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TABLE OF CONTENTS

CHAPTER 1
General

1.1 The Airport And Its Environs

1.1.1 The compatibility of an airport with its environs is an ideal that can be achieved by proper planning of the airport, control 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.

1.1.2Airport planning must be recognized as an integral part of an area-wide comprehensive planning programme. The location, size and configuration of the airport need 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 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. 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. To the extent that technical 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, 1and-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 Control

1.2.1 In recent years there has been increased public concern regarding the protection of the 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 controls should be applied at the airport and its environs.

1.2.2 The environment has been defined as including:

(a) Air, land and water;
(b) All layers of the atmosphere;
(c) All organic and inorganic matter and living organisms ;and
(d) The interacting natural systems referred to in a) to c).

Since all of these components interact, disruption to one may have a profound effect on the entire system. Therefore, to lessen local and global impacts, it is important that the entire civil aviation industry endeavors to control harmful emissions.

1.2.3 Pollution occurring in and around the airport has the potential to affect not only the immediate area, but also the surrounding areas. Because it can have an effect on human health and the ecology of the- surrounding area, efforts should therefore be made towards pollution prevention. Environmental controls thus provide a means of either decreasing pollution at the source or reducing the potential for negative environmental impacts. Controls such as air and water quality guidelines, aircraft engine noise limits, waste management plans, environmental emergency plans, and environmental management plans are necessary.

1.2.4 Airports can operate with limited environmental impact by incorporating environmental management plans and procedures with land-use planning, In the past, environmental management has concentrated on pollution abatement or control by finding ways to dispose of waste after it has been produced. More recently, organizations have been shifting toward pollution prevention, which focuses on reducing or eliminating the need for

pollution control. 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. Anticipatory action is used to preempt the need for control or remedy.

1.3 The Need For Land-Use Planning

1.3.1 The need for some public control of land in the vicinity of an airport was recognized in the early history of civil aviation. In general, these early measures were usually concerned with height control of possible hazards or obstacles to flight into or out of airports. Also recognized was the need to control potentially conflicting activities, such as:

(a) Activities that could cause electrical interference with radio communications and navigation aids;
(b) Lights that might confuse pilots in the clear interpretation of aeronautical lights; and
(c) The production of smoke that reduces visibility.

Although litigation regarding aircraft noise did occur in the early 1960s, it was only after the widespread introduction of commercial turbo-jet aircraft that the compatibility of land use with noise exposure in the vicinity of airports became a major consideration. Today, aircraft noise is probably the most significant form of pollution caused by aircraft operation and is therefore a major factor influencing land-use planning in the vicinity of airport

1.3.2 The requirement for land-use planning in the vicinity of an airport is twofold, namely:

(d) To provide for airport needs, e.g. obstacle limitation areas and future airport development, and
(e) To ensure minimal interference to the environment and the public, e.g. by locating residential areas away from zones subject to excessive noise or other pollution and by preserving parklands.

CHAPTER 2
Environmental Impacts Associated with Aviation Activities

2.1 General

This chapter deals with environmental problems related to airport and aircraft operations. It identifies most of the major environmental problems 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 problems 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 problems 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 solving the problem, as well as comments on the relevant activities of other Organizations, whenever pertinent.

2.2 Aircraft Noise

2.2.1 Since the introduction of jet aircraft, noise has been considered to be perhaps the most important environmental problem associated with civil aviation. Noise levels in the vicinity of airports are affected by two opposing trends: the replacement of noisy aircraft by quieter ones and the increasing number of aircraft movements. As a result, the problem of noise may decline at some airports but increase at others. The noise problem has prevented the expansion of airport capacity in some cases, thereby contributing to airport congestion. Because of this and other environmental problems, some States are considering limiting aircraft operations at airports based on environmental considerations, rather than on airport capacity. In other words, the standard "operational airport capacity- is replaced by measures of capacity based on environmental parameters.

2.2.2 Engine testing and auxiliary power units (APU s) used during ground operation, as well as other equipment such as ground power units (GPU s) and ramp vehicles, are additional noise sources at airports.

2.2.3 Sonic boom, caused by supersonic aircraft, is not a major problem at the present time but could become an issue if manufacturers proceed with plans for a new generation of supersonic aircraft. ICAO considered this problem in detail during the 1970s when supersonic aircraft operations were first introduced. Guideline material was published in 1975 (see Circular 126, Guidance Material on SST Aircraft Operations). ICAO's earlier work on this problem remains valid. At present, most States do not permit civil supersonic flights over their territories. For most aircraft types, the noise caused by aircraft en route (other than sonic boom) is not a significant problem because the aircraft are flying too high to cause a disturbance at ground level. However, this can be a problem in the case of helicopters and, if ever they materialize, aircraft driven by prop fan engines.

2.2.4 Annex 16 ECAR *** - Environmental Protection, Volume 1 - Aircraft Noise sets the Standards for noise certification of large subsonic jet and propeller-driven aircraft, small propeller-driven aircraft and helicopters. The Committee on Aviation Environment Protection (CAEP) keeps the Standards under review. At present, there are no specific Standards for supersonic aircraft. Annex 16 ECAR *** also includes guidelines for noise certification of APU s.

2.2.5 A worldwide policy has been developed regarding operating restrictions on non-noise-certificated aircraft and Chapter 2 aircraft, as adopted in 1990 (Resolution A28-31). Following the adoption of Resolution A28- 3, some States with noise problems (e.g. ECAC/EC and the United States) introduced operating restrictions on Chapter 2 aircraft.

1. Superseded by A33-7.

2.3 Air Quality In The Vicinity Of Airport

2.3.1 Air quality in the vicinity of airports is affected by aircraft engine emissions, emissions from airport motor vehicle and access traffic, and emissions from other sources (e.g. heating/power plants and incinerators).

2.3.2 Air pollution refers to a condition of the air marked by the presence therein of one or more air contaminants that can:
- 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 a major environmental problem in most countries, especially in urban areas, and is generally recognized to contain:
- Carbon dioxide (CO2),
- Carbon monoxide (CO),
- Oxides of nitrogen (NOX),
- Volatile organic compounds (VOC), hydrocarbons (HC), and
- Ozone (O3).

2.3.4 Carbon dioxide (CO2) is produced by the oxidation of carbon in fuel, while carbon monoxide (CO) is a product originating from the incomplete combustion of hydrocarbon fuels. Nitrogen oxides result from high temperature combination of nitrogen and oxygen (primarily NO and NO2) in aircraft engines and internal combustion sources. Volatile organic compounds (VOCs) which are directly emitted from the combustion process are considered carcinogenic, and chronic exposure to VOCs could cause health problems. Hydrocarbons (HC) cover a wide range of pure and impure hydrocarbons (methane, olefins, baldheads, ketenes and terrenes) whose sources include fuelling activities and incomplete combustion processes. Ozone (O3) is primarily a by-product of photochemical reactions and is known to play an important role in the chemistry of NOX and HC. It 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.

2.3.5 Although the air quality in the vicinity of airports is generally no worse, and in fact is often better than that found in most urban areas, it is nevertheless a cause for concern.

2.3.6 Sources of pollution at airports include:

(a) Aircraft engine emissions, in which the principal pollutant is NOX, while other pollutants are CO, unburned hydrocarbons and smoke;

(b) Emissions from heating/power plants and incinerators, such as fires set for the purpose of training rescue and fire fighting crews;

(c) Emissions from motor vehicles, notably from airport motor vehicles used by airport operators, air carriers and other businesses based at an airport; and

(d) Emissions from access traffic comprising of passengers" and visitors" motor vehicles, cargo and delivery trucks, and service and public transport vehicles.

2.3.7 Annex 16 ECAR *** -Environmental Protection, Volume Il - Aircraft Engine Emissions contains the Standards for the control of gaseous emissions through engine certification scheme. It establishes the limits for the emission of NOX, CO, unburned hydrocarbons, and smoke from new engines. The need to reduce air pollution emanating from emissions of airport motor vehicles, access traffic and other sources has attracted the attention of most governments and some intergovernmental organizations. The extent of the air pollution problem may vary from one airport to another, depending in particular on the location of an air pun and the availability of public transport facilities serving the airport. As more solutions emerge, the scope for reducing air pollution from the different sources should also increase.

2.4 Global Environmental Problems Arising From Airport Use

2.4.1 In recent years, evidence has emerged that the ozone layer around the earth, which protects us from harmful ultraviolet radiation, is being depleted as a result of complex chemical reactions involving man-made gases. Ozone depletion can be defined as the diminishing of the earth's protective stratospheric ozone layer primarily due to human activity. The leading causes of ozone depletion are chlorofluorocarbons (CFCs) and halos, foams, solvents and man-made chemicals that are commonly used in air conditioners and refrigerators. Since CFCs and halos are very stable and do not break down in the lower atmosphere, they are able to

rise to the stratosphere where they are broken down by ultraviolet radiation and, through a variety of -chain reactions, destroy the ozone layer.

2.4.2 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.

2.4.3 The principal cause of the 07onc-depletion problem is considered to be chlorofluorocarbons (CFCs) which are primarily employed as aerosol propellants or as refrigerants. Although civil aviation uses CFCs, it only uses small quantities.

2.5 Environmental Problems Arising From Construction and Expansion of Airports or Associated Infrastructure

2.5.1 The environmental problems 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 problems arise not only when new airports are being developed but also when existing airport facilities are expanded. The nature of the problems 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; however, in and 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 likely 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 sitting of some airports may interfere with 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 beings. For example, airport construction may destroy sources of food 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 also covered in detail in the Airport Services Manual (Doc 9137) EAC 139-20 Part 3 - Bird Control and Reduction. Appendix I to this manual outlines land uses that are compatible and incompatible with minimum bird hazards to aircraft.

2.5.9 As far as these environmental problems 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 Airport Planning Manual streams, rivers, lakes, etc. However, sub-surface water may also become contaminated when leaks or spills of fluids seep through the soil into the ground water.

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:

- Glycol, from de-icing/anti-icing of aircraft;
- Urea, from de-icing/anti-icing of runways, aprons, and taxiways;
- Fuel, from spills during refuelling and leaks from pipes or tanks;
- Fire suppressant chemicals and foams dispersed in fire fighting exercises;
- Dust, dirt and hydrocarbons from paved surfaces; and
- 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 dronish water quality in three primary ways:

(a)Toxic effect: Even a small amount of contaminant is 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 result in prolific alga and plant growth which, in turn, chokes up the water body, causing long-term degradation in water quality and community structure; and

(c) Oxygen depletion: The degradation of certain chemicals in the water leads to the consumption of large quantities of oxygen, causing the water to become oxygen-deficient which is detrimental to aquatic life.

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.

2.8 Environmental Problems Arising From Aircraft Accidents/Incidents Involving Dangerous Goods And Emergency Procedures

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 dump fuel into the atmosphere, although this is a rare occurrence. Air Traffic Control (ATC) establishes specific areas where fuel can be dumped in case of an emergency.

CHAPTER 3
Environmental Consequences and Control Measures

3.1 General

It Is interest of airport operations and the protection of the environment to implement pollution control measures at the airport and around its environs. These measures take the form of legislation and implementation. Some measures limit pollution at its source while others reduce its effect on the community and ecology. While environmental control measures should be applied generally throughout communities, discussion in this Chapter is limited to pollution controls associated with airports.

3.2 Noise Abatement

3.2.1 Before an aircraft is permitted to operate, it must receive noise certification granted by the State of Registry. Aircraft noise certification provisions are detailed in Annex 16 ECAR ***. In addition to the noise limitations imposed by aircraft certification, States and local authorities frequently implement local restrictions applicable to specific airports, aircraft types and/or operations. Such local restrictions have been responsible for the introduction of night curfews and even the banning of certain aircraft types due to noise considerations.

3.2.2 To meet the demand for quieter aircraft engines, manufacturers have undertaken research which has led to a considerable reduction of aircraft engine noise output. As a result, modem transport aircraft now being manufactured are much quieter than earlier generation aircraft, such as the B-707, B-727, B-7371200, DC-8 and DC-9.

3.2.3 Noise restrictions have necessitated the introduction of operational procedures to reduce the noise level in nearby areas. For example, the selection of specified approach and take-off paths and the modification of engine thrust settings for certain operational phases are commonly employed aircraft noise abatement procedures. Controls may also be imposed on the noise generated by aircraft engine and auxiliary power units (APU) ground running, ground movement of aircraft and certain airport construction activities.

3.2.4 In addition to the measures that attack noise at its source through certification, operational means, and scheduling, it is possible to reduce the effects of noise by:

a) Land-use planning (see Chapters 4 to 7), and
b) Acoustical barriers.

3.2.5 Acoustical barriers can include such wide-ranging measures as the use of protective ear coverings for people subjected to high-intensity noise, soundproofing of buildings, and methods for screening sound.

3.2.6 Trees may be planted to screen certain areas from some airport noise. A study in Japan of the sound insulating characteristics of wooded areas indicated that judiciously planted trees can offer good protection against ground run-up noise. Various configurations of insulating forest were considered but a study recommended the configuration shown in Figure 3- 1. The sloped embankment makes planting easier and a considerable sound-insulating effect can be expected, even during the early stage when the trees are not fully grown, because the embankment itself has a significant sound-insulating effect. Figure 3-2 shows the sound absorption effect of different tree species. The sound attenuation through 100 m of evergreen trees will be 25 to 30 dB.

3.2.7 When selecting trees to be used in the development of a sound-insulating forest, consideration should be given to selecting species which:

(a) are suitable to the climatic conditions of the airport site;
(b) have effective sound-insulation properties (e.g. do not shed their leaves or needles in winter and grow rapidly and densely);
(c) do not generate a bird hazard; and
(d) are easy to care for (e.g. healthy and not easily affected by blight or noxious insects buildings may be soundproofed to protect the occupants against excessive noise levels. Soundproofing in relation to building codes is discussed in 6.2.3 of this manual.

3.3.8 Studies on aircraft emissions have led to the publication of Annex 16 ECAR ***. Environmental Protection, Volume 11 - Aircraft Engine Emissions. This publication provides the Standards and Recommended Practices on instruments and methods used for measuring aircraft emissions from a range of engine types.

3.3.9 The transport of people, baggage, cargo, etc. to and from and within an airport area presents another source of air pollution. However, rail transport, "people movers" and, above all, careful initial layout design can all contribute significantly to the minimization of the environmental impacts and operating costs arising from such transport needs. The provision of an excellent public transport system may be outside the scope of the airport authority, but there is the possibility of encouraging staff to travel by this means. Provision can be made for inter-modal 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 surface transport providers.

3.4 Water Pollution Control

3.4.1 Airports are subject to both State and local environmental regulations which may include both quantity and quality discharge limits. Airport waste water must be treated before being discharged so as not to pollute ground water or nearby streams. Waste water may be treated on site or at a nearby municipal treatment system. It should be noted that local water quality regulations may require pre-treatment before discharge to a municipal system. In order for airport operators to control waste water at their facilities, pollution prevention planning can identify areas and activities to be managed. The type and nature of airport operations will influence the type and extent of waste water treatment. The primary products which can be found in untreated waste water discharges include fuel, oil and greases, and heavy metals.

