron area should be treated as contaminated. At a minimum, settling ponds are required to control sediment and particulates in the run-off as well as to prevent surges in downstream water courses. Storm water contaminated with oil, fuel, or aircraft and pavement de-icing products might need further treatment before it is released off the airport site or allowed to seep into the water table.

Aircraft de-icing

4.6.4.5 Aircraft de-icing glycol should be prevented from contaminating storm water. The drainage of a de-icing pad, whether central or satellite, should be designed to allow glycol recovery. Large airports in very cold climates might benefit from glycol recycling infrastructure (see 3.5 and 4.2.2.1 — Surface Water Quantity and Quality Control)

4.6.4.6 Water run-off contaminated with glycol can be collected for primary treatment (recycling or sewerage processing) or secondary treatment (settling ponds and irrigation or timed release) (see 4.3.1.21 Aircraft de-icing facilities).

4.6.5 Solid waste management

(see 3.6 and 4.5.1.4 — Solid waste management)

Airport infrastructure to assist with solid waste management can include the following:

- facilities for collecting, sorting and recycling of solid waste from terminals, offices, cargo, and aircraft;
- energy recovery for incinerated materials;
- composting facility for organic materials; and
- on-site processing and reuse of topsoil, excavated material, and used concrete.

4.6.6 Land, soil, and habitat management

4.6.6.1 A design to prevent the contamination of soil should include spill containment infrastructure for critical areas, such as a fuel farm, hazard material handling areas, and maintenance facilities (see 4.4.2.3 — Spill containment).

4.6.6.2 A hydrant system of the delivery of fuel to aircraft will reduce the handling of fuel along with the risk of fuel spills and the emissions of fuel trucks.

4.6.6.3 Some airports must manage conflicting requirements among the protection of certain plant and animal species, the need to manage the wildlife hazard, and the safe operation of aircraft. Habitat management (including storm water management) can include avoiding plant species and water bodies that might provide food and shelter for animal species that pose a risk to aircraft. This may include establishing alternative areas for target species away from aircraft movement areas and flight tracks (see 4.2.1.2 Wildlife hazard management).

Chapter 5

LAND USE

5.1 GENERAL

Land use around airports can impact the operational safety and efficiency of the airport, the safety of surrounding communities, and community exposure to the environmental effects of airport operations. Hence, activities around an airport that can affect the safe and efficient operation of aircraft and/or community exposure should be taken into consideration when planning land uses in the vicinity of airports. Similarly, land-use compatibility planning can also be utilized to minimize impacts such as aircraft noise on surrounding communities and local third'-party risk. As guidance on proper airport and land-use compatibility planning, this chapter describes a variety of possible land uses with a broad appreciation of their relative sensitivity to aircraft and airport operations, local third-party risk and aircraft noise exposure and describes their compatibility or incompatibility to aircraft noise and to airport operations.

5.2 NATURAL LAND USE

5.2.1 Every airport is different, as are the areas surrounding them. Natural areas, such as forests, open land, rivers, swamps, and bays are found in varying degrees in the vicinity of airports. In many cases, the presence of natural areas influences the selection of the airport site. In other cases, the selection is based on different factors, but the existence of natural areas can provide additional benefits.

5.2.2 The presence of natural features in aircraft approach and climb-out areas has done much to prevent aircraft noise problems. An example is a new airport which has been situated in the bend of a river to take advantage of the close-in water approaches under both ends of the runway. Runways located on filled land on the edge of bays also afford unobstructed approaches over water. New airports have even been located on artificial islands created specifically for the airport. Bird control measures should be used and proper reporting of bird strike problems followed in such cases.

5.2.3 Natural features have been, and can be, used to advantage not only in reducing noise impacts but also in adding natural elements and interest to the airport. Nevertheless, where rivers, lakes, bays or swamps are found in the airport area, bird hazard problems may exist. At some airports, this problem has been so serious as to cause accidents.

5.3 AGRICULTURAL LAND USE

Many airports provide an opportunity to establish agriculture in order to increase revenues. The agricultural use of land contributes several important factors to an airport programme, such as:

a) producing income from what might otherwise be waste or idle land;

b) providing crop cover and prevents soil erosion; and

c) eliminating the expense to the airport of mowing or taking care of the land.

Farming land inside or around an airport may attract wildlife which can represent a hazard to aviation. For example, birds are attracted by certain crops. The effect of crop cultivation on bird occurrence at airports is discussed in the *Airport Services Manual* (Doc 9137), Part 3 — *Wildlife Control and Reduction*.

5.4 HIGHWAYS AND RAILWAYS

5.4.1 In view of the existing network of highways and railways and the constant building, realignment and rebuilding that will take place in the future, it is sensible that highway and railway planning be coordinated with the airport plans to achieve maximum safety and environmental benefit. In planning a highway or railway system near an airport, or in planning a system which includes an access road or railway to the airport, coordination with the airport officials can often result in the highway or railway being located beneath the approach and climb-out paths of the aircraft. This is acceptable as long as potential obstacles such as high vehicles or road lighting (which may potentially cause confusion or endanger aircraft safety) are avoided and designated safety zones are maintained.

5.4.2 Highway and railway construction are, in general, a more preferred land use in the vicinity of airports than residential housing which would be adversely affected by noise and emissions. Areas adjacent to the road or rail network can be more easily adapted to commercial, industrial, and recreational uses. The development of road and rail, as well as commercial services, near an airport can be an effective way to prevent residential housing from developing in critical noise areas.

5.5 RECREATIONAL LAND USE

5.5.1 Every community needs recreational facilities, and there are a number of outdoor recreational uses that are compatible with airport operations. When such facilities must serve large population areas, a considerable amount of land is involved. Many airports have sufficient undeveloped adjacent land which, through proper planning, can be developed into complete recreational complexes. In terms of noise and public hazards, recreational uses such as playgrounds and athletic fields present limited problems.

5.5.2 Among possible recreational uses, parks require little development and are ideal for hiking and riding trails, and outdoor living facilities. Golf courses are increasing in popularity, and other recreational uses such as swimming pools, tennis courts, playgrounds, and athletic fields (non-spectator) may be grouped with a clubhouse-restaurant facility (except under the approach areas). Botanical gardens can be incorporated into these activities, and ponds blend with parks and golf courses. All add interest, beauty and activity to the airport surroundings. Recreational facilities combined with commercial or industrial areas can complement and support an airport and also serve the people living nearby. It should be remembered, however, that any land use in the airport vicinity must not present or create a hazard to aircraft operations, such as attracting birds.

5.5.3 Some recreational uses present larger issues in terms of noise and public hazard. Fairgrounds and racetracks, outdoor theatres, and amphitheatres are considered poor land uses. The potential risk of an aircraft accident and its effects should be considered when planning activities where large groups of people are involved. (The basic principles of individual and societal risk are discussed in Chapter 7). Tennis courts and golf courses, if located under approach areas to a busy airport, should be at least 3 km from the airport boundary. Other recreational uses reported as compatible within approximately 5 km of the airport include archery ranges, golf driving ranges, go-cart tracks, dog tracks, skating rinks and bowling alleys.

5.6 MUNICIPAL UTILITIES

5.6.1 The siting of municipal utilities at an airport is not only compatible but logical. The industrial, residential and commercial growth of the airport community creates increasing demands for water, sewage disposal and power utilities, and the concentration of these municipal requirements in the airport area has proven to be economical and wise. However, while all municipal utility uses are compatible in the sense that there is no noise problem, electrical plants and power lines could be considered an obstruction by many airport planners. Power plants and other industrial uses that emit a hot exhaust plume can create turbulence problems, and should be sited so the plume is not in the aircraft flight pattern. Landfills and incinerators may emit smoke, creating a visibility problem. Solar photovoltaic arrays should be appropriately sited in order not to create glint and glare that affects pilots, and personnel in air traffic control towers. Moreover, water storage, landfills and sewage treatment may attract birds. For Further details, see –the *Airport Services Manual* (Doc 9137), Part 6 — *Control of Obstacles.*

5.6.2 Special attention should be given to water resources within an airport environment to minimize impacts on both human and natural systems. Water supply is a necessity for the airport. With regard to land use, consideration must be given to the various water resources in the vicinity of the airport. Water resources include surface water, groundwater, floodplains, wetlands, and special water features like underground aquifers or wells. Water resources can provide drinking water for the airport and surrounding communities, but also support recreation, transportation, commerce, industry, agriculture, and aquatic ecosystems. Water resources generally function as an integrated natural system, and disruption or pollution of one part can have consequences to the functioning of other parts. Land-use decisions, both for the airport and within the larger watershed in which the airport resides, must consider the volume of water supply that is available for use in proportion to the size of facilities and number of residents or users. It is also important to consider the potential for impacts to the quality of the water resources by certain land uses. Agriculture around an airport, or industries with high-volume water needs, may have an effect on the availability of potable (drinking) water, and the potential for impacts to regional water resources that could result from airport operations as well as nearby land uses (see 5.7, 5.8 and 5.9 below).

5.7 COMMERCIAL LAND USE

5.7.1 Commercial activities include shopping centres, warehouses and offices. The bulk of commercial operations are carried out during daylight hours and is not affected by the problem of noise at night or during sleeping hours, as are residential areas. While noise is less of an issue, the possibility for public hazard should be considered for commercial development in and around airports.

5.7.2 Although commercial operations can be situated in areas subject to higher noise levels than residential developments, they generally cannot be carried out in the same areas as industrial operations, which are performed primarily indoors and have a higher associated noise level. Sound insulation and ventilation should be incorporated in the construction of commercial structures to the extent necessary in order to reduce exterior noise to a level acceptable for conducting business inside the building.

5.8 INDUSTRIAL LAND USE

5.8.1 Land use at airports increasingly involves non-aeronautical industry. These activities can provide valuable revenue for airport operators, but must be carried out with adequate consideration for safety and environmental protection.

5.8.2 The location of industrial sites at the airport has generally been found to be compatible with aircraft noise because of the relatively higher ambient noise level, both internal and external, associated with industrial activity. This factor, combined with the ever growing need for industrial land around airports, has contributed to the development of industrial parks in and around commercial and general aviation airports. Business has learned to take advantage of the unique benefits that air transportation can offer, and many major commercial enterprises are also located at airports.

5.8.3 Prospective sites for industrial development should still satisfy the following basic requirements:

a) desirable geographical location, considering the community in question;

b) availability of land of sufficient size to accommodate the planned industrial development;

c) access to commercial transportation facilities, in addition to air transportation, if necessary;

d) present and/or future availability of needed utilities;

e) access to nearby residential areas for the industrial employees, with reasonable commuting time; and

f) compatibility of proposed industrial development with other area land uses.

5.9 RESIDENTIAL AND INSTITUTIONAL LAND USE

5.9.1 In this publication, residential housing refers to single-family dwellings, multi-family dwellings, and estates. Institutional housing refers to community facilities such as schools, hospitals and churches. All these facilities should be planned and situated with thorough consideration of airport activities and the potential arrival and departure corridors with the goal to reduce the number of properties affected by aircraft noise and other environmental impacts.

5.9.2 In single-family dwellings in temperate and warm climates, families live outside during many of the daylight hours, especially in the summer months. This is also true of estates and, to a lesser extent, of multi-family dwellings, particularly where a community swimming pool exists. It is this outdoor activity that creates the real noise compatibility problem for residential property in the vicinity of the airport.

5.9.3 Institutional dwellings may require a greater degree of sound insulation than do residential structures because a lower sound level is necessary for indoor use. The requirements of patients in hospitals and of the speech level in schools and churches demand special evaluation if these facilities are located in the vicinity of the airport.

Chapter 6

LAND-USE PLANNING

6.1 GENERAL

6.1.1 The *Guidance on the Balanced Approach to Aircraft Noise Management* (Doc 9829) provides guidance on alleviating the problem of noise in the vicinity of airports. This “Balanced Approach” recommends consideration of four noise management pillars, one of which is land-use planning.

6.1.2 Land-use planning can be an effective means to ensure that the activities nearby airports are compatible with both current and future aviation activities. Its main goal is to minimize the population affected by aircraft noise by introducing land-use planning measures, such as land-use zoning around airports. In addition, land-use planning also can have safety benefits for those people living in the vicinity of an airport.

6.1.3 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.

6.1.4 Compatible land-use planning and management based on appropriate “planning” noise contours, rather than “current” noise contours, can prevent encroachment of residential development at airports where future aircraft noise levels are projected to increase. Using “current” noise contours for land-use planning can allow residential encroachment, thereby nullifying the benefits the reduced noise of the latest generation of quiet aircraft.

6.2 ASSESSING NOISE FOR LAND-USE PLANNING

6.2.1 The intrusiveness of aircraft noise in airport communities is dependent upon many factors including the following:

— sound pressure level;

— broadband frequency distribution;

— tonal content;

— noise duration;

— flight path, including take-off and landing profiles;

— number, frequency and time of day of operations;

— operating procedures (such as engine power settings, cutback altitude);

— aircraft configurations;

— mix of aircraft;

— runway utilization;

— time of day and year including meteorological conditions; and

— daily and seasonal meteorological variations.

All these factors contribute to the total aircraft noise exposure to nearby communities.

6.2.2 The response of communities to aircraft noise exposure is dependent upon such factors as:

— land use;

— building use;

— type of building construction;

— distance from airport;

— ambient noise in the absence of aircraft;

— diffraction, refraction, and reflection of sound due to buildings and topographical and meteorological conditions; and

— factors of a sociological nature including community attitudes.

All these factors contribute to the sensitivity of communities to the airport environment.

6.2.3 Methods for forecasting community exposure to aircraft noise have been developed:

a) to determine the relative merits of different aircraft operating procedures and runway utilization in reducing aircraft noise exposure; and

b) to serve as a guide for airport and community planners in planning land use and building construction in the vicinity of airports.

A description of these methods is given in the *Recommended Method for Computing Noise Contours around Airports* (Doc 9911).

6.2.4 Noise exposure forecasts are necessary in the development of programmes to limit the total exposure of communities to aircraft noise and to make airport operations and community life mutually compatible. These programmes must coordinate various measures such as the monitoring of noise caused by aircraft movements, forecasting future aircraft fleets and operations, and the planning and control of land use. Effective programmes can be established only if the basic principle is applied, namely that aircraft noise around an airport should be described, measured, forecast and, if necessary, monitored by methods that make due allowance for the effect such noise has upon people. As most land developments such as dwellings will be in place for many decades, it is important that aircraft noise forecasts for land-use planning be projected as far into the future as possible.

6.2.5 In general, land-use planning should be based on a “planning” noise contour for a projected future operational scenario or based on traffic forecasts and airport capacity, taking into account future runway and infrastructure development. Three time horizons are usually studied: short-term (around five years), medium-term (around ten years) and long-term (around fifteen years).

6.3 NOISE ZONES AND ASSOCIATED MAXIMUM NOISE INDICES

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 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. An approximate comparison can be made between the values of the different methods used by States (for a description of these methods, see the *Recommended Method for Computing Noise Contours around Airports* (Doc 9911)). France, applying the European Directive 2002/49EC at the national level, uses the L_{den} noise metric for noise contours around French aerodromes. For each noise exposure map, three and sometimes four noise zones are defined (PEB: Plan d’Exposition au Bruit) (see Table 6-1). The legal limit values in L_{den} for these noise zones may vary depending on the type of traffic and on local situations.

6.3.4 Land-use restrictions for new constructions vary with noise zones. For example, only housing and facilities necessary for aeronautical activities, as well as public facilities which are vital to the existing population are allowed within Zone A, whereas no land-use restrictions for new constructions but obligation to insulate new housing and to inform inhabitants within Zone D.

Table 6-1. Overview of the limit values for the definition of noise zones as per the Plan d'Exposition au Bruit (PEB)

	Zone A	Zone B	Zone C	Zone D
Usual situations (including major civil airports)	$L_{den} \geqslant 70$	$70 > L_{den} \geqslant (62 \text{ to } 65)$	$(62 \text{ a } 65) > L_{den} \geqslant 55 \text{ to } 57)$	$(55 \text{ a } 57) > L_{den} \geqslant 50$
Aerodromes defined in planning code article R. 147-1-1	$L_{den} \geqslant 70$	$70 > L_{den} \geqslant (62 \text{ to } 65)$	$(62 \text{ a } 65) > L_{den} \geqslant 52 \text{ to } 57)$	$(52 \text{ a } 57) > L_{den} \geqslant 50$
Specific military aerodromes	$L_{den} \geqslant 70$	$70 > L_{den} \geqslant (62 \text{ to } 68)$	$(62 \text{ a } 68) > L_{den} \geqslant 55 \text{ to } 64)$	$(55 \text{ a } 64) > L_{den} \geqslant 50$

6.3.5 In the United States, the Part 150 Airport Noise Compatibility Planning regulations establishes primary methods in guiding and controlling planning for aviation noise compatibility on and around airports. Part 150 includes a table titled "Land Use Compatibility with Yearly Day-Night Average Sound Levels." This table identifies various land-use recommendations that are compatible or incompatible with yearly DNL levels above 65 dB in 5 dB increments. Levels below DNL 65 dB are considered compatible for all indicated land uses and related structures without restrictions. Levels between DNL 65 and 75 dB are considered incompatible with residential or school land uses unless measures are taken to achieve additional noise level reductions (NLRs). Above DNL 75 dB, residential land uses are considered unacceptable, even with incorporation of noise attenuation measures. However, a variety of non-residential, open space, commercial and manufacturing land uses are identified as compatible in areas with DNL > 75 dB.

6.3.6 The land-use planning in Germany deals with building and settlement restrictions including the reimbursement for constructional soundproofing measures in residential buildings in the vicinity of airports and airfields. The type of land-use planning depends on the degree of aircraft noise exposure. For airports and airfields with flight operations that cause a rather high noise exposure, the Act for Protection against Aircraft Noise is applied. It requires the establishment of noise protection areas at commercial airports as well as military airfields with the operation of jet or heavy transport aircraft. The noise protection area is subdivided into two daytime protection zones and one night-time protection zone. The act contains different limit values for the individual zones. A distinction is made between existing and new or significantly expanded airports. Furthermore, there exists different limit values for airports and military airfields which are displayed in Tables 6-2 and 6-3.

Table 6-2. Overview of the limit values for existing airports or airfields according to the Act for Protection against Aircraft Noise

Type of airport/airfield	Daytime protection Zone 1	Daytime protection Zone 2	Night-time protection zone	
	$L_{Aeq, day}$	$L_{Aeq, day}$	$L_{Aeq, night}$	N x L_{Amax}
Civil airport	65 dB(A)	60 dB(A)	55 dB(A)	6 x 72 dB(A)
Military airfield	68 dB(A)	63 dB(A)	55 dB(A)	6 x 72 dB(A)

Table 6-3. Overview of the limit values for new or significantly expanded airports or airfields according to the Act for Protection against Aircraft Noise

Type of Airport/airfield	Daytime protection Zone 1	Daytime protection Zone 2	Night-time protection zone			
			Until 31.12.2010		From 01.01.2011	
	$L_{Aeq, day}$	$L_{Aeq, day}$	$L_{Aeq, night}$	N x L_{Amax}	$L_{Aeq, night}$	N x L_{Amax}
Civil airport	60 dB(A)	55 dB(A)	53 dB(A)	6 x 72 dB(A)	50 dB(A)	6 x 68 dB(A)
Military airfield	63 dB(A)	58 dB(A)	53 dB(A)	6 x 72 dB(A)	50 dB(A)	6 x 68 dB(A)

6.3.7 In the whole noise protection area, the construction of noise-sensitive buildings (e.g. hospitals, schools) is generally prohibited. In the daytime protection Zone 1 as well as in the night-time zone, the construction of new dwellings is also not allowed. For existing residential buildings located in these zones, the Act for the Protection against Aircraft Noise contains provisions that oblige the airport operator to cover the costs for constructional soundproofing measures at these buildings. Moreover, the expenses for the installation of ventilation systems in rooms that are predominantly used for sleeping are to be reimbursed by the airport operator for buildings in the night-time protection zone.

6.3.8 Expenses incurred for constructional soundproofing measures including the ventilation systems are reimbursed to a maximum amount of 150 Euros per square metre of living space. The noise insulation requirements are specified in a statutory decree.

6.4 COMMUNITY ENGAGEMENT

6.4.1 Airport operators need to consult and engage their neighbouring communities on an ongoing basis to keep them informed and foster their support for the operation of the airport and expansions of infrastructure. When planning a new airport, it will be the airport developer who should conduct this engagement. In many jurisdictions, such consultation is mandatory.

6.4.2 In the long-term, an airport needs to establish and maintain a relationship with local communities based on trust and transparency and keep groups well informed. It may be difficult to judge how much community engagement is needed and when enough has been done. Public consultation for a specific development project would generally be required until building and operational permits have been granted. However, most other engagements will usually need to be ongoing. Once a community is against the airport operation or a particular project, and the airport has lost the trust and support of the community, it is challenging to regain. One way of establishing such a community engagement would be to set up a working arrangement similar to the collaborative environmental management (CEM) process developed by EUROCONTROL.[1]

6.4.3 Noise and land-use planning will invariably be two of the most important concerns for communities. In addition to the issues discussed in this chapter, community engagement should also keep in mind the following considerations.

1. http://www.eurocontrol.int/collaborative-environmental-management-cem.

— Most noise exposure forecasts are based on noise metrics which use decibel units on a logarithmic scale and which are averaged over a long period such as three months or a year. While such metrics are usually appropriate for design and land-use planning, they may be inappropriate for community engagement. This is because time-averaged decibel-scale noise metrics can be difficult to understand to a lay audience and can arouse suspicions that the effects of impacts are being concealed.

— Noise contour lines can give an impression that outside the contours there is no audible (or visible) impact of aircraft.

— Supplementary noise indices such as those based on the noise level of individual events and the number of events should be included in public consultation information.

— Caution should also be used if charts of flight tracks are presented to the public that do not take into account actual track distribution that might occur either side of a designated track centre line.

6.4.4 ICAO has developed a circular on *Community Engagement for Aviation Environmental Management* (Cir 351), which provides case studies on community engagement, lessons learned and good practices. The circular is available on ICAO's website.

6.5 RISK OF AIRCRAFT ACCIDENTS AROUND AIRPORTS

6.5.1 Airports are centers for air traffic in the air transportation system. Consequently, their presence causes a convergence of air traffic over the area surrounding the airport. For those people living in the vicinity of an airport, this implies involuntary exposure to the risk of aircraft accidents.

6.5.2 Actual local risk levels around airports are perhaps higher than might be expected. Although the probability of an accident per flight is very low (typically in the order of 1 in 1 000 000), accidents tend to happen mostly during the take-off and landing phases of a flight and hence, close to an airport. The low probability of an accident per movement combined with the large number of movements (typically several hundreds of thousands) may suggest the probability of one accident per year near a large airport. This probability is of course much higher than the better known and smaller probability of being involved in an aircraft accident as a passenger.

6.5.3 Local risk levels around large airports are, in effect, of the same order of magnitude as those associated with participation in road traffic. Because an increase in airport capacity usually involves changes to runway layouts, route structures and traffic distributions which in turn affect the risk levels around the airport, third-party risk is an important issue in decision-making on airport development.

6.5.4 In order to assess such risks, 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.

6.6 LAND USES WITHIN NOISE ZONES AND HIGH RISK ZONES

Examples of the types of development allowed in the zones suggested in 6.3 are shown in Table 6-2. This table may be used as a guide for States contemplating or operating land-use planning schemes. It should however be emphasized that the examples of different development and land uses given in Table 6-2 should be taken only as a broad indication of the relative sensitivity of the activities mentioned to aircraft noise exposure. Other planning considerations, such as the need to provide community services (e.g. schools or hospitals) to communities already established in noise-exposed areas, may allow developments with adequate soundproofing, etc., in order to maintain the viability of the community.

Wherever possible, and particularly when planning the construction of new airports, the location of the airport should be considered as a part of the total planning environment, so that long-term community needs and the consequences of the airport's operation in terms of noise exposure are not in conflict (see Table 6-4).

Table 6-4. Some typical examples of compatible land uses around airports

	Zones		
	A	B	C
Examples of compatible land uses or development	Most land uses and development are not permitted	Some restriction on land uses and developments	Unrestricted land uses and developments
Agricultural: Crop farming	unrestricted	unrestricted	unrestricted
Industrial: Machine shop	unrestricted	unrestricted	unrestricted
Commercial: Warehouse and shipping	unrestricted	unrestricted	unrestricted
Offices and banking	restricted	restricted	unrestricted
Residential: Low-density housing	restricted	restricted	unrestricted
High-density housing	prohibited	restricted	unrestricted
Public facilities: Schools and hospitals	restricted	restricted	unrestricted

Note 1.— With respect to certain uses (e.g. housing and commercial), a development might be allowed in a zone of a higher restriction when other planning considerations indicate a need, and where suitable building techniques, sound insulation, etc., can reduce the aircraft noise exposure to an acceptable level.

Note 2.— In special cases where activities depend on speech communication (e.g. schools) or require more stringent standards (e.g. certain hospital activities), additional restrictions may be required to take into account absolute noise levels as well as total noise exposure, unless noise reduction can be ensured in the building construction.

Note 3.— The zones will have to be defined against a noise exposure scale (e.g. noise contour mapping) and will have to take into account local and national needs when the zones are drawn up.

6.7 REVIEW OF LAND-USE MEASURES WITH RESPECT TO AIRCRAFT NOISE IN VARIOUS COUNTRIES

Appendix 3 contains information on land-use measures applicable in various countries as of February 2016.

Chapter 7

LAND-USE ADMINISTRATION

7.1 GENERAL

7.1.1 Noise exposure is not the only factor to be taken into account for the purpose of land-use management in the vicinity of airports. It is recognized that economic factors are involved in land-use choices. 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.

7.1.2 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. Experience has shown that any attempt to control land use through easements and purchases is extremely expensive and cannot be considered as a solution to the entire aircraft noise problem. A more practical approach is the adoption of proper land-use planning and zoning. Zoning, however, is limited in its ability to effect changes around existing airports located in developed areas. Land use can be managed more effectively when zoning is applied to new airports and existing airports in still undeveloped areas.

7.1.3 Unfortunately, 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.

7.2 LAND-USE MANAGEMENT

7.2.1 Introduction

Various measures are available for managing the use of land around airports. The effectiveness of these measures for both existing and new airports should be considered on a case-by-case basis. Based on a survey of land-use measures and policies in the countries reviewed, it can be stated that no single strategy prevails over other strategies in dealing with this issue. While land-use management and noise-insulation measures are generally transferable from one place to another, the selection of a particular measure and the precise manner in which any measure is formulated, applied and financed depend to a great extent on specific national and local circumstances. Overall, land-use management measures can be categorized as:

a) planning instruments, including comprehensive planning, noise zoning, subdivision regulations, transfer of development rights, and easement acquisition;

b) mitigating instruments, including building codes, noise insulation programmes, land acquisition and relocation, transaction assistance, real estate disclosure, and noise barriers; and

c) financial instruments, including capital improvements, tax incentives and noise-related airport charges.

7.2.2 Planning instruments

Comprehensive planning

7.2.2.1 Comprehensive planning takes into account existing development and ensures that future development is compatible with various community goals. In most countries, the land-use planning and control authority rests with local governmental bodies, which may be obliged or advised to take into account aviation noise measures.

7.2.2.2 A well worked-out comprehensive plan that is used effectively to guide local land-use decisions and development (e.g. zoning, capital improvements planning, subdivision regulations, and environmental review) is among the most powerful and affordable of all compatibility strategies. This is particularly true in developing areas, but it can also be highly effective in guiding urban renewal or redevelopment. The success of such comprehensive planning depends upon its implementation through various developmental decisions and controls.

7.2.2.3 As a land-use control system in relation to airports, comprehensive planning is applied in varying degrees in all the countries surveyed. This strategy appears to be a valuable instrument that is transferable to other countries.

Noise zoning

7.2.2.4 Noise zoning for land use serves a two-fold purpose: the protection of the airport and the protection of the residents. It can be applied to existing airports as well as to future airport development. Zoning should take into account anticipated future airport development so that when airport development takes place, it has minimal impact. In some countries, such as France, there are noise maps that define land-use restrictions for new constructions (so-called PEB – Plan d'Exposition au Bruit) and noise insulation maps (so-called PGS – Plan de Gêne Sonore) that define those inhabitants who may benefit, under specific conditions, from home soundproofing grants.

7.2.2.5 Noise zoning enables a national or local government to define the uses for each parcel of land, depending on the level of noise exposure. It generally consists of a zoning ordinance which specifies land development and use constraints, based on certain noise exposure levels. The noise contours extending outward from the airport delineate areas affected by different ranges of noise exposure. No uses other than those specified for a particular area should be permitted.

7.2.2.6 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. The government authority would then ensure that any application of noise-sensitive developments are appropriately considered to ensure that developments only occur within acceptable noise zones, as prescribed by the relevant noise zoning regulations.

7.2.2.7 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. Having a single authority to enforce the continuity of noise zoning regulations across several local government areas within the airport noise contours can alleviate the problem of multi-jurisdictional interests.

7.2.2.8 Another issue is that the interests of the noise-affected communities near airports are not always consistent with the needs and interests of the airport operator nor with those of each other. Within local government authorities and various communities there is usually a desire for greater population growth, and rising land values. It is these drivers that are often in conflict with the need to preserve surrounding airport areas so as not to compromise the noise reduction benefits achieved from new generation aircraft, with the ultimate goal being to further reduce the total number of people affected by airport related noise.

7.2.2.9 Noise zoning can and should be used constructively to increase the value and productivity of the affected land. One of the primary advantages of zoning is that it may be used to promote land-use compatibility, while still leaving land in private ownership, on the tax rolls, and as economically productive as possible.

7.2.2.10 Zoning is not necessarily permanent and may be changed, although this may be difficult in some countries because of the local legal system. Zoning is usually not retroactive. Changing zoning primarily for the purpose of prohibiting a use which is already in effect is generally not possible. Where such zoning is allowed, an existing use may be allowed to remain as “nonconforming” until a later date when it is changed voluntarily to a conforming use. For this reason, zoning is most effective at airports that have not yet felt the impact of buildings. Furthermore, the proposed use of vacant land must be related to the market demand for the proposed activities, such as commerce or industry.

