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RƏQƏMSAL İNKİŞAF VƏ NƏQLİYYAT NAZİRLİYİ
DÖVLƏT MÜLKİ AVİASİYA AGENTLİYİ

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"Guidance for Land Use and Environmental Management" adlı sənədin 1-ci nəşrinin qüvvəyə minməsi barədə

Beynəlxalq Mülki Aviasiya Təşkilatının (ICAO) tələbləri nəzərə alınmaqla aerodrom istismarçılarının fəaliyyətinin tənzimlənməsi məqsədilə "Guidance for Land Use and Environmental Management" ("Ərazilərdən İstifadə və Ətraf Mühitin Menecmenti üzrə Təlimat") adlı sənədin 1-ci nəşri işlənib hazırlanmışdır.

Sözügedən sənədin tətbiqini təmin etmək məqsədilə "Azərbaycan Respublikasının Nəqliyyat, Rabitə və Yüksək Texnologiyalar Nazirliyi yanında Dövlət Mülki Aviasiya Agentliyi haqqında Əsasnamə"nin 5.6.6-cı yarımbəndini rəhbər tutaraq,

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1. "Guidance for Land Use and Environmental Management" Təlimatının 1-ci nəşri 2022-ci ilin 23 sentyabr tarixindən qüvvəyə minsin.
2. Sözügedən sənədin şamil edildiyi aidiyyəti mülki aviasiya subyektləri bu Təlimatın 2022-ci il 23 oktyabr tarixindən tam tətbiqini təmin etsinlər.
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Direktor **Arif Məmmədov**

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GUIDANCE
FOR LAND USE
AND
ENVIRONMENTAL MANAGEMENT

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0.4 RECORDS OF AMENDMENTS AND REVISIONS

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Edition: - *Release of a document having incorporated all previous revisions until the current version. New edition of a document will not show revised text in blue color. Current edition of a document shown on each page in footer.*

Revision: *- A change made to a part of document, where it is reflected with blue text or accompanied with a vertical line on right side of a document. Basic information on revisions (number and date) given in the List of effective Pages and indicated in header of affected page and in context itself.*

0.5 TERMS AND DEFINITIONS

Definition	Meaning
Aerodrome	A defined area on land or water (including any buildings, installation and equipment)intended to be used, either wholly or in part for the arrival, departure and surface movement of aircraft.
Aerodrome operator	İn relation to a certified aerodrome, means the holder of an Aerodrome Certificate.
Bird incident	Means an incident where: a)there Is a collision between an aircraft and one or more birds; b)where one or more birds pass sufficiently close to an aircraft in flight to cause alarm to the pilot.
De-icing/anti-icing facility	A facility where frost, ice or snow is removed (de-icing) from the aeroplane to provide clean surfaces, and/or where clean surfaces of the aeroplane receive protection (anti-icing) against the formation of frost or ice and accumulation of snow or slush for a limited periodof time. Note: Further guidance is given in the Regulation of Aircraft Ground De-icing/Anti-icing Operations (Doc 9640).
Obstacle	Any fixed (whether temporary or permanent) or mobile object or parts thereof, that: a) are located on an area intended for the surface movement of aircraft; orb) extend above a defined surface intended to protect aircraft in flight; orc) stand outside those defined surfaces and that have been assessed as being a hazard to air navigation.
Serious incident	Means an incident involving circumstances indicating that an accident nearly occurred.

0.6 ABBREVIATION

ATC	Air Traffic Control
ATS	Air Traffic Services
Az.SCAA	Azerbaijan State Civil Aviation Agency
ICAO	International Civil Aviation Organisation

0.7 REFERENCES

This Manual is based on the performance standards, specifications, and recommendations contained in documents the International Civil Aviation Organization (ICAO) Airport Planning manual Manual (Doc 9184), Part II, Land Use and Environmental Management.

0.8 PURPOSE

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.

“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.

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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

b) 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 endeavors 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. 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. G-AGA-001);

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.

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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 In some cases, to decrease impact from noise related to aviation activities, some airports limit aircraft operations based on environmental considerations, rather than on airport capacity or apply noise abatement procedures.

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).

2.2.3 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.

2.2.4 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.

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 manmade 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 (SOx) 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 (O3) 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 CO2, 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 (SF6). 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 G-AGA-001 - 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.

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 Resolutions3. This consists 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 tires, 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 the 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 percent; 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 NO2, CO, O3, SO2, some organic compounds (e.g. benzene (C6H6), 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 NO2 — though reported as if it were all NO2), whereas most State ambient air quality standards specify maximum concentrations of NO2. Similarly, the ICAO smoke number (SN)4 Standard is not consistent with PM10 and PM2.5 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.

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 CO2 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 G-AGA-020 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.

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 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

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;

— 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.

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 AAR-AGA-001. Risk management approach can be used to assess infrastructure and environmental management options.

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.

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 G-AGA-021.

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. G-AGA-001 — 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 G-AGA-019 —Pavement Design Manual.

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. G-AGA-019 — Pavement Design Manual, 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 G-AGA-017 — 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 G-AGA-020 — 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 G-AGA-020 — 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 G-AGA-014 — Visual Aids and G-AGA-015 — 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 Servicing1. ASTM International provides petroleum standards for aviation fuels, and ASTM Manual 5, Aviation Fuel Quality Control Procedures, provides a complete explanation of several common procedures used by fuel handlers2. 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.

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).

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 G-AGA-011 — 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 G-AGA-021 — 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 sunfacing.

— 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 switchoff. 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.

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).

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 G-AGA-001 — 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 G-AGA-016 — 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.

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 noisesensitive 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 Lden 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 Lden 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.

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)

6.3.6 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.

6.3.7 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.

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.

— 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.*

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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.

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.

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.

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 IPCC2:

— 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.

— 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 online at http://www.icao.int/environmentalprotection/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
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 — Higher risk of storm surge inundation due to sea level rise

Climate change variable	Potential impacts on airport infrastructure and operations
Increased intensity of storms (including impacts from high winds, intense precipitation events, and storm surges)	— Damage to airport infrastructure and airport buildings — Accelerated ageing of the airport facilities and infrastructure, such as runways — 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.

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 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. Longterm 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.