3.4.2 In order to determine the type of practices to be incorporated in a water pollution control programme, airport operators should conduct a review of the site conditions. This review should include the following:

(a) topography; presence of bodies of water; storm water discharge points, including infrastructure and natural bodies of water;
(b) drains, culverts and catch basins;
(c) paved areas and buildings;
(d) aircraft and vehicle service areas; and
(e) operational areas and activities, i.e. fuelling, de-icing. Petroleum and Chemical Management

3.4.3 Airports store and handle large quantities of petroleum and chemical products, which are potential sources of water pollution. The following paragraphs outline management practices that may be employed in maintenance areas, aprons, fuel farms, and de-icing areas.

3.4.4 Aircraft maintenance areas, as well as automotive and equipment service areas, should he provided with oil-water separators which are, in turn, connected to sanitary sewers leading to the municipal waste treatment plant serving the airport. All existing oil-water separators should be checked and upgraded when necessary by airport personnel to meet the requirements of the municipal sewerage treatment plants. All oil-water separators must be inspected by airport personnel on a monthly basis and deficiencies promptly corrected.

3.4.5 The primary pollutant originating from aprons is oil from spills and accumulations. Grease and suspended solids from various sources such as aircraft, service vehicles and minor aircraft maintenance may also occur. The airport pollution control programme must therefore focus on:

(a)strict enforcement of good housekeeping regulations to control pollution at its source and to minimize accidental spills;
(b)removal of accidentally spilled oil and fuel through containment and spill recovery;
(c) completion of all regular maintenance activities in hangars protected by oil-water separators in order to limit aircraft maintenance on the aprons;
(d) ban on washing of equipment in apron areas; and
(e)immediate cleaning of all spills of fuel or oil by using environmentally sound absorbents which are subsequently removed from the airport by licensed disposers.

3.4.6 Airport personnel must respond to spill reports, cheek all relevant access pits and sumps, monitor the removal of any fuel or oil found therein, and analyse spill reports 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.

3.4.7 Another water pollution problem is the presence of underground oil-saturated soils at fuel farms. Aside from above ground leakage from storage tanks, there are several potential sources of oil contributing to the oil-saturated soil beneath a fuel farm:

(a) Leakage in underground fuel distribution lines;

(b) Leakage from mechanical equipment which penetrates cracks and joints in the slabs beneath the equipment; and

(c) 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.

3.4.8 A number of steps can be taken to solve the problem of underground oil-saturated soils. When necessary, well points are installed at pre-selected locations to determine the presence and depth of oil. Pipes are inserted into the ground to a depth that ensures a penetration below the ground water elevation. A continuous slotted pipe assures that any oil floating on the surface of the underground water is free to enter the pipe at its natural elevation and also assures that any fluctuations in the underground liquid surface are accurately reflected inside the pipe.

3.4.9 A probe - an instrument developed to measure the depth of water that collects beneath fuel oil in storage tanks - is utilized to measure the pressure and depth of oil. An alarm sounds when the probe makes contact with the water. The probe is then withdrawn and its dry length and total length are measured. The elevation of the oil or water surface is calculated by subtracting the measured length from the re-established elevation at the top of the well-point. Once underground oil is detected at any well point, supplementary well points are installed around the first well point to define the horizontal limits and thickness of the oil-saturated soils. If oil is found in the supplementary well point, additional well points are installed, in stages. This procedure may be repeated through several stages until the outer perimeter of well points indicates the absence of oil.

De-icing Management

3.4.10 Since glycol, which is found in de-icing fluids, has a high Biochemical Oxygen Demand (BOD), aircraft de-icing fluids, if released into receiving waters, can be a potential pollution problem as well as a potential hazard to aquatic life. Excess de/anti-icing fluid running off an aeroplane, if allowed to mix with other surface run-off, poses the risk of contaminating the ground water. Furthermore, the fluids 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. Nevertheless, all excess fluids must be properly collected to prevent ground water contamination. All surface run-off from de-icing areas must be adequately treated before being discharged into storm water drains. For further information on aircraft de-icing, including environmental considerations, please refer to the Aerodrome Design Manual (Doe 9157), Part 2 - Taxiways, Aprons and Holding Bays, Chapter 3.

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

(a) reduce chemical usage by:

- centralizing spray operations,
- using designated de-icing pads,
- recapturing, filtering, and/or recycling glycol in leak-free tanks, and
- minimizing pavement de-icing on aprons by using pavement heating systems;

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

(c)maintaining the facility in good order, including: - pavement conditions, - storage area, and - runoff control.

3.4.12 Glycol management plans should be filed at the beginning of the de-icing season and should outline 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 DelAnti-icing Operations (Doe 9640).

3.5 **Waste Management**

3.5.1 Waste management is concerned with the reduction of both hazardous and non-hazardous wastes. The 4Rs - reduce, reuse, recycle and recover - are good practices for any workplace. A waste management programme should include the three practices: Planning, Procedures and Special Provisions.

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

(a) a description of design intent, construction details, overall land fill development plan, and site closure plan;
(b) a clear description of the chain of authority, organizational structure, job descriptions and job responsibilities for all personnel;
(c) an itemized list of requirements ;mandatory regulatory reporting
(d) an itemized list of internal, written reporting requirements and record keeping;
(e) a description of health and environmental monitoring programmes and related reporting requirements;
(f) a description of routine landfill operational procedures;
(g)emergency procedure plan; and
(h) training of all employees in landfill concepts and day-to-day landfill operating procedures, equipment operating instructions, safe practices and emergency procedures.

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

(a) describe waste reduction, reuse and recycling plans (i.e. reduce or eliminate operations/processes that generate solid waste, redesign processes to reduce waste, and substitute products for waste reduction);
(b) choose green 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; centralize responsibility for waste management and establish written procedures for loading/unloading and transfer operations;
(e) track waste generated and disposed by the following means: - identify waste streams, - evaluate the process generating the waste, - prioritize waste streams, - prepare inventory reports, and - maintain records on waste production and disposal costs;
(f) isolate hazardous wastes by containment and prevent mixing of hazardous and non-hazardous wastes;
(g) isolate liquid waste from solid waste;
(h) separate biomedical wastes with infection potential for special treatment and disposal; and
(i) segregate incompatible materials/wastes to avoid dangerous reactions in the event of a spill.

3.5.4 Special Provisions. It should be noted that in the management of hazardous wastes, special provisions will be required by airport operators. These provisions consist of the following:

(a) Perimeter security fence;
(b) Security alarms en the gate and security fence;

(c) Designated vehicle, wash-off area;
(d) Provision of 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; and
(g) Implementation of a bird and mammal control programme.

3.5.5 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 news letters. Employees should stay current on changes and new information to ensure adherence to policies and procedures.

3.6 Energy Management

3.6.1 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 is estimated that energy costs account for about 5 per cent of the operating costs of a modem airport and that use of the best available conservation techniques can reduce this cost by 5 to 20 per cent.

3.6.2 To assess energy and environmental performance, 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) [1]

(b) Pollutants released:
- directly per 1 000 passengers/TU, and
- indirectly per 1000 passenger/TU

1- A traffic unit is either an enplaned passenger, a deplaned passenger, or 100 kg of enplaned or deplaned cargo.

3.6.3 Reporting should be done annually so that performance improvements can be demonstrated and compared to other indicators, such as traffic, finance and employment. To use such performance indicators in a report, it is necessary to record actual energy consumption and to have information on the effects produced by using various energy sources. While indicators based on measures of consumption are essential for reports on environmental effects, indicators based on cost are essential from a management viewpoint.

3.6.4 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 energy 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.

3.6.5 An effective energy strategy will include a statement of objectives to make all personnel aware of what the organization is committed to achieve, but the pursuit of environmental performance without regard for cost is not a plan for success. The two main elements of an energy strategy should be the following:

(a) Choice of energy source: Without environmental consideration, the preferred energy sources, as selected from available sources, would be those with the lowest overall cost. Currently, the market costs of energy sources may not necessarily reflect their corresponding environmental impact. 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 coal.

(b) Effective utilization and management of energy: The key aim must be to conserve energy and still meet the operational objectives of the airport. To do this, it is necessary to understand where, how and why energy is used. This may be accomplished by means of an energy audit, which, for the sake of convenience, may be combined with an environment audit. To be effective, energy audits should be carried out at regular three-year intervals.

3.6.6 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 10 per cent more energy than is necessary. Other simple procedures include checking the insulation of pipe work , duct work and buildings themselves. 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 plant.

3.6.7 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. Where artificial lighting is installed, it should be apron privately 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 and/or ensuring that it does not add to the air conditioning loads of the building should also be taken into consideration.

3.7 Environmental Emergencies[2]

2.Also see Airport Services Manual, Doc 9137, Part 7 –Airport Emergency Planning. EAC 139

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

3.7.2 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 area
- Emergency telephone list, and
- Grid/reference maps.

(b) Actions
- Persons of authority - Site roles
- Major types of airport environmental emergencies
- -Site management/spill clean-up and restoration
- 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.

3.7.3 Environmental emergency planning should incorporate the following steps to emergency response:

(a) Secure: establish a hazard zone that will keep no emergency response personnel out of danger.
(b) Approach: approach from upwind to avoid coming in contact with vapours.
(c) Identify: utilize placards and/or 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.

3.7.4 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.

3.8 Environmental Impact Assessment of Airport Development Projects

3.8.1 An environmental impact assessment provides a systematic approach for identifying the environmental effects of proposed projects 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.

3.8.2 The environmental impact assessment report should contain the details that are needed to make informed decisions with respect to the environment. This is 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)carrying out a detailed and organized environmental screening of the project based on specific terms of reference and any approved modification/additions; an
(c)presenting the process and results in a screening report suitable for public scrutiny and decision making.

3.8.3 The environmental assessment process should include project description, environmental description, project/environment interaction analysis and its impact, and 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.

3.8.4 It is necessary to develop a description of both the physical and social environment, which includes:

(a) context, study area, and site plan;
(b) definition of the items in c) and d) which are to be addressed in the assessment;
(c) physical environment:
- physiographic and local topography
- soil
- landscaping
- surface water/drainage basins
- groundwater/aquifer
- air quality
- atmosphere/weather
- vegetation/crops
- terrestrial species/habitat
- aquatic species/habitat
- avifauna migration routes, and
- ecological systems

(d) Social environment: - land use - light emissions - impact on the community - recreational uses - aesthetics - employment - economic - municipal services - noise - archaeological factors/heritage, and planning framework

3.8.5 Project-environment interaction analysis requires identification of the environmental components listed in 3.8.4 which may be affected by each of the project construction and/or operational activities. A level one matrix should be used to identify the interaction between activities and general categories of environmental components involved.

3.8.6 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.

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

3.8.8 Ultimately, the environmental assessment should provide clear projections regarding the nature and type of 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.

3.8.9 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 effects (including any cumulative environmental effects)
- 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)

3.8.10 A follow-up programme should detail the monitoring programmes required to evaluate the effectiveness of the mitigation measures as well as to 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:

- the project involves new or unproven technology;-
- the project involves new or unproven mitigation measures;
- the assessment was based on a new assessment technique or model, or there is some uncertainty about the assessment's conclusion.

3.9 Environmental Management

3.9.1 Environmental Management Activities

3.9.1.1 The environmental management activities o an airport can be divided into three basic categories:

- environmental wariness,
- planning and monitoring, and
- remedial measures.

3.9.1.2 The objective of the 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.

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

- environmental assessments;
- monitoring and compliance;
- environmental audits, where necessary; and

- environmental emergency contingency plans.

3.9.1.4 The environmental assessment process has proven to be an important part of the project design procedures. 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.

3.9.1.5 Monitoring and compliance programmes assess air quality, water quality, soil and ground water 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.

3.9.1.6 Periodic inspections should he 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 or not the monitoring and compliance programmes are functioning properly and to identify any problems not previously detected. they provide the basis for action plans. In addition, such inspections are valuable tools for identifying opportunities for enhancing environmental management practices as a whole.

3.9.1.7 Although the ultimate goal of a proactive environmental strategy is to minimize the creation of environmental problems, in the interim, there is a need for remedial measures to correct situations resulting from material handling and management practices of the past.

3.9.2 Environmental Management System - ISO 14000 and EMS

3.9.2.1 Organizations like airports are becoming more concerned about achieving and demonstrating sound environmental performance by controlling the impact of their activities, products or services on the environment, taking into account their environmental policy and objectives. Meanwhile, legislation is more stringent, economic policies are developed to foster environmental protection, and there is a growing awareness of environmental matters among the public and stakeholders.

3.9.2.2 These changing conditions have led several organizations to carry out environmental reviews or audits to assess their environmental performance. To be effective, these reviews have to be conducted within a structured management system. For this purpose, the ISO 14000 Standard provides organizations with the elements of an effective environmental management system, which can be integrated with other management requirements, to assist them in achieving their environmental and economic goals.

3.9.2.3 The Environmental Management System known as EMS (ISO 14001, 1996) is part of the overall management system that includes organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy. EMS is seen as the best method to incorporate environmental management into all levels of corporate operations and decision-making processes.

3.9.2.4 Some of the benefits of implementing an E programme include:

- The long-term economic benefit of balancing and integrating economic and environmental interests;
- reduced costs associated with third party audits;
- Enhanced compliance with environmental legislation;
- Competitive advantage with customers who prefer or require ISO 14001 certification;
- Consolidation of all environmental programmes into one coherent system;
- Increased flexibility to changing circumstances.

3.9.2.5 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. By adopting ISO 14000 Standards and implementing an EMS, it is expected that airports will make a major push towards achieving environmental standards and objectives.

CHAPTER 4
Land Use

4.1 General

Land use around airports will impact the operational safety of the airport as well as the safety of the surrounding communities. Hence, activities around an airport that can affect the safe and efficient operation of aircraft should be taken into consideration when planning land uses in the vicinity of airports. As aircraft noise has become the major airport environmental problem impacting the development of land use around airports, its relationship with land use is a main concern in the development of land around airports. As guidance on proper airport and land-use compatibility planning, this chapter presents a variety of possible land uses with a broad appreciation of their relative sensitivity to aircraft noise exposure and describes their compatibility or incompatibility to aircraft noise and to airport operations.

4.2 Natural Land Use

4.2.1 Every airport is different, as are the areas surrounding them. Natural areas, such as forests, open land, rivers, swamps, bays - with and without wildlife - 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 provides additional benefits.

4.2.2 The presence of natural features in the approach and climb-out areas has done much to mitigate the aircraft noise problem. 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.

4.2.3 Natural features have been, and can be, used to advantage not only in protecting the airport against noise complaints but also in adding natural beauty and interest to the airport. Nevertheless, where rivers, lakes, bays or swamps are found in the airport area, bird hazard problem may exist. At some airports, this problem has been so serious as to cause accidents. Compatible and incompatible land uses around airports with a view to minimizing bird problems are identified in Appendix 1.

4.3 Agricultural Land Use

4.3.1 While it may not always be possible to use land for agricultural purposes in metropolitan areas, many airports may wish to do so in order to increase airport revenues. Privately owned land around airports may also be used for farming, provided this activity does not attract birds which represent a hazard to aviation.

4.3.2 The agricultural use of land contributes sever important factors to an airport programme:

(a) It produces income from what might otherwise be waste or idle land

(b) It provides crop cover and prevents soil erosion.

(c) It eliminates the expense to the airport of mowing or taking care of the land.

4.3.3 Furthermore, land that has been turned over to agriculture is still available for industrial or commercial development, recreational facilities, or public utilities at a later period. Crop cultivation may however have an adverse effect on aircraft operations due to the presence of birds, which are attracted by the seeds. The effect of crop cultivation on bird occurrence at airports is discussed in the Airport Services Manual (Doc 9137), Part 3 – EAC 139 - ** Bird Control and Reduction.