7.2.2.11 Noise zoning around airports is applied in nearly all surveyed countries as a planning measure to prevent new noise-sensitive developments near the airport. However, it is sometimes only applied to the larger or national airport(s). Ideally, noise zoning should be established for all airports.

Subdivision regulation

7.2.2.12 Noise zoning ordinances may include subdivision regulations. These regulations may serve as a guide to development in noise-impacted areas by reducing building exposure through orientation and density transfer and by providing open-space requirements.

7.2.2.13 Subdivision regulations on their own can be useful in minimizing noise impacts on new development. They would not affect existing development. By means of restrictive covenants, the owner is legally notified that the property is subject to noise from aircraft operations. Additionally, a covenant could require buildings to be designed and constructed in such a way as to minimize interior sound derived from exterior noise sources to the acceptable level.

Transfer of development rights

7.2.2.14 Under this concept, some of the development rights of a property are transferred to another property that is far from the airport where the rights may be used to intensify the level of allowable development. Land-owners could be compensated for the transferred rights by the sale of these rights at new locations or the purchase of the rights by the airport. Depending upon the market conditions and/or legal requirements, the airport could either hold or resell the rights.

7.2.2.15 The transfer of development rights must be fully coordinated with a community’s planning and zoning. It may be necessary for zoning ordinances to be amended in order to permit the transfer of development rights. Such transfers are usually effected within a single jurisdiction.

Easement acquisition

7.2.2.16 An easement confers the right to use a land-owner's property for a limited purpose, normally in exchange for some value. In the context of airport noise-compatibility planning, two general types of easements are available:

a) those which permit airport noise over land (including right of flight); and

b) those which prevent the establishment or continuation of noise-sensitive uses on the subject property.

7.2.2.17 For maximum effectiveness, easements should restrict the use of land to that which is compatible with aircraft noise levels. Easements should also ensure the right of flight over the property, the right to create noise and the right to prohibit future height obstructions into airspace. Restrictions that may be addressed by such easements include types of buildings, types of agricultural activity that may attract birds, electromagnetic interference, and light emissions.

7.2.2.18 The first type of easement described in 7.2.2.16 a), which simply buys the right to make noise over the land, has fewer advantages. It does nothing to change the noise-sensitive character of the land or to reduce noise for people on the property. However, it does legally protect the airport operator from noise litigation, financially compensates property owners for noise, and warns potential buyers that a property is subject to aircraft noise.

7.2.2.19 The second type of easement described in 7.2.2.16 b) can be a highly effective strategy for ensuring compatible development around airports in situations where land is being developed for the first time or is being redeveloped in connection with a land acquisition and relocation strategy or general urban redevelopment programme. The easement has the advantage of being permanent. It is less costly than outright purchase of land (if the land has not otherwise been purchased) and it allows the land to remain in private ownership, in productive use, and on local tax rolls. This latter type of easement is used most frequently in combination with noise insulation. Such easements are often required by airport owners in exchange for noise insulation. Again, the use of certain easements is dependent on the legal system.

7.2.3 Mitigating instruments

Building codes

7.2.3.1 Construction techniques and material standards often determine the interior noise levels of residential or commercial structures in noise-impacted areas. Building codes are essentially a legal means of requiring the incorporation of adequate sound insulation in new construction. Any noise-insulation strategy depends upon a closed-in structure for maximum effectiveness, and this in turn usually raises the issues of adequate ventilation and air conditioning in warm weather.

Noise insulation programmes

7.2.3.2 Noise insulation can lower interior noise levels for structures that cannot reasonably be removed from noise-exposed areas (e.g. residential buildings). Noise insulation is particularly effective for commercial buildings, including offices and hotels. However, it is much more desirable to control insulation requirements for such buildings from the outset, if they must indeed be constructed in noise-exposed areas. While there may be difficulties in getting sound insulation requirements incorporated in building codes for new construction, these are slight compared with the problems of effective soundproofing for existing buildings, particularly housing. Even if houses in high-noise areas were made of stonework, insulation and air conditioning may cost more than the value of the additional rent or sales' prices. The degree of insulation requirements varies from country to country. In some countries, the acceptable level of interior

noise is prescribed by legislation. As an example, French legislation defines indoor–outdoor noise reduction levels for each noise zone of a noise exposure map (PEB). These requirements are applied for new constructions and depend on the type and the allocation of the buildings.

7.2.3.3 A noise-insulation programme should be preceded by a structural and acoustical survey of all homes and other buildings earmarked for noise insulation. The cost of noise insulation depends upon several variables, such as the degree of insulation required (from insulating the attic only to insulating all exterior walls and ceilings and upgrading doors and windows), size and condition of the building, and location within the noise exposure area.

7.2.3.4 For effective noise insulation, it is necessary to have a closed-window condition, which may not be desirable to homeowners in all seasons and which imposes additional ongoing costs to home-owners for climate-control systems. The major drawback to noise insulation is that it does nothing to mitigate noise outdoors. This drawback however does not apply as much to schools, hotels, commercial structures, or even large apartment buildings, because they are frequently constructed with a closed-window condition and their activities usually take place indoors.

7.2.3.5 Other insulation programmes could include sound conditioning or air conditioning. This can contribute much towards making all types of dwellings acceptable during the hours when the interior of the building is in use; this is particularly important during the night-time hours. Hence, the amount of sound reduction must be balanced against the external sound level in order to achieve an acceptable noise level for the occupants of the dwelling. Installation of sound conditioning can be relatively simple if incorporated initially in new construction but becomes more complex if incorporated as a modification of old construction.

Land acquisition and relocation

7.2.3.6 This strategy involves the acquisition of land through purchase by the airport operator (or planning authority in case of new developments) and the relocation from the acquired land of residences and businesses that are not compatible with airport-generated noise levels. This strategy is within the direct control of the airport operator (or planning authority) and does not require additional action by another political entity.

7.2.3.7 Land acquisition and relocation assure an airport of long-term land-use compatibility. Acquired land can be cleared, sold with easements (to control future development), and redeveloped for compatible land uses. However, this strategy is not a practical solution to the total noise problem because it is costly and socially disruptive to buy all significantly noise-impacted land.

7.2.3.8 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.

Transaction assistance

7.2.3.9 Transaction assistance involves some level of financial and technical assistance to a homeowner who is trying to sell a noise-impacted property. It may involve paying realtors' fees. An airport operator may even buy the property which has been on the market for an extended period of time and then resell it. In order to become compatible with noise levels, the properties are noise-insulated prior to resale and usually resold with an easement. This strategy can be useful in areas where it has been decided that existing residential neighbourhoods will be maintained. It can also be less expensive than other acquisition strategies. Homeowners are sometimes given a choice of noise insulation/easement or transaction assistance. These choices enable those people most annoyed by noise to leave the area and prevent the airport authorities or developers from having to buy out everyone.

7.2.3.10 Transaction assistance is a comparatively new programme in the United States. It has not yet been comprehensively evaluated as a strategy in comparison to noise insulation/easement alone. It does appear, however, to offer more flexibility to property owners.

Real estate disclosure

7.2.3.11 The preparation of real estate disclosure notices is a common practice in cases where environmental regulations and issues affect development. Identification of the aviation noise impact on real estate may foster an awareness of airport/community relationships and serve notice to prospective buyers of potential disturbances caused by aircraft noise.

7.2.3.12 Incumbent property owners and realtors are often opposed to real estate disclosure because it makes it more difficult to sell noise-impacted property. It does not reduce the noise impact or the non-compatible land use. Instead, it may deter buyers who are the most sensitive to noise. Still, real estate disclosure ensures that a buyer who purchases a noise-impacted property is fully aware of the property's noise condition so that the buyer does not become a noise complainant or noise litigant in the future.

7.2.3.13 The strategy is used in the United States, sometimes in combination with an easement or an appropriate release with respect to noise from the buyer. The advantages of this strategy are its relatively low cost and its retention of otherwise viable residential areas.

Noise barriers

7.2.3.14 Noise barriers consist of earthen berms or man-made barriers on the ground which are located between sources of loud ground-level noise at the airport and very close-in, noise-sensitive receptors. Noise barriers must be both structured and positioned accurately to provide any meaningful relief. They are of limited use at airports except for ground-running operations, etc., and do not mitigate in-flight noise. However, they do appear to have a perceived benefit — people tend to hear less noise if they don't see the aircraft on the ground or the maintenance facility that is the source of the noise. It is also particularly beneficial to install earthen berms for visual appeal. A proper positioning of airport buildings can also function as a noise screen for adjacent communities. Any obstacle near a runway such as a noise barrier may cause wind disturbances for landing and departing aircraft and should be assessed for its impact on the flight handling and aircraft performance.

7.2.4 Financial instruments

Capital improvements planning

7.2.4.1 Development can be stimulated or discouraged by the presence or absence of an infrastructure network, which typically includes roads and utilities (power, gas, water and sewer). Other community facilities and services, such as schools, police, and fire service, also tend to promote development. Capital improvements can be planned in order to locate infrastructure in areas where industrial and commercial growth would be compatible. This strategy can also discourage certain types of growth, such as residential development, from areas that are deemed incompatible for such use. Similarly, the capital improvements programme can be developed to encourage noise-tolerant land uses with appropriate types, size, and locations of infrastructure in the noise-impacted areas.

7.2.4.2 This strategy may be appropriate for directing new development or extensive urban redevelopment. It is however not useful when the impacted areas are fairly well developed and already have adequate infrastructure. There may also be legal impediments to using this strategy when infrastructure improvements are required as part of the development plan.

Tax incentives

7.2.4.3 Tax incentive programmes are often used to promote noise-insulation improvements. The strategy is to provide tax incentives to existing incompatible uses in order to encourage structural improvements which would reduce interior noise levels.

7.2.4.4 Additional tax incentive programmes may be instituted by governmental bodies as a means of redeveloping specific areas. For instance, a designated blighted zone or foreign trade zone can be a catalyst for redevelopment.

7.2.4.5 Various tax incentives, such as reduction or elimination of property taxes, may also be introduced (usually to private industry) to encourage relocation or expansion of industry as a means to increase the local *ad valorem* tax base or to diversify the local economy.

7.2.4.6 Tax reduction or differential tax assessment can be offered as incentives for development in specific areas. For example, development of noise-tolerant uses in areas subject to higher noise levels can be encouraged, which may consequently discourage other noise-sensitive uses. Industrial development is particularly sensitive to taxation systems and is more affected by taxation than residential or commercial development. This type of strategy typically requires input and support from the local economic development agency in terms of designation of areas, and planning and zoning coordination with regard to compatibility and appropriate zoning issues.

Noise-related airport charges

7.2.4.7 While some view noise-related airport charges as an incentive to encourage the use of the quietest aircraft technology, these charges can be related to land-use planning if the funds are used for a sound insulation programme. Charges may be levied by airports with noise problems in order to recover the costs incurred for the alleviation or prevention of noise. The costs recovered should not exceed the costs incurred. The application of noise-related charges should follow the principles for such charges developed by ICAO and contained in the *ICAO's Policies on Charges for Airports and Air Navigation Services* (Doc 9082), paragraph 21 and in the *Guidance on the Balanced Approach to Aircraft Noise Management* (Doc 9829). Although ICAO recognizes the implementation of these noise-related charges by the airports, some States require approval for its application.

7.2.4.8 There are various systems of noise-related airport charges. One system divides all aircraft into several categories according to the noise production and determines the airport charge. Another system returns part of the landing fee if the aircraft meets certain noise criteria. A third system levies extra noise charges on top of the normal landing fee based on the noise production of the aircraft. In some countries, extra charges are levied on night operations because of the additional disruption during night hours.

Chapter 8

HERITAGE CONSIDERATIONS

8.1 GENERAL

Airports may often be located within or close to natural or cultural environments that have aesthetic, historic, scientific, social or national significance which States may wish to protect for future generations. Airports may also include buildings and artefacts on site which are deemed to have heritage values. It is important, therefore, to consider in the planning of airport infrastructure whether any development proposal may impact upon heritage elements at the airport and how such impacts may be mitigated.

8.2 DEFINITION OF HERITAGE

8.2.1 The United Nations Educational, Scientific and Cultural Organization (UNESCO) adopted the *Convention Concerning the Protection of the World Cultural and Natural Heritage*, commonly known as the World Heritage Convention, on 16 November 1972. It has since been ratified by 190 State Parties.

8.2.2 The World Heritage Convention defines cultural and natural heritage as follows:

a) cultural heritage is considered to be:

— monuments: architectural works, works of monumental sculpture and painting, elements or structures of an archaeological nature, inscriptions, cave dwellings and combinations of features, which are of outstanding universal value from the point of view of history, art or science;

— groups of buildings: groups of separate or connected buildings which, because of their architecture, their homogeneity or their place in the landscape, are of outstanding universal value from the point of view of history, art or science;

— sites: works of man or the combined works of nature and man, and areas including archaeological sites which are of outstanding universal value from the historical, aesthetic, ethnological or anthropological point of view.

b) natural heritage is considered to be:

— natural features consisting of physical and biological formations or groups of such formations, which are of outstanding universal value from the aesthetic or scientific point of view;

— geological and physiographical formations and precisely delineated areas which constitute the habitat of threatened species of animals and plants of outstanding universal value from the point of view of science or conservation;

— natural sites or precisely delineated natural areas of outstanding universal value from the point of view of science, conservation or natural beauty.

8.2.3 Individual States may also have environmental protection or conservation legislation with specific definitions of what constitutes a heritage value within national jurisdictions. States may also maintain national heritage registers with legal requirements of how places or items are to be managed.

8.3 AIRPORT HERITAGE MANAGEMENT

8.3.1 The management of heritage elements at an airport should be guided by the following principles:

a) The objective is to identify, document, respect, protect and conserve heritage elements for all generations.

b) The best available knowledge, skills and standards should be employed in making decisions on actions that may have a significant impact on heritage values.

c) Timely and appropriate provision should be made for community involvement, especially by people who have a particular interest in, or associations with, heritage places.

d) It is important to protect indigenous heritage values, sites and artefacts. Active participation of local indigenous communities in identification, assessment and management should be encouraged.

e) Conservation of a site should give regard to its heritage value as a whole without merely focussing on discrete entities.

f) Regular monitoring, reporting and reviewing of management activities to conserve heritage values are essential.

8.3.2 States may also impose legislative requirements or guidelines on the management and protection of environmental and heritage values. Environmental impact assessments for major airport development projects (see Section 3.4) may require the proponent to address heritage issues.

8.3.3 In order to address heritage concerns, an airport could develop a heritage management plan which provides strategic objectives, policies and proposed actions for managing the impact of airport developments and activities on heritage elements which fall under the airport's responsibility. This would be part of the operation of the airport and therefore not addressed in this document.

Chapter 9

CLIMATE CHANGE RESILIENCE AND ADAPTATION

9.1 GENERAL

9.1.1 The level of greenhouse gas emissions (GHG) in the atmosphere is understood to be having an effect on global climate change, which will continue in the future. According to the Intergovernmental Panel on Climate Change (IPCC), "Climate change is projected to amplify existing climate-related risks and create new risks for natural and human systems".[1] Despite States' agreement to limit global warming through the United Nations Framework Convention on Climate Change (UNFCCC), the effects of a changing climate on human activities are expected to intensify; this presents risks and challenges for all sectors of society including the aviation industry. Such effects could include disruptions to airport operations and impacts on airport infrastructure.

9.1.2 The purpose of this chapter is to identify possible impacts, risks and vulnerabilities produced by climate changes that are likely to affect airport infrastructure and operations. It will also present examples of effective adaptation and resilience practices to reduce projected climate change impacts on airports. Airports are often classed as critical infrastructure by their States and regions as they facilitate mobility, economic growth, and provide essential services during disaster and emergency recovery situations. Moreover, any disruption that results in a loss of capacity at one airport can have a ripple effect throughout the wider aviation network. In this context, it is important to develop resilience against the projected effects of climate change, as they may negatively impact service continuity for aircraft and airport operations. Airport planners and States should be aware of the impact of climate change on the aviation system and consider how to adapt and build resilience to reduce those impacts. This chapter focuses on how specific climate change vulnerabilities may affect airports and airport operations. Since climate change will have broad impacts on all systems, not just airports, there are other side effects of climate change that are not directly considered in this chapter, but may become important for future airport planning, including potential changes to global disease agents (lifespan and geographic region).

9.1.3 The projected effects of climate changes will vary according to geographical location. Possible impacts on airport operations and infrastructure include: changes in icing conditions, flooding from precipitation events or inundation from sea level rise, damage to infrastructure from storms, changes to runway usage due to higher temperatures or a change in the prevailing wind direction. In order to address these potential risks, it may be prudent when building or redeveloping airport infrastructure to consider incorporating climate change resilience and adaptation measures into the infrastructure development plan.

9.1.4 The Intergovernmental Panel on Climate Change (IPCC) defines the terms "adaptation", "resilience" and "vulnerability". These definitions are applicable to this chapter. Definitions from the IPCC[2]:

— **Adaptation:** The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.

1. https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/ar5_wgII_spm_en.pdf
2. IPCC Fifth Assessment Report: Synthesis Report, Annexes. https://www.ipcc.ch/pdf/assessment/report/ar5/syr/AR5_SYR_FINAL_Annexes.pdf

— **Resilience:** The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation.

— **Vulnerability:** The propensity or predisposition to be adversely affected by a particular risk or impact. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

9.2 IMPLEMENTING ADAPTATION ACTIONS AND DEVELOPING RESILIENCE

9.2.1 Climate change is a global issue with local impacts. Different adaptation and resilience measures will be appropriate for different airports and regions around the world, depending on the local climate and other considerations. Section 9.4 contains a list of potential vulnerabilities to climate change, along with potential adaptation actions and resilience measures that may be considered when planning for each of the climate challenges. Such measures are most effective when considered in the planning process and integrated into airport design and construction. However, adaptation and resilience can also be achieved at existing airports through specific improvements implemented over time. This section is not exhaustive of all potential climate impacts or ways to reduce those impacts.

9.2.2 When considering climate adaptation plans, it may be useful to build on the existing emergency recovery plans and assess which elements are relevant to resilience programmes. Local authorities may provide support and useful guidance that will help assess risks and identify measures to develop resilience in an effective way. In addition to impact-specific examples of resilience actions, the following overarching climate adaptation measures could be considered:

— Planning for the long-term: plans should be flexible to facilitate further adaptation as more is learned about the impacts of climate change.

— Pre-emptive action: taking pre-emptive action can be cost-effective, reducing both costs and damages in the longer term.

— Information-sharing and engagement: the sharing and dissemination of knowledge, research, and best practices could be an approach to advancing adaptation within the sector.

— Science-based decisions: climate change actions should be implemented using the best available information. Uncertainties in the science should not prevent action.

9.3 IDENTIFYING IMPACTS AND VULNERABILITIES

9.3.1 The first step of climate adaptation action is to identify the climate change impacts that are expected to affect the region where the airport is, or will be, located. Although the specific impacts will vary according to geographical location, projected impacts include the following (more detail is available in 9.4):

— Sea level rise
— Storm surge
— Increased intensity of storms
— Changes in average and extreme temperatures
— Changing precipitation
— Changing icing conditions

— Changes in wind speed, patterns and directions
— Desertification
— Changes in Biodiversity (wildlife and ecosystems)

9.3.2 Table 9-1 presents a non-exhaustive overview of possible consequences related to the most likely climate impacts; not all impacts will be applicable to all regions. A climate change risk assessment can help understand vulnerabilities and future climate impacts and should be considered in appropriate situations. Analysis should be carried out at the local level to determine the likelihood of these events, their impacts, and their severity on the operations of the airport. Such a risk management approach can be valuable for both the existing infrastructure and for the siting and development of new infrastructure. Existing airport infrastructure should be assessed to ensure that operational limits are still valid or if the airport design should be adapted to changing climate conditions. A climate change risk assessment could also include information on the cost and benefits of adaptation and resilience action versus inaction. One of the benefits of conducting a risk assessment is having the chance to evaluate existing vulnerabilities, as this enables planners to identify priorities and develop the appropriate adaptation and resilience measures for the adaptation programme. Once the risk assessment has been carried out, airport operators or developers need to decide what action to take to address and reduce the risks that have been identified. Some airports have already implemented adaptation programmes, and a set of case studies is available in Appendix 5 and online at http://www.icao.int/environmental-protection/Pages/environment-publications.aspx.

9.3.3 To address climate change impacts, adaptation and resilience, measures can be implemented as part of new infrastructure development or as part of ongoing operational and infrastructure improvements. In addition to these improvements, educational activities, such as staff training, sharing of best practices, experiences and solutions, and the implementation of processes which facilitate collaborative operational responses to climate change challenges, may also be beneficial.

Table 9-1. Climate impacts

Climate change variable	*Potential impacts on airport infrastructure and operations*[3]
Sea level rise	— Sea water damage or inundation of airport infrastructure — Risk of permanent inundation in some areas — Rising ground water tables damaging infrastructure — Ground transport links potentially at risk of inundation — Exposure to greater risk of storm surge inundation — In extreme cases, entire States may be threatened by sea level rise (i.e. some small island developing States)
Storm surge (coastal and riparian)	— Damage to airport infrastructure and airport buildings — Disruption of operations or temporary airport closure — Reduced airport accessibility for ground and air transport — Deposits after a storm surge increase the contamination risk[4] — Higher risk of storm surge inundation due to sea level rise
Increased intensity of storms (including	— Damage to airport infrastructure and airport buildings — Accelerated ageing of the airport facilities and infrastructure**,** such as runways

3. For the purpose of this chapter, **"**operations**"** refers to both aircraft and airport operations.
4. Storm surge can include toxic and hazardous materials from a variety of sources, including sewage. Following a storm, the area impacted by storm surge may need to be decontaminated before any other recovery action is taken.

Climate change variable	*Potential impacts on airport infrastructure and operations*[3]
impacts from high winds, intense precipitation events, and storm surges)	— Destruction of mobile or fragile equipment — Increased flight delays and cancellations — Temporary airport closure
Changes in average and extreme temperatures	— Exceedance of design standards leading to heat damage on airport surfaces — Longer runways needed to avoid additional take-off weight restrictions — Changes in heating and cooling requirements may increase energy consumption with associated environmental and financial costs — Overheating of equipment or degradation of performance — Impact on the amount, location and temporal distribution of traffic demand — Permafrost thawing may lead to ground instability causing damage both to aircraft movement areas (holes and buckling), and to infrastructure integrity and stability — Impact on fuel handling and storage, due to maximum temperature restrictions
Changing precipitation (increase and decrease)	— Need for increased airport surface drainage capacity (runway, taxiway, ramp and apron) — Risk of flooding or inundation of infrastructure — Potential risks to ground transport links — Increase of existing, or emergence of new, drought regions, leading to restricted access to water supply — Impacts on operations due to increasing precipitation — Abnormal precipitation quantities or locations
Changing icing conditions	— Increased use of pavement de-icers — Reduced airport capacity — Increased use of aircraft de-icing and anti-icing
Changes in wind speed, patterns and directions	— Limitation of aircraft operations at airports without crosswind runways due to high crosswinds and tailwinds — Increased risk to aircraft operations due to high and varying wind conditions — Potential risk of ground equipment being lifted and disrupting aircraft movements on the ground — Limitations to aircraft loading due to high winds — In extreme cases of high wind conditions, reduced airport capacity due to air traffic control tower closures
Desertification	— Increased risk of soil erosion around apron and runway — Water shortages — Sandstorms disrupting operations — Risk of encroachment of sand dunes on apron — Effects of sand dunes on aircraft operations — Effects of sand damage on airframes and engines

9.4 POTENTIAL VULNERABILITIES, ADAPTATION AND RESILIENCE MEASURES

9.4.1 Sea level rise and storm surges

9.4.1.1 **Potential vulnerabilities**

A rise in sea levels will exacerbate all other water issues at airports near coastal waters. Ground water tables will be higher, drainage systems will be less effective, and flooding from surface waters or storms will be more frequent and damaging. Airports in coastal locations that experience these disruptions need to consider their long-term options for mitigating these impacts. Airports located near rivers and streams may also be at risk from sea level rise or flooding. Rising water tables may threaten underground infrastructure and make an area more vulnerable to flooding from precipitation events. At some locations, ground transport links are also potentially at risk. In even more extreme cases, such as the challenges facing some small island developing States, the entire State may be threatened by sea level rise. The United Nations (UN) General Assembly has recognized the criticality of this group of countries and raised awareness of the challenges these regions are facing, including the impact of climate change on such States. Small island developing States face unique challenges because of their reliance on aviation for connectivity with other States and tourism development. For example, the UN has identified that Maurice Bishop International Airport (the main airport servicing Grenada and located on the southern coast of the island) would likely be inundated in a 50-centimetre sea level rise scenario and a 1-metre rise would inundate the Maldives.[5]

9.4.1.2 **Potential adaptation and resilience measures:**

Depending on location, economic factors, and operational needs, adaptation strategies may include: building infrastructure higher or reinforcing existing infrastructure (e.g. using saltwater-resistant materials and/or sealants), while respecting obstacle clearance surface, building or reinforcing sea defences, retaining or introducing natural barriers, allowing a certain degree of inundation as long as safety is not compromised, and being prepared to replace/repair or relocate assets as needed. It may also be beneficial to assess the potential performance of existing infrastructure (including drainage and storm water systems) to identify specific vulnerabilities under different future sea level rise scenarios.

9.4.2 Increased intensity of storms

9.4.2.1 **Potential vulnerabilities**

An increase in intensity of storm systems may cause damage to airport infrastructure, and impact operations. Vulnerabilities to airport infrastructure from increased intensity of storms include impacts from high winds, intense precipitation events, and storm surges. Sudden wind gusts may also affect ground equipment and pose additional risk to aircraft ground movement.

9.4.2.2 **Potential adaptation and resilience measures**

If climate change forecasts predict increased severity in storms for a particular area, it may be valuable to assess the potential performance of existing infrastructure (including drainage and storm water systems) to identify specific vulnerabilities under different future climate scenarios. Depending on the projected impacts, possible adaptation

5. United Nations. *International Year of Small Island Developing States 2014*. http://www.un.org/en/events/islands2014/didyouknow.shtml (accessed January 8, 2015)

strategies may include reinforcing infrastructure so that it can withstand high winds, hardening infrastructure so that it can withstand heavy precipitation (including snow and ice), or replacing traditional electrical cables with those that can withstand saltwater storm surge inundation (for coastal locations).

9.4.3 Higher average and extreme temperatures

9.4.3.1 **Potential vulnerabilities:**

9.4.3.1.1 An increase in both local average temperatures and extreme temperatures may impact infrastructure. Higher extreme summer temperatures may exceed design standards leading to heat damage on paved surfaces; asphalt-paved runways or aprons may experience difficulties due to surface melting during peak heat periods. Operationally, higher temperatures affect aircraft engine thrust available, and therefore also impact runway length requirements for take-offs. There may be a need for increased summer cooling of airport buildings with the attendant energy costs. Buildings which were designed for cooler climates may not be able to maintain comfortable temperatures during very hot periods, leading to overheating of equipment and health issues for employees. In the longer term, increased summer heat and humidity may impact the amount, location and temporal distribution of traffic demand.

9.4.3.1.2 Permafrost is beginning to thaw due to increasing temperatures. As the permafrost thaws, the ground may become less stable causing damage to infrastructure integrity and stability. Runways may develop holes and buckling due to the permafrost degradation.

9.4.3.2 **Potential adaptation and resilience measures**

9.4.3.2.1 In areas where the temperature is expected to increase significantly, it may be appropriate to design or redevelop runways and taxiways with materials that can withstand higher temperatures. In areas where higher temperatures may be a challenge for aircraft take-offs, future temperature and aircraft runway length calculations may need to be reconsidered when determining the appropriate runway length. The potential for increased cooling requirements, and its corollary increase in energy demands, may need to be accounted for in airport planning. Long-term traffic demand analyses should be considered as part of the business case for new infrastructure.

9.4.3.2.2 Where permafrost degradation is a concern, buildings may be rebuilt or reinforced to preserve structural integrity; runways may need to be resurfaced and drainage systems may need to be adjusted (standing water can accelerate permafrost degradation).

9.4.4 Changing precipitation

9.4.4.1 **Potential vulnerabilities**

9.4.4.1.1 Climate change is predicted to bring increased precipitation to some parts of the world. In these areas, aerodrome surface drainage capacity may need to deal with more frequent and intense precipitation events. Underground infrastructure, such as electrical equipment, may also be at risk of inundation from increased precipitation. At some locations, ground transport links are also potentially at risk.

9.4.4.1.2 Conversely, climate change is also predicted to decrease precipitation in other parts of the world, increasing existing or creating new drought regions. In areas with reduced precipitation or drought, airports may have restricted access to water supply.

9.4.4.2 **Potential adaptation and resilience measures**

9.4.4.2.1 In areas where increased precipitation is projected, flooding may occur from individual precipitation events. Flooding events may also be more frequent in these areas if the water table rises due to increased ground saturation. Determining where vulnerabilities to future flooding could occur may be possible by calculating the current surface drainage capacity against future precipitation forecasts. After determining where vulnerabilities exist, adaptation and resilience measures, such as increasing surface drainage capacity or relocating electrical infrastructure, may be established to mitigate vulnerabilities. Local authorities may provide support and useful guidance to help assess risks and identify resilience measures.

9.4.4.2.2 For areas where a decrease in precipitation is projected, drought and reduced water availability may become a challenge to airport operations. Determining where vulnerabilities exist may be done by reviewing the available climate scenarios for a particular area, and comparing these projections with forecasts for factors that influence water consumption demand, such as population, development, and energy needs. National and local governments may implement guidance or regulations on water consumption, which may be considered in future airport planning.

9.4.5 Changes in wind patterns

9.4.5.1 **Potential vulnerabilities**

Climate change may affect prevailing wind patterns. Wind conditions are critical to air operations safety and efficiency. Since runways should be constructed along a prevailing wind direction, wind data should be analysed to determine where new runways should be located and oriented for optimum wind coverage within allowable crosswind constraints. However**,** existing runways may experience more and stronger crosswinds if the prevailing direction changes. If crosswinds become too strong, some aircraft operations might have to be limited at airports without crosswind runways.