4.3.4 All agricultural uses have proven to be compatible with aircraft noise, with the exception of poultry farms. Location of these farms within approximately 5 km of an airport is not recommended because of the adverse reaction of the fowl to high levels of aircraft noise. It should also be noted that birds may be attracted to some pig farms where garbage is used as fodder.

4.4 Highways and Railways

4.4.1 In view of the existing vast network of highways and railways and the constant building, realignment and rebuilding that will take place in the future, it is only sensible that highway and railway planning be coordinated with noise abatement plans of airports. In planning a highway or railway system near an airport or in planning one 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.

4.4.2 The highway or railway construction can take the place of housing projects which would be adversely affected by noise, while adjacent areas can he more easily adapted to commercial, industrial, and recreational uses and parks. Not only can residential areas be removed but they can actually be prevented from developing in critical noise areas by locating the highway or railway there.

4.5 Recreational Land Use

4.5.1 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.

4.5.2 A survey of recreational land uses in airport areas revealed the inter-relationships of the activities that support the idea of a community recreation complex in the vicinity of the airport. 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. Among possible recreational uses, golf courses are increasing in popularity, parks require little development and are ideal for hiking and riding trails, and outdoor living facilities, 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 industrial areas can complement and support an airport and also serve the workers living near by.

4.5.3 A review of the experiences with the many types of recreational facilities indicates that, in terms of noise and public hazards, playgrounds and athletic fields present marginal problems. However, fairgrounds and racetracks, outdoor theatres, and amphitheatres are considered poor 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 5.) 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.

4.6 Municipal Utilities

The sitting 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 are considered a hazard by many airport planners. Landfills and incinerators may create a smoke problem. Moreover, water storage, landfills and sewage treatment may attract birds.

4.7 Commercial Land Use

4.7.1 Commercial activity is similar to residential activity in that there are people going into and out of buildings and the area. However, the bulk of commercial operations is carried out during daylight hours and is not affected by the problem of noise at

night or during sleeping hours as residential areas are. In addition, persons pursuing the normal business activities found in commercial areas are not generally as disturbed by aircraft noise as are those in residential areas.

4.7.2 Commercial activities established in or around the airports can range from shopping centres to pet cemeteries. Here too the potential risk and effects of an aircraft accident should be considered.

4.7.3 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 conditioning and air conditioning 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.

4.8 Industrial Land Use

4.8.1 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. With respect to industrial sites around airports, the potential risk and effects of an aircraft accident should be taken into account when planning activities involving a large number of people.

4.8.2 Encouraging industrial development in airport areas can lead to important benefits. First, the industrial noise tends to make inhabitants more amenable to aircraft noise. This should not, however, deter industrial developers from using sound and air conditioning to reduce aircraft noise. Second, as a result of its location near the airport, these industries will usually become supporters of the airport and be interested in airport operations. In addition, airport owners operator and operators can derive a substantial income by selling or leasing the undeveloped land, or by developing the land and subsequently leasing or selling it to industrial firms.

4.8.3 However, prospective sites for industrial development must 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.

4.8.4 It should be noted, however, that due consideration should be made before those industries that emit offensive noises, odours and smoke, or that create electronic interference with airport operations are sited at the airport or its vicinity.

4.9 Residential and Institutional Land Use

4.9.1 In this publication EAC 139-16, residential housing refers to single-family dwellings, multi-family dwellings, and estates. Institutional housing refers to community facilities such as schools, hospitals and churches, mosques . All these facilities should be planned and situated with thorough consideration of airport noise and the potential risk of aircraft accidents.

4.9.2 Sound conditioning and air conditioning 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.

4.9.3 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.

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

CHAPTER 5
Land-use Planning

5.1 General

The problem of noise in the vicinity of airports can only be solved by pursuing all possible means to alleviate it. Proper land-use planning can contribute materially to the solution. There are substantial benefits to be gained from the correct application of land-use planning techniques in the development of new airports. While these benefits should not be overstated, more attention should be given to proper land use planning as a tool. In many instances, though, the benefits may be realized only in the long term, and any solution to the noise problem is also likely to be long range. Efforts to correct situations detrimental to proper land use around airports should however not be ignored simply because of the time required 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.

5.2 Assessing Noise for Land-Use Planning

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

- sound pressure level
- broadband frequency distribution
- special irregularities
- noise duration
- flight path including take-off and landing profiles number of operations
- operating procedures (such as engine power settings)
- mix of aircraft
- runway utilization
- time of day and year including meteorological conditions

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

5.2.2 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
- factors of sociological nature

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

5.2.3 Methods for forecasting aircraft noise exposure and predicting community response 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 Circular 205, Recommended Method for Computing Noise Contours

5.2.4 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 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 and, if necessary, monitored by methods that make due allowance for the effect such noise has upon people.

5.3 Noise Zones And Associated Maximum Noise Indices

5.3.1 A review of current practices used by States countries shows that there are two basic approaches to the establishment of noise zones around the airport.

(a) The first approach is a broad approach typified by designation of at least two zones. The preference for this approach is due to the accuracy of the techniques used to measure and forecast noise exposure (current accuracy level is believed to be at least 5 dB) and the greater flexibility in application.

(b) With the second approach, States countries favour more than two noise zones because the finer gradation allows for more optimized utilization of the land area around the airports. When applying the zones to existing airports, this approach enables planners to identify the most effective remedial treatments. While the basic accuracy of the noise exposure indices is perhaps coarse, planning authorities compensate for this shortcoming with the finer distinction between zones. there is unanimous agreement that the structure of noise zones must be inherently related to the particular environment where they are applied.

5.3.2 A minimum of two zones should be established for the purpose of land-use planning with regard to aircraft noise in the vicinity of airports:

	Noise . exposure level	Restrictions
Zone A	high	Noise-sensitive land uses have to be restricted and most developments are not permitted
Zone B	moderate	There may be some need to restrict land uses and developments

These zones may be subdivided into various noise exposure levels for appropriate land-use planning and other measures by the national or local authorities. Outside these noise zones, restrictions are generally not required.

5.3.3 The values of the noise exposure indices, corresponding to the noise zones adopted for land-use planning, should form a logical progression. States countries 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 countries *. However, the materials submitted by the United States (DNL method), the United Kingdom (16H-Leq), France (IP method), Germany (Q method), and the Netherlands (Ke method) indicate that the correlation between the ICAO unit and the units used by States countries is:

(a) Strictly limited to a particular situation, e.g. the standard reference situation;

(b) only an approximation and is affected by the accuracy of the method used to convert one unit of perceived noise level to another, e.g. the dB(A) and the PNdB when considering the IP method; and

(c) impossible to establish when the physical properties of sound being measured are basically different (e.g. when comparing the dB(A) and PNdB methods). Consequently, Table 5-1 only allows a rough comparison to be made for a specific situation and cannot be used as a conversion table.

* For a description of these methods, see Circular 205, Recommended Method. for Computing Noise Contours around Airports.

5.4 Risk of Aircraft Accidents Around Airports

5.4.1 Introduction

5.4.1.1 Airports are centres 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.

5.4.1.2 Although the public is generally aware of the fact that flying is a very safe mode of transportation and that the probability of an accident is very small,

the frequent noise associated with aircraft passing overhead nevertheless acts as a strong reminder of that possibility.

5.4.1.3 Irrational as they may seem, 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.

5.4.1.4 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.

5.4.1.5 Major airport development plans, such as building additional runways, almost invariably involve government decision making and public inquiries. Therefore, the public's perception of the local consequences of developments is of paramount importance.

5.4.2 The Netherlands Experience: Method for Assessing Third Party Risk Around Airports

To prevent third party risk from becoming emotionally driven in the evaluation of airport development options, objective and accurate risk information is necessary to provide guidance to local and national authorities, the population around the airport, and the airport operator. Because no adequate method for third party risk assessment existed worldwide, the National Aerospace Laboratory (NLR) of the Netherlands was contracted by the government of the Netherlands to develop a comprehensive method for the assessment of third party risk around airports and to apply this method to the development plans of Amsterdam/Schiphol Airport. This NLR method and its derivative are now used to calculate risk contours and noise contours, respectively.

5.4.3 The Netherlands Experience: Definitions of Third Party Risk

5.4.3.1 Risk is generally defined as a combination of the probability of an event and the severity of that event. For third party risk analysis around airports, objective measures of risk are required and two dedicated measures of risk are often used: individual risk and societal risk.

5.4.3.2 Individual risk is defined as the probability (per year) that a person permanently residing at a particular location in the area around the airport will be killed as a direct consequence of an aircraft accident.

5.4.3.3 Societal risk is defined as the probability (per year) that more than N number of people will be killed as a direct consequence of a single aircraft accident.

5.4.3.4 While individual risk is location- speci fi c, it is present whether or not someone is actually residing at that location. Societal risk applies to the entire area around the airport and hence is not location-specific within that area and only exists when people are actually present in the area around the airport. In an unpopulated area, individual risk levels may vary from location to location, but societal third party risk is zero by definition.

5.4.4 The Netherlands Experience. Methodology Used to Calculate Third Party Risk

5.4.4.1 The NLR method used to calculate third party risk around airports consists of three main elements: the probability of an aircraft accident in the vicinity of the airport, the accident location probability model, and the accident consequence model.

5.4.4.2 To use the NLR method, the probability of an aircraft accident in the vicinity of the airport must first be determined. This probability depends on

the probability of an accident per aircraft movement and the number of movements (landings and take-offs) carried out per year.

5.4.4.3 The probability of an accident per movement, i.e. the accident rate, is based on historical data of the number of movements carried out and the number of accidents that occurred during these movements. The accident rate is not constant over time. Due to a steady improvement in the level of aviation safety, coupled with volume growth, the accident rate has decreased at a diminishing rate over the years. The development of the accident rate over time is derived from a statistical function which can subsequently be used to extrapolate future, accident rates.

5.4.4.4 Since large differences in safety levels exist between different types of operation and different regions of the world, a careful data domain definition is required in order to provide airport- specific results.

5.4.4.5 The probability of an accident in a particular year is established after determining the accident rate and combining this with the number of movements in that particular year. If this probability were equally distributed around the airport, then it could be represented by a cylinder centred at the airport, with the height of the cylinder representing the local probability of an accident. (Figure 5-1a)

5.4.4.6 In reality, the local probability of an accident is not equal for all locations around the airport. The probability of an accident in the proximity of the runways is higher than at some distance from the runways. Furthermore, the local probability of an accident is dependent on the proximity of routes taken by arriving and departing air traffic. The probability of an aircraft accident is thus higher in the area within the proximity of a route and is lower as the area is farther away from the route. Consequently, the local probability of an accident is strongly dependent on the location relative to runways and traffic routes. This function is represented in an accident location probability model, the second main element of the third party risk assessment methodology.

5.4.4.7 The accident location probability model is based on historical data of accident locations. The distribution of accident locations relative to arrival and departure routes is derived from statistical functions. By combining the accident location probability model with the accident probability, the local probability of an accident can be calculated for each location in the area around the airport. This probability can be presented as a local vector of which the length indicates the local probability. (Figure 5-1b)

5.4.4.8 A person residing in the vicinity of an airport is at risk not only when an aircraft accident occurs at this person's exact location, but also when an accident occurs in this person's close proximity. The accident consequences may have lethal effects at considerable distances from the impact location.

5.4.4.9 The dimensions of the accident area are a function not only of the aircraft and impact parameters, but also of the local type of terrain and obstacles. Consequently, the size of the accident area is not equal for every location around the airport. (Figure 5-1c)

5.4.4.10 The influence of the aircraft, impact parameters and the type of terrain on the size of the accident consequence area, as well as the lethality of the consequences, are defined in the accident consequence model, the third main element of the third party risk assessment methodology.

5.4.4.11 By combining the three main elements of the third party risk assessment methodology, individual risk and societal risk can be calculated for each particular location around the airport. These risks can be expressed in risk contours in the same way as noise contours and appropriate measures are established. Detailed information can be obtained from the Directorate-General of Civil Aviation or the National Aerospace Laboratory (NLR) of the Netherlands.

5.4.4.12 For the development of Amsterdam/Schiphol Airport, risk contours are calculated using the NI-R method with risk factors of 5×10^{-5}, 10^{-5} and 10^{-6}. In the highest risk zones, no permanent dwellings are allowed and certain activities are restricted. Existing dwellings will be demolished. In the lower

risk zones, new developments are prohibited, but existing dwellings are allowed.

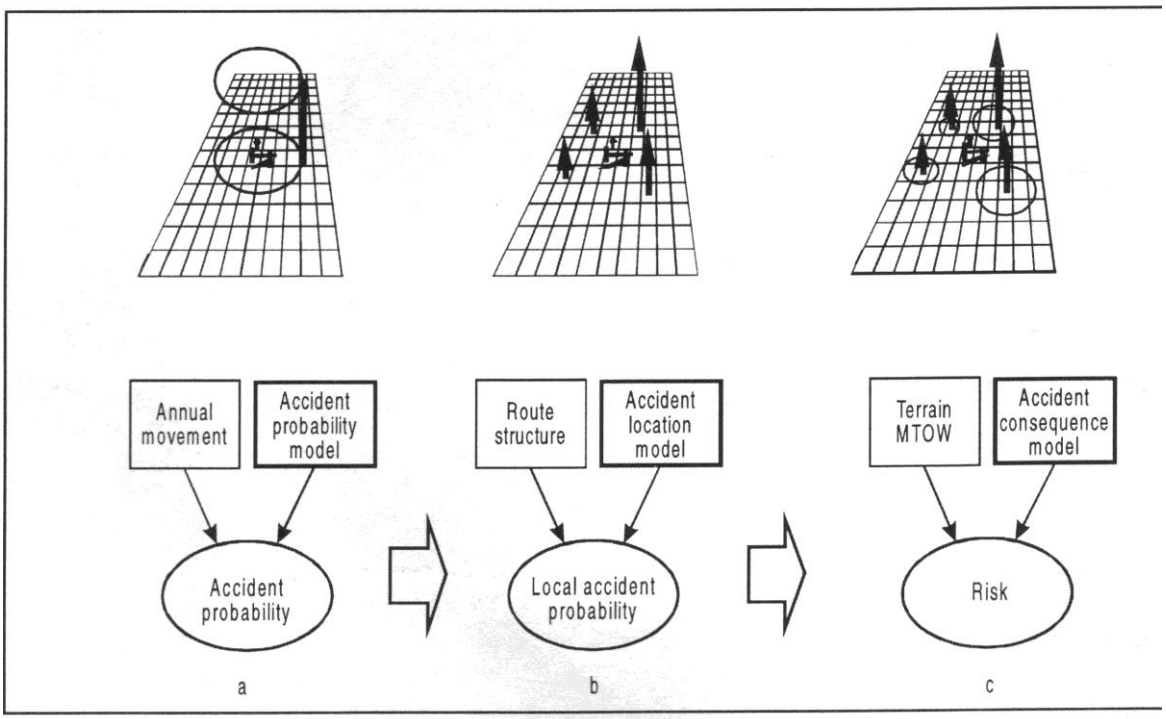

Figure 5-1. Methodology for third party risk

5.4.4.13 It may be noted that, aside from the Netherlands, external risk analyses for airports are required by law (under an environmental impact assessment) in the United Kingdom for Heathrow and Manchester airports, in Finland for Helsinki Vantaa Airport, in Australia for Sydney Airport and in Malaysia for the new Kuala Lumpur Airport.

5.5 Land Uses Within Noise Zones And High Risk Zones

Examples of the types of development allowed in the zones suggested in 5.3 are shown in Table 5-2. This table may be used as a guide for States countries contemplating or operating land-use planning schemes. It should however be emphasised that the examples of different development and land uses given in Table 5-2 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 sound-proofing, 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.

5.6 Review of Land-Use Measures With Respect To Aircraft Noise In Various Countries

Appendix 2 contains information on land-use measures applicable in various countries as of 1 January 1997.

Table 5-2 . Some typical examples of compatible land uses around airports

Examples of compatible land uses or developments	ZONES		
	A	B	Outside
	Most land uses and developments	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 Offices and banking	unrestricted restricted	unrestricted restricted	unrestricted unrestricted
Residential			
Low-density housing	unrestricted	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 case where activities depend on speech communication (eg. 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.

CHAPTER 6
Land-use Administration

6.1 General

6.1.1 The technical factors which form the basis of all methods used to evaluate total aircraft noise exposure are not the only factors to be taken into account for the purpose of land-use control in the vicinity of airports. It is recognized that economic factors are involved when determining compatible land uses. For this reason, the authorities, local or central, The ECAA 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 fully implemented.

6.1.2 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 controlled more effectively when zoning is applied to new airports and existing airports in still undeveloped areas.

6.1.3 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 local issues are the return that the owners or developers want from their properties, the local government's interest in increasing the tax base, and the interest of the 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 and controls, based on objective criteria, to minimize the amount of noise-sensitive development close to airports, while allowing for other productive uses of the land.

6.2 Land-Use Control Systems

6.2.1 Introduction

Various measures are available for controlling 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 Egypt reviewed, it can be stated that no single strategy prevails over other strategies in dealing with this issue. While land-use control and noise-insulation measures are generally transferable from one place to another, the selection of a particular measure or measures over others 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 control 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 improve merits, tax incentives and noise-related airport charges.

6.2.2 Planning Instruments Comprehensive Planning

6.2.2.1 Comprehensive planning takes into account existing development and ensures that future development is compatible with various community goals. In Egypt 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.

6.2.2.2 A well worked-out comprehensive plan that is used effectively to guide local land-use decisions and development controls (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 still developing areas, but it can also be highly effective in guiding urban renewal or redevelopment. The success of such comprehensive planning depends upon its appropriate implementation through various developmental decisions and controls**.**

6.2.2.3 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

6.2.2.4 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, interference to the vicinity will be minimal.

6.2.2.5 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.

6.2.2.6 A single authority should have overall responsibility for developing land-use criteria for use and development area Local zoning of an and land use should be consistent with these criteria, and the authority should be empowered to make amendments to ensure consistency.

6.2.2.7 Such a single- authority approach may overcome the problem of multi-Jurisdictional interests in the airport environs which has sometimes prevented effective zoning. This of course involves the transfer of zoning powers to some higher governmental level, such as an area wide planning agency or the State, with the designated public agency exercising the authority to ensure compatibility between airports and their neighbours. Local jurisdictions with zoning power (cities, towns or larger administrative units) have rarely taken effective zoning action needed to alleviate the problem of multi-jurisdictional interests, because a given airport often affects several jurisdictions and the coordination of zoning is difficult. Moreover, zoning has proven extremely vulnerable to development pressures and local politics. Another problem is that the interests of the affected communities are not always consistent with the needs and interests of the airport operator nor with those of each other. Within each community, there is usually a desire for a larger tax base, population growth, and rising land values, and these goals are often in conflict with the need to preserve the airport environs for "non-sensitive" activities.

6.2.2.8 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.

6.2.2.9 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.

6.2.2.10 Noise zoning around airports is applied in nearly all the surveyed countries as a physical 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

6.2.2.11 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.

6.2.2.12 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. This strategy is applied in Canada, Lithuania, the Netherlands, New Zealand, Poland, and some parts of the United States.

Transfer of Development Rights

6.2.2.13 Under this concept, some of the development rights of a property are transferred to another property that is far from the airport where the fights may be used to intensify the level of allowable development. Landowners could be compensated for the transferred rights by the sale of these fights 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 fights.

6.2.2.14 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. In the United States, some experience has been gained in working with airport operators on the use of this instrument. Lithuania also mentioned this as a useful instrument. However, its transferability to other countries depends upon the prevailing legal systems.

Easement Acquisition

6.2.2.15 An easement confers the right to use a landowner's property for a limited purpose. In the context of airport noise-compatibility planning, two general types of easements are available:

(a) those which permit noise over land; and

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

6.2.2.16 For maximum effectiveness, easements should restrict the use of land to that which is compatible with aircraft noise levels. Easements should also ensure the fight of flight over the property, the fight to create noise and the fight 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.

6.2.2.17 The first type of easement described in 6.2.2.5.1 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 wares potential buyers that a property is subject to aircraft noise.

6.2.2.18 The second type of easement described in 6.2.2.5.1 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 the United States in combination with noise insulation. Such easements are often required by airport owners in exchange for noise insulation. Easements are possibly amenable to transfer to other countries, depending on the le al s stem.

6.2.3 Mitgating Instruments Building Codes

6.2.3.1 Minimum structural construction techniques and material standards often determine whether changes in current standards or the adoption of new standards can increase the interior noise-reduction 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 Building codes are usually applied in most countries.

Noise Insulation Programmes

6.2.3.2 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 sound-proofing 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. (An example of soundproofing recommendations submitted by France is given in Table (6-1.)

6.2.3.3 A noise-insulation programme should be preceded by a structural and acoustical survey of all homes and other buildings car-marked for noise insulation. The cost of noise insulation can range from the equivalent in U.S. dollars of $2 000 to $50 000 per dwelling, depending 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.

6.2.3.4 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 homeowners 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.

6.2.3.5 Insulation programmes for noise-affected dwellings around airports (mostly in coordination with noise zoning) are applied in: Australia, Denmark, France, Germany, Ireland, Japan, the Netherlands, Latvia, New Zealand, Norway, Poland, Republic of Korea, Spain, Switzerland, the United Kingdom, and the United States.

6.2.3.6 Noise insulation appears to be transferable to other countries. However, in Greece and Italy, for example, noise insulation is not considered to be an adequate measure due to the warm climate which leads people to leave their windows open.

Land Acquisition and Relocation

6.2.3.7 This strategy involves the acquisition of land through purchase by the airport operator (or planning authority ministry of planning 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.

6.2.3.8 Land acquisition and relocation assure an airport of long-term land-use compatibility. Acquired land can be cleared, sold with casements (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.

Table 6-1. Soundproofing recommendations in France

	Zone A	Zone B	Zone C	Immediately outside of Zone C
Housing buildings exceptionally accepted	45 dB(A)	40 dB(A)	35 dB(A)	30 dB(A)
Premises used for teaching and caring	47 dB(A)	40 dB(A)	35 dB(A)	35 dB(A)
Premises used as offices, hotels, etc	45 dB(A)	40 dB(A)	35 dB(A)	35 dB(A)

6.2.3.9 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. In Australia, Brazil, France, Ireland, Japan, the Netherlands, Latvia, Poland, Republic of Korea, Switzerland, and the United Kingdom, this strategy has also been applied in relation to new airport development and special cases.

Transaction Assistance

6.2.3.10 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. In extreme cases, an airport actually buys properties which have been on the market for an extended period of time and then resells them. In order to become compatible with noise levels, the properties are noise-insulated prior to resale and usually resold with an casement. 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. Home owners 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.

6.2.3.11 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. Transaction assistance is also applied in Australia and in some European countries, e.g. Germany (around Dusseldorf Airport) and the Netherlands.

Real Estate Disclosure

6.2.3.12 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.

6.2.3.13 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.

6.2.3.14 The strategy is used in the United States, sometimes in combination with an casement 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. Real estate disclosure with respect to noise impact appears to be transferable to other countries.

Noise Barriers

6.2.3.15 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 psychological 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.

6.2.3.16 Noise barriers are used in Denmark, France, Germany, Japan, the Netherlands, Norway, Poland, Republic of Korea, Switzerland, the United Kingdom and the United States, as well as in many other countries in specific cases.

6.2.4 Financial Instruments

Capital Improvements Planning

6.2.4.1 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 city 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.

6.2.4.2 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. The strategy is applied in Latvia, Poland, Republic of Korea, Spain, and in some parts of the United States.

6.2.4.3 Capital improvements planning, to the extent that it is useful, may be amenable to transfer to other countries, particularly developing countries.

Tax Incentives.

6.2.4.4 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.

6.2.4.5 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.

6.2.4.6 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.

6.2.4.7 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.

6.2.4.8 In Canada and the United States, this strategy is applied in some cases, but the value of tax incentives for compatible land-use purposes has not been evaluated. There is also little information regarding its use and effectiveness. In some other countries (e.g. the Netherlands), the housing tax depends on the location of the house and the quality of its environs. Noise and less attractive surroundings would thus imply a lower level of the housing tax.

Noise-related Airport Charges

6.2.4.9 Noise-related airport 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 ECAA and contained in the ICAO's Policies on Charges for Airports and Air Navigation Services (Doc 9082), paragraph 21. 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.

6.2.4.10 There may be competitive implications for noise charges, either between airports or States ECAA . Noise-related charges are applied at some, if not all, airports in Australia, Belgium, France, Germany, Japan, the Netherlands, Latvia, Norway, Republic of Korea, Sweden, Switzerland, the United Kingdom and the United States.

APPENDIX 1
Cases Of Effective Land-Use Management Around Airports

1. Amsterdam/Chisholm Airport, The Netherlands

1.1 Amsterdam/Chisholm Airport has been in operation since 19 September 1916. It was initially a military airfield, but was converted to commercial operations shortly after World War I (in 1919). Thus, for more than 80 years, the airport has occupied the same location in the east corner of reclaimed land from the former Harley mermen, just 10 km from the centre of the city of Amsterdam. During these 80 years, the airport grew from a small grass landing area of 190 acres to a 5 000-acre airport with 4 major runways and a traffic volume of more than 350 000 aircraft movements, carrying over 30 million passengers and I million tonnes of freight in 1997. Further development will include a new fifth runway and extension of the terminal in 2003 to achieve a capacity of more than 40 million passengers, along with significant improvement of the environmental situation.

1.2 The further development of the airport, along with the development of the surrounding communities where large numbers of new houses were needed after World War 11, created serious noise problems at the end of the 1960s, when the first commercial jet aircraft arrived.

1.3 In 1967, a special committee advised the Government to introduce a method to assess aircraft noise and to establish noise zones around the airport, with maximum noise levels based on the results of a public survey. Houses and other noise-sensitive buildings situated within these noise zones were to be insulated, and new developments were not to be allowed. The Aviation Act was amended accordingly (in 1978) to give a legal basis for noise zoning, with the result that noise zoning became mandatory around all airports (civil and military) in the Netherlands.

1.4 The Government prepared a Structural Outline Plan for Civil Aviation (1979), which laid down its policy with respect to the development of aviation and environmental capacity. In this Plan (approved in Parliament in 1988), designated noise zones were published for all airports. Local authorities were required to respect these noise zones when drawing up their own development plans.

1.5 In 1991, a policy agreement on the future development of the airport and its surroundings was reached between the national government, local authorities, Schiphol Airport, the national airline KLM and the railways. This document listed more than 100 anti-noise and anti-pollution measures to improve living conditions in the region as well as to improve access between the airport and the region by new road and rail infrastructure.

1.6 The final decision on building the fifth runway (in an area west of the airport between Amsterdam and Haarlem that had been kept free of housing development based on earlier agreements between the Government and local authorities) was reached in 1995 after lengthy public discussions based on various case studies on the future of Schiphol Airport. This final decision is subject to the condition that the total environmental impact should improve or at least not be worse than in 1990. A survey of the health situation of the people living in the region had also been carried out and will be repeated every five years.

1.7 Regarding aircraft noise, the target is to have no more than 10 000 houses within the legal 35Ke noise contour of the new five-runway system. Because of the new noise-impacted area covered by the fifth runway, the area of the 35Ke noise contour for the five-runway system is much larger than that for the four-runway system. However, owing to the far-sighted policy of keeping the area free of housing development, the total number of houses could be reduced from some 15 000 within the noise contour of the four-runway system down to 10 000 for the five-runway system, despite the expected growth in traffic volume.

1.8 With respect to the other environmental aspects, such as local air pollution and odour, similar targets were set and will be maintained. The prevailing principle for air pollution applies to quantities Of CO_2, CO, NO_X, VOS, SO_2 and black smoke that are emitted. For odour, the prevailing principle applies to the number of people affected.

1.9 Other measures taken are further increase in landing fees for noisy aircraft and operational restrictions for certain aircraft types during evening and night-time periods to ensure the non-infringement of the legal noise zones.

1.10 Third party risk around airports is another important issue. External safety zones are established in the same way as noise zones. These zones describe the risk for people who live around the airport of being killed in an aircraft accident over a one-year period. Risk calculations were made using a newly developed model to assess aircraft accident risk around airports, as discussed in 5.4. External safety zones have been established around Schiphol Airport for accident risk rates of 5 x 10^{-5}, 10^{-5} and 10^{-6}. Within the safety zones, a construction ban is in effect for new houses and office buildings. In the highest risk areas, all houses will have to be demolished before 2015; this means that based on a recent survey, 87 houses around Schiphol Airport will have to be demolished.

1.11 A noise-insulation programme for houses and other noise-sensitive buildings situated within the legal noise zones of 35Ke (daytime) and 26dB(A)-LAeq (indoors, during the night period) involves about 14 000 buildings, apart from the 4 500 buildings that have already been insulated since the start of the first insulation programme in 19~3. The total costs of this programme (demolition of houses within the 65Kc contour included) amount to more than 750 million guilders. These costs are to be recovered by noise charges levied on the airlines. Meanwhile, the costs of demolishing houses within the safety zone of 5 x 10^{-5} are estimated at 30 million guilders.

1.12 The total expenses for new infrastructure and new commercial and industrial development in the Schiphol area, including landscaping, will be about 280 million guilders, of which 150 million guilders will be financed by the Government. All other costs are to be raised by the airport, project developers, etc., with a small contribution from the European Community.

2. The Australian Experience land-Use Planning Around Airports

2.1 National Policy

2.1.1 The Federal Government of Australia has an established national policy applicable to land-use planning around existing airports. However, while jurisdictional responsibility for land-use planning around airports rests with State and local government, State governments have generally agreed to adopt the national policy of the Federal Government.

2.1.2 The national policy is based on each airport developing an Australian Noise Exposure Forecast (ANEF) with noise impact contours. Noise exposure levels are calculated in ANEF units which take into account:

(a) the intensity, duration, tonal content and spectrum of audible frequencies of the noise coming from aircraft take-offs, approaches to landing, and reverse thrust after landing;
(b) forecast frequency of aircraft types and movements on various flight paths; and
(c) the average daily distribution of aircraft take-off and landing movements in daytime and night-time hours.

2.1.3 The ANEF may be developed for a validity period of 15 years in order to represent the ultimate capacity of the airport. For land-use planning purposes, the contours are meaningful at the delineation of 20-25-30-35-40 ANEFs.