9.4.5.2 **Potential adaptation and resilience measures**

9.4.5.2.1 Changes in wind patterns are a longer term impact of climate change that may affect some geographical areas. To determine if an airport may be vulnerable to these changes, planners may work with local and regional meteorological experts. Adapting to changes in wind patterns could include making changes to the current runway position/orientation and length to accommodate aircraft that can operate in stronger crosswinds conditions**,** or adding a crosswind runway in order for aircraft that cannot operate in strong crosswinds to be able to do so.

9.4.5.2.2 Future wind patterns should also be considered when planning airport buildings to ensure that, as far as possible, they will not give rise to undesirable local wind effects, such as turbulence and wind shear, which may affect future aircraft and ground vehicle operations as well as personnel safety.

9.4.6 Desertification

9.4.6.1 **Potential vulnerability**

Desertification is the process in which more land becomes desert. Climate change is contributing to desertification by leading to many dry regions becoming dryer and hotter. Unprecedented heat waves are already being recorded in many regions, especially in the tropics. Desertification is also responsible for increased water scarcity and increased frequency of weather events such as high-intensity tropical cyclones and sandstorms in many regions.

9.4.6.2 **Potential adaptation and resilience measures**

Airports planners and designers may need to design windbreaks to reduce dust and sand, by planting trees that require little water and that do not attract wildlife, and use recycled water for irrigation.

9.4.7 Changes in biodiversity

9.4.7.1 **Potential vulnerabilities**

Climate change may induce modifications in wildlife, such as changes in wildlife migration patterns, local biodiversity, and increases in wildlife hazards. One specific change may be shifts in the diversity of bird species that are present on an airport; in some areas, there could be an increase of heavy weight migratory bird populations (e.g. grey goose, white stork). Migratory birds represent a challenge at airports globally due to their potential impact on aircraft operations. Biodiversity challenges are likely to be localized depending on the ecosystem and climate change impacts in a particular area. One example of a localized impact to biodiversity is the potential for increased locust swarms in North Africa and the Middle East due to changes in rain events. Biodiversity changes may have an impact on wildlife hazards at an airport and its vicinity.

9.4.7.2 **Potential adaptation and resiliency measures**

Wildlife evolution should be monitored to detect any change in populations. This monitoring will enable airports to develop adaptation and resiliency methods to reduce impacts.

Appendix 1

CASE STUDIES: AIRPORT INFRASTRUCTURE FOR ENVIRONMENTAL MANAGEMENT

This appendix will be completed and available on the ICAO website as case studies are submitted to the ICAO Secretariat.

Appendix 2

CASE STUDIES: EFFECTIVE LAND-USE MANAGEMENT AROUND AIRPORTS

1. AMSTERDAM/SCHIPHOL AIRPORT, THE NETHERLANDS

1.1 Land-use planning

1.1.1 In the Netherlands, according to the Aviation Act an airport decree (LIB) with spatial planning rules near Schiphol Airport is required. The following limitations for land use are formulated within different zones of the airport:

— 71 dB(A) L_{den}: noise-sensitive developments are not allowed. Existing developments need to be removed. Removal is not compulsory.

— 10^{-5} risk zone: new developments are not allowed. Existing developments need to be removed. Removal is not compulsory.

— 58 dB(A) L_{den}: restrictions for new noise-sensitive housing and working developments.

— 10^{-6} risk zone: restrictions for housing and working developments.

1.1.2 Zones with respect to airport noise are defined by using the L_{den} method. Zones with respect to safety are defined using a probabilistic calculation.

1.2 States best practices

1.2.1 The land-use planning measures used for most airports include:

— Comprehensive planning, including an environmental impact assessment (EIA) for airport improvements, with an effect on noise climate. An EIA is compulsory for runway extensions over 1 800 m.

— Noise zoning is applicable to all aerodrome categories.

— Building codes include noise insulation for noise-sensitive buildings in legal noise zones.

— Acquisition/relocation and transaction assistance are applied to large airport developments (i.e. new runways).

— Demolition of houses is applied to high noise exposure areas over 65 Ke and in high third-party risk areas on both ends of runways.

— Noise barriers are applied to shield noise from certain ground activities (i.e. engine testing).

— Noise monitoring and flight tracking systems are installed around Amsterdam/Schiphol, Maastricht/Aachen and Rotterdam, the Hague, airports.

1.2.2 Noise charges are raised from the airlines for each landing (on top of the landing fee) to recover the costs of the insulation programmes and to encourage the use of less noisy aircraft during the evening and night periods.

1.3 Noise monitoring

1.3.1 In the yearly airport evaluation reports, monitoring of the noise limits is executed. The legally established noise zones near Amsterdam/Schiphol airport are enforced by the stipulation of runway allocation rules and the strict monitoring and evaluation of the Airport Usage Plan. The Airport Usage Plan has to be submitted to the Minister of Transport in October of each year. If the plan shows that the expected operations for the next year will stay within the legal noise zone, the plan is approved accordingly. Evaluation of the plan at the end of the year must confirm that the airport operation has been executed within the legally established rules. If not, measures are imposed on the airport. The legally established noise zones around other airports are enforced by continuous monitoring of the noise development throughout the year. By monitoring and reporting on the ongoing development continuously, infringements of the legal noise zones can be detected at an early phase. If necessary, measures have to be taken to stay within the noise zones.

1.3.2 The noise insulation scheme near Amsterdam/Schiphol airport started in 1983 and was finished in 2013. Around Groningen Airport Eelde all 10 houses within the 40 Ke contour have been insulated against noise. Around the airport Rotterdam 19 houses are isolated. In 2010 a new instruction was established. Now within the 40 Ke contour 23 houses are considered necessary for noise features. Implementation will take place in 2015. On the basis of the noise zone that was legally established in 2001, 833 houses within the 40 Ke contour of Maastricht Aachen Airport have been insulated against noise. The costs of the programme totalled € 30 million. On the basis of the noise zone that was legally established in 2004, another 157 houses within the new 40 Ke contour of Maastricht Aachen Airport have been insulated against noise. The costs of the programme totalled € 6 million.

1.3.3 Noise charges are raised on top of landing fees to finance the costs of the insulation scheme around airports. Extra noise charges are imposed for the evening and night periods to encourage the use of less noisy aircraft.

1.4 Other land-use measures for non-noise impacts

In addition to the zones mentioned above, restrictions regarding the safe use of airports and the operations of air navigation instruments are also defined in the airport decree (LIB). A 6 km zone is defined with a restriction for developments that attract birds. Furthermore, agreements with farmers are made in a wider area of Amsterdam/Schiphol to curb the foraging by birds, as much as possible.

2. LAND-USE PLANNING IN BRAZIL

2.1 Land-use planning

2.1.1 In Brazil, the Noise Zoning Plans (PZR — *Planos de Zoneamento de Ruído*) are regulated by the Brazilian Regulation for Civil Aviation — RBAC 161, and are applied to all airports in Brazil.

2.1.2 The main objectives of the PZR are to represent the area affected by the impact of the noise resultant from airport operations and, combined with the proper land-use compatibility, function as a tool to preserve the airports development in harmony with the local communities.

2.2 Land-use guidelines for the avoidance of wildlife hazards

2.2.1 The Federal Law 12.725, enacted in the year of 2012, establishes the Airport Safety Area (ASA), a circular area with a 20 km radius, with its centre located over the geometric centre of the largest aerodrome runway, where use and occupation are subject to special restrictions due to the wildlife hazard attractiveness.

2.2.2 The Federal Law 12.725 also establishes the National Program for the Wildlife Risk Management (NPWRM), developed and coordinated by the military and civil aviation authorities along with the environmental authorities. The NPWRM sets up, among other responsibilities and obligations, the restrictions to land use in the ASA.

2.2.3 The ASA restrictions must be observed and enforced by the:

— municipal authorities — regarding the urban land-use planning and control, as well as being responsible for implementing and supervising the NPWRM;

— environmental authorities — regarding the environmental licensing and its supervision; and

— aerodrome operators — regarding the aerodrome site.

Whenever a wildlife attractant is identified in the ASA, outside the aerodrome site, the following sanctions are applicable by the municipal authorities:

— warning notifications;

— daily fines;

— activity suspension;

— area or establishment interdiction;

— construction embargoes.

2.3 Noise monitoring

2.3.1 n Brazil, RBAC 161 defines two different types of PZR according to the annual aircraft movements of the airport: the Basic Plan (PBZR – *Plano Básico de Zoneamento de Ruído*) and the Specific Plan (PEZR – *Plano Específico de Zoneamento de Ruído*). The PBZR has two noise contours (65 and 75 dB) and is based on standard airport operations profiles. The PEZR has five noise contours (65, 70, 75, 80, 85 dB) elaborated/detailed for a particular airport, based on its specific operational profile. Land-use compatibilities defined for PZR are associated with the noise level, as described in Tables A2-1 and A2-3:

Table A2-1. PBZR: land-use compatibility

Land use	Noise level (dB)		
	Below 65	65 – 75	Above 75
Residential	Y	N (1)	N
Educational	Y	N (1)	N
Health	Y	30	N
Churches, auditoriums and concert halls	Y	30	N
Government services	Y	25	N
Transportation	Y	25	35
Parking lots	Y	25	N
Commercial uses and services	Y	25	N
Utilities	Y	25	N
Industrial uses	S	25	N
Agricultural and forestry	S	S (3)	S (4)
Livestock	S	S (3)	N
Mining and fishing	S	S	S
Stadiums, gymnasiums, parks, amusement parks, camping grounds	S	S	N
Acoustic shells and amphitheaters	S	N	N
Agricultural exhibits and zoos	S	N	N
Golf camps, riding clubs, water parks	S	25	N

Notes:

Y (Yes) = Compatible land uses.
N (No) = Incompatible land uses.
25, 30, 35 = Usually compatible land uses. Measures to achieve a reduction of a noise level of 25, 30 or 35 dB must be incorporated in the design/construction of buildings.
(1) Whenever determined that the uses are allowed, measures to achieve a reduction of a noise level of at least 25 dB must be adopted.
(2) Residential buildings require a reduction of 25 dB in the noise level.
(3) Residential buildings require a reduction of 30 dB in the noise level.
(4) Residential buildings are incompatible.

Table A2-2. PEZR: land-use compatibility

Land-use	Noise level (dB)					
	Below 65	**65 – 70**	**70 – 75**	**75 – 80**	**80 – 85**	**Above 85**
Residential	Y	N (1)	N (1)	N	N	N
Educational	Y	N (1)	N (1)	N	N	N
Health	Y	25	30	N	N	N
Churches, auditoriums and concert halls	Y	25	30	N	N	N
Government Services	Y	Y	25	30	N	N
Transportation	Y	Y	25	30	35	35
Parking lots	Y	Y	25	30	35	N
Commercial uses and services	Y	Y	25	30	N	N
Wholesale trade Building materials, large equipment	Y	Y	25	30	35	N
Public utilities	Y	Y	25	30	35	N
Industrial uses	Y	Y	25	30	35	N
Precision industries	Y	Y	25	30	N	N
Agricultural and forestry	Y	Y (2)	Y (3)	Y (4)	Y (4)	Y (4)
Livestock	Y	Y (2)	Y (3)	N	N	N
Mining and fishing	Y	Y	Y	Y	Y	Y
Stadiums, gymnasiums, parks, amusement parks, camping grounds	Y	Y	Y	N	N	N
Acoustic shells and amphitheaters	Y	N	N	N	N	N
Agricultural exhibits and zoos	Y	Y	N	N	N	N
Golf camps, riding clubs, water parks	Y	Y	25	30	N	N

Notes:
Y (Yes) = Compatible land uses.
N (No) = Incompatible land uses.
25, 30, 35 = Usually compatible land uses. Measures to achieve a reduction of a noise level of 25, 30 or 35 dB must be incorporated in the design/construction of buildings.
(1) Whenever determined that the uses are allowed, measures to achieve a reduction of a noise level of at least 25 dB must be adopted.
(2) Residential buildings require a reduction of 25 dB in the noise level.
(3) Residential buildings require a reduction of 30 dB in the noise level.
(4) Residential buildings are incompatible.

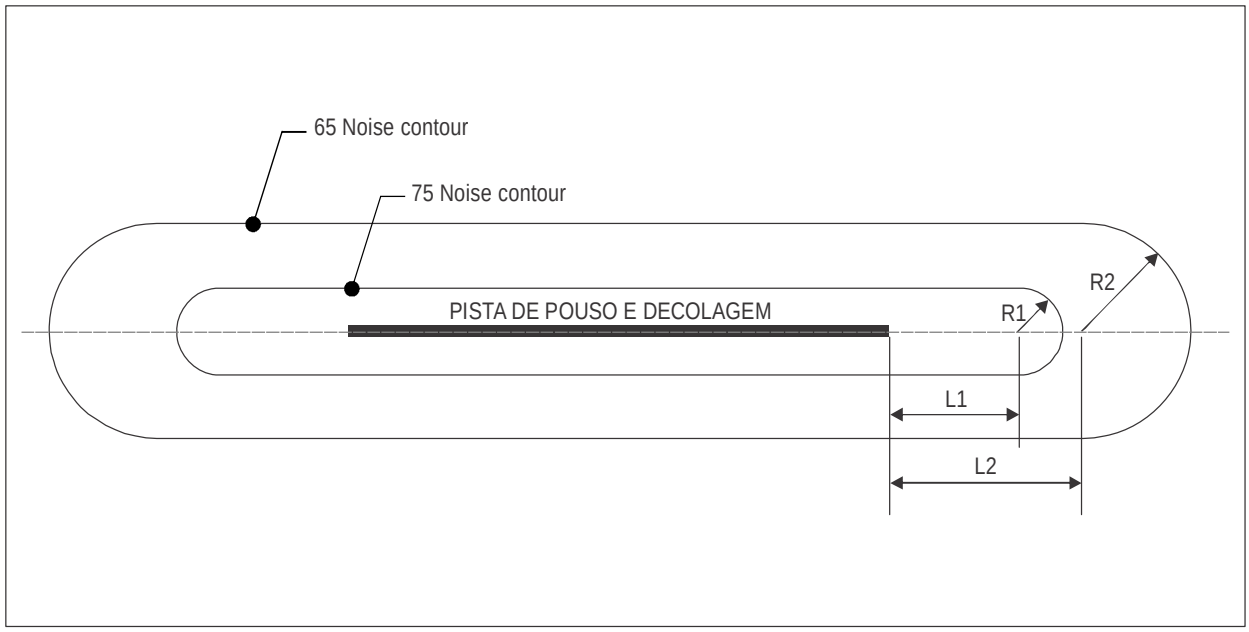

Figure A2-1. 75 and 65 noise contours

L1: Horizontal distance measured on the extended runway centre line, between the runway heading and the centre of the semicircle of radius R1.

L2: Horizontal distance measured on the extended runway centre line, between the runway heading and the centre of the semicircle of radius R2.

R1: Radius of the 75 noise contour semicircle centred on the end of the extended runway centre line.

R2: Radius of the 65 noise contour semicircle centred on the end of the extended runway centre line.

2.3.2 The PBZR noise contours 75 and 65 dB have simplified geometric shapes and their dimensions and configurations are presented in Figure A2-1 and Table A2-3. The PBZR has four classes, defined by the number of aircraft movements in the previous year. Its different dimensions are shown in Table A2-3.

Table A2-3. 75 and 65 noise contours dimensions (metre)

Annual aircraft movements	Class	L1	R1	L2	R2
Up to 400	1	70	30	90	60
From 401 to 2.000	2	240	60	440	160
From 2.001 to 4.000	3	400	100	600	300
From 4.001 to 7.000	4	550	160	700	500

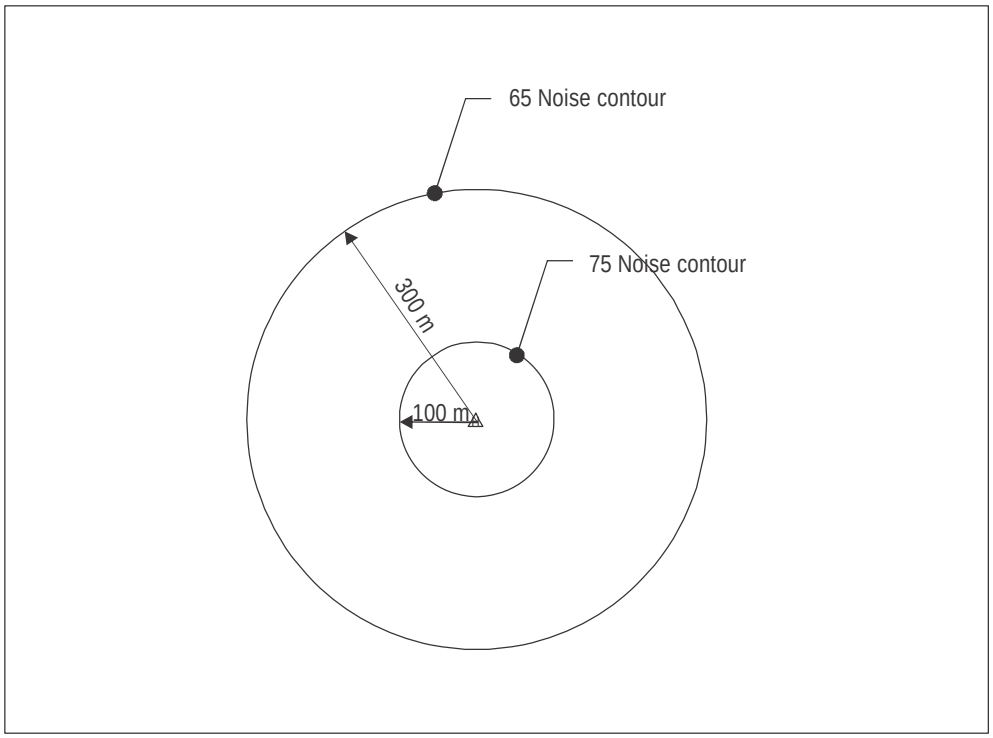

Figure A2-2. 75 and 65 noise contours for helipads

2.3.3 For helipads, the 75 and 65 noise contours are two concentric circles with radii of 100 m and 300 m, respectively, plotted from the geometric centre of the helipad, as shown in Figure A2-2 .

2.3.4 The five PEZR noise contours are calculated with computer programmes using DNL mathematical methodology. The night-time period, between 10 PM and 7 AM, must be considered for noise contours calculation.

2.3.5 The noise contours must be calculated for the runways systems planned for the airport infrastructure expansion, considering the estimated aircraft movements number and types in the end of the planning horizon.

2.3.6 The land-use compatibility for the PEZR is presented in Tables A2-1 and A2-2.

3. THE JAPANESE EXPERIENCE — ENVIRONMENTAL MEASURES AND LAND-USE PLANNING AROUND AIRPORTS

3.1 Land-use planning

In Japan, the Aircraft Noise Prevention Law (ANPL) does not provide a basis for land-use planning and control, because land-use planning and control are basically the responsibilities of local governments.

3.2 States best practices

In Japan, strong landownership prevents local governments from carrying out uncomplicated/straightforward control and/or land-use planning, and people generally prefer “soundproofing” rather than “removal of houses”. Consequently, there was no practical means to prevent new residents from building houses in the noise zones. However, the awarding of compensation was limited to those that had existed at the time the noise zones were designated, which in effect worked as a deterrent to prevent new construction of private houses.

3.3 Noise monitoring

3.3.1 The national government and airport authorities have carried out environmental remedial measures for reducing the impact of aircraft noise around fourteen designated airports for civil aviation, based on the “Law Concerning Prevention of Disturbance by Aircraft Noise in the Vicinity of Aerodromes for Public Use” (abbreviated Aircraft Noise Prevention Law (ANPL)), which was initially enacted in 1967 and amended in 1974, to eliminate specific incompatible land uses and to reduce noise impact at the receiver by sound insulation at the national government’s expense.

3.3.2 The amended law provides for:

a) subsidies to soundproof existing private houses as well as public buildings such as schools in a “Class-1” zone with 62 L_{den} or more;

b) compensation for relocating residents in a “Class-2” zone with 73 L_{den} or more; and

c) improvement to green buffer zones in a “Class-3” zone with 76 L_{den} or more. (Note that the “Class-1, 2 and 3” zones were previously defined as 75 WECPNL-Japan (WECPNLJ) or more, 90 WECPNLJ or more and 95 WECPNLJ or more, respectively, and “Class-1” zone was initially defined as 85 WECPNLJ or more.)

3.3.3 The Special Act for Aircraft Noise in Areas Surrounding Designated Airports was enacted in 1978. This law, under which Narita is the first and only airport to be designated up to now, provides for:

a) a zone that would be greater than 62 L_{den} ten years hence, schools, hospitals, residences and apartment complexes cannot be built without special soundproofing;

b) a zone in which the sound exposure ten years hence is expected to be over 66 L_{den}, called a “special noise protection zone”, the building of new residences is banned. The landowners can request the Narita Airport Authority to buy the land in question;

c) the “special noise protection zone” of the Special Act for Aircraft Noise in Areas Surrounding Designated Airports, the governor has the authority to order buildings presently in violation of the standards to be destroyed or relocated to less noise-sensitive areas;

d) where the land so cleared is owned by the national government, the land is then to be used for parks and playgrounds by the local governments, which must be free of charge;

e) the noise situation to be reviewed every five years based upon a forecast of ten years hence; and

f) a fine of up to 200 000 yen applicable for violation of the law.

3.3.4 The Special Act for Aircraft Noise in Areas Surrounding Designated Airports bans new residential home construction and requires local prefecture governments to make land-use plans. It requires dispensing compensation for the control of land use, which requires substantial funds. As it is not so long since the establishment of the New Tokyo (Narita) International Airport, the population density around Narita Airport is still not so high. But effective land-use control and planning is required. By this designation, construction of houses in areas where L_{den} is more than 66 dB was restricted, and sufficient soundproofing is obligatory in houses in areas where L_{den} is more than 62 dB. The Narita Airport Authority (NAA) will be able to advance noise countermeasures effectively by means of both compensation and planned land use.

3.3.5 Historically, aircraft noise around civil airports in Japan had become a serious problem soon after the introduction of jet aircraft into civil aviation early in the 1960s. For example, at Osaka International Airport, which had already been located in a highly urbanized area, noisy jet operations caused serious social problems and directly resulted in many lawsuits against the Government requesting both compensation for noise damage and enforcement of noise abatement measures, such as a ban of night-time activities, which was raised by residents in the vicinity of the airport through the middle of the 1970s. To solve the problem of such severe noise impact around airports, the Ministry of Transport took the necessary control measures at the sound's source, such as the banning of flight operations of jet aircraft in the night-time at Osaka and Tokyo International Airports. In 1967, the Diet enacted the ANPL, which provided for sound insulation of public buildings such as schools and hospitals, compensation for relocating people from noisy areas, etc., in order to improve people's living environments. But the World Exposition held at that time further increased jet operations at Osaka, which caused more complaints against noise as well as emissions and odours. Simultaneously, public nuisances at various industrial sites of material and products had clearly become a difficult problem. To solve such problems in a uniform manner, the national government enacted a "Basic Law for Pollution Control" in 1967, resulting in the establishment of the Environment Agency in 1971. Also in 1968, the Ministry of Transport founded a private sector organization "Aircraft Nuisance Prevention Association" (the present Airport Environment Improvement Foundation), which implemented a large field survey on aircraft noise around Osaka Airport and drew up noise contours around Osaka Airport, using WECPNLJ calculated approximately from noise levels and frequencies of noise events.

3.3.6 In 1973, the Environment Agency introduced the Environment Quality Standards for Aircraft Noise (EQSAN): 70 WECPNLJ or less in areas exclusively for residential use and 75 WECPNLJ or less in areas where ordinary living conditions are required. In the discussion leading to the EQSAN, the national government council for considering measures against public nuisances had stressed the importance of source noise control measures, land-use planning and control, and relocation and improvement of green zones in especially noisy regions.

3.3.7 In 1974, the ANPL law was amended to cover inadequacies in the original 1967 law such as the lack of subsidies for insulating private houses. During the discussion relating to the amendment, it was agreed that, on a long-term basis, future airport construction should be planned on the sea surface or on land after sufficient land-use planning around the proposed area. As for existing airports, on a long-term basis, it was decided to consider their removal to regions without severe noise impact. It was also decided, as environmental remedial measures for the time being, to relocate houses in the vicinity of airports (Class-2 and 3 zones) and redevelop the outer land area for noise-compatible planned use (Class-1 zone).

3.3.8 In the amended ANPL, the national government was also requested to cooperate with relevant local governments and to set up the organization of environmental improvements, if necessary. Two such semi-governmental organizations were established for Osaka and Fukuoka in 1974 and 1976.

3.3.9 In 1985, two organizations were merged into one organization with two headquarters located in Osaka and Fukuoka. In 2012, tasks related to Osaka International Airport were transferred to newly established New Kansai International Airport Company, which led to the abolishment of the headquarters in Osaka.

3.3.10 The main tasks of the current organization are;

a) the demolishing of buildings and the construction of a "green area" in zone-3;

b) redeveloping old areas near the airport;

c) payment of residential soundproofing; and

d) payment of compensation for land, buildings and relocation moving expenses.

4. LAND-USE PLANNING AROUND AIRPORTS IN SWITZERLAND

4.1 Land-use planning

In Switzerland, land-use planning and management are under the responsibility of the regional authorities, which are guided by the federal authorities. The federal law also indicates the method of determining noise around airports and how it should be considered/evaluated.

4.2 States best practices

4.2.1 A very close link exists between land-use planning (management) and noise. In Switzerland, the whole territory is assigned to a particular mode of land use. A degree of sensitivity ("DS", designated by the regional authority) characterizes building zones according to their land use:

— DS I: quiet area for relaxation, hospital;

— DS II: residential area (houses, residential buildings) without (even small) firms and industries;

— DS III: combined area with both residential and industrial activities; and

— DS IV: noisy area with industrial buildings only.

4.2.2 The basis of land-use planning and management is determined by combining the different degrees of sensitivity and the noise-exposure-limit values, as shown in Table A2-4.

4.2.3 Areas where planning values are not exceeded may be developed. Development, however, may not result in the emission values being exceeded. Areas where emission values are exceeded may not be developed.

4.2.4 It is also possible to change from one degree of sensitivity to another less stringent. For example, a modification of degree could make it possible to construct buildings in an area where this was previously not allowed. Thereby, another type of land use can be given to an area (e.g. modification from residential to small industries). The idea is to use lands close to airports for "noisy" activities and to make it possible to develop residential areas farther away.

4.3 Noise monitoring

4.3.1 In order to assess aircraft noise, the Swiss law deals with noise-exposure-limit values. These values, determined according to the noise impact contours of similar values surrounding the airports, are categorized in three types:

— planning values;
— emission limit values; and
— alarm values.

Table A2-4. Noise exposure levels

Degree of sensitivity	*Planning values Lr in dB(A)*		*Emission limit values Lr in dB(A)*		*Alarm values Lr in dB(A)*	
	Day	*Night*	*Day*	*Night*	*Day*	*Night*
I 3	5 3	4 3	55	4 5	60	5 5
I I	5 7	47/50[1]	60	50/55[1]	65	60/65[1]
I I I	6 0	5 0	65	5 5	70	6 5
I V	6 5	5 5	70	6 0	75	7 0

1. During the night, the highest values concern only the first night hour (22:00-23:00); the other values are for the second (23:00-24:00) and the last night hour (05:00-06:00). Between 24:00 and 05:00, airports are closed.

4.3.2 The values are modelled on the basis of the number of movements (ten-year forecasts taking into account the future development of the airport), the flight tracks and the fleet mix. Decibels A -dB(A) are used as units which are evaluated on an average level of noise based upon one-year operations (day: Lr = 16h Leq; night: Lr = 1h Leq for each hour).

4.3.3 By drawing these three contours on a map, the result can be described as noise zones. The noise exposure limit values have been defined by the federal authorities and take account of different annoyances according to the same level of noise on the basis of the period (day/night) and the sensitivity of the zone concerned (i.e. DS). For instance, the noise-exposure-limit values are lower in residential areas than in industrial zones. Similarly, the values are more severe during the night than during the day. (NB: night-time is defined as from 22:00 to 24:00 and from 05:00 to 06:00; there is no traffic between 24:00 and 05:00).

4.3.4 The Sectoral Plan for Aviation Infrastructure (SPA), approved by the Federal Council in October 2000, covered three national airports: Zurich, Geneva and Basle-Mulhouse. The SPA is a coordination instrument relating to spatial planning, transport policy and environmental policy. Its target is to coordinate flight operations and environmental protection requirements around airports (such as related to noise) in a consensus-oriented way. One of the main goals of SPA is to decrease the number of persons affected by noise and, above all, avoid affecting more people. The partners involved in the coordination are the federal, regional and local authorities on the one hand and the airport operators on the other. The aim is to jointly identify the potential future conflicts between airports (infrastructures and operations) and their surroundings. It is only by all partners reaching an agreement on the future potential situation (traffic growth, increasing noise charge and spatial development), that harmonized urbanization and sustainable airport development can be reached.

4.3.5 In the year 2013, the following statistics were recorded:

Zurich	262 193 aircraft movements	24 905 283 passengers
Geneva	188 767 aircraft movements	14 418 729 passengers
Basle-Mulhouse	91 153 aircrafts movements	5 853 104 passengers

4.3.6 The SPA contains indicative noise contours for all airports as a land-use management tool. Local and cantonal authorities have to take into consideration and respect the SPA in their development projects. SPA is clearly restrictive for land use. All parties involved in the development of airports are also bound by it.

4.3.7 By using this approach for noise problems around airports, Switzerland is on its way towards reaching its goals. In addition, the SPA has been established in such a way (coordination between all stakeholders) that it allows all partners involved to express their opinion efficiently, in order to eliminate or at least reduce potential conflicts.

4.4 Future predictions / source of conflict

In Switzerland, the mid-term forecast predicts an increase in traffic volume — both in the number of operations and in the number of passengers. Also, more people are living closer to airports and the demand for building permits is increasing as the availability of undeveloped land diminishes. This local congestion together with the forecast increase in traffic volume, and therefore noise, is the main source of conflict.

5. LAND-USE PLANNING AND ENVIRONMENTAL CONTROL AT FRANKFURT AIRPORT (GERMANY)

5.1 Land-use planning

Under German law, land-use planning is a step-by-step process, the responsibility for which lies in various hands. The Federal Republic of Germany and its states hold responsibility for the framework planning; this is then put into concrete form and implemented at regional and local levels. Plans which significantly change the essence of the airport are subject to an examination of their environmental compatibility as part of the planning approval process and may also, under certain circumstances, have to be examined for their compliance with Directive 92/43/EEC (Flora-Fauna-Habitat Directive).