2.1.4 Following a study by the National Acoustic Laboratories, an Australian dose response function was developed for residential land-use compatibility purposes. As a result, a 25 ANEF contour was adopted as the limit for residential development in areas around airports. However, the study also found that some people in the 20-25 ANEF considered the noise unacceptable. A land-use table, Table AI - 1, is included in the Australian Standard AS2021 -1994 and is applicable mainly to new developments on Undeveloped land around airports.

2.1.5 In the areas around airports where established residential development has existed for some time, it is generally not feasible to apply appropriate land use unless re-zoning opportunities for individual properties arise.

2.2 Case Of Melbourne/Tullamarine Airport

2.2.1 Melbourne Airport is a major domestic and international airport, with some 156 000 aircraft movements in 1996. Because it was developed in the early 1970s fr~in a largely green field site and appropriate planning/zoning practices were already in place by that time, the Melbourne Airport provides one of the better outcomes of effective land use planning in areas around airports in Australia.

Table AI-1. Building site acceptability based on ANEF zones

Building Type	Acceptable	Conditional	ANEF Zone of Site **Unacceptable**
House, home unit, flat, caravan park	Less than 20 ANEF (Note 1)	20 to 25 ANEF (Note 2)	Greater than 25 ANEF
Hotel, motel, hostel	less than 25 ANEF	25 to 30 ANEF	Greater than 30 ANEF
School, university	Less than 20 ANEF (Note 1)	20 to 25 ANEF	Greater than 25 ANEF
Hospital, nursing home	Less than 20 ANEF (Note 1)	20 to 25 ANEF	Greater than 25 ANEF
Public building	Less than 20 ANEF (Note 1)	20 to 30 ANEF	Greater than 30 ANEF
Commercial building	Less than 25 ANEF	25 to 30 ANEF	Greater than 35 ANEF
Light industrial	Less than 25 ANEF	25 to 30 ANEF	Greater than 35 ANEF
Other industrial	Acceptable in all ANEF zones		

Note L- The actual location of the 20 ANEF contour is difficult to define accurately, mainly because of variation in aircraft flight paths. Because of this, procedures using the maximum aircraft noise levels for the relevant aircraft and the required noise reduction / attenuation should be used.

Note 2-Within 20 to 25 ANEE some people may find that the land is not compatible with residential or educational uses. Land-use authorities may consider the incorporation of noise control features in the construction of residences or schools to be appropriate.

2.2.2 The land-use control system in place reflects an integrated approach adopted jointly by the airport operator, the State government and the local authorities around the airport. The State government has introduced a system of overlay controls for residential and other developments which are carried out by the local authorities around the airport in concert with the airport operator.

2.2.3 The overlay controls largely reflect the ANEF contours and the Australian Standard AS2021-1994. Under relevant planning arrangements, residential and similar developments are precluded from certain noise-affected areas. For the broader area expanding out to the equivaleed of approximately 25 ANEF, local authorities have to refer certain development applications to the airport operator whose decision on whether the application should be approved has to be applied by the local authorities. This decision can be appealed through the Administrative As a result of this system, there is only a limited amount of residential or other development around this airport which is inconsistent with the Australian Standard AS2021-1994.

2.3 Other Land-Use Planning Experiences In Australia

2.3.1 Australia has extensive land-use planning experiences. In some instances, the planning guidance outlined in AS2021-1994 was adopted, but not in other instances. As a result, residential buildings have been constructed within the 25 and above ANEF contour.

2.3.2 As communities become better informed and more aware of issues such as aircraft noise, they have put greater pressure on local authorities to carry out appropriate land-use planning and on aviation authorities and airlines to implement noise-abatement practices.

2.3.3 In Australia, residential buildings have been located around airports for many years and more recent developments have occurred. To remedy this situation, the interests of the people who have already invested in the locality have to he balanced with the arrangements for potential interested parties. This conflict of interest issue is one that confronts some airports and there are no easy solutions for the local authorities and State governments who are responsible for land-use planning around airports. Where inappropriate development has occurred, experience has shown that pressure has been brought to bear on airports in relation to certain flight tracks of arriving and departing aircraft, and calls for curfews are not uncommon.

2.3.4 Australia is considering developing and providing additional information to the community, such as provide data on the flight paths of aircraft using the airport. This may be a useful supplement to the ANEF contours to better inform the communities around airports before commitment to residential buildings is made.

3. Land-Use Management Around Washington Dulles International Airport /united States

3.1 Washington Dulles International Airport, which opened in November 1962, is located in Fairfax and Loudon Counties, Virginia, about 50 km west of downtown Washington D.C. Today, Dulles is the primary international gateway serving the U.S. capital and handles approximately 300 000 operations annually with its three-runway layout. With five runways planned for the future, the annual operations will probably exceed 740 000.

3.2 As one of the first major airports to be designed and built after the advent of the commercial jet age, Duties was planned with aircraft noise in mind. The airfield, which is approximately 4 500 ha (or 45 million M2), includes noise-buffer areas extending 2 400 m between the ends of the runways and the perimeter fence. The selected airport site and the vast majority of its surrounding land were farmland. This proved beneficial at the time of the original airport development and in the subsequent years when the use of the neighbouring land was decided by local government action.

3.3 For most of its early years, Duties was underuti lized, operating some international and transcontinental service, but very little short- and medium-range services. Deregulation changed everything. In the early 1980s, Dulles grew rapidly as new airlines began to serve Washington D.C. Since flight operations at Washington National Airport were, and are still, limited by the High Density Rule of the Federal Aviation Administration (FAA), almost all of the new services operate at Dulles. While pleased with the stable growth trend and realizing that the airport is adequately equipped to handle the growth, officials at the airport and in local government also recognized that appropriate off-airport land-use planning was necessary to ensure sustained growth at Dulles, the local region's primary economic resource.

3.4 The Counties of Loudon and Fairfax and airport management understood that conflicts could occur when residential and other noise-sensitive land uses are in close proximity to the airport. Accordingly, the planning staffs of the Counties and the airport were tasked to come up with a land-use plan that would provide an environment where both the airport and its surrounding properties could be developed in the region's best interest.

3.5 The objective was to develop a set of land-use rules, tailored to the special needs of each county, that would prevent incompatible land use of the environs around the airport. As a result of this regional effort, undertaken over the past 12 years, the airport and its neighboring jurisdictions are reaping the benefits of the growth without having to restrict flight operations.

3.6 Loudon County, which had a great deal of undeveloped land near the airport, adopted very aggressive land-use restrictions. The County defined the areas subject to the restrictions with Day-Night Level (DNL) contours based on long-range forecasts, using the planned five runway configuration and 740000 annual operations. Loudon's restrictions, which are included in the County's Dulles North Area Plan and codified in zoning regulations, are set forth in Table A 1 -2.

3.7 Fairfax County zoning prohibits new residential development within the DNL 75 contour. The Comprehensive Plan, which heavily influences decisions on proposed changes to existing land use, recommends against any new residential development within the DNL 60 contour.

4. Land-Use Planning In Brazil

4.1 The Brazilian Methodology

4.1.1 Since 1982, the unit adopted in Brazil for calculating cumulative noise nuisance is called the Weighted Noise Index (WNI). After 1994, the mathematical formula

Table A l-2. Land-use restrictions guidelines for Loudon County

	Restrictions
Areas with DNI- 65 or higher	No new residential development
Areas with DNL 60 or higher, but less than DNI- 65	Residential units must be designed to ensure that the maximum interior DNL does not exceed DNI-45
	Aviation easements allowing aircraft over flights must be provided to the Metropolitan Washington Airports Authority (airport operator), and statements disclosing the close proximity of the airport to the residential property and the likelihood of aircraft over flights and aircraft noise must be included in sales literature (including print media advertising), the sales contract, and the deed
Areas outside of but within 1 mile of the DNI- 60 contour	Disclosure requirement listed above

for calculating WNI was changed to allow for direct field measurements. The data used to forecast WNI at a given point in the vicinity of an airport are:

- aircraft mix
- average number of day and night operations
- distribution of aircraft movements over the various flight tracks to and from the airport runways
- technical data on all aircraft operating in the airport (take-off profile, average take-off weight, SEL x distance x power for each aircraft, landing profile, etc.)

The WNI of an airport is given by the formula:

$$WNI = 10 \log_{10} \{ 1/24[15^{(10\,LD/10)} + 9^{(10\,(LN + 10)110)}l \}$$

in which:
LD is the Leq in the daytime (from 7 am to 10 pm) and
LN is the Leq in the night-time (from 10 pm to 7 am).

4.1.2 The assessment of do magnitude of noise pollution due to airport operations is initially based on the traffic growth at the airport over a period of 20 years. Those studies take into account the fleet evolution, the number of operations, the approach and climb procedures, and others.

4.1.3 The noise impact is determined for different operation scenarios and the most critical operational scenario is selected based on the WNI formula described in 4. 1. 1. Accordingly, the WNI 65 and 75 contours are used as the basis of the Noise Zoning Plan for the airport under study. (Refer to Figure AI A.)

Noise Zoning Plan

4.2.1 The Noise Zoning Plan is the most important tool used to ensure the compatibility of the urban and airport planning processes. It became a Federal Legislation in 1979 and was incorporated into the Brazilian Air Code by a specific Act in June 1982. The Noise Zoning Plan defines areas subject to critical airport noise exposure and specifies land-use restrictions that will ensure that the airport environs are compatible with noise levels and that aircraft

operation is compatible with the existing and proposed patterns of land use. It is therefore the basis for appropriate land use in the surrounding areas of the airport, ensuring a harmonious link with the community living there.

4.2.2 Noise Zoning Plans have been implemented in over 100 Brazilian airports. The Brazilian legislation specifies two different types of Noise Zoning Plans, the Basic Plan and the Specific Plan. The Basic Noise Zoning Plan establishes very stringent restrictions on land use and is more adequate for controlling the use of land in still undeveloped areas. On the other hand, being a much more flexible plan, the Specific Noise Zoning Plan is best applied to the already developed surrounding areas of the airport. As a rule, all airports in Brazil have either a Basic or Specific Noise Zoning Plan.

4.2.3 The land-use restrictions adopted by each noise zoning plan are based on the situations described in Table A1-3.

4.2.4 In the Noise Zoning Plans, runways are classified in terms of take-off and landing movements to allow for the development of noise impact contours. The classifications are outlined in Table AI-4. According to the Brazilian legislation on Noise Zoning Plans, the application of a Specific Noise Zoning Plan is mandatory for airports with Class 1 runways. The Basic Noise Zoning Plan applies to all other airports and heliports. When applied to an airport, the Specific Noise Zoning Plan automatically replaces the Basic one.

4.2.5 In order to define noise contours for Basic Noise Zoning Plans, the parameters and dimensions outlined in Table Al-5 must be applied.
The noise contours for the Specific Noise Zoning Plans are generated based on forecasts of the airport's operating procedures during a 20-year planning period, as mentioned in 4.1.2 and 4.1.3 of this appendix

Table A1-3. Land-use restrictions for Basic and Specific Noise Zoning Plans in Brazil

Areas *within the noise contours* of..	Basic *Noise Zoning* Plan	*Specific Noise Zoning Plan*
75 WNI	Only agricultural and industrial uses and outdoor recreational activities are permitted.	Housing and public facilities, such as schools and hospitals, are not permitted.
	Industrial buildings must be insulated.	Industrial and certain commercial buildings may be permitted if buildings are insulated. Outdoor recreational activities are permitted
65 WNI	Housing and public facilities, such as schools and hospitals, are not permitted.	Public facilities, such as schools and hospitals, are not permitted
	Agricultural, commercial and industrial uses are considered adequate and acceptable	Industrial and commercial uses are permitted if offices have adequate soundproofing.

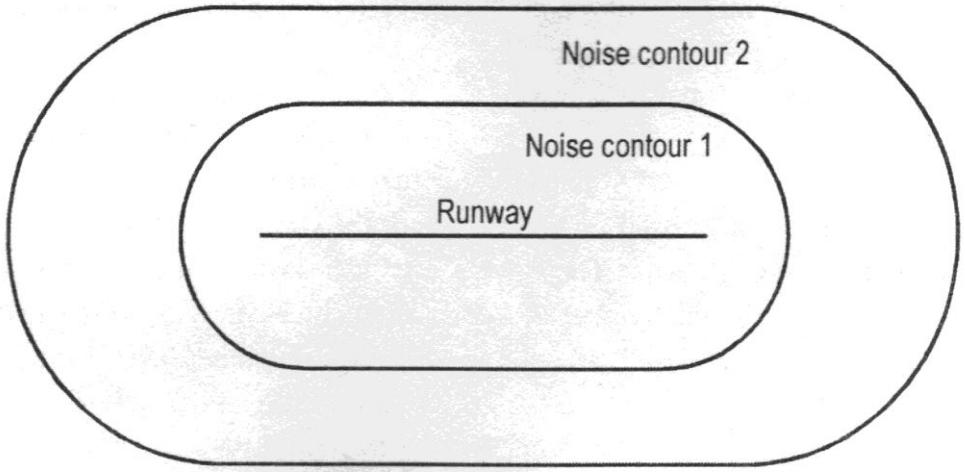

Figure A1-1. Noise contours for noise zoning plans

Table A1-4. Runway classifications under Noise Zoning Plans in Brazil

Class 1	Runway for High-density International/ Domestic Scheduled Aviation	A runway in which the sum of aircraft take-offs and landings corresponds to over 6 000 annual movements or more than 2 night movements.
Class 2	Runway for Medium-density International/ Domestic Scheduled Aviation	A runway in which the sum of aircraft take-offs and landings corresponds to 3 600 up to 6 000 annual movements and less than 2 night movements.
Class 3	Runway for Low-density International/ Domestic Scheduled Aviation	A runway in which the sum of aircraft take-offs and landings is inferior to 3 600 annual movements and has no night movements
Class 4	Runway for High-density Regional Scheduled Aviation	A runway in which the sum of aircraft take-offs and landings corresponds to over 2 000 annual movements or more than 4 night movements.
Class 5	Runway for Low-density Regional Scheduled Aviation	A runway in which the sum of aircraft take-offs and landings is inferior to 2 000 annual movements or less than 4 night movements
Class 6	Runway for General Aviation	

Table Al-5. Definition of noise contours for Basic Noise Zoning Plan in Brazil

Noise contour	Runway class	Length	Width
1		Length of the runway + 1 500 m extension in each direction	240 m in each direction, starting at the runway axis
	3 and 4	Length of the runway + 500 m extension in each direction	180 m in each direction, starting at the runway axis
	5 and 6	Length of the runway + 300 m extension in each direction -	100 m in each direction, starting at the runway axis
	Heliports	Radius of 100 m	
2		Length of the runway + 2 500 m extension in each direction	600 m in each direction, starting at the runway axis
	3 and 4	Length of the runway + 1 200 m extension in each direction	400 m in each direction, starting at the runway axis
	5 and 6	Length of the runway + 500 m extension in each direction	200 m in each direction, starting at the runi axis
	Heliports	Radius of 300 m	

APPENDIX 2
Land-use guidelines for the avoidance of bird hazard& Bird hazard considerations only

The land uses tabulated below should not be considered as an exhaustive listing, but merely as examples of how various land uses may be graded in two areas, Areas A and B, surrounding an airport. These areas are drawn up by describing two concentric circles (radii of 3 and 8 km,

Land-use guidelines

respectively) around an airport, centred on the Airport Reference Point. Any land use that has the potential to attract birds to the airport vicinity should be the subject of a study to determine the likelihood of bird strikes to aircraft using the airport.