5.2 Noise monitoring

5.2.1 In Germany, a noise protection buffer area exists around Frankfurt Airport in accordance with Article 4 of the German Air Traffic Noise Act (2007). This buffer area is defined as the envelope curve around three noise zones, two for daytime (6 am to 10 pm) and one for night-time (10 pm to 6 am). The inner day zone 1 is defined as the area in which the equivalent continuous sound level Leq3 caused by aircraft operations exceeds a value of 60 dB(A). Day zone 2 is defined as the area in which the equivalent continuous sound level Leq3 caused by aircraft operations has a value of 55 to 60 dB(A). The night zone is defined as the envelope curve of the Leq3(night) = 50 dB(A) contour and a contour in which per average night aircraft movements cause at least 6 events of maximum sound levels of 68 dB(A) L_{max} or above. In the whole noise protection buffer area, there is a general ban on new residential housing areas and new particularly

noise-sensitive institutions, such as hospitals, schools and kindergartens. Within day zone 1 and the night zone a noise insulation program had to be implemented for existing public homes, and existing particularly noise-sensitive institutions. The data necessary for determining what constitutes an area qualifying for protection from night- time noise are taken from an operational/traffic forecast. With 701.000 movements/year, it over-estimates the current actual amount of aircraft noise.

5.2.2 For the purposes of long-term noise protection, the German state of Hessen has additionally laid down a residence restriction zone around the airport, which locally reaches further than the noise protection buffer area implemented. In accordance with the German Air Traffic Noise Act of 2007, no new residential areas are to be given planning permission in this residence restriction zone.

5.3 Environmental control and management

5.3.1 A number of environmental measuring and monitoring schemes are in place at the Frankfurt Airport.

5.3.2 Since 1964, the Frankfurt Airport Operator (Fraport) has been operating an aircraft noise monitoring facility, which has been continually expanded and updated. The system currently consists of 28 stationary measuring points and three mobile measuring containers. In 1965, for the first time ever in Germany, the local government of Hessen took up the position of an independent body specifically responsible for aircraft noise at Frankfurt Airport, acting as an intermediary between the airport and the airlines on the one hand and the local residents on the other.

5.3.3 In 1966, the “Commission for Protection against Aircraft Noise at Frankfurt Airport” was brought to life, comprising, among others, representatives from the surrounding communities, the relevant authorities, and representatives from the airport, air traffic control and the airlines. The Commission has the task of advising the authorities responsible for granting planning permission and those responsible for air traffic control about measures to protect against aircraft noise and against air pollution caused by air traffic (§ 32b of the German Aeronautics Act).

5.3.4 In the early 1970s, Lufthansa, the Federal Administration of Air Navigation Services (DFS) (the former federal office for air traffic control) and Fraport AG Group (FAG) (Fraport’s predecessor) joined forces to develop the noise-reducing “Frankfurt flight approach” procedure, which has since become a global standard. In 1974, Frankfurt was the first airport in the world to give airlines a financial incentive to deploy quieter aircraft and to use the new flight approach procedure. This formed the basis for the method practised at a later date at all German airports, of charging different landing fees for loud and quieter aircraft types.

5.3.5 As part of the airport’s efforts to set up an air pollutant control system, a new facility for measuring air pollutants and airborne substances was brought into operation in 2002. While two stationary measuring containers determine the impact of air pollution on a continual basis, a third mobile measuring container gives the airport the opportunity to monitor the spread, in spatial terms, over the entire area affected. Moreover, the airport operates software tools for calculating emissions and their spread. Such tools can show the separate proportions of air pollution specifically relating to the airport and the airport’s vicinity.

5.3.6 There have been 370 measurement points set up to check the quality and composition of ground water at the airport premises and in the immediate vicinity, 240 of which are located directly on the airport premises. A large number of these measurement points are a component of the ground water quality control scheme which Fraport has been conducting for many years now. The local authorities and water boards are also involved in this scheme and can gain direct access to the data.

5.3.7 The airport’s compliance with all the clauses and stipulations of Germany’s water protection policies is supervised by a company representative specifically assigned to the task of water protection. There is a water protection alarm plan in place to assure that if any damage should occur, the problem is reported and corrected immediately.

5.3.8 There is a waste management plan in place in order to steer and control the flow of waste incurred at the airport. The airport's compliance with all the clauses and stipulations of Germany's waste management policies is supervised by a company representative specifically assigned to the task of waste management.

5.3.9 The airport prepares and updates a biotope report in connection with its preventative measures against bird strikes. This report, alongside the airport's general assessment of bird strike risk, provides significant guidelines regarding the content of the cultivation/biotope management plan at the airport and in its immediate vicinity. The landscape is cultivated in such a way as to make it unattractive to large bird species. The areas between the taxiways, amounting to some 500 hectares, probably constitute the region's largest non-agricultural area of greenery. One by-product of the airport's biotope management plan is that its surface areas boast a notably wide and valuable range of unusual plant and insect life.

5.3.10 In 1999, Fraport introduced an environmental management plan to steer and control its overall operational environmental protection policy. This meets the requirements of ISO 14001 and those of the more stringent European decree EC 761/2001 Eco-Management and Audit Scheme (EMAS). EMAS contains major, tighter requirements as to the examination of legal compliance and information available to the general public. Moreover, EMAS relates to the specific location and thus also includes indirect environmental factors not caused by the airport operator itself.

5.3.11 Within the framework of EMAS/ISO 14001, Fraport makes continual efforts to improve its environmental performance and to moderate the impact of the airport on the environment, wherever this is necessary and feasible. The following points should be mentioned in this context.

5.4 Soundproofing scheme

5.4.1 In October 2011, ahead of the inauguration of the new runway, a new soundproofing scheme was defined by the Hesse Government, based on federal law. This new scheme strives towards daytime and night-time peace for those residents living within an area particularly affected by aircraft noise. This involves, where necessary regarding the occurring noise level, installing of soundproof windows and sound-absorbing ventilation in houses within a specific area qualifying for protection from noise. The boundaries of the daytime noise area correspond to a noise contour within an equivalent continuous sound level of 60 dB(A). Those for night-time noise correspond to a noise contour defined by a combined criteria of, on average, six occurrences of night-time aircraft noise with a maximum noise level indoors of at least 53 dB(A) and an equivalent continuous sound level of 50 dB(A) take place. "Night-time" is defined as the period from 22:00 to 06:00 local time.

5.4.2 The data necessary for determining what constitutes the area qualifying for protection from night- time noise are taken from an operational/traffic forecast which over-estimates the current, actual amount of aircraft noise. The goal of the soundproofing scheme is to reach, on average, an equivalent continuous sound level of 40 dB(A) daytimes and 30 dB(A) night-times, each one for existing buildings. There are some 86.000 households located within the area qualifying for protection from night-time noise and 12.500 households within the area qualifying for protection from daytime noise. The scheme also includes all institutions particularly worthy of protection, such as kindergartens, schools, hospitals and retirement homes.

5.5 Noise and emission related fees

5.5.1 A tariff system linking take-off and landing fees with the aircraft noise actually measured was introduced and took effect on 1 January 2001, and has been continuously updated since then. This tariff system allows airports to differentiate even further than the ICAO classification system permits (Annex 16, Volume I, Chapters III and IV), and separates the various aircraft types into 16 different noise categories, based respectively on their take-off or approach noise level (either individually or as a group) measured by the airport's noise measurement facility. There is a substantial difference in the noise-related surcharges imposed between Class 1 and Class 16. At night, additional noise-related surcharges are imposed.

5.5.2 The purpose of this system is to give the airlines an even greater incentive to deploy state-of-the-art, quieter aircraft at Frankfurt Airport. Additional night-time surcharges are imposed on night-time flights, which are also differentiated according to the 16 noise classes, and noisy aircraft (marginal Chapter III) pay additional surcharges in the evening and early morning hours (20:00-08:00) and on weekends. This system is intended particularly to discourage the airlines from using noisy aircraft during the most sensitive periods.

5.5.3 On 1 January 2008, Frankfurt Airport and Munich Airport introduced an emission charge mainly based on the NOx-emissions of the aircraft. The charge is 3 € per kg NOx during a standard ICAO-LTO cycle, and is calculated for each individual aircraft. In the meantime, most major German airports have adopted this system. The purpose of the emission charge is to encourage airlines to order aircraft with low NOx engines to improve local air quality around the airport.

5.6 Night flight restrictions

The restrictions on night flights at Frankfurt Airport have increasingly been tightened, and flights are not permitted to be scheduled between the hours of 11:00 pm and 05:00 am. Late arrivals of aircraft scheduled before 11:00 pm are allowed until midnight. Late departures between 11:00 pm and midnight are possible only with individual permission by the air traffic authority. Between midnight and 05:00 am no exemptions are possible.

5.7 Ecological projects/environmental fund

Since 1997, Fraport has been giving its support to specific projects in the field of nature and environmental protection, environmental promotion and ecological research within a circumference of some 30 km around the airport. The environmental fund set up by the airport for this purpose has since sponsored more than 200 projects, investing a total amount of 13 million euros.

5.8 Compensation measures

For all airport planning work performed at Frankfurt Airport, Fraport undertakes every effort to keep the impact on nature and the surrounding landscape to an absolute minimum and implements compensatory and replacement measures if this is either not possible or is possible only to an insufficient degree. For the most part, such measures involve cultivating new biotopes or replanting forests.

5.9 Communications

The airport reports on its environmental management performance in various ways. Notably, every two years, it issues an environmental statement which is examined by an external expert, and in the years in between it releases abridged statements. It prepares an aircraft noise report twice a year, which the results of the aircraft noise measuring facility are shown and explained in detail. This report also provides information on current measures in place and new knowledge gained on the subject of aircraft noise. There is also an annual Air Quality Report. Furthermore, Fraport's website also provides a wide range of information on the topics of environment and planning. It also offers detailed information on the personal situation concerning noise pollution by an address-related approach.

6. ITALY'S LAND-USE PLANNING AND MANAGEMENT RELATED TO AREAS ADJACENT TO AIRPORTS

6.1 Current State policy on land-use planning and management related to areas adjacent to airports

6.1.1 In Italy, land-use planning and management is under the direct responsibility of Regions and Municipalities, in compliance with the National Regulatory framework.

6.1.2 A new approach-related to flight operations and additional and special rules on airport surroundings, is provided by the Italian primary legislation (Air Navigation Code) and other specific laws related to environmental issues.

6.1.3 In order to implement the Air Navigation Code provisions, the Italian Civil Aviation Authority (ENAC) has defined and issued technical requirements and policies about the land-use planning in areas adjacent to airports, in compliance with ICAO and EASA regulations, and identified as areas of constraint.

6.2 States best practices

The relation between the airport and its surroundings must be carefully analysed from two different points of view: flight operations safety issues and neighbourhood issues (safety and health).

6.3 Flight operations safety

6.3.1 The Italian Air Navigation Code provides specific requirements. Other requirements are issued by ENAC through specific regulation, endorsing ICAO Annex 14 into national regulation. In addition, specific requirements are provided for various hazards, such as photovoltaic installations dazzle, lasers dazzle, and wildlife strikes.

6.3.2 Related constraints provide specific requirements for buildings, constructions and human activities in the ATS of the airport and are related to Instrumental Procedures Surface, Building Restricted Areas (BRA ICAO EUR DOC 015) for CNS facilities and other provisions issued by ENAC.

6.3.3 These requirements are collected/shown on a map called "*Mappa di Vincolo*" provided, published and approved by local municipalities in agreement with ENAC. After the map is approved, the municipality has to adjust all the local planning accordingly, and consequently, can authorize new buildings assuring that their height complies with the applicable constraints and that the potential risk to air navigation is minimized.

6.4 Neighbourhood safety and health

6.4.1 The Air Navigation Code foresees two typologies of planning tools, developed by ENAC:

a) The first is a Risk Management Plan, for all civil airports, drawn up and adopted by the local Administration, based on the criteria fixed by ENAC regulations. Each Risk Management Plan is produced and developed by the local municipality and approved by ENAC.

b) The second is a constraint related to the Third-Party Individual Risk Analysis, also requested by the Air Navigation Code, Third-Party Individual Risk Analysis. This planning tool limits anthropic levels through limitation of people in the areas and avoiding specific activities (e.g. shopping center). These restrictions apply to new buildings and new activities.

6.4.2 The Risk Management Plan allows the identification of land use not compliant with the level of exposure to the risk generated by a potential aircraft incident and provides limitations for the number of people who live, work or are present in the surroundings. Figure A2-3 and A2-4 show the different layout of the Risk Management Plan for airports with runway lengths classified codes 1 and 2 or codes 3 and 4.

6.4.3 For each area, ENAC regulations provide guidelines in order to avoid the presence of building typologies related to the presence of a large number of people, such as a shopping center, sports stadium, huge convention center, etc. Furthermore, in such zones closer to the runway, the land use must prevent and limit the construction of new residential areas.

6.4.4 The footprint of the plan has been defined by ENAC on the basis of its own database that considers aircraft accidents that have occurred worldwide in last fifteen years.

6.4.5 In addition to the Risk Management Plan, the Italian regulation foresees the second tool (a constraint related to the Third-Party Individual Risk Analysis, also requested by the Air Navigation Code, Third-Party Individual Risk Analysis) in the case of airports with a traffic volume at least of 50 000 movements per year (current or planned in the Airport Master Plan). this tool is . ENAC has developed a model to assess the Third-Party Risk. The model defines the Public Safety Zones (PSZs) which regulate the destination of use of the territory. ENAC lists those zones for the local Municipalities which take them into account in defining their urban plans. Similar to the Risk Management Plan, the Third-Party Individual Risk analysis limits anthropic level through limitation of people in the areas, avoiding specific activities, imposing a construction burden and, in the highest risk areas, displacing specific activities or buildings outside the safety zones.

6.5 Airport noise management

6.5.1 The main reference within the Italian noise regulation is the Ministry of Environment Decree 31/10/1997 – “Measurement methodology of airport noise, in enactment of the Law n. 447/95". The Italian CAA manages Noise Pollution issues generated by airports through local departments.

6.5.2 A special Commission, chaired by ENAC, approves the mapping of noise contours and cleared zones, in cooperation with the Ministry of Environment, Public Agencies, Regions and local Municipalities.

6.5.3 After the approval of the maps, local Municipalities must modify and give compliance to their urban plans on land-use forecasting.

6.5.4 The Italian regulations consider scientific indicators for the airport noise measurement (LVA) and tree-homogeneous zones for perceived noise levels (noise contours): “A” zone with LVA between 65 and 60 dB(A), “B” zone with LVA between 75 and 65 dB(A) and “C” zone with LVA over 75 dB(A).

6.5.5 In two of these three zones, anthropic activities are limited; in particular, in “B” zones, residential activity is not permitted and any other activity (farming or raising livestock, industrial and similar commercial activities, tertiary or ancillary) are allowed following the adoption of appropriate sound insulation measures. In “C” zones, activities are allowed only if functionally related to the use of airport facilities and services.

6.5.6 In the airport surroundings, noise reduction requirements are defined by ENAC in a specific document.

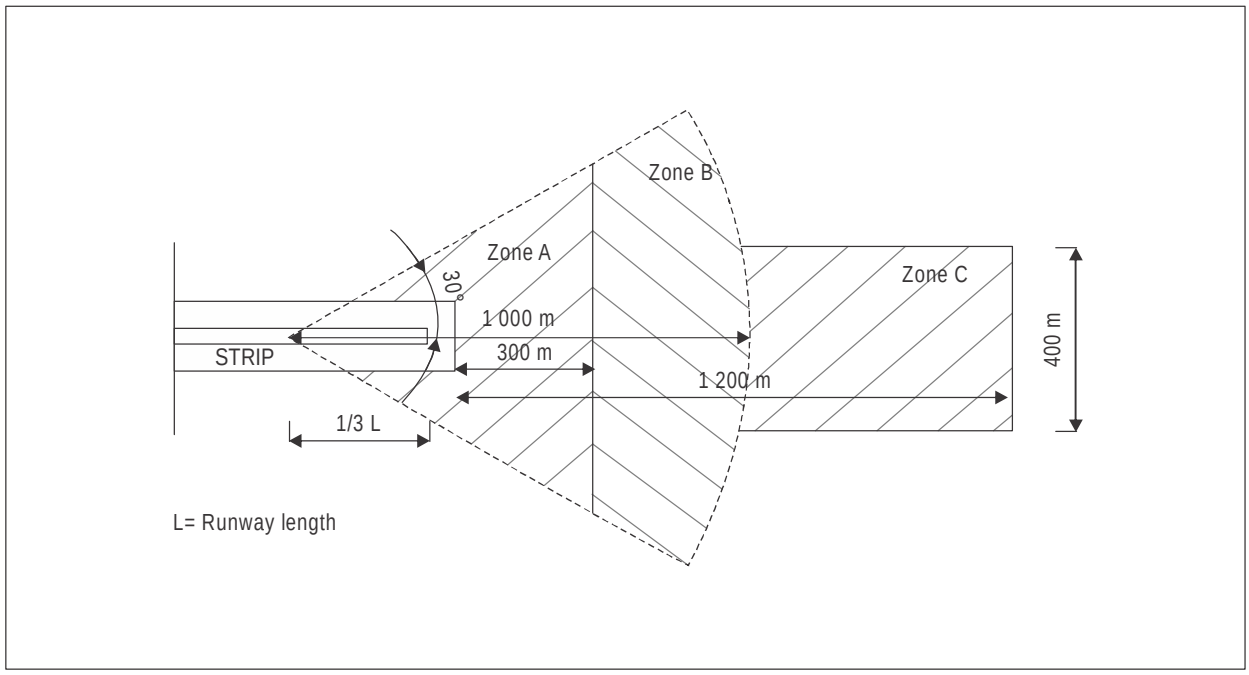

Figure A2-3. Airports with runway lengths classified codes 1 and 2

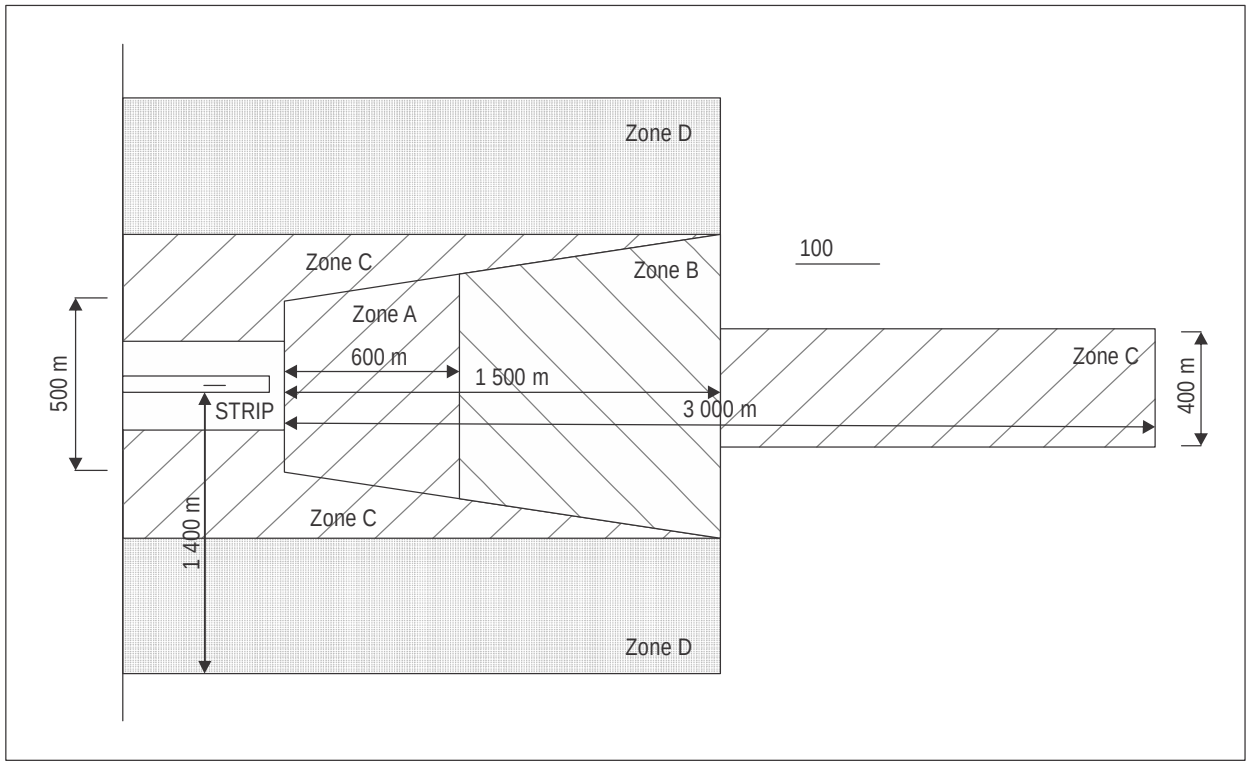

Figure A2-4. Airports with runway lengths classified codes 3 and 4

6.6 Airports Master Plans

6.6.1 Airport Master Plans are drafted by the airport managing company based upon a procedure that involves a preliminary approval by ENAC, an environmental impact assessment by the Ministry of Environment and an urban assessment by the Ministry of Public Works and Transportation, in cooperation with regional and local Authorities to ascertain the proposal's compliance with urban planning. The target is to reach an agreement between the administrations, and integrate the airport development with Regions and Municipalities plans and policies. The final approval is granted by ENAC: it implies a declaration of public utility and benefit of the works reported in the Master Plan and a formal alteration to the local urban planning and related planning instruments.

6.6.2 In this way, the land-use forecast elaborated in the Master Plan in a given timelapse scenario becomes prescriptive and binding.

7. LAND-USE PLANNING AND MANAGEMENT AROUND AIRPORTS IN SWEDEN

7.1 Land-use planning

7.1.1 In Sweden, land-use planning is the prerogative of municipalities. The Swedish Transport Administration is involved in the land-use planning process as a party in the consultation procedure. The Swedish Transport Administration provides relevant information about, and sees to, the interests of the aviation sector in the planning processes. These include, among others, noise restriction areas and obstacle limitation surfaces around airports including areas of interest for the future expansion of the airports.

7.1.2 The major airports in Sweden are designated by the Swedish Transport Administration to be of national interest for transport and communication in accordance with Swedish law. This means that the County Administrative Boards have the obligation to check that the above-mentioned interests of the airports are protected in the planning processes.

7.2 Noise monitoring

7.2.1 In 1996-97 the Swedish government adopted national guidelines for traffic noise which should not be exceeded when building new residential buildings or erecting infrastructure including major reconstructions. These are:

— 30 dB(A) as an equivalent indoor level;

— 45 dB(A) as a maximum indoor level at night;

— 55 dB(A) as an equivalent outdoor level (by the facade); and

— 70 dB(A) as a maximum level at a patio connected to the building.

7.2.2 For aircraft noise, the outdoor level is set to FBN 55 dB(A), which is a noise index identical to L_{den}.

7.2.3 The national guidelines include two steps to reduce aircraft noise exposure. The first step has already been achieved at most of the Swedish Airports. As a second step, noise insulation of buildings should at least include properties exposed to the following noise levels outdoors:

— FBN 60 dB(A);

— 70 dB(A) as a maximum level, when the noise event occurs on average three times per night;

— 80 dB(A) as a maximum level, when the noise event occurs regularly during daytime and in evenings; and

— 90 dB(A) as a maximum level, when the noise event occurs regularly during daytime on weekdays only and during occasional evenings.

7.2.4 The Swedish Environmental Courts have, in several cases, established terms for reductions of aircraft noise that go beyond the goal of the second step

8. LAND-USE PLANNING AND MANAGEMENT AROUND AIRPORTS IN CUBA

8.1 Land-Use planning

State policies on land-use planning and management adjacent to airports are under the control of the Directorate of Civil Aerodromes Aeronautical Institute of Cuba (IACC). The management is done in close coordination with the National Institution that controls the politics of policy planning and organizational charting, which covers physical addresses planning governance structures throughout the country. The legal standard governing the approval process for new development programmes is the Resolution No. 91/06 of the Ministry of Economy and Planning. Section 1, Chapter 1X — Authorization of land use — indicates that the location of investments is established from the plans and studies of Zoning and Planning, which according to their characteristics and peculiarities are analysed by the IACC. Thus, all proposed construction or investment in land adjacent to the airports reach the IACC Address Aerodromes.

8.2 Noise monitoring

The International Standard 26 was established in 1999 — Noise Habitable Zones — Health Hygienic Requirements This standard specifies the method for measuring the sound level, which is used as an indicator of environmental noise with possible forecast models and maximum tolerable levels eligible in living areas, both inside the home and in the surrounding urbanized areas.

8.3 States best practices

8.3.1 The Cuban government considers all recommendations worldwide that are compatible with the attenuation or elimination of all production procedures harmful to the environment and human health. Throughout, the Cuban policy should also contribute to the welfare of human beings.

8.3.2 The IACC state duties are to incorporate the environmental dimensions between policies, plans, projects, programmes and other actions to be in line with the economic and social sustainable development.

8.4 Unsuccessful practices

No unsuccessful practices.

9. LAND-USE PLANNING AND MANAGEMENT AROUND AIRPORTS IN ETHIOPIA

9.1 Land-use planning

Current state policy on land-use planning and management is proactive toward safe aviation operations. The amended aviation act gives a legal basis for land-use planning and management around airports in Ethiopia.

9.2 States best practices

9.2.1 The areas around the airports are declared to be the Aviation zone, in accordance with the specifications of ICAO Annex 14 to Chicago Convention; so that, all land-use requirements are included in the municipality's Master Plan regulations. Aany construction in these areas require the Ethiopian Civil Aviation Authority's approval prior to construction. The ECAA Act basically requires permission from the Civil Aviation Authority prior to any development in the vicinity of an airport.

9.2.2 There is a close relationship and arrangements among the Municipality, Airport Operator and the Civil Aviation Authority in the use of areas adjacent to airports. Upon receiving a request for development adjacent to an airport, the municipality first figures out the necessary requirements based on the ECAA Act and sends a request to the Civil Aviation Authority. The Civil Aviation Authority then studies the proposal with priority to ensure safety of flight operations prior to granting permission and only then may development proceed.

9.3 Unsuccessful practices

There have been no reports of unsuccessful practices.

10. LAND-USE PLANNING AND MANAGEMENT AROUND AIRPORTS IN JORDAN

10.1 Land-use planning

The civil aviation regulator in Jordan, namely, Civil Aviation Regulatory Commission (CARC) is fully mandated, by the power of the basic Civil Aviation Law of 2007, to manage the land-use planning around public airports. Such mandate was reinforced by a Council of Ministers/Cabinet resolution as part of the state policy to maintain the safe operation of aircraft within the Jordanian airspace and its public airports. Accordingly, the intervention of CARC on the subject of land-use planning goes further than the boundaries of public airports (when deemed necessary). Nevertheless, to secure the integrity of its assignment, CARC’s has based its mandate on the following criteria:

— Protection of national airspace and the surrounding area of public airports from industrial obstacles hazards;

— The environmental factors which have a direct impact on the safety of air navigation and land-use planning around public airports;

— The governmental strategic initiatives, with regard to the alternate electrical power supply projects, such as, generating the electrical power from wind power, solar systems panels, oil shale rocks, and peaceful nuclear power.

10.2 States best practices

10.2.1 In order to control the reliability of the land-use planning practices around public airports and outside its boundaries (when deemed necessary), CARC has formed a specialized committee chaired by an aerodrome expert, including specialists from all the related civil aviation's specialists: ATS; CNC; Commercial Pilot; Aviation Environment and AIS).The committee has been delegated to tackle, through studying and evaluating the applications, are received by CARC from the related governmental agencies, the public and the private sector, and to conduct the required aeronautical studies and risk assessments to ensure the implementation of the state policy as stated above. The terms of reference that govern the said committee's procedure is based on the following legal and technical references:

1. The Civil Aviation Law No.41 of 2007;
2. Jordan Civil Aviation Regulations No. 77 (Objects affecting Navigable Airspace);
3. Jordan Civil Aviation Regulations No.150 (Noise Compatibility Planning);
4. Jordan Civil Aviation Regulations No. 301 (Civil Aviation Environmental Regulations);
5. The Regulatory Advisory Circular on Establishment of landfill/ Solid Waste Near Airports;
6. Annex 14 Vol. I / Chapter 6 entitled "Visual Aids for Denoting Obstacles"
7. The determination of CARC on the limitation of the commercial Solar Systems Panels' project locations near the public airports.

10.2.2 To strengthen the States best practices and to control and manage the land-use planning at the national level with reference to the aforesaid criteria, the responsibilities of the governmental and military agencies are consigned, in a precise approach, as follows:

— The Civil Aviation Regulatory Commission is the only entity that, is authorized by the power of the law to tackle land-use planning and air navigation safety;

— The governmental and the military agencies shall provide the Royal Jordanian Geographical Centre with updated data regarding the industrial obstacles;

— The Royal Jordanian Geographical Centre has to bring up to date its obstacle database after receiving the above-mentioned data, in order to fulfill the ICAO requirements concerning e-TOD in coordination with CARC;

— The Jordanian airspace users, who exercise low flying aircraft operations, are obliged to notify CARC about any disrupted obstacle or any surveillance observation that may jeopardize air navigation safety, such as a highrise building within the vicinity of any public airport;

— Every related agency is in charge of overseeing the effectiveness and sustainability of obstacle lighting and marking, which falls under its jurisdiction as per CARC's requirements;

— The land planning authorities, local municipalities and Ministry of Environment are accountable for implementing CARC's requirements, which are interrelated to the landfill locations and the locations of the facilities that may constitute a potential attractant to wildlife/birds. Furthermore, the land planning authorities shall implement all the governing measures to reduce civil aviation noise up to the acceptable levels around public airports in coordination with CARC.

— The Ministry of Power and Mineral Resources is responsible for implementing CARC's requirements concerning the renewable energy projects locations.

— The Ministry of Public Works and Housing by the use of its Construction Codes Committee has the authority to include CARC's requirements concerning the best construction practices, in order to decrease the noise level at the areas that border public airports and similarly for highrise building lighting specifications.

10.3 Unsuccessful practices

The only unsuccessful practice in Jordan is the incompatibility of the land-use planning around the oldest Jordanian airport (Amman / Marka International Airport), beyond the instituting of the Civil Aviation Regulatory Commission. Such incompatibility of the land-use planning constitutes a crucial concern as the land planning authority has issued construction licences without considering the penetration of the OLS and the acceptable indoor noise levels. However, presently, the remaining unused lands are under the full control and management of CARC and the land planning authority is committed not to issue any construction permit without the consent of CARC.

11. LAND-USE PLANNING AND MANAGEMENT AROUND AIRPORTS IN MAURITIUS

11.1 Currents State policy on land-use planning and management related to lands adjacent to airports

11.1.1 The Airport Master Plan, 2004, offers extra development potential with additional capacity provided by a second runway and additional areas allowing for a new dedicated passenger terminal, general aviation terminals, Freeport cargo areas, etc. The Airport Master Plan indicates land required for the operational areas and all the landside facilities. These areas need to be safeguarded from other residential and industrial development. The expansion of the airport also has implications for future development within the District both with regards to height and noise. As per the Airport Master Plan, the forecasted passenger traffic for 2022 is 5.3 million passengers with yearly aircraft movements of 38 500 aircraft.

11.1.2 With a view to protect land for future airport expansion and control development around the airport, the Grand Port Savanna Outline Planning Scheme 2006 was developed by the Ministry of Housing and Lands in accordance with the provisions of the Town and Country Planning Act 1954. The Outline Planning Scheme provides, amongst others, the legal and strategic framework for the planning, shaping and control of land use and height control within the vicinity of the airport.

11.1.3 The Grand Port Savanna Outline Planning Scheme 2006 makes provision for Noise Exposure Areas, based on a two runway configuration. Four noise exposure areas, subject to high noise impact, have been identified and integrated in the Outline Planning Scheme. These are:

1) Zones where some acoustic protection is required to new housing if permitted;

2) Zones where no new residential micro-element should be permitted. Only infill development in existing built-up areas are allowed, subject to acoustic protection;

3) Zones where no residential development should be allowed; and

4) Zones where existing houses should be relocated.

11.1.4 The Outline Planning Scheme also includes the Obstacle Limitation Surfaces (Approach Surface, Transitional Surface, Inner Horizontal Surface, Conical Surface and Outer Horizontal Surface) which are subjected to height control. Any construction within these surfaces requires a “No Objection Certificate” from the Director of Civil Aviation. Also, the Pleasance Airport (Building Restrictions) Act 1964 provides height restrictions within the vicinity of the airport.

Appendix 3

FACT SHEETS ON LAND-USE PLANNING MEASURES RELATED TO AIRPORTS, AS PRACTICED IN VARIOUS COUNTRIES

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

€	EURO. Currency in some Member States of the European Union
ANEF	Australian Noise Exposure Forecast method
B	Noise exposure metric in Kosten units used in the Netherlands
Bkl	Noise exposure metric in Leq for light aircraft used in the Netherlands
Chapter 2 aircraft	Aircraft with a noise certificate according to Annex 16 — *Environmental Protection*, Volume I — *Aircraft Noise*, Chapter 2
CHF	Swiss franc (national currency of Switzerland)
CNEL	Continuous Noise Exposure Level (= leq)
dB(A)	decibel with A-weighting, measure for noise
DENL	Day-Evening-Night noise Level (used in Denmark)
DNL	Day-Night noise Level (used in the United States)
EC	European Commission
EEC	European Economic Community
EFN	Norwegian noise exposure index (similar to CNEL)
EPNL	Effective Perceived Noise Level in EPNdB, used for aircraft noise certification
FBN	Swedish noise exposure index (similar to Ldn)
IP	Index Psophic method used in France
Ke	Kosten method used in the Netherlands
L_{aeq}	Equivalent noise level in dB(A)

L_{amax}	Maximum noise level in dB(A)
L_{dn}	Equivalent noise level in dB(A) with day and night weighting
L_{den}	Equivalent noise level in dB(A) with day, evening and night weighting
L_{eq}(16h)	Equivalent noise level for a period of time (i.e. 16h period)
L_{eq}	Specific equivalent noise level in dB(A) used in Germany
MFN	Norwegian noise exposure index (similar to L_{amax})
NEF	Noise Exposure Forecast
NNI	Noise and Number Index, noise calculation method used in Ireland and Switzerland (until 1997)
VFR	Visual flight rules
Won	National currency of the Republic of Korea
WECPNL	Weighted Effective Continuous Perceived Noise Level in EPNdB, used in Japan and the Republic of Korea
WNI	Weighted Noise Index
Yen	National currency of Japan

Country:	AUSTRALIA	Major airport(s)	Other airports
		Sydney Melbourne Brisbane Perth Adelaide Gold Coast Cairns Canberra Hobart Darwin	Thousands of small aerodromes and airstrips

Land-use planning	— Land-use planning is applied at all airports. — The State and local authorities are responsible for land-use planning. — The Australian noise metric is the Australian Noise Exposure Forecast (ANEF) system. ANEFs are the official forecasts of future noise exposure patterns around an airport and they constitute the noise contours on which land-use planning authorities base their controls. — The ANEF system was developed as a land-use planning tool aimed at controlling encroachment on airports by noise-sensitive buildings. The system underpins Australian Standard AS2021 'Acoustics—Aircraft noise intrusion—Building siting and construction'. The Standard contains advice on the acceptability of building sites based on ANEF zones. — The acceptability criteria vary depending on the type of land use. However, the most crucial criterion specifies that land with an aircraft noise exposure level of less than 20 ANEF is acceptable for the building of new residential dwellings.
Type of measures used for most airports	— Comprehensive planning — Noise zoning — Noise insulation programmes (only around Sydney Airport and Adelaide Airport) — Land acquisition and relocation (only around Sydney Airport and Adelaide Airport) — Real estate disclosure (around some airports) — Noise-related landing charges (only for Sydney Airport and Adelaide Airport)
Noise monitoring	A Noise and Flight Path Monitoring System (NFPMS) collects noise and flight path data at Brisbane, Cairns, Canberra, Gold Coast, Sydney, 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. 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.

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.

Noise insulation schemes

In 1994, a noise insulation programme was introduced around Sydney Airport and in 2000 an equivalent programme was introduced around Adelaide Airport. These programmes were financed by the airlines through a noise levy imposed on top of the landing fee of all jet aircraft using the airports. These programmes are now closed and all eligible residential buildings have had the opportunity to be insulated.

The noise limits for the insulation programme were:

Over 40 ANEF – acquisition of noise-sensitive buildings
40 – 30 ANEF – residences are insulated
30 – 25 ANEF – public buildings are insulated

Over 4000 residences (including apartment buildings) were insulated under the Sydney insulation programme, and over 600 under the Adelaide programme. Additionally, a number of public buildings including schools, churches, nursing homes, childcare centres and hospitals were insulated in both cities as part of the respective programmes.

Indoor noise level targets were as follows:

The noise limits for the insulation programme are:

over 40 ANEF — acquisition of noise-sensitive buildings

40 – 30 ANEF — residences are insulated

30 – 25 ANEF — public buildings are insulated

The number of residences (including apartment buildings) in the insulation programme is approximately 4 750.

There are also 21 schools, 1 hospital, 7 nursing homes, 21 childcare centres and 24 churches.

Indoor noise level targets are as follows:

Schools	
libraries, study areas	50 dB (A)
teaching areas	55 dB (A)
Nursing homes/hostels	
bedrooms	50 dB (A)
living areas/TV rooms	55 dB (A)
social activity areas	70 dB (A)

	Childcare centres sleeping areas 50 dB (A) other areas 55 dB (A) Churches religious activities 50 dB (A) Hospitals wards and theatres 50 dB (A) laboratories 65 dB (A) service areas 75 dB (A)
Enforcement of noise zoning	State Government, rather than the Federal Government, has jurisdiction over local authorities who are limited by State Government planning legislation. State planning legislation does not however provide mandatory land-use planning controls on all development and building situations.
Noise charging schemes	Apart from levies under the previous noise insulation programmes at Sydney and Adelaide, no other noise charges are applied at Australian airports.
Other land-use planning measures for non-noise impacts	The National Airports Safeguarding Advisory Group (NASAG), comprising Commonwealth, State and Territory Government planning and transport officials, the Australian Department of Defence, the Civil Aviation Safety Authority, Airservices Australia and the Australian Local Government Association, has developed the National Airports Safeguarding Framework (NASF). The NASF is a national land-use planning framework that aims to ensure that aviation noise and safety requirements are recognized in land-use planning decisions through guidelines being adopted through State and territory jurisdictions. The NASF has implications for anyone working in town planning, residential or commercial development, building construction or related industries. It consists of a set of guiding principles with six guidelines relating to: — managing the impacts of aircraft noise; — building generated windshear and turbulence; — wildlife strikes in the vicinity of airports; — wind turbine installations (wind farms) and wind monitoring towers; — distractions to pilots from lighting in the vicinity of airports; and — intrusions Into the Protected Operational Airspace at Airports. It is the responsibility of each jurisdiction to implement the NASF into their respective planning systems. Each State and territory will align their respective planning processes with the NASF principles and guidelines as appropriate.

Country:	AUSTRIA	Major airport(s)	Other airports
		Vienna	Graz Innsbruck Linz Salzburg

Land-use planning	Applicable to all airports. According to the Austrian constitution, land-use planning falls under the jurisdiction of the Austrian provinces. However, during the preparation of a new Austrian "noise abatement law", the Department of Civil Aviation negotiates with the provinces to include a coordination procedure in land-use planning measures. To reduce noise in the vicinity of airports, the Austrian ordinance *Zivilluftfahrzeug — LŠrmzulŠssigkeitsverordnung* (ZLZV) of 1995 is much more stringent than the EU directive 92/14–EWG. Operation of Chapter 2 aircraft is almost eliminated at the Austrian airports. At Vienna Airport, Chapter 2 jets are only permitted during daytime between 06.00 and 22.30 hours local time. Presently, discussions are under way to reduce the time window from 06.30 to 22.00 hrs. The result of this "early ban" of Chapter 2 jets has led to a remarkable reduction of the noise zones around airports.
Type of measures used for most airports	— Comprehensive planning — Noise zoning
Noise monitoring	Noise monitoring, including flight tracking, is practiced around Vienna and Salzburg airports.
Noise insulation schemes	Since 1980, the Leq 66 dB(A)-contour (based on the traffic over the busiest half of the year) around Vienna Airport has been shrinking and no housing is located within this contour.
Enforcement of noise zoning	Unknown.
Other land-use planning measures for non-noise impacts	Unknown.

Country:	BANGLADESH	Major airport(s)	Other airports
		Harzrat Shahjala International Airport, Dhaka Shah Amanat International Airport, Chittagong	Osmani International Airport Cox's Bazar, Jessore, Rajshahi Saidpur, Barisal

Land-use planning	Applicable to all airports. The urban land-development board/authority or municipal corporation, as applicable, is responsible for land-use planning.
Type of measures used for most airports	— Comprehensive planning; — Building codes applicable to all new buildings in the vicinity of airports.
Noise monitoring	— Not applicable for most of the airports; — Have future plan for concerned airports.
Noise insulation schemes	— Not applicable for most of the airports; — Have future plan for concerned airports.
Enforcement of noise zoning	Not applicable now.
Noise charging schemes	Not applicable now.
Other land-use planning measures for non-noise impacts	Not applicable now.

Country:	BELGIUM	Major airport(s)	Other airports
		Brussels/Zaventem	In Flanders: Antwerp/Deurne Kortrijk Oostende In Wallonia: Liège/Bierset Charleroi

Land-use planning	Applicable to all airports. Royal Decrees and Ministerial Decisions refer only to the Brussels/Zaventem National Airport. Both Flanders and Wallonia have their own regional regulations.
Type of measures used for most airports	Comprehensive planning.
Noise monitoring	Noise monitoring, including flight tracking, is practised around the Brussels/Zaventem Airport.
Noise insulation schemes	Not applicable.
Enforcement of noise zoning	Not applicable.
Other land-use planning measures for non-noise impacts	Noise contours are calculated in Leqs for the Brussels/Zaventem Airport in order to assess the effects of changes in flight tracks over populated areas.

Country:	BOTSWANA	Major airport(s)	Other airports
		Sir Seretse Khama International Airport Maun International Airport Kasane International Airport Francistown International Airport	Selibe Phikwe Airport Ghanzi Airport

Land-use planning	The Department of Town and Regional Planning is responsible for spatial planning nationally, however, individual municipalities are responsible for planning in their respective districts. The Minister responsible for Civil Aviation is empowered to impose prohibitions or restrictions on the use of any area of land or water as may be necessary to ensure safe and efficient civil aviation. The Civil Aviation Authority is responsible for land-use control and control of obstacles in the vicinity of any airport or airfield. Botswana does not yet have noise zoning regulations, however, Botswana Bureau of Standards is in the process of developing the national standards for noise and noise impact assessment guidelines. The noise metric mostly in use at Botswana airports is the Noise and Number Index (NNI). FAA's Integrated Noise Model (INM) was used to calculate the NNI aircraft noise contours at SSKI and Maun airports. The Environmental Impact Assessment Study commissioned in the year 2000 for all the major airports had however used the Ldn metric.
Type of measures used for most airports	— Comprehensive planning. — Environmental impact assessment. — Land acquisition and relocation of property (Maun airport only). — Noise barriers (SSKI airport). — Buffer zone (Maun airport). Comprehensive plans dependent on extensive consultations and environmental impact assessments are developed for each new airport development or major airport improvements, etc.
Noise monitoring	Noise monitoring is not effected at any of Botswana airports.
Noise insulation schemes	Noise insulation schemes are not practised.
Enforcement of noise zoning	Noise zoning is not practised in Botswana.
Noise charging schemes	Not practised.

Other land-use planning measures for non-noise impacts	Environmental impact assessments are carried out for each new airport development or major airport improvements. Besides the forecasting of noise levels the EIAs look into air quality studies and bird/wildlife hazard management studies based on the baseline and projected air traffic. Extensive consultation with all stakeholders and socio-economic reports are all factors in land-use planning around airports in Botswana.

Country:	BRAZIL	Major airport(s)	Other airports
		São Paulo Intl. Airport Rio de Janeiro Intl. Airport Brasília Intl. Airport	Viracopos Intl. Airport Santos Dumont Domestic Airport Congonhas Domestic Airport

Land-use planning	— All airports must have a noise zoning plan. — Airport operators must submit the noise zoning plans to the National Civil Aviation Agency – ANAC. — Brazilian Regulation for Civil Aviation RBAC 161 regulates the noise zoning plans, with the residential incompatibility starting at 65 dB DNL. — Local authorities should incorporate noise zoning plans and land-use measures into local plans.
Type of measures used for most airports	— Noise zoning plan. — Airports with more than 7 000 aircraft movements per year must implement an Airport Noise Management Commission, responsible for noise mitigation actions. — Airports with more than 120 000 aircraft movements per year and with 50% or more of the noise zoning plan's 65 dB DNL contour area occupied by residences must implement noise monitoring. — Operational restrictions may be applied.
Noise monitoring	Permanent noise monitoring is being installed in São Paulo International Airport, Brasília International Airport and Santos Dumont Domestic Airport (Rio de Janeiro).
Noise insulation schemes	Noise insulation may be required for specific land-uses in certain areas of the noise zoning plan.
Enforcement of noise zoning	— The application of noise zoning plans in the land use should be conducted by local authorities. — Airports should monitor the ongoing developments through the airport management commission.
Noise charging schemes	— Noise charging schemes are not implemented in Brazil.

Other land-use planning measures for non-noise impacts	— Federal Law 12725/2012 defines the Airport Safety Area – ASA, a circle area of 20 km radius around the airports, where wildlife attractant activities are not allowed. — Local authorities are responsible to inspect the ASA and to control the land-use within that area.

Country:	CANADA	Major airport(s)	Other airports
		Calgary Edmonton Halifax Montréal/Dorval Montréal/Mirabel Ottawa International Toronto/L.B.Pearson Vancouver Victoria Winnipeg	Gander Quebec City Regina Thunder Bay Saskatoon St. John's + hundreds of smaller aerodromes

Note.— The Canadian airport system is in transition, with the operation and management of the airports being transferred from the Federal Government to local authorities under a lease arrangement. The ownership of land of 26 national airports will however remain with the Federal Government. Meanwhile, noise management is not expected to change substantially as the Federal Government will retain regulatory control over flight procedures, including those related to noise abatement, and land-use control will remain at the provincial/municipal level.

Land-use planning	All airports in Canada are encouraged to promote land-use planning for compatibility with surrounding lands. The Federal Government produces guideline material that is based on social response to aircraft noise. Airports, in turn, promote acceptance of the guidelines in the municipalities they serve. Under the constitution of the country, provincial governments have responsibility for land-use planning and these governments, for the most part, delegate this responsibility down to municipalities. Provincial governments retain the power to overrule a municipal decision upon appeal from an individual. With respect to national airports, municipalities control land use within policy frameworks established by provincial governments. Provincial governments rely, to varying extent, on federally sponsored aircraft noise impact guideline material to establish policy. The Canadian noise metric for aircraft noise is the NEF method. Incompatible land use (especially residential housing) may begin as low as NEF 25. At NEF 30, speech interference and annoyance caused by aircraft noise are, on average, established and increasing. By NEF 35, these effects are very significant. New residential development is therefore not compatible with NEF 30 and above and should not be undertaken. The airports with the most traffic are those that are heavily involved in land-use planning. They are: Toronto/L.B.Pearson, Montreal/Dorval, Vancouver, Calgary, Winnipeg, Edmonton, and Ottawa International airports, and smaller sites including Saskatoon, Regina, Thunder Bay, Quebec City, and St. John's.

Type of measures used for most airports	— Comprehensive planning — Noise zoning[1] — Subdivision regulation — Building codes[2] — Tax incentives
Noise monitoring	Flight tracking systems are in place in Vancouver, Calgary, Winnipeg, Toronto/Pearson, Montreal/Dorval, and Ottawa International airports as well as Toronto/City Centre and Edmonton municipal airports. These systems are used to provide evidence for enforcement of noise abatement flight procedures and complaint investigation.
Noise insulation schemes	Noise insulation programmes are not in place in Canada.
Enforcement of land-use measures/noise zoning	Municipal fines are imposed for non-adherence to subdivision plan approvals. Other than this municipal action, no penalties exist to aid in enforcement of land-use measures.

1. A new development or redevelopment is generally approved when it is proposed adjacent to existing incompatible land uses. Several appeals by airport officials have been unsuccessful in preventing new development or redevelopment.
2. Noise insulation features are included in the condition of approval in subdivision agreements.

Country:	CHILE	Major airport(s)	Other airports
		Chacalluta, Arica Diego Aracena, Iquique Cerro Moreno, Antofagasta Mataveri, Isla de Pascua Arturo Merino Benítez, Santiago El Tepual, Puerto Montt President Carlos Ibáñez, Punta Arenas	

Land-use planning	The competent authority is the Housing and Urban Planning Ministry. The general regulations on land use are set out in the Land Regulation Plans that cover the airport. Those documents are approved by Supreme Decrees and are subject to strategic environmental assessments.
Measures used for most airports	There is a comprehensive certification for all airports in the country: ISO 1400, 18000 and 9000. The main airport of the country, Arturo Merino Airport in Santiago which serves 90% of international flights, has an environmental monitoring system comprising an air quality station and a noise monitoring system. Environmental commitments are undertaken with the government authorities. No noise insulation measures are taken outside the airport. Inside the airport complex, most of the buildings have glazed panels that reduce aircraft noise emissions.
Noise monitoring	At the Santiago airport an aircraft noise monitoring system has been introduced, with three monitoring stations connected to a server receiving input from radar and flight plans. The stations serve to measure parameters such as Ldn and Yldn, and produce noise level curves based on FAR 150. At other airports in the network, noise maps are developed based on FAR 150 for monitoring purposes.
Noise insulation schemes	There are no noise insulation schemes.

Enforcement of noise zoning	There is no national regulation to mandate noise zoning. Nevertheless, zoning is observed insofar as the main airports are located well away from population centres.
Noise charging schemes	There are none.
Other land-use planning measures for non-noise impacts	All of the airports in the country have protected zones for building height, which affects land-use planning in the vicinity. Regarding bird management plans, the airport of Santiago has designated an area where no activities may be carried out that attract birds. The area is approved as part of overall land-use planning, by Supreme Decree.

Country:	CHINA (Hong Kong Special Administrative Region)	Major airport(s)	Other airports
		Hong Kong International Airport	N/A

Land-use planning	In Hong Kong, the Hong Kong Planning Standards and Guidelines (HKPSG), which can be downloaded from the website of the Planning Department of the Government of Hong Kong SAR, is a Government manual of criteria for determining the scale, location and site requirements of various land uses and facilities. This manual is applied in planning studies, preparation/revisions of town plans and development control. According to HKPSG, exposure to aircraft noise is described by Noise Exposure Forecast (NEF) contours).
Type of measures used for most airports	For the Hong Kong International Airport, reference had been made to the assessments by the Airport Authority Hong Kong with regard to the NEF contours, i.e. the coverage of the NEF25 contour, so as to avoid the location of noise-sensitive land uses. Review of an update of the NEF25 contour has been included in the environmental impact assessment conducted by the Airport Authority Hong Kong. The Civil Aviation Department (CAD) of the Government of Hong Kong SAR monitors the noise generated by aircraft along the flight paths by an aircraft noise and flight track monitoring system.
Noise monitoring	The aircraft noise and flight track monitoring system comprises 16 noise monitoring terminals which are located along or close to the flight paths operating into and out of the Hong Kong International Airport. With the assistance of the system, the CAD monitors the effectiveness of the aircraft noise mitigating measures.
Noise insulation schemes	Not applicable.
Enforcement of noise zoning	Not applicable.
Noise charging schemes	Not applicable.
Other land-use planning measures for non-noise impacts	To ensure the aerodrome safety of the Hong Kong International Airport, planning measures for non-noise impacts (such as adherence to the approved plant species list to reduce bird hazards and vetting of building plans/development proposals for compliance with airport height restrictions requirements) are coordinated among the Airport Authority Hong Kong and/or the Government agencies for implementation.

Country:	CUBA	Major airport(s)	Other airports
		At the 10 airports with international operations: MUCC; MUCF; MUCL; MUCM; MUCU; MUHA; MUHG; MUMZ; MUSC; MUVR.	Others: MUBA; MUBR; MUBY; MUCA; MUGT; MUGV; MUKW; MULM; MUMO; MUNG; MUPB.

Land-use planning	— Resolution No. 91/06 of the Ministry of Economy and Planning is the legal regulation governing investments in the country. Section 1, Chapter IX - Land-use Authorization indicates that investment decisions shall be determined on the basis of the plans and studies of the Office of Land-use and Urban Planning; — Resolution No. 132/2009 of the Ministry of Science, Technology and the Environment mandates and governs the Environmental Impact Assessment process so as to ensure that potential environmental impacts are duly considered at the early stages of project planning and design and that measures are identified to prevent, mitigate, control, rehabilitate and compensate for any negative impacts, and to highlight any positive impacts; — Cuban Regulation 26:1999 Noise in Habitable Zones, Sanitary and Hygiene Requirements establishes the method for measuring the noise level used as an ambient noise indicator, together with possible forecasting models and maximum acceptable and tolerable levels in habitable zones, both inside homes and in built up adjacent areas.
Measures used for most airports	— Environmental impact assessment; — Restrictions on new buildings; — Noise reduction at source; — Land-use planning and administration; — Operational procedures for noise reduction; — Restrictions on engine tests in repair hangars.
Noise monitoring	Not applicable.
Noise insulation schemes	Not applicable.

Enforcement of noise zoning	Not applicable.
Noise charging schemes	The following data relate to compliance with Annex 16 per aircraft type: **Aircraft Type** — **Compliance with Standard** AN-26 — Annex 16, Volume I, Chapter 2 AN-24RV — Annex 16, Volume I, Chapter 2 YAK-40 — Annex 16, Volume I, Chapter 2 Embraer 110 — Annex 16, Volume I, Chapter 2 IL-18D — Annex 16, Volume I, Chapter 3 (Certain limits apply) YAK-42D — Annex 16, Volume I, Chapter 3 ATR-42-300 — Annex 16, Volume I, Chapter 3 ATR-42-500 — Annex 16, Volume I, Chapter 3 ATR-72-212 — Annex 16, Volume I, Chapter 3 TU-204-100CE — Annex 16, Volume I, Chapter 4 TU-204-100E — Annex 16, Volume I, Chapter 4 IL-96-300 — Annex 16, Volume I, Chapter 4 AN-158 — Annex 16, Volume I, Chapter 4
Other land-use planning measures for non-noise impacts	— Law No. 81 on the Environment; — National Environmental Strategy; — Environmental Strategy for Cuban Civil Aviation; — Cuban Aviation Regulation No. 16 (RAC-16) on Environmental Management; — Cuban Aviation Regulation No. 14 (RAC-14), Chapter IV: Operations, Facilities and Service; Section 6: Mitigating the Danger of Collisions with Birds and Other Animals; — National Plan for Reducing CO_2 Emissions.

Country:	CZECH REPUBLIC	Major airport(s)	Other airports
		Praha/Ruzyne (LKPR)	

Land-use planning	Provide information on laws, national/local authorities responsible for land-use planning, noise contours adopted, metric used, etc. Law : Building Act. 183/2006 Coll. on town and country planning and building code n) planning documentation 1. development principles; 2. plan; 3. regulatory plan. National/Local Authorities responsible for land-use planning : Ministry of regional development (1) The powers in the cases of the town and country planning are executed, pursuant to this Act, by the authorities of municipalities and administrative regions. Local council a) decides, within the separate powers, on procurement of the plan and the regulatory plan b) approves, within the separate powers, the task, or instructions for elaborating the plan before approval, c) issues, within the separate powers, the plan, d) issues the regulatory plan, (1) Regional office within the delegated powers a) procures the development principles and, in the cases stipulated by the law, the regulatory plan for the areas and corridors of the supra local importance, b) procures the non-statutory planning materials, (2) Regional council a) issues, within the separate powers, the development principles, b) approves, within the separate powers, the task, or instructions for processing the draft of the development principles, c) approves, within the separate powers, the report on the development principles implementation, d) issues the regulatory plan in cases stipulated under the law,

Special powers on the territory of the Capital City of Prague

On condition that the Metropolitan authority of the Capital City of Prague7 procures the plan for the territory of the Capital City of Prague, the powers of the regional office are executed by the Ministry. If the authority of the municipal district procures the plan for the specified part of the Capital City of Prague, the powers of the regional authority is executed by the Metropolitan authority of the Capital City of Prague.

Noise contours:

When exceeding health noise limits from traffic at international airports, that annually provide more than 50 000 take-offs or landings and military airports, the airport operator shall design issue “general measure” according to Administrative Code to establish a noise protective zone. General measures for the establishment of noise protective zone issue Civil Aviation Authority in agreement with the regional health authority. Noise protective zone based on the noise contours of limit value.

Metric used

The noise limits are expressed in A-weighted equivalent sound level LAeq separately for whole day-time (06:00-22:00LT) and for whole night-time (22:00-06:00LT). Measurement period is from May to October (six month).

Day limit:

LAeq,16h = 60 dB

Night limit:

LAeq,8h = 50 dB,

Act No. 49/1997 Coll. on civil aviation

Article 37

(1) A protected zone shall be set up around aviation structures. The protected zone shall be established by the Authority by a general measure, in keeping with the administrative code, upon consultation with the regional planning office. The Authority shall use a general measure as indicated in the second sentence to designate specifications for the protected zone and individual measures for the protection of aviation structures.

(2) The protected zone for aviation structures shall be divided into a protected zone

a) for the airport and
b) ground facilities.

(3) The airport protected zone shall be divided into a protected zone

a) with a construction ban,
b) with height limits on construction,

c) for protection from dangerous and deceptive lighting,
d) with a laser equipment ban,
e) with restrictions on the aboveground construction of high tension and very high tension cables,
f) for noise and
g) an ornithological zone.

(4) A protected zone for aviation safety facilities divided into a protected zone

a) for radio navigation facilities and
b) lighting facilities and
c) aviation ground structures.

Article 89

Civil Aviation Authority shall further

b) serve as a special building authority for aviation structures,
c) set up protected zones around aviation structures,
d) set up a special noise control zone in consultation with competent regional health authorities,

Type of measures used for most airports

Provide information on the different measures taken, such as: comprehensive planning, environmental impact assessment, noise zoning, noise barriers, noise monitoring and flight tracking, noise insulation, building codes, acquisition/relocation, etc.

Measures at LKPR:

— Environmental impact assessment according to 2001/42/ES
— Noise zoning see information to previous section
— Noise monitoring and flight tracking (ANOMS 8 from BaK, 13 NMT)
— Noise insulation

Noise monitoring

Provide information on whether there is a noise monitoring system in place; number of airports with noise monitoring systems and data collected usage.

LKPR uses data from NTMS (Noise And Track Monitoring System).

<u>Continuous Noise and flight track monitoring</u>

Values for equivalent acoustic pressure levels given in monthly reports are not comparable to hygienic limits designated in Art. 5 Par. (12) of Government Decree No. 272/2011 Coll., on Protecting Health from the Negative Impact of Noise and Vibration.

Noise limits equivalent to the acoustic pressure level A generated by air traffic during the daytime and night-time periods are based upon a typical flight day defined using the currently valid Methodological Guidelines for the Measurement and Evaluation of Air Traffic Noise, issued by the Surgeon General of the CR, ref. no. OVZ-32.0-19.02.2007/6306. A typical flight day is understood to be the mean of flight days during the six-month period with the highest air traffic (May through October). The resulting values for equivalent levels of acoustic pressure for daytime and night-time periods in each locality measured, which

are comparable with hygienic limits, are always processed in November of the year in question.

In accordance with Art. 42b of Act No. 49/1997 Coll. on Civil aviation, the Prague Ruzyne airport operator presented the Ministry of Transport of the CR "Report on the Airport Noise Situation at Prague Ruzyne Airport"

A report on the airport noise situation shall be prepared every two calendar years by the airport operator and sent to the Ministry of Transport by 30 June of the year following the second calendar year addressed by the airport noise report.