Land Use	Area A	Area B
Agriculture	YES	YES
landscape nurseries*	YES	YES
tree farming*	YES	YES
stock farming*	YES	YES
dairy fanning*	YES	YES
sod farming	NO	YES
piggeries	NO	YES
fruit tree farming	NO	YES
Wildlife Sanctuaries		
bird sanctuaries	NO	NO
game reserves	NO	NO
Recreational		
golf courses*	YES	YES
parks*	YES	YES
playgrounds*	YES	YES
athletic fields*	YES	YES
riding trails*	YES	YES
tennis, lawn bowling*	YES	YES
picnic and campgrounds	YES	YES
riding academies	NO	YES
racetracks	NO	YES
fair grounds	NO	YES
outdoor theatres	NO	YES
Commercial*		
offices	YES	YES
retail sales	YES	YES
hotels and motels	YES	YES
restaurants	YES	YES
parking lots	YES	YES
indoor theatres	YES	YES
warehouses	YES	YES
shopping centres	YES	YES
Land Use	Area A	Area B
service stations	YES	YES
cemeteries	YES	YES
drive-in restaurants	NO	YES
food-processing plants	NO	YES
Municipal Utilities*		
water treatment	YES	YES
non-food garbage landfill	YES	YES
food garbage disposal	NO	NO

Source: Transport Canada, Land Use in the Vicinity Airports.

* These are general guidelines for planning and land-use zoning only. The avoidance of bird hazards during airport operations is another subject that can involve special controls to keep land free from food and shelter for birds.

APPENDIX 3
Fact Sheets on Land-use Planning Measures Related to Airports, As Practiced in Various Countries

The following Fact Sheets on Land-use Planning present data from various countries and are based on a worldwide survey conducted by ICAO on 1 January 1997.
Fact sheets marked with an asterisk (*) indicate that the country is one of the 15 Member States of the European Union, where comprehensive environmental impact assessments for large developments, including airports, are mandatory according to Council Directive 851337/EEC of 27 June 1985, as amended by Directive 9711 I/EC of 3 March 1997).

Glossary Of Acronyms And Abbreviations

ANEF	Australian Noise Exposure Forecast method
B	Noise exposure metric in Kosten units used in the Netherlands
BkI	Noise exposure metric in Leq for light aircraft used in the Netherlands
Chapter 2 aircraft	Aircraft with a noise certificate according to Annex 16 EACR ** - Environmental *Protection,* Volume 1 - Aircraft *Noise,* Chapter 2
CHF	Swiss franc (national currency of Switzerland)
CNEL	Continuous Noise Exposure Level (= leq)
dB(A)	decibel with A-weighting, measure for noise
DENL	Day-Evening-Night noise Level (used in Denmark)
DNL	Day-Night noise Level (used in the United
Dfl	Netherlands guilder (national currency of the.Netherlands)
DM	German mark (national currency of Germany)
EC	European Commission
EEC	European Economic Community
EFN	Norwegian noise exposure index (similar to CNEL)
EPNL	Effective Perceived Noise Level in EPNd13, used for aircraft noise certification
FBN	Swedish noise exposure index (similar to Ldn)
FF	French franc (national currency of France)
IP	Index Psophic method used in France
IR£	Irish pound (national currency of Ireland)
Ke	Kosten method used in the Netherlands
Laep	Equivalent noise level in dB(A)
Lamax	Maximum noise level in dB(A)
Ldn	Equivalent noise level in dB(A) with day and night weighting
Lden	Equivalent noise level in dB(A) with day, evening and night weighting
Leq(16h)	Equivalent noise level for a period of time (i.e., 16h period)
Leq	Specific equivalent noise level in dB(A) used in Germany
MFN	Norwegian noise exposure index (similar to Lamax)
NEF	Noise Exposure Forecast
NNI	Noise and Number Index, noise calculation method used in Ireland and Switzerland (until 1997)
VFR	Visual fight rules
Won	National currency of the Republic of Korea
WECPNL	Weighted Effective Continuous Perceived Noise Level in EPNdB, used in Japan and the Republic of Korea
WNI	Weighted Noise Index
Yen	National currency of Japan

Country:	AUSTRALIA	Major airport(s)	Other airports
		Adelaide Brisbane Cairns Coolangatta Melbourne Perth Sydney	Thousands of small aerodromes and airstrips

Land-use planning	Land-use planning is applied at all airports. The State and local authorities are responsible for land-use planning. The Australian noise metric is the ANEF method, with noise limits of 40, 30 and 25 ANEF.
Type of measures used for most airports	— Comprehensive planning — Noise zoning — Noise insulation programmes (only around Sydney Airport) — Land acquisition and relocation (only around Sydney Airport) — Transaction assistance (only around Sydney Airport) — Real estate disclosure (around some airports) — Noise-related landing charges (only for Sydney Airport) A combination of comprehensive planning and noise zoning, together with real estate disclosure as a legal obligation, is considered as the most effective measure for controlling the use of land around airports, especially for new "green field" situations. For existing situations, the effectiveness of land-use planning controls is considered limited.
Noise monitoring	A noise monitoring system is installed around the seven airports mentioned above. Generally, noise monitoring provides the basis for flight path reports at each airport which show arrival and departure tracks on a quarterly basis. It also provides the basis for regular reviews of aircraft operators and noise abatement procedures at all airports.
Noise insulation schemes	In 1994, a noise insulation programme was introduced around Sydney Airport. The programme is financed by the airlines through a noise levy imposed on top of the landing fee of all aircraft using the airport. The total costs are estimated at A$300 million. The noise limits for the insulation programme are: over 40 ANEF — acquisition of noise-sensitive buildings 40 – 30 ANEF — residences are insulated 30 – 25 ANEF — public buildings are insulated The number of residences (including apartment buildings) in the insulation programme is approximately 4 750. There are also 21 schools, 1 hospital, 7 nursing homes, 21 child care centres and 24 churches.

	Indoor noise level targets are as follows: Schools libraries, study areas 50 dB (A) teaching areas 55 dB (A) Nursing homes/hostels bedrooms 50 dB (A) living areas/TV rooms 55 dB (A) social activity areas 70 dB (A) Child care centres sleeping areas 50 dB (A) other areas 55 dB (A) Churches religious activities 50 dB (A) Hospitals wards and theatres 50 dB (A) laboratories 65 dB (A) service areas 75 dB (A)
Enforcement of noise zoning	State Government, rather than the Federal Government, has jurisdiction over local authorities who are limited by State Government planning legislation. State planning legislation does not however provide mandatory land-use planning controls on all development and building situations.
Other land-use measures	No other land-use measures are applied.

Country:	AUSTRIA*	Major airport(s)	Other airports
		Vienna	Graz Innsbruck Linz Salzburg

Land-use planning	Applicable to all airports According to the Austrian constitution, land-use planning falls under the jurisdiction of the Austrian provinces. However, during the preparation of a new Austrian "noise abatement law", the Department of Civil Aviation negotiates with the provinces to include a coordination procedure in land-use planning measures. To reduce noise in the vicinity of airports, the Austrian ordinance *Zivilluftfahrzeug — Lärmzulässigkeitsverordnung* (ZLZV) of 1995 is much more stringent than the EU directive 92/14–EWG. Operation of Chapter 2 aircraft is almost eliminated at the Austrian airports. At Vienna Airport, Chapter 2 jets are only permitted during daytime between 06.00 and 22.30 hours local time. Presently, discussions are underway to reduce the time window from 06.30 to 22.00 hrs. The result of this "early ban" of Chapter 2 jets has led to a remarkable reduction of the noise zones around airports.
Type of measures used for most airports	— Comprehensive planning — Noise zoning
Noise monitoring	Noise monitoring, including flight tracking, is practiced around Vienna and Salzburg airports.
Noise insulation schemes	Since 1980, the Leq 66 dB(A)-contour (based on the traffic over the busiest half of the year) around Vienna Airport has been shrinking and no housing is located within this contour.
Enforcement of noise zoning	Unknown
Other land-use measures	Unknown

Country:	BELGIUM*	Major airport(s)	Other airports
		Brussels/Zaventem	In Flanders: Antwerp/Deurne Kortrijk Oostende In Wallonia: Liége/Bierset Charleroi

Land-use planning	Applicable to all airports Royal Decrees and Ministerial Decisions refer only to the Brussels/Zaventem National Airport. Both Flanders and Wallonia have their own regional regulations.
Type of measures used for most airports	Comprehensive planning
Noise monitoring	Noise monitoring, including flight tracking, is practiced around the Brussels/Zaventem Airport.
Noise insulation schemes	Not applicable
Enforcement of noise zoning	Not applicable
Other land-use measures	Noise contours are calculated in Leqs for the Brussels/Zaventem Airport in order to assess the effects of changes in flight tracks over populated areas.

Country:	BOTSWANA	Major airport(s)	Other airports
		SSKL, Gaborone	Francistown Kasane Maun

Land-use planning	The Department of Town and Regional Planning is responsible for land-use planning. The noise metric in Botswana is the Weighted Noise Index (WNI) Method while the noise contours are based on forecast noise levels.
Type of measures used for most airports	— Comprehensive planning — Noise zoning A combination of comprehensive planning and noise zoning is considered as the most effective measure for controlling the use of land around airports, especially in new situations. This should be a recommendation for environmental factors and mandatory for obstacle limitations.
Noise monitoring	Not applicable
Noise insulation schemes	Not applicable
Enforcement of noise zoning	Zoning Plan regulation is enforced by the Department of Town and Regional Planning.
Other land-use measures	No other land-use measures are applied.

Country:	BRAZIL	Major airport(s)	Other airports
		Sao Paulo/Guarulhos International Rio de Janeiro International Brasilia International Porto Alegre International Salvador International Sao Paulo/Congonhas Recife International Campinas International Fortaleza International Manaus International Rio de Janeiro/Santos Dumont	56 airports under INFRAERO Administration, operating domestic regional and international traffic plus approximately 2 000 small and medium-sized airports

Land-use planning	Applicable to all public airports In Brazil, land-use guidelines are issued at State and municipal levels but the zoning and land-use planning document (Noise Zoning Plan) is issued and approved by the Brazilian Civil Aviation Authority. Local authorities should incorporate airport noise zones and land-use measures into local plans. The Brazilian Civil Aviation Authority uses the WNI Method, with the values 65 and 75 WNI used for calculating noise contours. The relation between WNI and subjective nuisance is: below 65 — no complaints expected between 65 and 75 — a considerable number of complaints can be expected above 75 — a large number of complaints is expected. Residents may take legal action in order to reduce the level of nuisance
Type of measures used for most airports	— Comprehensive planning — Noise zoning — Noise insulation. Building standards exist in some restricted areas. The indoor noise level is established by environmental authorities and varies from 45 to 55 dB (A), depending on the city/state. — Land acquisition and relocation
Noise monitoring	The implementation of a noise monitoring system is being studied at Sao Paulo International Airport (Guarulhos) and other major airports.
Noise insulation schemes	None
Enforcement of noise zoning	Local authorities are subject to Federal Government planning legislation, but there are no penalties to aid in enforcement of land-use measures.
Other land-use measures	The costs of other land-use measures are unknown.

Country:	CANADA	Major airport(s)	Other airports
		Calgary Edmonton Halifax Montreal/Dorval Montreal/Mirabel Ottawa International Toronto/L.B.Pearson Vancouver Victoria Winnipeg	Gander Quebec City Regina Thunder Bay Saskatoon St. John's + hundreds of smaller aerodromes

Note. — The Canadian airport system is in transition, with the operation and management of the airports being transferred from the Federal Government to local authorities under a lease arrangement. The ownership of land of 26 national airports will however remain with the Federal Government. Meanwhile, noise management is not expected to change substantially as the Federal Government will retain regulatory control over flight procedures, including those related to noise abatement, and land-use control will remain at the provincial/municipal level.

Land-use planning	All airports in Canada are encouraged to promote land-use planning for compatibility with surrounding lands. The Federal Government produces guideline material that is based on social response to aircraft noise. Airports, in turn, promote acceptance of the guidelines in the municipalities they serve. Under the constitution of the country, provincial governments have responsibility for land-use planning and these governments, for the most part, delegate this responsibility down to municipalities. Provincial governments retain the power to overrule a municipal decision upon appeal from an individual. With respect to national airports, municipalities control land use within policy frameworks established by provincial governments. Provincial governments rely, to varying extent, on federally sponsored aircraft noise impact guideline material to establish policy. The Canadian noise metric for aircraft noise is the NEF method. Incompatible land use (especially residential housing) may begin as low as NEF 25. At NEF 30, speech interference and annoyance caused by aircraft noise are, on average, established and increasing. By NEF 35, these effects are very significant. New residential development is therefore not compatible with NEF 30 and above and should not be undertaken. The airports with the most traffic are those that are heavily involved in land-use planning. They are: Toronto/L.B.Pearson, Montreal/Dorval, Vancouver, Calgary, Winnipeg, Edmonton, and Ottawa International airports, and smaller sites including Saskatoon, Regina, Thunder Bay, Quebec City, and St. John's.
Type of measures used for most airports	— Comprehensive planning — Noise zoning[1] — Subdivision regulation — Building codes[2] — Tax incentives

1. A new development or redevelopment is generally approved when it is proposed adjacent to existing incompatible land uses. Several appeals by airport officials have been unsuccessful in preventing new development or redevelopment.
2. Noise insulation features are included in the condition of approval in subdivision agreements.

Country:	DENMARK*	Major airport(s)	Other airports
		Copenhagen Billund	Aalborg Aarhus Karup Maribo Odense Ronne Sindal Sonderborg Thisted

Land-use planning	Applicable to all airports In Denmark, land-use planning is a responsibility of the provincial authorities. Airport noise zoning is based on the legal framework of the Environmental Law (1973). The Danish Environmental Agency establishes recommended noise limit values for zoning purposes. These recommended limit values are: a. For commercial airports: — Residential areas 55 dB — Single houses in open land 60 dB (preferably 55 dB and Lamax below 70 dB) — Commercial areas 60 dB — Recreational areas used overnight 50 dB — Other recreational areas 55 dB b. For other airfields: — Residential areas 45 dB (50 dB for important regional airfields) — Single houses in open land 50 dB — Commercial areas 60 dB — Recreational areas used overnight 45 dB — Other recreational areas 50 dB The Danish noise metric is the Lden method. The noise level in dB is calculated by the Day-Evening-Night noise index as an average of the 3 busiest months of the year; 5 dB is added for evening (19.00 to 22.00 hours) noise and 10 dB for night-time (22.00 to 07.00 hours) noise. In case of operations connected with parachuting, VFR landing circuits, ultra-lights, aerobatics and pleasure flights, an additional 5 dB is added (except for Mondays to Fridays between 07.00 to 19.00 hours). Noise contours are based on forecast noise levels. The time horizon is normally 8 years, which is the number of years for which an environmental approval is normally issued. Noise contours are to be reviewed/updated when a new environmental approval is needed.