OPERATIONAL RESTRICTIONS TO REDUCE AIRPORT NOISE

Article 42a

Operational restrictions to reduce airport noise shall be understood to mean measures aimed at reducing access to the airport for subsonic jet aircraft with a take-off weight of 34 tons or greater or a total count of passenger seats greater than 19, or limiting their operation at the airport.

Article 42b

(1) If limits on noise designated by special regulation[3] are exceeded on a long-term basis, the Ministry of Transport shall issue a ruling on the introduction of operational limits for the reduction of noise at any airport which has handled more than 50 000 take-offs and landings yearly by subsonic jet aircraft during the prior calendar year.

(2) The basis for the ruling specified in Paragraph 1 shall be a report on the noise situation at the airport or opinion under a special legal regulation[4]. A report on the airport noise situation shall be prepared every two calendar years by the airport operator and sent to the Ministry of Transport by 30 June of the year following the second calendar year addressed by the airport noise report.

(3) The Ministry of Transport shall take the following into consideration in issuing its ruling:

a) the benefits of restricting operations for the reduction of noise at the airport and in its protected zone in keeping with article 37 and a special legal regulation[5],
b) anticipated costs for the introduction of operational restrictions for the reduction of noise at the airport and its influence on airport operation.

(4) The ruling must be made public for a period of 15 days from the date it takes effect on

3. Act No. 258/2000 Coll., on safeguarding public health and on the amendment of some corresponding legislation, as amended by later regulations.
Government Regulation No. 502/2000 Coll., on protecting health against the adverse effects of noise and vibration, as amended by Government Regulation No. 88/2004 Coll.
4. Act No. 100/2001 Coll., on evaluating influences on the natural environment and amendments to some corresponding legislation (Act on Evaluating Influences on the Natural Environment), as amended by Act No. 93/2004 Coll.
5. Art. 31 Act No. 258/2000 Coll., on safeguarding public health and on the amendment of some corresponding legislation, as amended by later regulations

the official noticeboard of the Ministry of Transport, as well as in the Aeronautical Information Publication without undue delay, 2 months at the latest before the conference of the International Air Transport Association on flight schedules takes place.

(5) If it is necessary to ensure that the noise limits specified in Paragraph 1 are not exceeded, the Ministry of Transport may, in its ruling, limit the operation of aircraft designated under a special European Community regulation[6] (hereinafter "designated aircraft") at the airport, up to and including a complete ban on their operation. The Ministry of Transport may, however, take into consideration the nature of operation of the aircraft if it is of an exceptional character or if it involves flights for purposes of rebuilding, repairing or maintaining aircraft.

(6) A ruling by the Ministry of Transport under Paragraph 5 shall limit the number of take-offs and landings by the aircraft designated at the airport for a period of six months after the ruling becomes effective, so that the count of take-offs and landings of the designated aircraft at the airport in question is not higher than during the same period in the preceding calendar year. 12 months at the earliest after the ruling issued under Paragraph 5 takes effect, the Ministry of Transport may modify it so that the number of take-offs and landings by the designated aircraft at the airport does not exceed 20% of the total number of landings and take-offs by each operator during the preceding calendar year. If the imposition of operational limits occurs during the course of a calendar year, the Ministry of Transport shall limit the number of take-offs and landings by the designated aircraft during this calendar year by an appropriate proportion of the maximum figures indicated above.

(7) The Ministry of Transport shall send its ruling under Paragraph 1 to the European Commission without delay upon its taking effect, as well as to other Member States of the European Union.

(8) Details of the report on the airport noise situation shall be designated in the implementing legislation.

Noise insulation schemes

Provide information on noise insulation schemes (e.g. indoor noise level, costs, number of houses, etc.)

At LKPR:

Indoor noise level and descriptors are stated with the nature of the outdoor limits. See first section.

Day limit:

LAeq,16h = 50 dB

Night limit:
LAeq,8h = 40 dB,

6. Art. 2 Letter d) of Directive 2002/30/EC of the European Parliament and of the Council of 26 March 2002 on the establishment of rules and procedures with regard to the introduction of noise-related operating restrictions at Community airports.

	Since 1998, there has been a complete exchange of windows and balcony doors for noise-resistant models with the prescribed sound insulation. The focus is on so-called protected areas encompassing apartments and family houses, schools and preschools, structures which serve healthcare and social purposes and functionally similar buildings in villages and urban areas within the Noise Protection Zone around Prague/Ruzyne Airport. Insulation program has been implemented in 3 017 buildings with total coast of 622 032 798 millions CZK (23 038 252 EUR).
Enforcement of noise zoning	Provide information on law enforcement applied on noise zoning (responsible for the enforcement, any penalties/fines in place or just legal obligations, do airports report and monitor the ongoing developments). At LKPR: Responsible for the enforcement applied on noise protection zone is Civil Aviation Authority.
Noise charging schemes	Provide detailed information on noise charges system (acoustical group of aircraft or aircraft chapters, period of the day, evening and night period, etc.) costs for other land-use measures, (such as relocation, rebuilding of roads to relieve traffic to and from airport, compensation schemes for real estate owners affected by the enlargement of noise zones, etc.). At LKPR: Basis for calculation of noise charge is noise category and aircraft. Noise charge is applied only to aircraft with MTOW over 9 tons. Aircraft are assigned to the noise category according to the following criteria related to the limits of ICAO Annex 16/I, Part II. Aircraft certified according Chapter 3, 4 and 5 or 2 - 2.4.2: The difference are calculated by deduction of noise level values given in noise certificate from noise limit according the appropriate chapter of part II of ICAO Annex 16/I. Aircraft is included into respective noise category according to the accrued difference in accordance with Chapter 4. In the case, that in some point the noise level is over the limit of the appropriate chapter of part II of ICAO Annex 16/I, aircraft is included into next higher noise category. Category 1 – the accrued difference 15 EPNdB or more Category 2 – the accrued difference from 10 to 14,9 EPNdB Category 3 – the accrued difference from 5 to 9,9 EPNdB Category 4 – the accrued difference from 0 to 4,9 EPNdB Category 5 – the accrued difference less than 0 EPNdB or aircraft certified according to Chapter 2 - 2.4.1. Rate per tonne (including tonne initiated) of the MTOW: Category 1 5,90 CZK Category 2 12,90 CZK Category 3 29,90 CZK

	Category 4 61,90 CZK Category 5 122,90 CZK *Note: there is no connection between noise charges and land-use planning.*
Other land-use planning measures for non-noise impacts	Provide detailed information on additional planning measures for non-noise impacts, such as for bird strikes, climate change, etc. N/A

Country:	DENMARK	Major airport(s)	Other airports
		Copenhagen	Aarhus
		Billund	Esbjerg
		Aalborg	Herning
			Karup
			Kodling/Vamdrup
			HCA/Odense
			Roskilde
			Bornholm/Maribo
			Odense
			Bornholm/Rønne
			Sindal
			Stauning
			Sønderborg
			Vojens/Skrydstrup

Land-use planning

In Denmark land-use planning is a responsibility of local authorities. Airport noise zoning is based on the legal framework of the Environmental Law.

The Danish Environmental Agency has established recommended noise limit values for zoning purposes. The recommended values are:

For airports[7] and military bases:

— Residential areas	55 dB
— Single houses in open land	60 dB[8]
— Commercial areas	60 dB
— Recreational areas used overnight	50 dB
— Other recreational areas	55 dB

For general aerodromes[9]:

— Residential areas	45 dB (50 dB for important regional airfields)
— Single houses in open land	50 dB
— Commercial areas	60 dB
— Recreational areas used overnight	45 dB
— Other recreational areas	50 dB

The Danish noise metric is the L_{den} method. The noise level is calculated by the Day-Evening-Night noise index as an average of the 3 busiest months of the year. 5 dB is

7. The term “airport” is used for aerodromes where most of the traffic consists of commercial transport of passengers, goods and mail with large aircraft.
8. As a starting point, new residential areas ought not to be planned where noise exposure L_{DEN} is over 55 dB or the maximum value ($L_{A\,MAX}$) is over 70 dB.
9. The term "General aerodrome” is used for aerodromes where traffic consists almost solely of general aviation and special traffic categories such as, school flying with light aircraft, parachute flying, uptaking of gliders ultralight flying, etc.

	added for evening noise (19:00 – 22:00 hours) and 10 dB for night-time noise (22:00 – 07:00 hours). In case of operations connected with parachuting, VRF landing circuits, ultra-lights, aerobatics and pleasure flights, an additional 5 dB is added (except for Mondays to Fridays between 07:00 to 19:00 hours). Maximum value of the A-weighted sound pressure level from take-offs and landings at night is calculated for the most noisy aircraft (for a single operation) that is entered in the DENL calculations for each flight route or flight sector. For a flight route (with dispersion) the calculations are based on the nominal flight route. The "average flight route" is used for a flight sector. In residential and recreative areas with overnight accommodation the maximum value should not exceed 70 dB for general aerodromes and 80 dB for airports, military airbases and heliports for ambulance flights. Noise contours are based on forecast noise levels. The time horizon is normally 8 years, which is the number of years for which an environmental approval is normally issued. Noise contours are to be reviewed/updated when a new environmental approval is needed.
Type of measures used for most airports	Comprehensive planning, including environmental impact assessment for airport developments with effect on noise climate. Noise zoning, applicable to all airports. Noise insulation programmes (only used for Copenhagen Airport). Noise monitoring and flight tracking system (only operational at Copenhagen Airport. All these measures are considered effective in both new and existing situations.
Noise monitoring	Noise monitoring and flight tracking system (only operational at Copenhagen Airport) Copenhagen Airport operates an online web track service, where neighbours and other interested parties can follow the actual flights and the registrations from the noise monitoring system.
Noise insulation schemes	Only for Copenhagen Airport in the 1980s.
Enforcement of noise zoning	Each airport has an approval from the environmental authorities. Noise monitoring in relation to land-use planning is only used for helipads with ambulance flights, where no environmental permit is required.

Noise charging schemes	None.
Other land-use planning measures for non-noise impacts	To prevent bird strikes there are provisions in the Danish Planning Act whereby the municipalities are required to avoid establishing installations that might attract birds at a distance of up to 13 km from the airport, unless it has been documented that the risk is acceptable. Also establishing of new wetlands requires a dialogue with the Danish Transport Authorities and the Royal Danish Air Force to prevent unacceptable consequences to flight safety.

Country:	EGYPT	Major airport(s)	Other airports
		Cairo	Abu-simbel
		Luxor	Taba/Ras El Nakab
		Aswan	Port Said
		Hurghada	El Arish
		Sharm El Sheikh	Shark El Oweinat
		Alexandria/Alexandria	St. Catherine
		Alexandria/Borg El-Arab	Dakhala
		Asyut	El Kharga
			El Tor
			M. Matruh
			Giza/Embaba
			El Gora

Land-use planning

Land-use planning is the a responsibility of the Egyptian Civil Aviation Authority, according to Civil Aviation Law No. 28 of 1981, Law for the Environment No. 4 for 1994 and its executive regulations. The Egyptian Environmental Affairs Agency recommended the following noise limits:

TYPE OF ZONE	PERMISSIBLE LIMITS FOR NOISE INTENSITY DECIBEL (A)					
	DAY (7 am to 6 pm)		EVENING (6 pm to 10 pm)		NIGHT (10 pm to 7 am)	
Commercial, administrative & downtown area	55	65	50	60	45	55
Residential areas (including some workshops) or commercial businesses or on public roads	50	60	45	55	40	50
Residential areas in the city	45	55	40	50	35	45
Residential suburbs with low traffic	40	50	35	45	30	40
Rural residential areas (hospitals and gardens)	35	45	30	40	25	35
Industrial areas (heavy industries)	60	70	55	65	50	60

Type of measures used for most airports	— Comprehensive planning, including environmental audit and compliance action plan for the major airports, and environmental impact assessment (EIA) for the new construction in Marsa Alam Airport. — Noise zoning, applicable to major airports. — Noise barriers, applied to Cairo Airport only. — Noise monitoring and flight tracking system, studied at Cairo, Hurghada and Sharm El Sheikh Airports. Other airports were not included as they are located away from the residential areas.
Noise monitoring	Noise monitoring systems are being considered for implementation at the Cairo, Sharm El Sheikh and Hurghada International Airports. Woods have been planted around the airports to shield noise.
Noise insulation schemes	The population near Cairo International Airport is estimated at 4 to 5 million, living within 70 to 90 dBA noise contour, Nasr City District alone is populated by about 1 million people. A future plan would consider soundproofing for the houses in the nearest airport vicinity.
Enforcement of noise zoning	Not applicable
Noise charge system	Noise and emission charges would be applied on reciprocal basis with other countries. Noise charges for violating aircraft became applicable upon the installation of the noise monitoring systems by 2001.

Country:	ERITREA	Major airport(s)	Other airports
		Asmara	Assab Massawa

Land-use planning	Applicable to all airports The State Government is responsible for land-use planning. Comprehensive planning is applied to all airport development. Eritrea is a new nation with very low air traffic. So far, noise has not been a matter of much concern in this region. However, it is recognized that it is high time to consider the problem of aircraft noise before this becomes a serious nuisance.
Type of measures used for most airports	Comprehensive planning Such measures should be applied as a legal obligation.
Noise monitoring	Not applicable
Noise insulation schemes	Not applicable
Enforcement of noise zoning	Not applicable
Other land-use planning measures for non-noise impacts	No other land-use measures are applied.

Country:	FINLAND	Major airport(s)	Other airports
		Helsinki/Vantaa	over 20 other airports and aerodromes

Land-use planning	Land-use planning is based on the Finnish Land-use and Building Law. Authorities responsible for land-use planning are Municipalities and Regional Councils. National guidance is by the Ministry of Environment. Applicable to all airports. Comprehensive planning is applied to all airport development. The Finnish noise metric for airports is L_{den}, with 55 L_{den} as the guideline for new noise-sensitive housing. Noise contours are based on forecast noise levels with a time horizon of 10 to 25 years.
Type of measures used for most airports	Comprehensive planning by the Municipality regarding noise-sensitive buildings. Noise zoning
Noise monitoring	A noise monitoring and flight tracking system (ANOMS by Bruel&Kjaer) with 9 fixed measuring stations and two mobile measuring stations is operational at Helsinki-Vantaa Airport. Short-term measurements undertaken at other airport when necessary. Aircraft noise contour studies carried out at all airport at regular interval (from once per year to once in ten years)
Noise Insulation schemes	Not applicable. The normal sound insulation of Finnish houses is roughly 30 dB(A) due to good thermal insulation against climate conditions. Extra noise insulation is considered necessary only at some areas near Helsinki-Vantaa airport in new residential developments. Around Helsinki-Vantaa airport about 18 000 people live within the L_{den} 55 dB noise contour. (*The 2002 data must be false or old, because the actual number for Helsinki-Vantaa Airport in year 2000 is 14 000 people and in 2003 there was 9000 people living inside 55 dB L_{den}.)*

Enforcement of noise zoning	Official future noise contours are established in environmental permit processes according to Finnish Environmental Protection Law for all airports. Permit must be updated frequently in 10-15 years. The enforcement of applying noise contours in land-use planning is, however, based on the Land-use and Building Law.
Noise charging schemes	Noise charges only at Helsinki-Vantaa airport. Night-time noise charge for jet departures and arrivals in hours 23.00-06.00 LMT. Noise charge is calculated based on the arithmetic mean of fly-over and side line noise levels according to the ICAO Annex 16 volume I chapter II. The charge is higher in between hours 00.30-05.29 LMT.
Other land-use planning measures for non-noise impacts	In land-use plan ”Air traffic areas” are allowed only for buildings and structures, which are intended to serve air traffic. Height restrictions are mandatory and articles, which could afflict ANS devices, are not allowed. Activity producing particles, dust, mist, explosive gases, radiation or lighting, which could be risk for air traffic safety, is not allowed in the vicinity of an airport. Also open water areas or particular farming, which could attract birds, are not allowed in the vicinity of the airport because of air traffic safety reasons.

Country:	FRANCE	Major airport(s)	Other airports
		Paris/Charles-de-Gaulle Paris/Orly Paris/Le Bourget Lyon/Saint Exupéry Nice/Cote d'Azur Marseille/Provence Toulouse/Blagnac Bâle/Mulhouse Bordeaux/Mérignac Nantes/Atlantique Strasbourg/Entzheim Beauvais/Tillé	Around 400 aerodromes (including military bases and small airfields)

Noise metric	The noise metric used for noise contours around French aerodromes (PEB and PGS) is the L_{den} both defined at the European level (EU directive 2002/49) and at the French national level (planning code art. R147-1) $L_{den} = 10 \log \frac{1}{24}\left[12 \times 10^{\frac{L_d}{10}} + 4 \times 10^{\frac{L_e+5}{10}} + 8 \times 10^{\frac{L_n+10}{10}}\right]$
Land-use planning	Applicable to around 260 aerodromes of all categories (civil and military). Local authorities have to incorporate airport noise zones and land-use measures into local land-use plans. Noise contours for land-use planning are based on traffic forecast and must take into account infrastructures, tracks and procedures changes. 3 time horizons are studied: short-term around 5 years, medium-term around 10 years, and long-term around 15 years. These noise maps are called noise exposure maps (PEB: Plan d'Exposition au Bruit) and are reviewed/updated when necessary. Local authorities, neighbourhood associations are involved in the procedure to formally adopt a new noise exposure map around an aerodrome. A local public inquiry is also organized during the consultation phase.

3 and sometimes 4 noise zones are defined for each PEB. The legal limit values in L_{den} for these noise zones may vary depending on the type of traffic and on local situations.

	Zone A	Zone B	Zone C	Zone D
Usual situations (including major civil airports)	$L_{den} \geq 70$	$70 > L_{den} \geq (62 \text{ to } 65)$	$(62 \text{ to } 65) > L_{den} \geq (55 \text{ to } 57)$	$(55 \text{ to } 57) > L_{den} \geq 50$
Aerodromes defined in planning code art. R.147-1-1	$L_{den} \geq 70$	$70 > L_{den} \geq (62 \text{ to } 65)$	$(62 \text{ to } 65) > L_{den} \geq (52 \text{ to } 57)$	$(52 \text{ to } 57) > L_{den} \geq 50$
Specific military aerodromes	$L_{den} \geq 70$	$70 > L_{den} \geq (62 \text{ to } 68)$	$(62 \text{ to } 68) > L_{den} \geq (55 \text{ to } 64)$	$(55 \text{ to } 64) > L_{den} \geq 50$

Land-use restrictions for new constructions vary with noise zones:

— Zone A: only housing and facilities necessary for aeronautical activities are allowed, as well as public facilities which are vital to the existing population.

— Zone B: as for zone A + constructions necessary for industrial, commercial and farming activities are permitted.

— Zone C: as for zone B + :

- non-grouped individual housing located in sectors which have already been developed, provided that such work does not lead to a large increase in the number of inhabitants exposed to noise levels;
- renovation work or restoration of existing buildings without increase in the number of inhabitants exposed.

— Zone D: no land-use restrictions for new constructions, but obligation to insulate new housing and to inform inhabitants. This zone is mandatory only for major airports.

Independent administrative authority ACNUSA

The ACNUSA (Authority for Airport Nuisance Control) is an administrative authority in the aviation environmental field created by law n° 99-588 of 12 July 1999.

ACNUSA independence is guaranteed by its members' appointment method.

ACNUSA can make recommendations on any environmental topics around all civil airports (noise measurements, noise index, procedures changes, local air quality, regulation changes, etc.) and has an extended role for major airports: for instance, ACNUSA is always involved in the procedure to review a noise exposure map or a noise insulation map or to change a main procedure around a major airport.

The Authority has also the power to issue, after investigation, administrative fines to aircraft operators which infringe a local operational restriction.

Type of measures used for most airports	Examples of measures taken around major airports: — land-use restrictions for new constructions inside PEB noise zones; — specific noise insulation requirements for new constructions inside noise zones; — noise insulation programme; — noise monitoring and flight tracking; and — environmental impact assessment in case of flight track change.
Noise monitoring system	Noise measuring and flight tracks monitoring systems are in place around major airports to control noise levels and flight tracks and to inform and communicate with the public. These monitoring systems managed by airport operators should be audited, on a regular basis, to check their compliance with technical requirements. The monitoring systems are not directly used for land-use planning purpose.
Noise insulation scheme	A mandatory noise insulation programme has been put in place around the major French airports since 1992. A traffic criterion is applied to set the list of airports concerned by this insulation scheme: either the number of movements of aircraft above 20 tons exceeds 20 000 per year or the number of movements of aircraft above 2 tons exceeds 50 000 per year and, moreover, one of the noise maps of the airport also has an intersection area with one of the noise maps of an airport which meets the first traffic criterion. In 2015, 12 airports are concerned by this programme: Paris/CDG, Paris/Orly, Paris/Le Bourget, Nice, Lyon, Marseille, Toulouse, Bâle-Mulhouse, Bordeaux, Nantes, Strasbourg and Beauvais. The noise insulation maps (PGS: Plan de Gêne Sonore) are based on estimated traffic, applicable procedures and infrastructures that will be in use in the year following the date of the publication of the map. PGS are different from noise exposure maps. Three noise zones are defined for each PGS: — Zone I: L_{den} > 70 dB — Zone II: 70 > L_{den} > (62 to 65) — Zone III: (62 to 65) > L_{den} > 55 Inhabitants who already live inside a PGS noise zone may benefit, under specific conditions, from home soundproofing grants. Financial support varies between noise zones. Airport operators are in charge of noise insulation scheme management. Concerning new allowed constructions inside PEB noise zones, French regulations define objectives in term of relative noise reduction between outdoor and indoor noise levels and not absolute indoor noise levels.

Enforcement of noise zoning	Local authorities have to enforce land-use measures inside noise contours. Local representatives of national government (Préfets) are responsible for monitoring the legality of building permits. ACNUSA is in charge of exposing infringements of noise regulations. ACNUSA also has the power to issue, after investigation, administrative fines to aircraft operators which infringe a local operational restriction.
Noise charging schemes	The noise insulation scheme is fed by a noise charge system in place on each major airport. The amount of the noise charge due by aircraft operator for each take-off depends on the: — MTOW of the aircraft; — acoustic performance of the aircraft; — period of the day: there are weighting factors for evening and night movements; and — airport: the noise charge is louder around airports with many houses to insulate. Weighting factors used to fix the amount of noise charges are often updated to take into account the evolution of the number of remaining houses to be insulated around each airport.
Other land-use planning measures for non-noise impacts	

Country:	GERMANY	Major airport(s)	Other airports
		Berlin (3 airports) Düsseldorf Frankfurt Köln/Bonn München	Bremen Dresden Erfurt Hamburg Hannover Leipzig-Halle Munster/Osnabruck Nürnberg Paderborn Saarbrücken Stuttgart

Land-use planning	In German Aircraft Noise Law from 2007 there are noise contours in which the airports finance noise insulation and where restrictions exist for building new houses. At the regional level, additional contours to restrict building activities can be found. The problem is that there are still many possibilities to build new houses in some areas near the airports.
Type of measures used for most airports	Most of the airports have noise monitoring and flight tracking and make it visible for the public. Noise zoning is obligatory since 1974. For new or extended airports, an environmental impact assessment is required. Acquisition and relocation is also used by extension projects (FRA-CASA).
Noise monitoring	German airports have to install a noise monitoring system by law (§ LuftVG § 19a). The airports make the data visible for the public.
Noise insulation schemes	In the German Aircraft Noise Law from 2007 there are noise contours in which the airports finance noise insulation. Within the law there are limits for existing and for new or extended airports. For existing airports (outdoor levels): 65 dB day and 55 dB at night with a 6 x 72 dB-criteria for the single noise event. For new airports: 60 dB day and 50 dB at night with 6 x 68 dB criteria for the single noise event. There is a 16-h-average noise level for the day and an 8-h-average noise level for the night. In the night, there are criteria for the single noise event, which dominates the night contour. The noise insulation results in indoor noise levels of 32 to 27 dB(A) in existing buildings, and 29 to 24 dB(A) in new buildings at night. For the day, the noise level is 10 dB(A) higher. German airports spent 540 Mio. € on sound insulation in the last decades (from 1974). In addition to that, 400-600 Mio. € for the new measures is expected from the new German Aircraft Noise Law. In average we spent 5.000 € per dwelling.

	For new situations, an indoor noise level of 55 dB(A) is recommended. Any compensation scheme for real estate owners adversely affected by the establishment or enlargement of noise zones has to be financed by the airport operator.
Enforcement of land-use measures/noise zoning	No information.
Noise charging schemes	Noise-related landing charging schemes have been established in Germany for many years. They started in 3 categories (Non-Chapter, Chapter 2, Chapter 3) and were developed over the years as new aircrafts came into operation. Since some years we have noise-related landing charges related to measured noise have existed for a number of years. This system is established at the larger German airports, such as FRA, MUC, DUS and BER. For smaller airports, the use of a more simple, but effective possibility in using the noise certification level of the aircraft. Such a system results also in a well differentiated system. Both systems use different charges for day and night.
Other land-use planning measures for non-noise impacts	No.

Country:	GREECE	Major airport(s)	Other airports
		Athens (LGAV)	Thessaloniki (LGTS) Heraklio (LGIR) Rhodes (LGRP) Corgue (LGKR) Chania (LGSA) Kos (LGKO) + some 32 other regional and island airports

Land-use planning	The National Authority responsible for land-use planning and noise protection is the Ministry of Environment, Energy & Climate Change. National Laws established for noise protection and land-use planning around airports are: Presidential Decree (PD) 1178/81 describes noise zoning and land-use planning around airports. PD 487/84 & PD 330/90 describe noise certification for civil aviation aircrafts. PD 80/2004 incorporates the European Directive 2002/30/EC & 2002/49/EC to Greek legislation. Ministerial Decisions: 13586/724_28-3-2006 & 211773_27-4-2012 which specify the noise contours measuring procedures and transportation noise limits. Metric used is L_{den} , L_{day} , $L_{evening}$ & $L_{night.}$
Type of measures used for most airports	Measures used are: land-use planning, environmental impact assessment, noise zoning. For big airports, additional measures are: noise monitoring and flight tracking.
Noise monitoring	Athens Airport (LGAV) has an effective noise monitoring system (with 10 noise monitoring terminals in the area) which operates related to flight tracking system. The other airports do not have a noise monitoring system, but periodically noise measurements take place and data collected is reported to local authorities.
Noise insulation schemes	No specific noise insulation schemes for buildings. Building insulation schemes are mainly driven by thermal and energy-saving legislation.
Enforcement of noise zoning	The Ministry of Environment, Energy & Climate Change is responsible for the enforcement and penalties applied on noise legislation with the Hellenic Environmental Inspectorate (HEI) department.

Noise charging schemes	There is no specific noise charge system. For airlines, aircraft charges may apply based on airport authority rules for incompliance with noise certification. For airports, penalties and charges may apply for incompliance with environmental legislation (noise included) by HEI.
Other land-use planning measures for non-noise impacts	None.

Country:	INDIA	Major airport(s)	Other airports
		Delhi Mumbai Bangalore Hyderabad Cochin Chennai Kolkata	Agartala, Agra, Agatti, Ahmadabad, Aizwal, Allahabad, Amritsar, Aurangabad, Bagdogra, Belgaum, Bhavnagar, Bhopal, Bhubneshwar, Bhuj, Chandigarh, Coimbatore, Dehradun, Dharamshala, Dibrugarh, Dimapur, Diu, Guwahati, Gorakhpur, Goa, Gaya, Gawalior, Hubli, Imphal, Indore, Jabalpur, Jaipur, Jammu, Jamnagar, Jodhpur, Jorhat, Kanpur, Khajuraho, Kullu, Kozhikode, Leh, Lucknow, Ludhiana, Madurai, Mangalore, Mysore, Nagpur, Patna, Pondicherry, Pune, Porbandar, Port Blair, Raipur, Rajkot, Rajamundry, Ranchi, Shillong, Silchar, Srinagar, Surat, Tiruchirapally, Tirupati, Thiruvananthapuram, Thoise, Tuticorn, Udaipur, Vadodra, Varanasi, Vii aywada, Vishakapatnam

Land-use planning	The responsible authorities at the national level are the Ministry of Environment & Forests, Ministry of Civil Aviation and Ministry of Urban Development. At the local level, the information is as follows: **Bangalore:** BMRDA (Bangalore Metropolitan Regional Development Authorities), KIADB (Karnataka Industrial Area Development Board) and BIAAPA (Bangalore International Airport Area Planning Authority). Zonal Regulations for BIAAPA Local Planning Area are prepared under the clause (iii) of sub-section (2) of section 12 of the Karnataka Town and Country Planning Act, 1961 (http://www.biaapa.nl). Also, the Karnataka State Pollution Control Board provides consent for establishment and for operation of the airport. **Cochin:** Panchyat (local assembly) and Municipality.

	Delhi: National Capital Region of Delhi, Delhi Development Authority (DDA), New Delhi Municipal Corporation (NDMC), Municipal Corporation of Delhi (MCD). Delhi Development Authority under Sections 7 - 11A of the DD Act of 1957. Refer to Master Plan of Delhi 1962,2001 & 2021. These documents provide for restrictions and zoning. **Mumbai:** Maharashtra Regional Town & Country Planning Act, 1966 is applicable for land-use planning as per the requirements of Urban Development Department (UDD), Govt. of Maharashtra (GoM) for Chhatrapati Shivaji International Airport (CSIA) as well as for area around CSIA Notified Area. The development shall be as per Interim Development Plan of CSIA Notified Area, approved by GoM. Specific provisions have been made in the Act for zoning & restrictions related to change of land use, FSI, etc. For CSIA, Mumbai Metropolitan Region Development Authority (MMRDA) has been appointed as the Special Planning Authority (SPA) by Govt. of Maharashtra. Municipal Corporation of Greater Mumbai (MCGM) is responsible for land-use planning around the airport in accordance with the development plan for Greater Mumbai.
Type of measures used for most airports	**Bangalore:** Environmental Impact Assessment before scheduling, single engine taxi, etc. **Cochin:** Environmental Impact Assessment before airport code applies wherever state building rules not available. **Noise contours:** **Bangalore:** May 2014 **Cochin:** No **Delhi:** 2013 **Delhi:** Pilot study (2013) **Noise metric:** **Bangalore:** L_{day}, $L_{evening}$, L_{night}, L_{den}, L_{de}, DNL, L_{eq}, etc. **Cochin**: No **Delhi: :** L_{day}, $L_{evening}$, L_{night}, L_{den}, L_{de}, DNL, L_{eq}, L_{Amax}, etc. **Mumbai: :** L_{day}, $L_{evening}$, L_{night}, L_{den}, L_{de}, DNL, L_{Amax}, etc.
Noise monitoring	**Bangalore:** Two Temporary stations. Installation of permanent system in progress. **Cochin:** No **Delhi:** permanent system with 5 stations since 2010/2011. **Mumbai:** Expected in 20l4. Data will be used by the DGCA for planning purposes, assessment of noise limits, assessment of violations, etc.
Noise insulation schemes	India: Insulation schemes not applicable.

Noise charging schemes	India: No charging schemes.
Other land-use planning measures for non-noise impacts	Not applicable.

Country:	INDONESIA	Major airport(s)	Other airports
		Jakarta/Soekarno-Hatta Surabaya Denpasar Medan/Kualanamu Makassar	+ 232 smaller airport + hundreds of airfields

Land-use planning	Applicable to all airports. Local authorities are responsible for land-use planning. The noise metric used is the WECPNL method. The legal limits value for land-use measure are: 70 ≤ WECPNL <75: allowed for all building except hospitals and schools. 75 ≤ WECPNL <80: allowed for all building except hospitals, schools and residential areas. WECPNL ≥80: allowed for airport facilities buildings with insulation, green belt buffer and agricultural areas. Noise contours are calculated based on forecast noise levels.
Type of measures used for most airports	— Comprehensive planning, applicable to all airports by airport master planning and local/regional land-use planning. — Environmental impact assessment, applicable to all airports for new constructions and expansion. — Noise zoning, applicable to all airports. — Noise barriers, applied to major airports and some other airports. — Noise monitoring, instantaneous measurement (twice a year).
Noise monitoring	Not applicable.
Noise insulation schemes	Not applicable.
Enforcement of noise zoning	Not applicable.
Noise charging schemes	Not applicable.

Other land-use planning measures for non-noise impacts	Unknown.

Country:	IRELAND	Major airport(s)	Other airports
		Dublin Shannon Cork	Connaught Donegal Galway Kerry Sligo Waterford

Land-use planning	Applicable to all airports Comprehensive planning is applied to all airport development in order to control the use of land. The local authorities are responsible for land-use planning. The Irish noise metric for aircraft noise is the NNI method, with a limit value of 50 NNI. Noise contours for Dublin Airport are based on forecast noise levels for the year 2000. They were reviewed/updated in 1998.
Type of measures used for most airports	— Comprehensive planning — Noise zoning — Land acquisition and relocation Such measures should be applied as a legal obligation.
Noise monitoring	Not applicable
Noise insulation schemes	In 1991, a noise insulation scheme started around Dublin Airport. The programme is financed by the airport. No noise charges are raised. Under the programme, 100 houses and 1 school situated within the 50 NNI noise contour. The total costs are estimated at about IR£ 2 million. No specific indoor noise levels are required or recommended. No other compensation scheme is applied
Enforcement of noise zoning	Not applicable
Other land-use planning measures for non-noise impacts	No other land-use measures are applied.

Country:	ITALY	Major airport(s)	Other airports
		Roma/Fiumicino	Alghero
		Milano/Linate	Bari
		Venezia	Bolzano
		Catania	Brescia
		Bologna	Cagliari
		Bergamo	Crotone
		Napoli	Cuneo
			Firenze
			Foggia
			Genova
			Grosseto
			Lamezia Terme
			Lampedusa
			L'Aquila
			Marina di Campo
			Olbia
			Palermo
			Parma
			Pantelleria
			Perugia
			Pescara
			Pisa
			Reggio Calabria
			Rimini
			Ronchi dei Legionari
			Roma Ciampino
			Salerno Pontecagnano
			Taranto
			Torino
			Tortolì
			Trapani Birgi
			Treviso
			Verona
			Villanova d'Albenga

Land-use planning	Primary Legislation: Law 447 dated 26 October 1995 Ministerial Decree dated 31 October 1997 Ministerial Decree dated 29 November 2000 President of Italian Republic Decree n. 496 dated 11 December 1997 President of Italian Republic Decree n. 476 dated 9 November 1999 Legislative Decree n. 13 dated 17 January 2005

	Acceptable Means of Compliance and interpretative material: ENAC Circular APT-26 dated 3 July 2007; ENAC Circular APT-29 dated 29 February 2008. Based on Ministerial Decree dated 31 October 1997 noise levels at and in the vicinity of all Italian airports is determined by the following expression: $$L_{VA} = 10\log\left[\frac{1}{N}\sum_{j=1}^{N} 10^{L_{VAj}/10}\right] dB(A)$$ Noise zoning is established as follows: — Zone A: Lva Index up to 65 dB (A) — Zone B: 65 dB(A) <Lva < 75 dB (A) — Zone C: Lva Index over 75 dB(A) In terms of land use no limitations are envisaged in Zone A. In Zone B agricultural, commercial and industrial activities are allowed; no residential buildings or houses are allowed. In Zone C only activities related to the operation of the airport are allowed.
Type of measures used for most airports	-— Noise zoning; — Noise related landing charge; — Noise barriers; — Noise insulation interventions where noise limits are exceeded; — Environmental impact assessment in case airport major changes or new airports are envisaged.
Noise monitoring	A noise monitoring system is applied in 23 Italian airports.
Noise insulation schemes	Noise insulation measures are defined on a case-by-case basis and are relevant to those buildings where noise limits (zoning) are exceeded. Noise levels are expected to be checked inside the buildings.
Enforcement of noise zoning	Noise zoning has to be endorsed by the local government. Noise levels are monitored by the aerodrome operator under the regional agency for environment surveillance. Respect of the flight trajectories is assured by the ATSP; enforcement and relevant sanctions are assured by ENAC.
Noise charging schemes	Noise charging schemes at the regional level are based mainly on aircraft chapters; general aviation and special operation flights (e.g. police, military emergency) are exempted.

Other land-use planning measures for non-noise impacts	Requirements for the airport operators to perform a wildlife risk assessment at or near the airports and to define a specific procedure to minimize the wildlife risk at the airport have been established. Guidelines on the evaluation of hazardous activities at or near the airport (e.g.: farms, green areas, water basins, dumps) according to the ICAO guidelines have been provided to the stakeholders.

Country:	JAPAN	Major airport(s)	Other airports
		Tokyo/Narita	Kouchi
		Tokyo/Haneda	Fukooka
		Osaka	Kumamoto
		Hakodate	Oita
		Sendai	Miyazaki
		Niigata	Kagoshima
		Matsuyama	Naha

Land-use planning	Applicable to all designated airports, according to the National Aviation Act, local authorities are required to incorporate airport noise zones and land-use measures into local plans. The noise metric is the L_{den} method. The legal limit values for land-use measures are: — 62 L_{den} — existing houses are to be insulated; — 73 L_{den} — house removal and land acquisition; — 76 L_{den} — green belt buffer. The legal limit for noise insulation schemes is 62 L_{den} for households.
Type of measures used for most airports	— Comprehensive planning, including environmental impact assessment (EIA) for airport developments with effect on noise climate (now applied to Osaka and Fukuoka airports). — Noise zoning is applicable to all 14 designated airports. — Building codes include noise insulation for noise-sensitive buildings in the legal noise zones of the 14 airports. — Acquisition/relocation is applied to all 14 airports. — Noise barriers are applied in specific cases to shield noise from certain ground activities, such as engine testing. — Noise monitoring systems are installed around all 14 airports. — Noise-related airport charges are raised from the airlines for each landing at the 14 designated airports. — Flight tracking systems are installed around Tokyo/Haneda airport and Tokyo/Narita airport.

Noise monitoring	At the fourteen (14) airports under government control (Hakodate, Sendai, Niigata, Haneda, Narita, Itami(Osaka), Matsuyama, Kochi, Fukuoka, Ooita, Kumamoto, Miyazaki, Kagoshima and Naha), noise level meters have been installed under the major flight paths around the airports to monitor and evaluate the aircraft noise at all times. L_{den} has been adopted to compute noise level. Data collected are mainly used for monitoring the ongoing developments of aircraft noise and for publicizing the relative data on the website as well.
Noise insulation schemes	Since 1967, noise insulation schemes have been carried out around all 14 designated airports. These programmes are financed by the national government. The national budget for implementation of aircraft noise control measures in 2013 was about 35 billion yen. The number of houses in these insulation schemes is unknown. For existing buildings, the required specific indoor noise level is 47 L_{den}.
Enforcement of noise zoning	No penalties are in force.
Noise charging schemes	The cost of land acquisition and relocation of about 7 260 houses around the 14 designated airports amounted to 409 billion yen (national budget 1967 to 2013).
Other land-use planning measures for non-noise impacts	Nothing in particular.

Country:	REPUBLIC OF KOREA	Major airport(s)	Other airports
		Gimpoe (Seoul) Gimhae (Busan) Jeju Incheon	

Land-use planning	Applicable to the international airports listed above. In the Republic of Korea, land-use planning is a responsibility of the national government. Noise is measured using the WECPNL method, with a noise limit of 75 WECPNL or greater for noise insulation schemes. Noise contours around airports are based on actual monitored noise levels and are reviewed/updated every five years.
Type of measures used for most airports	— Comprehensive planning — Noise zoning — Building limits — Noise insulation programmes — Land acquisition and relocation — Noise barriers — Capital improvement planning — Noise-related airport charges (however, except for Incheon airport) — Resident support programme — Subscription TV support — Air-conditioning installation For new situations, subdivision regulation, transfer of development rights, easement acquisition, transaction acquisition, real estate disclosure and tax incentives are also considered as effective measures on a legal obligation basis.
Noise monitoring	A noise monitoring system is installed around Gimpo, Gimhae, Incheon and Jeju international airports.
Noise insulation schemes	Since 1991, noise insulation schemes have been introduced around Gimpo, Gimhae and Jeju international airports. The insulation programmes and other compensation schemes for real estate owners are financed largely by the national government and partially by airlines (out of the noise charges raised on top of landing fees). About 31 239 houses are situated within the noise limit of 75 WECPNL. The required indoor noise level after insulation is 60 WECPNL. The total costs of the insulation programmes is about 485 billion won. Land acquisition and relocations affects 82.6 km^2 of land at the costs of about 350 billion won.
Enforcement of noise zoning	The zone has been set up to prevent the spread of noise.

Noise charging schemes	
Other land-use planning measures for non-noise impacts	In 2010, the "Act on Airport Noise Prevention and Assistance to Affected Area" was established to improve the environment and improve business.

Country:	KUWAIT	Major airport(s)	Other airports
		Kuwait International Airport – KIA	Udairi Army Airfield Ali Alsalem Air Base Ahmad Aljaber Air Base

Land-use planning

— Applicable to all airports.

— The Government of Kuwait is responsible for land-use planning.

— The Kuwait Municipality is the authority responsible for land-use planning at the State. The Directorate General of Civil Aviation is the concerned authority for the major airport (KIA) land-use planning, and the Kuwait Environmental Public Authority is responsible for the environmental issues.

— The noise metric used in Kuwait is the Leq and the Kuwait environmental legislation (Appendix No. 18-2, Decisions No. 210/2001) sets out the following noise level limits depending on the level used:

Type of area	Day (dBA)	Evening (dBA)	Night (dBA)
Residential areas	55	50	45
Urban residential areas with some commercial activities and workshops	60	55	50
Industrial and commercial areas	70	65	60

Type of measures used for most airports

— Comprehensive planning for the major airport (KIA).

— Environmental impact assessment (an independent study prepared within Kuwait International Airport Master Plan 2012), for the major airport (KIA).

— Noise zoning for the major airport (KIA).

All the measures are considered effective in the existing and new situations at KIA.

Noise monitoring	— The KIA Master Plan 2012 provides an Environmental system, including a noise monitoring system; the system of monitoring is under study and will be applied soon at the major Airport, KIA. — The Kuwait Environmental Public Authority used an independent system for the State (Environmental Monitoring Information System of Kuwait-Emisk, EPA, KUWAIT 2010, BEATONA).
Noise insulation schemes	A noise insulation scheme is not applicable at KIA; the system of insulation is under study and will be applied soon.
Enforcement of noise zoning	Not yet applicable.
Noise charging schemes	Not yet applicable.
Other land-use planning measures for non-noise impacts	Unknown.

Country:	LATVIA	Major airport(s)	Other airports
		Riga	

Land-use planning

Land-use planning is applied to all airports and is the responsibility of the local authority.

The noise metric used is L (Max Noise Level), with a noise limit of 80 dB(A) at working places.

Type of measures used for most airports

— Comprehensive planning as a legal obligation

— Noise zoning, only applied to Riga Airport

— Advisory noise insulation programme, applied to Riga Airport

— Land acquisition and relocation, applied to Riga Airport

— Capital improvement planning, applied to all airports

— Noise-related airport charges are advised

Noise monitoring

Not applicable

Noise insulation schemes

A noise insulation programme was introduced around Riga Airport in 1993. The number of noise-sensitive buildings within the 80 dB(A) noise limit is 3. The total cost of the programme financed by the national government is approximately USD 200 000.

Specific indoor noise level required under the Occupational Safety Standards system are as follows:

Equivalent Aircraft Noise Level (dB (A))

	Day	Night
Hospital	35	25
Convalescent home	40	40
School dwelling	40	30
Hotel	45	35
Hotel (halls)	50	
Restaurants	55	
Stations	60	

Enforcement of noise zoning	Not applicable
Other land-use planning measures for non-noise impacts	Land acquisition and relocation has been applied for 660 ha of land at a total cost of USD 63 859.

Country:	LITHUANIA	Major airport(s)	Other airports
		Vilnius International Airport Palanga International Airport Kaunas International Airport	

Land-use planning	Land can be used in the vicinity of airports in compliance with the provisions of Law on Aviation of the Republic of Lithuania and Resolution on the Special Guidelines for the Land and Forest Use of the Republic of Lithuania.
Type of measures used for most airports	Comprehensive planning, including environmental impact assessment for airport improvements.
Noise monitoring	Vilnius, Kaunas and Palanga Airports complete aircraft noise monitoring in the vicinity of the airports and assess the impact of the aircraft noise on the environment and must produce and approve strategic noise maps.
Noise insulation schemes	Local authorities are responsible for noise insulation schemes.
Enforcement of noise zoning	Noise zones are not legally established.
Noise charging schemes	Not applicable.
Other land-use planning measures for non-noise impacts	No other land-use measures are applied.

Country:	LUXEMBOURG	Major airport(s)	Other airports
		Luxembourg	

Land-use planning

Laws and regulations

Law of 28 July 2011 amending the amended Law of 19 July 2004 on zoning and urban development;

Law of 30 July 2013 on land-use;

Grand Duchy Regulation of 17 May 2006 mandating the *Airport and Vicinity Land-use Plan;*

Building regulations in nearby municipalities.

National and local authorities

The Ministry of Sustainable Development and Infrastructure (Department of Zoning, Department of the Environment, Department of Transport), municipalities near Luxembourg Airport and the Zoning Board.

Noise curves adopted

Strategic noise mapping conducted in accordance with the provisions of *European Parliament and Council Directive 2002/49/EC of 25 June 2002 on the assessment and management of environmental noise*, giving the level of noise based on the L_{den} (24-hour clock) and Lnight (night) indicators.

Measurement method used

Use of AIP data in accordance with the community standard.

Type of measures used for most airports

Reassessment of zones in the *Airport and Vicinity Land-use Plan* on the basis of noise

The no-construction zones will be determined on the basis of the noise maps and the *Noise Exposure Plan for Long-term Airport Development* (PDLT).

General and specific zoning plans for nearby municipalities

The general zoning plan of a municipality is prepared on the basis of a preparatory study on the whole of the municipal territory, and includes an overall analysis of the existing situation with data from the action plans developed for the zones specified in the strategic noise maps. The analysis prevents existing general zoning plans [PAGs] from extending into zones with severe noise pollution.

	Municipal building regulations Municipalities must adapt their building regulations so as to include noise protection standards for new buildings according to noise exposure levels. Noise insulation *Grand Duchy Regulation of 18 March 2013 on the granting of financial aid for sound insulation improvements in homes exposed to aircraft noise at Luxembourg Airport*. The amounts of financial aid are determined on the basis of zoning in the *Noise Exposure Plan for Long-term Airport Development* (PDLT).
Noise monitoring	Airport noise measurement system The Air Navigation Administration (ANA) manages five noise measurement stations at the sole airport of Luxembourg. The measurement data and statistics developed are available on the ANA website.
Noise insulation schemes	Creation of an assistance scheme for insulating homes in noise management zones First phase: Zone A is determined on the basis of isocontour L_{den} = 70 dB(A) or L_{night} = 60 dB(A) as per the 2011 strategic noise map; Second phase: Zone B of the map (L_{den} = 65 dB(A), L_{night} = 55 dB(A)). The indoor noise insulation objectives for homes are determined based on the maximum noise level (L_{Amax}) when an aeroplane flies over: — 45 dB(A), in night quarters; — 55 dB(A), in day quarters.
Enforcement of noise zoning	— Zone A is determined by isocontour L_{den} = 70 dB(A) or L_{night} = 60 dB(A) as per the 2011 strategic noise map; Zone B of the map (L_{den} = 65 dB(A), L_{night} = 55 dB(A)); Zone C of the map (L_{den} – 60 dB(A), L_{night} = 50 dB(A)), etc. — Implementing authority: Ministry of Sustainable Development and Infrastructure — Department of the Environment.

Noise charging schemes	Aircraft movements are banned in principle between 23:00 and 06:00 at Luxembourg Airport. However, standing exemptions may be granted to operators under certain conditions, and a night flight charge is applied to any take-offs or landings during those times.
Other land-use planning measures for non-noise impacts	None.

Country:	THE NETHERLANDS	Major airport(s)	Other airports
		Amsterdam/Schiphol Rotterdam Eindhoven (military/civilian)	De Kooy Groningen/Eelde Maastricht/Aachen Lelystad

Land-use planning	According to the Aviation Act, an airport decree (LIB) with spatial planning rules near Schiphol Airport is formulated. The following limitations for land use are formulated within different zones from the airport. — 71 dB(A) L_{den}: noise-sensitive developments are not allowed. Existing developments need to be removed. Removal is not compulsory, — 10-5 risk zone: new developments are not allowed. Existing developments need to be removed. Removal is not compulsory, — 58 dB(A) L_{den}: restriction for new noise-sensitive housing and working developments, — 10-6 risk zone: restriction for housing and working developments. Zones with respect to airport noise are defined by using the L_{den} method. Zones with respect to safety are defined using a probabilistic calculation.
Type of measures used for the most airports	— Comprehensive planning, including environmental impact assessment (EIA) for airport improvements with effect on noise climate. An EIA is compulsory for runway extensions over 1 800 m. — Noise zoning is applicable to all aerodrome categories. — Building codes include noise insulation for noise-sensitive buildings in legal noise zones. — Acquisition/relocation and transaction assistance are applied to large airport developments (i.e. new runways). — Demolition of houses is applied to high noise exposure areas over 65 Ke and in high third-party risk areas on both ends of runways. — Noise barriers are applied to shield noise from certain ground activities (i.e. engine testing). — Noise monitoring and flight tracking systems are installed around Amsterdam/Schiphol, Maastricht/Aachen and Rotterdam the Hague airports. — Noise charges are raised from the airlines for each landing (on top of the landing fee) to recover the costs of the insulation programmes and to encourage the use of less noisy aircraft during the evening and night periods.

Noise monitoring	In the yearly airport evaluation reports, monitoring of the noise limits is executed.
Noise insulation schemes	The noise insulation scheme near Amsterdam/Schiphol airport started in 1983 and was finished in 2013. Around the Groningen Airport Eelde, all 10 houses within the 40 Ke contour have been insulated against noise. Around the Rotterdam Airport, 19 houses are isolated. In 2010 a new instruction was established. Now within the 40 Ke contour, 23 houses are considered necessary for noise features. Implementation will take place in 2015. On the basis of the noise zone that was legally established in 2001, 833 houses within the 40 Ke contour of Maastricht Aachen Airport have been insulated against noise. The costs of the programme totalled € 30 million. On the basis of the noise zone that was legally established in 2004, another 157 houses within the new 40 Ke contour of Maastricht Aachen Airport have been insulated against noise. The costs of the programme totalled € 6 million.
Enforcement of noise zoning	The legally established noise zones near Amsterdam/Schiphol airport is enforced by the stipulation of runway allocation rules and the strict monitoring and evaluation of the Airport Usage Plan. The Airport Usage Plan has to be submitted to the Minister of Transport in October of each year. If the plan shows that the expected operations for the next year will stay within the legal noise zone, the plan is approved accordingly. Evaluation of the plan at the end of the year must confirm that the airport operation has been executed within the legally established rules. If not, measures are imposed on the airport. The legally established noise zones around other airports are enforced by continuous monitoring of the noise development throughout the year. By monitoring and reporting on the ongoing development continuously, infringements of the legal noise zones can be detected at an early phase. If necessary, measures will be taken to stay within the noise zones.
Noise charging schemes	Noise charges are raised on top of landing fees to finance the costs of the insulation scheme around airports. Extra noise charges are imposed for the evening and night periods to encourage the use of less noisy aircraft.
Other land-use planning measures for non-noise impacts	Besides the zones mentioned above, restrictions regarding the safe use of airports and the working of air navigation instruments are defined in the airport decree (LIB). A 6 km zone is defined with a restriction for developments that attract birds. Furthermore, agreements with farmers are made in a wider area of Amsterdam/Schiphol to curb the forage of birds as much as possible.

Country:	NORWAY	Major airport(s)	Other airports
		Oslo/Fornebu new Oslo/Gardermoen + 19 other airports	+ 26 regional airports (STOL)

Land-use planning	Applicable to all airports In Norway, only guidelines exist for aircraft noise zones. Municipalities can divert from the recommendations given by the national authorities. In some cases, land-use plans are made in contradiction to the official guidelines. The Norwegian noise metrics are the EFN (equivalent to CNEL) and MFN (Lamax). Noise contours around airports are based on forecast noise levels with a time horizon of 10 to 20 years. The noise contours are reviewed/updated every four years.
Type of measures used for most airports	— Comprehensive planning, including environmental impact assessment (EIA) for airport developments with effect on noise climate — Noise zoning is applicable to all airports — Building codes applies to all new buildings within noise zones, not specifically airport related — Noise insulation programmes are applied to the new Oslo/Gardermoen Airport — Noise barriers applied to Bodo Airport — Noise monitoring and flight tracking system installed at Oslo/Fornebu Airport — Noise-related airport charges are raised from the airlines for each landing of Chapter 2 aircraft at Oslo/Fornebu and Bodo Airports
Noise insulation schemes	For the new Oslo Airport: In 1995, a noise insulation scheme started around the new Oslo/Gardermoen Airport. The programme is financed by the owner of the new airport. The costs are integrated into the cost of establishing the new airport. Houses with outdoor noise levels over EFN 60 and/or MFN 85 during night-time and/or MFN 90 during daytime will be insulated. In addition, for new buildings, indoor noise limits (with closed windows) in schools and dwellings must be below EFN 35 and MFN 60. The number of houses and apartments in this insulation scheme has still to be decided. There are one school and one hotel to be insulated. The total costs are not yet known.

	For others: The Government has decided that all residents near roads, railways or airports that are subject to indoor noise levels over LAeq = 42 dB(A) will have their houses insulated down to this level.
Enforcement of noise zoning	Local authorities can enforce the agreed measures in their land-use regulations.
Other land-use planning measures for non-noise impacts	The costs of other land-use measures are unknown.

Country:	NEW ZEALAND	Major airport(s)	Other airports
		Wellington International Airport Auckland International Airport	

Land-use planning	Since 1989, the New Zealand airports have been deregulated. There is no longer a central authority responsible for land-use planning and noise control. This responsibility now rests with the local authorities. The noise metric is the DNL method. Noise contours are based on forecast noise levels related to the airport capacity. These contours are reviewed/updated every 10 years.
Type of measures used for most airports	— Comprehensive planning — Noise zoning — Subdivision regulation — Building codes — Noise insulation programmes (funded by developer) Comprehensive planning, noise zoning, subdivision regulation and real estate disclosure are considered to be the most effective measures for controlling the use of land around airports. For Wellington International Airport, these measures are considered not particularly effective because the airport was extended in 1953 and continues to operate in a challenging environment, with houses in some cases only 100 m from the runway centre line. Noise policy is based on containing the noise levels, not preventing development which has already taken place.
Noise monitoring	A noise monitoring system is installed around Wellington International Airport. The system is used for monitoring compliance with the noise contours. Auckland International Airport has a monitoring system planned for the near future that will be used to monitor and manage noise allowances.
Noise insulation schemes	Since 1995, developers have been required to provide insulation in areas close to Auckland International Airport. In areas subject to more than 55 dB(A) Ldn, insulation must ensure an internal environment of less than 45 dB(A) Ldn. Over the next 20 years, it is estimated that some 4 250 houses will be subject to noise in excess of 55 dB(A) Ldn. Probably some 2 000 of these will be new developments which will require developer-funded insulation.

Enforcement of noise zoning	Penalties to enforce the land-use measures were to be introduced after August 1997.
Other land-use planning measures for non-noise impacts	No other land-use measures are applied.

Country:	POLAND	Major airport(s)	Other airports
		Warsaw Chopin Airport	Krakow Airport Katowice Airport Gdansk Lech Walesa Airport, Wroclaw Airport Poznan Airport, Warsaw — Modlin Airport Rzeszow Airport Lodz Airport Szczecin Goleniow Airport LUblin Airport Bydgoszcz Szwederowo Airport Zielona Gora Airport

Land-use planning	Information on: a) Laws — Spatial planning and land development act of 27 March 2003. b) National/local authorities responsible for land-use planning — competent local government at the level of parish, district (second level of local government), province. e) Noise contours adopted, metric used, etc. — in accordance with Directive 2002/49/EC of the European Parliament and the Council of 25 June 2002 relating to the assessment and management of environmental noise.
Type of measures used for the most airports	Information on the different measures: a) environmental impact assessment; b) environmental programme for relevant airport; c) ecological overview for the relevant airport; d) areas of limited use for the relevant airports; e) continuous and periodic noise monitoring; f) noise insulation; and g) acoustic maps, etc.

Noise monitoring	a) In accordance with national law, airports, which handle at least 50 000 flight operations per year have an obligation to perform continuous noise monitoring. h) Airports located in metropolitan areas or having arrival or departure routes near metropolitan areas, with more than 10 000 flight operations per year, have an obligation to perform continuous noise monitoring c) In smaller airports (between 5 and 50 000 flight operations per year), there is an obligation to perform periodic noise monitoring.
Noise insulation schemes	Data is not available. The Civil Aviation Authority ensures that civilian aircraft comply with environmental Standards in accordance with Annex 16 of the Chicago Convention. In cases of exceeded permissible noise levels in the environment, the competent local authorities or environmental authorities may impose operational restrictions or establish an area of limited use around the airport.
Enforcement of noise zoning	Data is not available.
Noise charging schemes	The possibility of introducing noise charges is given by the Aviation Law and National Regulation of Ministry of Transport, Construction and Maritime Economy of 23 January 2013 on airport charges. There are two airports in Poland where noise charges have been introduced, particularly at the night period: Warsaw Chopin Airport and Warsaw Modlin Airport. a) Warsaw Chopin Airport: noise charges are collected for each landing of an aircraft. The unit charge rate (for each tone or part of a tone of MTOM) is dependent on the aircraft noise category (1-5) and the hour of landing and take-off. b) Warsaw Modlin Airport: noise charges are collected for each landing and take-off by the older generation aircraft (aircraft with a cumulative margin of noise from 0 to 9,99 EPNdB and aircraft without noise certificates).
Other land-use planning measures for non-noise impacts	Data is not available.

Country:	PORTUGAL	Major airport(s)	Other airports
		Lisbon	Faro Porto Funchal Ponto Delgada + 9 other island airports, as well as Bragança Covilhâ and some small mainland airports

Land-use planning	Applicable to all airports No legislation on noise zoning around airports are in force at the moment. However, new housing development is in general restricted to within a 75-dB contour by local authorities. National Law No. 251/87, Articles 26 and 27, deal with aircraft noise levels, with noise calculations based on a Leq method: Leq = La + 13.3log N – 52.
Type of measures used for most airports	Comprehensive planning Noise zoning
Noise monitoring	Some mobile equipment available
Noise insulation schemes	Not applicable
Enforcement of noise zoning	Not applicable
Other land-use planning measures for non-noise impacts	Unknown

Country:	QATAR	Major airport(s)	Other airports
		Hamad International Airport Doha International Airport	Al-Khor (Domestic)

Land-use planning	Land-use planning for the State of Qatar is under the responsibility of the Urban Planning Development Authority under the Ministry of Municipality and subsequently this falls under the obligation of the Qatar Civil Aviation Authority.
Type of measures used for most airports	Comprehensive planning — Not implemented yet. Environmental impact assessment — Not implemented yet. Noise zoning — Not implemented yet. Noise barriers — Available in all International Aerodromes. Noise monitoring and flight tracking, noise insulation, building codes, acquisition/relocation, etc. — Not implemented yet.
Noise monitoring	Noise monitoring systems are not installed yet.
Noise insulation schemes	Noise insulation schemes are not in place.
Enforcement of noise zoning	Not applicable.
Noise charging schemes	*Not applicable*
Other land-use planning measures for non-noise impacts	Not applicable.