Type of measures used for most airports	— Comprehensive planning, including environmental impact assessment (EIA) for airport developments with effect on noise climate — Noise zoning: applicable to all airports — Building codes: applicable to all new buildings in the vicinity of airports (if situated within a noise zone). The required indoor noise level is 30 dB(A). — Noise insulation programmes: only applicable to Copenhagen Airport — Noise barriers: applicable to Copenhagen Airport — Noise monitoring and flight tracking system: only operational at Copenhagen Airport All these measures are considered effective in new and existing situations.
Noise insulation schemes	Between 1982 and 1985, a noise insulation scheme was carried out around Copenhagen Airport. The programme was financed by the national government. The total costs amounted to DKr 105 million. Outdoor noise levels are 65, 70 and 75 DENL. In the programme were 3 300 houses between 65 and 70 dB(A), 1 100 houses between 70 and 75 dB(A), and 300 houses over 75 dB(A).
Enforcement of noise zoning	Each airport has an approval from the environmental authorities. Noise monitoring is not used in relation to land-use planning.
Other land-use measures	The costs of other land-use measures are unknown.

Country:	EGYPT	Major airport(s)	Other airports
		Cairo	Abu-simbel
		Luxor	Taba/Ras El Nakab
		Aswan	Port Said
		Hurghada	El Arish
		Sharm El Sheikh	Shark El Oweinat
		Alexandria/Alexandria	St. Catherine
		Alexandria/Borg El-Arab	Dakhala
		Asyut	El Kharga
			El Tor
			M. Matruh
			Giza/Embaba
			El Gora

Land-use planning

Land-use planning is the a responsibility of the Egyptian Civil Aviation Authority, according to Civil Aviation Law No. 28 of 1981, Law for the Environment No. 4 for 1994 and its executive regulations. The Egyptian Environmental Affairs Agency recommended the following noise limits:

TYPE OF ZONE	PERMISSIBLE LIMITS FOR NOISE INTENSITY DECIBEL (A)					
	DAY (7 am to 6 pm)		EVENING (6 pm to 10 pm)		NIGHT (10 pm to 7 am)	
Commercial, administrative & downtown area	55	65	50	60	45	55
Residential areas (including some workshops) or commercial businesses or on public roads	50	60	45	55	40	50
Residential areas in the city	45	55	40	50	35	45
Residential suburbs with low traffic	40	50	35	45	30	40
Rural residential areas (hospitals and gardens)	35	45	30	40	25	35
Industrial areas (heavy industries)	60	70	55	65	50	60

Type of measures used for most airports

— Comprehensive planning, including environmental audit & compliance action plan for the major airports, and environmental impact assessment (EIA) for the new construction in Marsa Alam Airport
— Noise zoning, applicable to major airports
— Noise barriers, applied to Cairo Airport only
— Noise monitoring and flight tracking system, studied at Cairo, Hurghada and Sharm El Sheikh Airports. Other airports were not included as they are located away from the residential areas.

Noise monitoring	Noise monitoring systems are being considered for implementation at the Cairo, Sharm El Sheikh and Hurghada International Airports. Woods have been planted around the airports to shield noise.
Noise insulation schemes	The population near Cairo International Airport is estimated at 4 to 5 million, living within 70 to 90 dBA noise contour, Nasr City District alone is populated by about 1 million people. A future plan would consider soundproofing for the houses in the nearest airport vicinity.
Enforcement of noise zoning	Not applicable
Noise charge system	Noise and emission charges would be applied on reciprocal basis with other countries. Noise charges for violating aircraft became applicable upon the installation of the noise monitoring systems by 2001.

Country:	ERITREA	Major airport(s)	Other airports
		Asmara	Assab Massawa

Land-use planning	Applicable to all airports The State Government is responsible for land-use planning. Comprehensive planning is applied to all airport development. Eritrea is a new nation with very low air traffic. So far, noise has not been a matter of much concern in this region. However, it is recognized that it is high time to consider the problem of aircraft noise before this becomes a serious nuisance.
Type of measures used for most airports	Comprehensive planning Such measures should be applied as a legal obligation.
Noise monitoring	Not applicable
Noise insulation schemes	Not applicable
Enforcement of noise zoning	Not applicable
Other land-use measures	No other land-use measures are applied.

Country:	FINLAND*	Major airport(s)	Other airports
		Helsinki/Vantaa	over 20 other airports and aerodromes

Land-use planning	Applicable to all airports Comprehensive planning is applied to all airport development. The Finnish noise metric for airports is the Lden, with 55 Lden as the noise limit. Noise contours are based on forecast noise levels with a time horizon of 10 to 15 years.
Type of measures used for most airports	— Comprehensive planning — Noise zoning Such measures should be applied as a legal obligation.
Noise monitoring	A noise monitoring and flight tracking system (GEMS by Lochard — Australia) with 4 noise measuring stations is operational around Helsinki/Vantaa Airport.
Noise insulation schemes	Not applicable The normal insulation of Finnish houses against climate conditions is roughly 30 dB(A). No extra noise insulation is considered necessary. Around Helsinki/Vantaa Airport, about 57 000 people live within the 55 Lden noise contour.
Enforcement of noise zoning	No enforcement of noise zones is applied.
Other land-use measures	No other land-use measures are applied.

Country:	FRANCE*	Major airport(s)	Other airports
		Paris/Charles-de-Gaulle Paris/Orly Lyon/Satolas Nice/Cote d'Azur Marseilles/Provence	Bâle-Mulhouse (jointly operated by France and Switzerland) Bordeaux Montpellier Nantes Strasbourg Toulouse + some 260 smaller airports and airfields

Land-use planning	Applicable to 270 aerodromes of all categories (civil and military), according to Law No. 85–696 of 11 July 1985. Local authorities are obliged to incorporate airport noise zones and land-use measures into local plans. Noise contours for land-use planning are based on forecast noise levels with a time horizon of around 15 years. These noise contour maps are called *Plan Exposition Bruit* (PEB) which are reviewed/updated when necessary. For noise insulation schemes around the six major airports, a second map (*Plan de Géne Sonore*) based on the actual noise exposures is used. The noise metric for both maps is the IP method. In simplified formula, it reads: IP = Lpn + 10log N – 32 The legal limit values for land-use measures are: Zone A = > 96 IP: only housing and facilities necessary for aeronautical activities are allowed, as well as public facilities which are vital to the existing population Zone B = 89 – 96 IP: as for zone A +, official residences necessary for private, commercial and farming activities are permitted Zone C = 72/84 – 89 IP: non-grouped private buildings located in sectors which have already been developed and renovation work or restoration of existing buildings are permitted, provided that such work does not lead to a large increase in the number of inhabitants exposed to excessive noise levels. The limit value for zone C has to be determined by the Prefect of the Department. The legal limit for noise insulation schemes is 84 IP, extended to the *Plan Exposition Bruit* (PEB) when PEB is available.

Type of measures used for most airports

— Comprehensive planning, including environmental impact assessment (EIA) for airport developments with effect on noise climate
— Noise zoning is applicable to all aerodrome categories
— Building codes include noise regulations for new noise-sensitive buildings in the PEBs
— Acquisition/relocation is applied at a few airports
— Noise barriers are applied in very specific cases to shield noise from certain ground activities, such as engine testing
— Noise monitoring and flight tracking systems are installed around Paris/Charles-de-Gaulle, Paris/Orly and Bâle/Mulhouse Airports
— Noise-related airport charges are raised from the airlines for each landing and take-off on the six major airports

All these measures are applied to existing as well as new situations where appropriate.

In the near future, more noise monitoring systems will be installed and local contracts between airports, airlines and communities will be approved with respect to the noise situation and the development of the airport. Paris/Charles-de-Gaulle will have such a contract with an independent control authority.

The updating of the regulation on noise is under discussion. This could lead to an extension of the noise zones (lower IP values) where housing construction are restricted. Furthermore, the noise insulation programmes could be extended to larger zones and other airports.

Noise charge system

In France, the following noise charge system has been is in force as of 1 January 1996

Acoustical grouping of aircraft	Charge (6h to 22h)	Charge (22h to 6h)
1 + non-noise certificated aircraft	$24 \times t \times \log M$	$48 \times t \times \log M$
2 B727-100, B737-100, Mercure	$8 \times t \times \log M$	$16 \times t \times \log M$
3 B747-100, DC9-10, F28-3000	$4 \times t \times \log M$	$8 \times t \times \log M$
4 B747-300	$2 \times t \times \log M$	$4 \times t \times \log M$
5 B747-400, B767, A300, A310, F27	$t \times \log M$	$2 \times t \times \log M$

t = 34 FF at Paris/Charles-de-Gaulle and Paris/Orly
t = 12,5 FF at Nice/Cote d'Azur, Marseille/Provence and Toulouse/Blagnac
t = 0,5 FF at Lyon/Satolas
M = maximum certificated mass of aircraft (MTOW)

Noise insulation schemes

Since 1973, noise insulation schemes have been carried out around Paris/Charles-de-Gaulle and Paris/Orly Airports.

According to Law No. 92–1444 of December 1992, first applied in 1995, mandatory insulation programmes were required of all six major airports.

The legal limit for noise insulation schemes is 84 IP, extended to the PEB noise zoning, if available.

No specific indoor noise level is required.

	The number of houses in the insulation schemes is unknown. Most of the houses are located around Paris/Orly Airport.
Enforcement of noise zoning	No penalties are in force, only legal obligations.
	Noise monitoring is in force around Paris/Charles-de-Gaulle, Paris/Orly and Bâle/Mulhouse to control noise levels and flight tracks, and to inform and communicate with the public. There is no real application of land-use planning.
Other land-use measures	The costs of other land-use measures is unknown, but considered not very high.

Country:	GERMANY*	Major airport(s)	Other airports
		Berlin (3 airports) Düsseldorf Frankfurt Köln/Bonn München	Bremen Dresden Erfurt Hamburg Hannover Leipzig-Halle Munster/Osnabruck Nürnberg Paderborn Saarbrücken Stuttgart

Land-use planning	Land-use planning is applied to 18 airports with scheduled flights. According to the Air Traffic Noise Act of March 30, 1971, with respect to commercial airports connected to the airline traffic network and military airfields designed for the operation of jet aircraft, the Federal Government has to establish noise protection areas in the vicinity of airfields in order to protect the public from hazards and from considerable disturbances or annoyance caused by aircraft noise. Provincial authorities are responsible for land-use planning. In Germany, the Leq[1] method is applied for aircraft noise, with noise limits for land-use planning at 75 dB(A) and above. The noise contours around airports are partly based on actual monitored noise levels and partly on forecast noise levels for a time horizon of 10 years. The noise contours are reviewed when there is a change of over 3 dB.
Type of measures used for most airports	— Comprehensive planning — Noise zoning — Noise insulation programmes — Noise barriers — Noise-related airport charges
Noise monitoring	Noise monitoring systems are in place at the 18 airports with scheduled flights. The calculation of noise contours as a basis for land-use planning does not directly take the data of the monitoring systems as a source. The measured noise data are used for updates of the database for the calculation procedure.
Noise insulation schemes	Since 1971, noise insulation schemes have been carried out around the 18 airports with scheduled flights. The insulation schemes are financed by the airports out of their revenues. To encourage the use of quieter aircraft, the landing fees are charged according to the noise production of aircraft. No information on the total number of houses is available. (For Dusseldorf Airport, the figure is 1 725.) The costs of the noise insulation schemes are estimated at DM 666 million for all 18 airports with scheduled flights up to 1995.

1. Where applicable, regarded as good noise mitigation measures (rather than controlling use of land).

	For new situations, an indoor noise level of 55 dB(A) is recommended. Any compensation scheme for real estate owners adversely affected by the establishment or enlargement of noise zones has to be financed by the airport operator.
Enforcement of land-use measures/noise zoning	Not applicable
Other land-use measures	No other land-use measures are applied.

Country:	JAPAN	Major airport(s)	Other airports
		Tokyo/Narita Tokyo/Haneda_ Osaka Hakodate Sendai Niigata Nagoya Matsuyama	Kochi Fukuoka Kumamoto Oita Miyazaki Kagoshima Naha

Land-use planning	Applicable to all designated airports, according to the National Aviation Act Local authorities are required to incorporate airport noise zones and land-use measures into local plans. The noise metric is the WECPNL method. The legal limit values for land-use measures are: 75 WECPNL — existing houses are to be insulated 90 WECPNL — house removal and land acquisition 95 WECPNL — green belt buffer The legal limit for noise insulation schemes is 75 WECPNL for households.
Type of measures used for most airports	— Comprehensive planning, including environmental impact assessment (EIA) for airport developments with effect on noise climate (now applied to Osaka and Fukuoka airports) — Noise zoning is applicable to all 15 designated airports — Building codes include noise insulation for noise-sensitive buildings in the legal noise zones of the 15 airports — Acquisition/relocation is applied to all 15 airports — Noise barriers are applied in specific cases to shield noise from certain ground activities, such as engine testing — Noise monitoring and flight tracking systems are installed around all 15 airports — Noise-related airport charges are raised from the airlines for each landing at the 15 designated airports
Noise insulation schemes	Since 1967, noise insulation schemes have been carried out around all 15 designated airports. These programmes are financed by the national government. The national budget for implementation of aircraft noise control measures in 1996 was about 36 billion yen. The number of houses in these insulation schemes is unknown. For existing buildings, the required specific indoor noise level is 60 WECPNL.
Enforcement of noise zoning	No penalties are in force.
Other land-use measures	The cost of land acquisition and relocation of about 6 000 houses around the 15 designated airports amounted to 305 billion yen (national budget 1967 to 1996).

Country:	REPUBLIC OF KOREA	Major airport(s)	Other airports
		Kimpo (Seoul) Kimhae (Busan) Cheju	

Land-use planning	Applicable to the international airports listed above. In the Republic of Korea, land-use planning is a responsibility of the national government. Noise is measured using the WECPNL method, with a noise limit of 80 WECPNL or greater for noise insulation schemes. Noise contours around airports are based on actual monitored noise levels and are reviewed/ updated every five years.
Type of measures used for most airports	— Comprehensive planning — Noise zoning — Building codes — Noise insulation programmes — Land acquisition and relocation — Noise barriers — Capital improvement planning — Noise-related airport charges For new situations, subdivision regulation, transfer of development rights, easement acquisition, transaction acquisition, real estate disclosure and tax incentives are also considered as effective measures on a legal obligation basis.
Noise monitoring	A noise monitoring system is installed around Kimpo, Kimhae and Cheju international airports.
Noise insulation schemes	Since 1991, noise insulation schemes have been introduced around Kimpo, Kimhae and Cheju international airports. The insulation programmes and other compensation schemes for real estate owners are financed largely by the national government and partially by the airlines (out of the noise charges raised on top of the landing fees). About 17 000 houses are situated within the noise limit of 80 WECPNL. The required indoor noise level after insulation is 65 WECPNL. The total costs of the insulation programmes is about 1 000 billion won. Land acquisition and relocation affects about 3 million m^2 of land at the costs of about 350 billion won.
Enforcement of noise zoning	Penalties exist to enforce the land-use measures.
Other land-use measures	The costs of other land-use measures are unknown.