Country:	REPUBLIC OF MACEDONIA	Major airport(s)	Other airports
		LWSK LWOH	nil/ICAO

Land-use planning	— With Article 3, paragraph 1 from the Regulation 5.2, the ICAO Annex 14 is transposed as a national regulation. — Law on Protection against Environmental Noise environmental noise protection (OGRM No. 79/2011).
Type of measures used for most airports	The following steps were taken: — Take-off Jet Blast Velocity and Noise Study for Skopje “Alexander the Great” Airport, R. Macedonia. — Jet Blast Study for Skopje “Alexander the Great” Airport, R. Macedonia. — 24-hour continued noise measurement at the airport “Alexander the Great” Airport, R. Macedonia.
Noise monitoring	RM has only two airports and has not yet installed a permanent noise monitoring system. Once per year measurements are performed during the peak month (July) at the airport in Skopje.
Noise insulation schemes	CAA has no data, does not perform the monitoring and measuring — the standards are given in the Law on Protecting against Environmental Noise.
Enforcement of noise zoning	Part XIII — Misdemeanor sanctions in the Law on Protection against Environmental Noise (for airports — Article 58, para. 1, item 5).
Noise charging schemes	— Article 189 Paragraph 1 item 33 from the Aviation Act – a fine of 2000 to 10000 EUR if aircraft has no Noise Certificate; — has not established additional charging for noise at the airports; and — has no other charging systems.
Other land-use planning measures for non-noise impacts	The Law on Protection against Environmental Noise, in Articles 19 and 22 – requests every spatial and urban plan to contain measures for non-noise impact.

Country:	ROMANIA	Major airport(s)	Other airports
		Henri Coanda Intl. Airport (LROP/ OTP)	3 airports subordinated to the Ministry of Transport 12 airports - subordinated to the local public administration 1 private airport

Land-use planning	**Governmental Decision no. 321/2005,** with subsequent modifications, relating to the assessment and management of environmental noise (transposing the Directive 2002/49/EC of the European Parliament and of the Council, relating to the assessment and management of environmental noise): — For 10 airports (LROP, LRBS, LRCL, LRIA, LRCV, LROD, LRSB, LRTM, LRBM, LRBC) the strategic noise maps had to be elaborated until 301h of June 2012, and the corresponding action plans for noise reduction, until 18th of July 2013. — The strategic noise maps and the action plans are approved by Order of the Minister of Transport for Henri Coanda Intl. Airport and by Decisions of County Councils for the others. **Ministerial Order no. 678/1.344/915/1.397/2006** for the approval of the guidelines for the interim computation methods of noise indicators for noise caused by the activities of the industrial areas, road traffic, railway traffic and air traffic in the vicinity of airports — the interim computation method for air traffic is ECAC.CEAC Doc. 29 'Report on Standard Method of Computing Noise Contours around Civil Airports', 1997. Of the different approaches to the modeling of flight paths, the segmentation technique referred to in section 7.5 of ECAC.CEAC Doc. 29. **Ministerial Order no. 1830/2007** for the approval of the guidelines regarding achievement, analysis and evaluation of the strategic noise maps; **Ministerial Order no. 152/558/1119/532/2008** approving the guidelines concerning the adoption of limit values and their application when they draw up action plans, for the noise indicators L_{den} and L_{night} for the noise caused by road traffic on the main roads and in agglomerations, rail traffic on the main railways and in agglomerations, major airports air traffic and/or urban airports and for the noise in agglomerations areas where are carried out IPPC industrial activities: The limit values of the noise indicators L_{den} and L_{night} are calculated for the most exposed to noise facades of the buildings and they as follows: — Order of the Minister of Transport no. 1261/2007 for the approval of the Romanian Civil Aeronautical Regulation RACR-PM "Environment Protection", third edition - transposing the following Directives: Directive 2002/30/EC of the European Parliament and of the Council, on the establishment of rules and procedures with regard to the introduction of noise-related operating restrictions at Community airports; Directive 2006/93/EC of the European Parliament and of the Council, on the regulation of the operation of airplanes covered by Part II, Chapter 3, Volume 1 of Annex 16 to the Convention on International Civil Aviation, second edition (1988); Directive 89/629/CE of the European Council on the limitation of noise emission from civil subsonic jet airplanes.

Ministerial Order no. 118/2003, with the subsequent modification, for the approval of the Romanian Civil Aeronautical Regulation concerning the conditions for the approval of technical documentation for the objectives in civil aeronautical easements areas — RACR — CADT, second edition — provides highlights for the local public administration authorities concerning the declaration of the civil aeronautical easements areas and the establishment of adequate protection regime of these areas, as well as limits and land-use conditions, conditions for the use of buildings, amenities, activities, etc. in these areas.

Ministerial Order no. 493/2007 for the approval of the Romanian Civil Aeronautical Regulation concerning the establishment of the civil aeronautical easements and the civil aeronautical easements areas RACR-SACZ, third edition from 2007 — the nature and content of the civil aeronautical encumbrances, characteristics, conditions and general requirements for the civil aeronautical easements areas, as well as the enabling framework for the extension and/or utilization of the buildings, amenities, activities, lands, etc., in the civil aeronautical easements areas (limitation, restrictions, etc.). The regulation is binding for all the legal and individual entities developing activities or who own lands, buildings, equipment/ installations and amenities in these areas on the Romanian territory.

Law no. 350/2001 concerning land-use planning and urbanism, with subsequent modifications — require the elaboration of the zonal urban plan, in case of the transport infrastructures. This plan includes regulations concerning the use of land and establishes: regulation concerning construction regime, territorial area function, percentage.

Governmental Decision no. 525/1996, for the approval of the General Urban Planning Regulation — provides that it will be avoided — the location of the buildings with dwellings in the vicinity of contaminant producing sources, loud noises and vibrations sources such as airports;

Governmental Decision no. 445/2009, with subsequent modification, on the assessment of the effects of certain public and private projects on the environment, transposing the Directive 2011/92/EU — states that the building of airports with at least a runway with no less than 2 100 m length or the change or extension of such a project that can have significant negative impact on the environment, is subject to environmental impact assessment.

Type of measures used for most airports

— Environmental noise impact assessment.

— Strategic noise maps (LROP, LRBS, LRCL, LRIA, LRCV, LROD, LRSB, LRTM, LRBM, LRBC) and Action Plan for preventing and reducing environmental airport noise where applicable.

Other noise related measures applied, mentioned on the AIP Romania Publication:

ICAO Noise Abatement Departure Procedures, applied for different aerodromes and RWYs, as described in the AIP Romania Publication (chapter AD 1.1-3);

For LROP and LRCL aerodromes, the APU is permitted to function at a maximum of 15 minutes after BLOCK ON TIME and may be started with a maximum of 30 minutes before STD;

LROP Noise abatement procedures:

To minimize disturbance in areas adjacent to the airport, Captains are requested to avoid the use of reverse thrust after landing, consistent with safe operation of the aircraft, especially between 2300 and 0700 (local time).

ATC will approve idle ground engine runs. Permission for ground testing in excess of idle must be requested through the marshal. All engine tests above idle must commence in the Engine Test Bay.

Times of operation are 0600-2300 LT. Engine testing on the open airfield will only be allowed for Chapter 2 aircraft between 0900 and 1700 and Chapter 3 aircraft between 0600 and 2300.

Propeller-driven aircraft are to be classified as Chapter 3.

LROP local aerodrome regulations for taxiing aircraft on the apron:

Aircraft may leave nose-in positions only by the aid of towing cars or using power back. Reverse thrust shall not be used. Aircraft operators shall make suitable arrangements.

LRBS Noise abatement procedures:

1. General rules:

1.1 Each aircraft operator using the airport shall ensure at all times that the aircraft is operated in a manner calculated to cause the least disturbance practicable in areas surrounding the airport.

1.2 Ground running tests of aircraft engines is not permitted on stands.

2. Night-time restrictions applicable between 22.00-06.00 LT:

2.1 Reverse thrust other than idle thrust shall only be used to an extent unavoidable for safety reasons.

2.2 Pilots will avoid the use of auxiliary engines or auxiliary power unit (APU).

2.3 The following operations are not permitted:

a. Technical or training flights (except MTOW < 5700 Kg);

b. planning and operating of flights of aircraft with MTOW 50 tones. Delayed flights are allowed to operate on LRBS, but no later than 22.30 LT, those flights will be charged according to 2.4 and GEN 4.1-6.

2.4 The landing charges on BUOURE5TI / Befineasa - Aurel Vlaicu are established in accordance with the MTOW of the aircraft and the applicable ICAO Annex 16 provisions, as specified in AIP ROMANIA GEN 4.1-6.

	3. Exemptions: The night-time restrictions are not applicable for the following type of operations: aircraft landing in emergency situations; aircraft performing humanitarian, medical, ambulance flights, stated in the Flight Plan; STATE aircraft or HEAD flights, stated in the Flight Plan.
Noise monitoring	No monitoring systems in place.
Noise insulation schemes	No noise insulation schemes in place.
Enforcement of noise zoning	N/A
Noise charging schemes	Additional charges applied for services provided between 10.00 pm - 06.00 am to non-scheduled flights (LRSB).
Other land-use planning measures for non-noise impacts	Measures for bird strike prevention (LRSB, LRIA, LRCL), preservation of natural habitats and natural nesting (LRTM, LRCL).

Country:	SERBIA	Major airport(s)	Other airports
		Nikola Tesla, Belgrade Constantine the Great, Nig	

Land-use planning	Basic legal regulation for land-use planning is the Law on planning and construction ("Official Gazette of the Republic of Serbia" 72/2009, 81/2009 — correction, 64/2010 — decision of Constitutional Court, 24/2011, 121/2012, 42/2013 — decision of Constitutional Court, 50/2013 — decision of Constitutional Court, H 98/2013 — decision of Constitutional Court). This law regulates: the conditions and modalities of spatial planning and development, the development and use of land and the construction of facilities; carrying out supervision over the application of this law and supervisory inspections; other issues of significance in the development of space, landscaping and use of land, and the construction of facilities. Mode of using the land is determined by a planning document: Spatial Plans (Spatial Plan of the Republic of Serbia, Regional Spatial Plan, Spatial Plan of the unit of local administration, Spatial Plan of the region of special use) and Urban plans (General Urban Plan, General Regulation Plan and Detailed Regulation Plan). The local administration is authorized to implement spatial planning for land around the airport (granting the location and building permits, etc.). Air Transport Law ("Official Gazette of the Republic of Serbia" No 73/10 57/11 and 93/12) in Art. 200-203 regulates: — the obligation of aviation entities shall undertake measures for the protection of the environment against aircraft noise and other noise-related external factors, resulting from aviation operations and services; — the obligation of the aerodrome operator to apply environmental protection measures; — the obligation of aircraft operators to pay a charge for environmental protection from: aircraft noise and aircraft engine emissions, used for the implementation of appropriate measures of protection, for the mitigation of harmful effects of aircraft noise and aircraft engine emissions; for the remedying of hazardous consequences; and for the development of the strategic noise maps and action . — the obligation of the operators of general purpose aerodromes and the aerodromes intended for commercial air transport, where more than 50 000 take-offs and landings took place throughout the previous year to provide permanent measuring of noise. Law on Noise Protection (Official Gazette of the Republic of Serbia" No. 36/2009 and 88/2010). This Law regulates: entities of noise protection; modalities and conditions of noise protection; noise measurement; access to information on noise; inspection and other issues of interest for environment and human health Regulation of noise indicators, limits, methods

	for evaluating noise indicators, harassment and the harmful effects of environmental noise ("Official Gazette of the Republic of Serbia" No.75/2010). This regulation prescribes the indicators of environmental noise, limits, methods for evaluating noise indicators, harassment and the harmful effects of noise on human health. Regulation of noise indicators, limits, methods for evaluating noise indicators, harassment and the harmful effects of environmental noise ("Official Gazette of the Republic of Serbia" No.75/2010). This regulation prescribes the indicators of environmental noise, limits, methods for evaluating noise indicators, harassment and the harmful effects of noise on human health. The main noise indicator used is the noise level for day-evening-night noise and is expressed in decibels dB (A). Using the additional noise indicators: authoritative noise LRAeqT level of noise exposure (SEL) LAE. Limit values of key indicators of noise outdoors are between 50 and 65 dB (A) during the day and between 40 and 55 dB (A) per night depending on the acoustic zone.
Type of measures used for most airports	— Spatial planning. — Acoustic zoning.
Noise monitoring	Currently not applied. Measurement of noise at airports still does not occur, due to the fact that, according to Article 203 of Air Transport Law, only the airports where more than 50 000 aircraft operations have an obligation to measure noise and no airport in Serbia has reached that number of aircraft operations.
Noise insulation schemes	Currently not applied.
Enforcement of noise zoning	Currently not applied.
Noise charging schemes	Currently not applied.
Other land-use planning measures for non-noise impacts	Unknown.

Country:	SOUTH AFRICA	Major airport(s)	Other airports
		O.R. Tambo International Cape Town International King Shaka International Kruger Mpumalanga International Pilanesberg International Polokwane International Port Elizabeth International Lanseria International Bloemfontein International Upington International	Many other airports and strips

Land-use planning	Local authorities are responsible for land-use planning. Noise contours are based on forecast noise levels. The time horizons are related to the relevant airport development proposals.
Type of measures used for most airports	— Comprehensive planning, including environmental impact assessments (EIA) for airport developments. — Noise zoning. — Building codes. . — Noise monitoring and flight tracking systems.
Noise monitoring	Noise monitoring and flight tracking systems are installed at O.R. Tambo, Cape Town and King Shaka International Airports.
Noise insulation schemes	None.
Enforcement of noise zoning	Local authorities are responsible for enforcing land-use measures.
Noise charging schemes	None.
Other land-use planning measures for non-noise impacts	None.

Country:	SPAIN	Major airport(s)	Other airports
		Major airport(s): Those classified as such in accordance with Directive 2002/49/EC	Other airports:
		Adolfo Suárez - Madrid – Barajas Barcelona – El Prat Málaga Palma de Mallorca Gran Canaria Tenerife Norte Tenerife Sur Valencia Alicante Ibiza Bilbao Sevilla	34 airports and 2 heliports

Land-use planning	The December 29, 1999 Directive was introduced by Law 48/1960, on 21 July 1999, Air Navigation — the concept of acoustic aviation easement intended to protect land uses in areas near airports affected by noise, using them for noise curves defined in the master plans of the airports. EL RD 1367/2007 of 19 October 1999 sets new criteria for calculating (homogeneous indicators) and acoustic values to define infrastructure easements General Interest State. Finally, Law 5/2010, of 17 March, sets deadlines to define acoustic easements airports with the new criteria. National authorities should be responsible for defining and approving airports areas (easements) that exceed the target values as a result of noise from the infrastructure. Local authorities should ensure that land uses that are fixed in their plans for the interior of the easements are compatible with aircraft noise. The easement area is bounded by the curve Ld = 60 B, 60 dB and Le = Ln = 50 dB, being indicators defined in Directive 49/2002. The calculation method is recommended by the Directive 49/2002 for noise from aircraft: ECAC.CEAC Doc 29 "Report on Standard Method of Computing Noise Contours around Civil Airports".
Type of measures used for most airports	— Comprehensive planning. — Environmental impact assessment. — Noise zoning. — Noise monitoring and flight tracking. — Optimal use of tracks. — Acoustic Insulation Plans
Noise monitoring	Today there are 6 airports with existing noise monitoring systems. These are complete systems that detect, measure and associate the noise produced by aircraft flying over the microphones installed in strategic areas of the environment. The sound control is not limited to aircraft in flight, it also performs sound control on land, especially at night, in areas of the parking platform next to aircraft populations bordering airports. Airports with such surveillance systems are:

— Adolfo Suárez Madrid-Barajas
— Barcelona-El Prat
— Valencia
— Palma de Mallorca
— Málaga-Costa del Sol
— Alicante-Elche

More details of such surveillance systems are available at the following address: (http://www.aena-aeropuertos.es/csee/Satellite/sostenibilidad/es/Page/1237548016941//Sistemas-de-monitorado-de-ruido.html)

Noise insulation schemes

To date Acoustic Insulation Plans have been implemented at airports of A Coruña, Adolfo Suárez Madrid-Barajas, Alicante-Elche, Barcelona-El Prat, Bilbao, Girona-Costa Brava, Gran Canaria, Ibiza, La Palma, Málaga-Costa del Sol, Melilla, Menorca, Palma de Mallorca, Pamplona, Sabadell, Santiago, Tenerife Norte, Valencia y Vigo.

Actions implemented to date in this area are summarized in the table below:

ACOUSTIC INSULATION PLANS (accumulated data)								
INDICATOR	2006	2007	2008	2009	2010	2011	2012	2013
Plans approved	9	10	10	16	17	19	20	19
Census dwellings entitled to apply sound insulation	17.726	18.142	18.614	21.850	26.404	27.078	27.197	29.670
Houses with acoustic isolation implemented	12.306	13.353	14.599	15.300	16.390	17.498	17.958	18.725

Enforcement of noise zoning

Under the provisions of Law 21/2003 Air Safety State Aviation Safety Agency (EASA) is competent to inspect and sanction noncompliance of aviation easements.

Noise charging schemes

Other land-use planning measures for non-noise impacts

The costs of other land-use measures are unknown.

Country:	SWEDEN	Major airport(s)	Other airports
		Stockholm-Arlanda Bromma-Stockholm Goteborg-Landvetter Malmo	Borlange, Gallivare, Goteborg-Save, Halmstad, Jonkoping, Kalmar, Karlstad, Kiruna, Kramfors-Solleftea, Kristianstad, Linkoping-SAAB, Lulea, Norrkoping, Ronneby, Skelleftea, Stockholm-Skavsta, Stockholm-Vasteras, Sundsvall-Harnosand, Trollhattan-Vanersborg, Umea, Uppsala-Arna, Visby, Vaxjo, Are-Ostersund, Angelholm, Orebro, Ornskoldsvik.

Land-use planning	The national Planning and Building Act consists of rules for new buildings. The Swedish Transport Administration is responsible for the development of noise contours used for building permits around the major airports (as well as the other airports in the list above) in Sweden. The Swedish Environmental law consists of rules for supervision of the existing environmental situation including noise. According to that law, airports with a longer runway than 1 200 m must have an environmental permit to be allowed to operate. The permit and its conditions are decided in the environmental court. The Swedish Environmental Protection Agency is responsible for seeing to the interests of the Swedish Environmental law. The noise metric used for aerodromes is the FBN (equivalent to L_{den}).
Type of measures used for most airports	The major airports in Sweden have developed a "Noise Management Plan", consisting of different types of measures based on the four pillars of the Balanced Approach together with a fifth pillar: information to the public. The questions below mainly relate to land-use planning and information to the public. Land-use planning consists of cooperation with the surrounding communities concerning building permits in different noise zones for different kinds of new buildings, as well as noise insulation of existing houses. Acquisition has been used for highly noise-exposed houses. Information to the public means flight tracking to check that the environmental conditions are fulfilled and also to comment on noise complaints on certain noise events. Noise monitoring at certain strategic measurement points is being done.

Noise monitoring	Noise monitoring is being done with several purposes. One purpose is to inform the public about the measured noise levels, and other purposes can be to find the best substitution of aircraft types in ANP used for calculation or to evaluate different kind of noise abatement procedures. Two of the major airports in Sweden have a permanent noise monitoring system installed which is connected with the flight tracking system.
Noise insulation schemes	The noise insulation schemes are based on the conditions in the environmental permit for each airport and may thus vary between different airports. But typical indoor levels are equivalent level 30 dBA and maximum level 45 dBA. Typical costs: 126 000 Swedish crones for a typical one-family house. Until 2012, Swedavia (the Swedish service provider for state-owned airports) have insulated 1 500 houses.
Enforcement of noise zoning	The Swedish Environmental law consists of rules for supervision of the existing environmental situation including noise. The County Administrative Board (and sometimes the community) is supervising the noise zoning. The airports report and monitor this legal obligation (no fines). When necessary, the County Administrative Boards will intervene against municipal decisions regarding housing around airports.
Noise charging schemes	The major airports in Sweden have noise departure charges based upon EPNL and the noise sensitivity of the airport (a noise-sensitive airport is an airport exposing many people to noise, for example a city airport). These charges are financing the flight track monitoring system, the noise monitoring stations, noise experts and noise insulation measures.
Other land-use planning measures for non-noise impacts	No.

Country:	SWITZERLAND	Major airport(s)	Other airports
		Zurich/Kloten Geneva/Cointrin Basel/Mulhouse (operated jointly by Switzerland and France)	7 regional airports 24 local airfields + numerous heliports/helipads

Land-use planning	Applicable to all aerodrome categories (civil and military), according to the Sectoral Plan for Aviation Infrastructure, National Aviation Act and Environmental Protection Law Local authorities are required to incorporate airport noise zones and land-use measures into local plans. For all airports, the noise metric is the Leq with limit values between 50 and 75 dB(A). Leq are based on one year operation data (day (06:00 – 22:00): Lr = 16h; night Lr = 1h Leq for each night hour). A degree of sensitivity (DS) characterizes building zones according to their use. The three types of noise exposure limit values are determined according to the noise impact contours of similar values surrounding the airport. By combining DS and limit values, one can obtain the location where building is authorized, restricted or possible under conditions.
Type of measures used for most airports	— Comprehensive planning, including environmental impact assessment (EIA) for airport improvements with effect on noise climate — Noise zoning is applicable to all aerodrome categories — Building codes include noise insulation for noise-sensitive buildings in legal noise zones — Acquisition/relocation and easement/transaction assistance are applied to some cases for very highly exposed sites — Noise barriers are applied in some cases to shield noise from certain ground activities (such as engine testing) — Noise monitoring and flight tracking systems are installed around all major airports — Noise charges are raised from the airlines for each landing (on top of the landing fee) to recover the costs of the insulation programmes and to encourage the use of less noisy aircraft during the evening and night periods Comprehensive planning, noise zoning and, in some cases, land acquisition and relocation are considered the most effective measures for controlling the use of land around airports, especially in new cases. Land-use planning around Zurich/Kloten and Geneva/Cointrin Airports is considered to have had limited effect because the areas were already well-developed at the time of the introduction of the noise zones (around 1980).

	In 1997, the Swiss Supreme Court gave landowners the right to claim compensation for the reduction in value of their properties. It was estimated that this would cost the airport operators CHF 1 to 2 billion (5 to 10 times the cost of soundproofing the houses). It seems clear that the airports will not be able to bear these costs.
Noise monitoring	Noise monitoring systems are installed around Basel/Mulhouse, Geneva/Cointrin and Zurich/Kloten Airports.
Noise insulation schemes	Noise insulation programmes are financed by the house owners, if the houses were built after the establishment of noise zones. Only limited insulation costs were financed by airports so far (excluding hospitals, schoolhouses, and churches). Large-scale insulation programmes have not yet been started. A noise insulation programme around the major airports based on the new Leq contours affects about 6 000 to 8 000 houses. The costs of the new insulation schemes are estimated at 400 million CHF. In the national building code, conditions for new buildings are a minimum building shell damping index (Ia = 50 dB) or (new) window damping index (R'w = 40/35/30).
Enforcement of noise zoning	Noise zones are published. They are part of the Sectoral Plan for Aviation Infrastructure and are directly applicable to building authorizations and communal planning. Noise monitoring systems are installed around all major airports. There is no direct link with land-use planning. Noise monitoring has primarily a political significance. Monitoring is used to verify and adjust noise contours.
Noise charging schemes	Noise-related landing charges to encourage the use of less noisy aircraft.
Other land-use planning measures for non-noise impacts	The cost of other land-use measures is not known.

Country:	UNITED KINGDOM	Major airport(s)	Other airports
		London/Heathrow London/Gatwick London/Stansted Manchester	Aberdeen Birmingham Bristol East Midlands Edinburgh Glasgow London/City London/Luton

Land-use Planning	Local planning policies and decisions are a matter for the local authority. Planning decisions can be called in by the Minister on decisions of national importance. The Government's National Planning Policy Framework (NPFF) (see attached link https://www.gov.uk/government/policies/making-the-planning-system-work-more-efficiently-and-effectively/supporting-pages/national-planning-policy-framework) says that planning policies and decisions should aim to avoid a situation where noise gives rise to significant adverse impacts on health and quality of life, as a result of new development (including around airports), and to mitigate and reduce, to a minimum, other adverse impacts on health and quality of life, arising from noise from new developments, including through the use of conditions. Previous detailed planning guidance on minimizing the adverse impact of noise set out in Planning Policy Guidance 24 has been withdrawn. This will be replaced shortly with broader based web guidance.
Type of measures used for most airports	Noise zoning is applicable to all airports but will be a decision for the local authority. The Government's Aviation Policy Framework (APF) (see attached link https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/153776/aviation-policy-framework.pdf issued in March 2013, sets out that the Government expects airport operators to offer households exposed to levels of noise of 69dBLAeq, 16hr or more, assistance with the cost of moving.
Noise monitoring	The airports listed all have noise monitors which enable them to monitor noise in the vicinity of the airport. Further details will be provided on the airport's websites.
Noise insulation schemes	The airports listed all have noise insulation schemes. Each airport will have details of their schemes on their website. These insulation schemes are financed by the airport operators. There are no statutory schemes in the UK and airports are free to set out their own schemes. However, guidance set out in the APF expects airport operators to offer acoustic insulation to residential properties and noise-sensitive buildings, such as schools and hospitals exposed to levels of noise of 63 dBLAeq 16hr or more. Whilst under the Civil Aviation Act 1982, the Government has the power to specify the noise insulation scheme for Heathrow and Gatwick, but it has not done so for many years and these airports are now responsible for setting their own schemes.
Enforcement of noise zoning	Local authorities can enforce the agreed measures through the planning system which includes legal procedures for enforcement. Operations which do not comply can in theory be closed down.

Noise charging schemes	Some of the larger UK airports use landing charges to encourage cleaner and quieter aircraft. A report by the UK Civil Aviation Authority (CAA) in October 2013 found approaches to differential landing charges varied across the six airports reviewed – London Heathrow, London Gatwick, London Stansted, Manchester, East Midlands and Birmingham. The CAA called for charges to be more consistently linked to impact to maximize the incentives for more environmentally friendly operations. A copy of the report can be found at http://www.caa.co.uk/docs/33/CAP%201119%20Noise-related%20charging%20review.pdf
Other land-use planning measures for non-noise impacts	

Country:	UNITED STATES	Major airport(s)	Other airports
		40 airports among the largest 100 airports in the world	+ thousands of smaller ones

BACKGROUND: The FAA identifies public-use airports that are important to the system for inclusion in the United States airport plan, known as the National Plan of Integrated Airport Systems (NPIAS). All commercial service airports are included in the NPIAS and selected general aviation airports.[10] A commercial service airport with more than 10 000 annual enplanements is called a primary airport. There are 389 primary airports that are divided into four categories: large, medium, small, and non-hub airports. The remaining 2 964 NPIAS airports are mostly used by general aviation aircraft and are referred to as non-primary airports. High-capacity general aviation airports in major metropolitan areas, referred to as relievers, have been developed to provide pilots with an attractive alternative to using congested large and medium hub airports, which account for the majority of noise mitigation and compatibility projects.

Land-use planning	The Federal standard for airport noise annoyance and mitigation is the 65 dB DNL contour. Individual State laws authorize local land use and development laws or ordinances. Adoption and application of noise contours in local ordinances depend on local leadership to substantiate effective prevention and mitigation strategies for compatible airport land-use issues. Local governments may establish a lower noise threshold contour to reflect their local preference on land-use planning and controls. Federal incentives are available for planning and implementation of noise compatibility programs by local airport owners with their adjoining land-use governing jurisdictions. Through FAA's voluntary Noise Compatibility Planning programs, under Title 14 Code of Federal Regulations Part 150, FAA has funded over 200 airport noise compatibility programs across the United States and territories. In addition, the FAA can help fund noise compatibility planning as well as some types of noise mitigation in impacted communities, in partnership with their local airport.
Type of measures used for most airports	The types of measures used for many United States airports include: — Comprehensive planning, including environmental review of all airport development that potentially affects noise; — Noise zoning; — Subdivision regulation; — Transfer of development rights; — Easement acquisition and relocation; — Transaction assistance; — Real estate disclosure;

10. Commercial service airports are defined as public airports receiving scheduled passenger service and having 2 500 or more enplaned passengers per year.

	— Noise barriers; and — Sound Insulation.
Noise monitoring	In the United States, most larger airports, particularly large and medium hub airports, have monitoring systems in place. Some have received Federal financial assistance for the supporting infrastructure. Many airports maintain dedicated noise offices to help monitor, analyse and respond to noise-related issues.
Noise insulation schemes	Numerous sound insulation programs are applied around airports and are focused on interior habitable living spaces in residences as well as school classrooms and libraries, as well as other noise-sensitive functions such as healthcare facilities and places of worship. Airports can fund these programs through a number of mechanisms, including airport revenue, Federal grants or Passenger Facility Charge (PFC) revenues.
Enforcement of noise zoning	Provide information on law enforcement applied on noise zoning (responsible for the enforcement, any penalties/fines in place or just legal obligations, do airports report and monitor the ongoing developments). In some cases, there are stringent restrictions on numbers of aircraft per period, noise levels and deviation from flight tracks. Some other airports only penalize unauthorized deviations from flight tracks. However, United States law limits the types of noise-related restrictions that airports may impose on aeronautical users. In some cases, there are mandatory curfews that were put in place before current laws were established. Many airports have established voluntary restrictions that are monitored but cannot be “enforced” per se.
Noise charging schemes	Not aware of any noise charging schemes at airports in the United States.
Other land-use planning measures for non-noise impacts	Airports that receive Federal Airport Improvement Program grants actively work with their surrounding communities to develop effective airport-compatible land-use policies, laws and requirements. Land-use planning measures are in place for control of wildlife hazard attractants, high structures and other obstructions to safe navigation (smoke plumes, solar glare, thermal plume disruption, radio and electrical interference, etc.), and airport safety clearances. There is cooperation at the Federal level for effective enforcement of wildlife hazard mitigation and control. For example, Federal law permitting landfill development requires landfills to be located without creating wildlife attraction hazard to airports. Airport-compatible land-use measures are implemented via state and local land-use planning, zoning, local building and development laws, siting and design feasibility considerations to meet Federal airspace hazard determination mandates, airport purchase of land and/or development rights to prevent incompatible development. Several states (e.g. California, Florida) have legislation that require development of local airport land-use compatibility plans that guide local zoning and land development decisions in the airport environs.

Appendix 4

CASE STUDIES: HERITAGE MANAGEMENT

This appendix will be completed and available on the ICAO website as case studies are submitted to the ICAO Secretariat.

Appendix 5

CASE STUDIES: CLIMATE CHANGE ADAPTATION AND RESILIENCE

This appendix will be completed and available on the ICAO website as case studies are submitted to the ICAO Secretariat.

Appendix 6

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