Country:	LATVIA	Major airport(s)	Other airports
		Riga	

Land-use planning	Land-use planning is applied to all airports and is the responsibility of the local authority. The noise metric used is L (Max Noise Level), with a noise limit of 80 dB(A) at working places.
Type of measures used for most airports	— Comprehensive planning as a legal obligation — Noise zoning, only applied to Riga Airport — Advisory noise insulation programme, applied to Riga Airport — Land acquisition and relocation, applied to Riga Airport — Capital improvement planning, applied to all airports — Noise-related airport charges are advised
Noise monitoring	Not applicable
Noise insulation schemes	A noise insulation programme was introduced around Riga Airport in 1993. The number of noise-sensitive buildings within the 80 dB(A) noise limit is 3. The total cost of the programme financed by the national government is approximately US$ 200 000. Specific indoor noise level required under the Occupational Safety Standards system are as follows: Equivalent Aircraft Noise Level (dB (A))

	Day	Night
Hospital	35	25
Convalescent home	40	40
School dwelling	40	30
Hotel	45	35
Hotel (halls)	50	
Restaurants	55	
Stations	60	

Enforcement of noise zoning	Not applicable
Other land-use measures	Land acquisition and relocation has been applied for 660 ha of land at a total cost of US$ 63 859.

Country:	LITHUANIA	Major airport(s)	Other airports
		Vilnius Palanga International Airport Kaunas	

Land-use planning	Land-use planning is not yet applied to airports. The State Authority is responsible for land-use planning. The measures mentioned below are based on the traffic forecast for 2005 and were reviewed in 1996.
Type of measures used for most airports	— Comprehensive planning, as a legal obligation — Subdivision regulation, as a legal obligation — Transfer of development rights, as a legal obligation — Building codes are applied to all airports
Noise monitoring	Not applicable
Noise insulation schemes	Not applicable. Local authorities are responsible for noise insulation schemes.
Enforcement of noise zoning	Not applicable
Other land-use measures	In accordance with the established criteria on object heights, a forest (in the recreational zone) near Palanga International Airport was felled with a view to improving aircraft landing conditions.

Country:	LUXEMBOURG*	Major airport(s)	Other airports
		Luxembourg	
Land-use planning	Applicable to all airports Noise zoning regulation is based on the German (Leq) method. Noise contours are calculated based on future traffic forecast.		
Type of measures used for most airports	— Comprehensive planning — Noise zoning		
Noise monitoring	None. A policy decision was taken that the investment was not justified.		
Noise insulation schemes	Not considered because houses have been built very close to the airport after the airport was completed		
Enforcement of noise zoning	Not applicable		
Other land-use measures	Unknown		

Country:	THE NETHERLANDS*	Major airport(s)	Other airports
		Amsterdam/Schiphol Rotterdam Maastricht/Aachen	De Kooy (military/civilian) Eindhoven (military/civilian) Groningen/Eelde (civilian) Twenthe (military/civilian) + 11 small airfields

Land-use planning	Applicable to all aerodrome categories (civil and military), according to National Aviation Act, amended in 1978 Local authorities are required to incorporate airport noise zones and land-use measures into local plans. The noise metric is the Kosten method (Ke). In simplified formula, it reads: B = 1,33Lmax + 20Log(N.ngem) – 157 The legal limit values for land-use measures are: 35 Ke — new noise sensitive developments are not allowed 40 Ke — existing noise sensitive buildings are to be insulated 65 Ke — all noise sensitive buildings are to be demolished When regular night operations take place at an airport, a special night noise index is applied of LAeq 26 dB(A) for indoors. Sleeping rooms inside this 26 dB(A)-contour are to be insulated to this limit value. The noise metric for small airfields with traffic up to 6 000 kg MTOM is the Bkl method. Noise zones are established with a legal limit value of Bkl at 50 dB. New noise-sensitive developments are not allowed. Existing noise-sensitive buildings may stay without noise insulation. Noise contours for the larger airports are based on forecast noise levels for the year 2015. These noise contours are legally established and only to be reviewed in very special cases. For the small airfields, the noise contours are based on the situation in 1995. In 2000, the legal noise limits were reduced from 50 dB to 47 dB.
Type of measures used for most airports	— Comprehensive planning, including environmental impact assessment (EIA) for airport improvements when runway over 1 800 m long, with effect on noise climate — Noise zoning is applicable to all aerodrome categories — Building codes include noise insulation for noise-sensitive buildings in legal noise zones — Acquisition/relocation and transaction assistance are applied to large airport developments (i.e., new runways) — Demolition of houses is applied to high noise exposure areas over 65 Ke and in high third-party-risk areas on both ends of runways — Noise barriers are applied to shield noise from certain ground activities (i.e., engine testing) — Noise monitoring and flight tracking systems are installed around Amsterdam/Schiphol and Maastricht/Aachen Airports — Noise charges are raised from the airlines for each landing (on top of the landing fee) to recover the costs of the insulation programmes and to encourage the use of less noisy aircraft during the evening and night periods

Noise insulation schemes

All noise-sensitive buildings in 40 Ke noise zones are to be insulated with noise reduction packages from 30 dB to 40 dB. For airports with regular night operations, a specific night noise index of LAeq = 26 dB(A) exists for indoors. Sleeping rooms inside these night noise zones have to have extra insulation.

The noise insulation scheme around Amsterdam/Schiphol Airport started in 1983 and will be finished in 2003 when the fifth runway comes into operation.

The first insulation scheme covering 3 600 houses, 4 schools and 1 hospital/nursing home within the 40-Ke contour of the present four-runway system was finished in 1996. About 120 houses were demolished because of high noise levels (over 65 Ke). The total costs of this programme amounted to f. 295 million.

A second insulation scheme started in 1998. This programme included about 5 000 houses within the 40-Ke contour of the five-runway system and about 7 000 additional houses within the LAeq = 26 dB(A) night contour with only sleeping room insulation. The estimated costs of this second programme amounted to f. 450 million.

The noise insulation scheme around Maastricht-Aachen Airport started in 1985. The first programme consisted of sleeping room insulation for 1 300 houses within the 55 dB(A)-noise footprint of the Fokker F-27, the largest aircraft that was allowed to operate at night.

The costs of this programme totalled f. 24 million. A new insulation scheme around the new East-West runway will start as soon as the final decision on the project is taken. This programme includes about 400 houses within the 40-Ke contour and 3 900 additional houses within the LAeq = 26 dB(A) night contour. The costs of this programme are estimated at f. 80 million. The Netherlands authorities have offered the same noise protection as required by the national law for people living over the borders in Belgium and Germany and affected by noise from the new East-West runway. This is still under discussion.

Around Rotterdam Airport, the noise insulation scheme will start as soon as the noise zone is legally established. This programme includes about 1 000 houses and 1 hospital/nursing homes within the 40-Ke contour. The costs are estimated at f. 70 million.

Around Groningen/Eelde Airport, less than 10 houses will be situated within the 40-Ke contour. This programme will start as soon as the noise zone is legally established. The costs are estimated at f. 500 000.

The insulation schemes around De Kooy, Eindhoven and Twenthe Airports — military airfields with regular civil aviation — are carried out by the Ministry of Defence based on an agreement between the Ministers of Defence and Transport. Noise charges are raised from civil aircraft to partially finance the costs of these programmes.

Enforcement of noise zoning

The legally established noise zones around airports are enforced by preventive and strict measures.

Preventive measures are the Airport Usage Plan, together with the continuous monitoring of the noise development throughout the year. The Airport Usage Plan has to be submitted to the Minister of Transport in October of each year. If the plan shows that the expected operations for the next year will stay within the legal noise zone, the plan is approved accordingly; otherwise, measures have to be taken to stay within the noise zones. By monitoring and reporting on the ongoing development continuously, infringements of the legal noise zones can be detected at an early phase.

	Strict measures exist for the enforcement of the flight tracks and flight corridors. Airline captains will be prosecuted for unauthorized deviation from flight tracks.
Other land-use measures	The costs of land acquisition, development of green areas and compensation for loss of recreation for the fifth runway of Amsterdam/Schiphol Airport are estimated at f. 162 million. For the new East-West runway of Maastricht-Aachen Airport, these costs are estimated at f. 50 million.
Noise charges	Noise charges are raised on top of landing fees to finance the costs of the insulation scheme around airports. Extra noise charges are imposed for the evening and night periods to encourage the use of less noisy aircraft.

Country:	NORWAY	Major airport(s)	Other airports
		Oslo/Fornebu new Oslo/Gardermoen + 19 other airports	+ 26 regional airports (STOL)

Land-use planning	Applicable to all airports In Norway, only guidelines exist for aircraft noise zones. Municipalities can divert from the recommendations given by the national authorities. In some cases, land-use plans are made in contradiction to the official guidelines. The Norwegian noise metrics are the EFN (equivalent to CNEL) and MFN (Lamax). Noise contours around airports are based on forecast noise levels with a time horizon of 10 to 20 years. The noise contours are reviewed/updated every four years.
Type of measures used for most airports	— Comprehensive planning, including environmental impact assessment (EIA) for airport developments with effect on noise climate — Noise zoning is applicable to all airports — Building codes applies to all new buildings within noise zones, not specifically airport related — Noise insulation programmes are applied to the new Oslo/Gardermoen Airport — Noise barriers applied to Bodo Airport — Noise monitoring and flight tracking system installed at Oslo/Fornebu Airport — Noise-related airport charges are raised from the airlines for each landing of Chapter 2 aircraft at Oslo/Fornebu and Bodo Airports
Noise insulation schemes	For the new Oslo Airport: In 1995, a noise insulation scheme started around the new Oslo/Gardermoen Airport. The programme is financed by the owner of the new airport. The costs are integrated into the cost of establishing the new airport. Houses with outdoor noise levels over EFN 60 and/or MFN 85 during night-time and/or MFN 90 during daytime will be insulated. In addition, for new buildings, indoor noise limits (with closed windows) in schools and dwellings must be below EFN 35 and MFN 60. The number of houses and apartments in this insulation scheme has still to be decided. There are one school and one hotel to be insulated. The total costs are not yet known. For others: The Government has decided that all residents near roads, railways or airports that are subject to indoor noise levels over LAeq = 42 dB(A) will have their houses insulated down to this level.
Enforcement of noise zoning	Local authorities can enforce the agreed measures in their land-use regulations.
Other land-use measures	The costs of other land-use measures are unknown.

Country:	NEW ZEALAND	Major airport(s)	Other airports
		Wellington International Airport Auckland International Airport	

Land-use planning	Since 1989, the New Zealand airports have been deregulated. There is no longer a central authority responsible for land-use planning and noise control. This responsibility now rests with the local authorities. The noise metric is the DNL method. Noise contours are based on forecast noise levels related to the airport capacity. These contours are reviewed/updated every 10 years.
Type of measures used for most airports	— Comprehensive planning — Noise zoning — Subdivision regulation — Building codes — Noise insulation programmes (funded by developer) Comprehensive planning, noise zoning, subdivision regulation and real estate disclosure are considered to be the most effective measures for controlling the use of land around airports. For Wellington International Airport, these measures are considered not particularly effective because the airport was extended in 1953 and continues to operate in a challenging environment, with houses in some cases only 100 m from the runway centre line. Noise policy is based on containing the noise levels, not preventing development which has already taken place.
Noise monitoring	A noise monitoring system is installed around Wellington International Airport. The system is used for monitoring compliance with the noise contours. Auckland International Airport has a monitoring system planned for the near future that will be used to monitor and manage noise allowances.
Noise insulation schemes	Since 1995, developers have been required to provide insulation in areas close to Auckland International Airport. In areas subject to more than 55 dB(A) Ldn, insulation must ensure an internal environment of less than 45 dB(A) Ldn. Over the next 20 years, it is estimated that some 4 250 houses will be subject to noise in excess of 55 dB(A) Ldn. Probably some 2 000 of these will be new developments which will require developer-funded insulation.
Enforcement of noise zoning	Penalties to enforce the land-use measures were to be introduced after August 1997.
Other land-use measures	No other land-use measures are applied.

Country:	POLAND	Major airport(s)	Other airports
		Warsaw/Okecie	Gdansk Krakow Kielce Lodz Poznan Wroclaw Others will be introduced gradually

Land-use planning	Land-use planning is applied to all communications, recreational and service airports for which acoustic maps have already been developed. In Poland, the local authorities are responsible for land-use planning. The Polish noise metric is the Leq method, with noise limits of 65, 60, 55, and 50 dB(A). These limits refer to sounds during daytime. Night-time limits are lowered by 10 dB(A). Presently, the existing legal regulations are being updated. It is assumed that the method used for aviation will be changed to the LDN method. The noise contours for Warsaw/Okecie Airport are based on actual monitored noise levels and forecast noise levels. On the other airports, the number of operations is very low, therefore they do not qualify for the installation of noise monitoring systems. The forecast noise level maps developed for Warsaw/Okecie Airport include the noise strain defined for the expected final intensity of operations relevant to the runway-capacity. In the case of the other airports, noise level maps are being developed, taking into account the expected future increase of operations, to a 10-year time horizon. It is expected that the verification of the noise contours should be updated every five years, taking into account mainly the increase of operations, changes in the aircraft operated, etc.
Type of measures used for most airports	— Comprehensive planning — Noise zoning — Subdivision regulation — Building codes — Noise insulation programmes (only around Warsaw/Okecie Airport) — Land acquisition and relocation (only around Warsaw/Okecie Airport) — Noise barriers (only at Warsaw/Okecie Airport) — Capital improvement planning These measures are considered effective for prevailing and especially new situations.
Noise monitoring	A noise monitoring system is installed around Warsaw/Okecie Airport. There are 12 ground measuring stations, located in four landing zones and one mobile measuring station. The measuring stations are connected to the airport's radar. The system was used for acoustic measurements to develop an acoustic map. It is being used to register prevailing levels of noise. After finalizing all legal requirements, it will also be used to collect penalty fees.

Noise insulation schemes	In 1990, a noise insulation programme was introduced around Warsaw/Okecie Airport. This programme consisted of 16 apartment blocks (double glazing on the sound source side); 1 school (15 classes sound-insulated); 1 hospital; some nurseries, care centres, clinics and 3 business sites. The insulation programme is financed by the Government and the airport operator. For existing and new apartment buildings, the noise level allowed inside the flats during daytime hours (from 0600 to 2200) is Leq = 40 dB(A), during night-time hours (from 2200 to 0600), Leq = 30 dB(A). Depending on the uses of these apartments, the sound levels may change. This is regulated by the Polish Norm PN–87/B–02151/02 — *Building Acoustics: Sound Protection of Apartments in Buildings and Permissible Values of Sound Level.*
Enforcement of noise zoning	Not yet applicable
Other land-use measures	Other land-use measures are the purchase of 3 ha of land and the assignment of new apartments to 72 families. As part of the programme to improve the acoustic climate, some local roads have been rebuilt into two-way roads in order to relieve the traffic to and from Warsaw/Okecie Airport. The costs of these measures amounted to about US$ 2.11 million. Compensation schemes for real estate owners adversely affected by establishment or enlargement of noise zones are to be financed by the airport operator. However, the Government may participate in the costs in justified cases.

Country:	PORTUGAL*	Major airport(s)	Other airports
		Lisbon	Faro Porto Funchal Ponto Delgada + 9 other island airports, as well as Bragança Covilhã and some small mainland airports

Land-use planning	Applicable to all airports No legislation on noise zoning around airports are in force at the moment. However, new housing development is in general restricted to within a 75-dB contour by local authorities. National Law No. 251/87, Articles 26 and 27, deal with aircraft noise levels, with noise calculations based on a Leq method: Leq = La + 13.3log N – 52.
Type of measures used for most airports	Comprehensive planning Noise zoning
Noise monitoring	Some mobile equipment available
Noise insulation schemes	Not applicable
Enforcement of noise zoning	Not applicable
Other land-use measures	Unknown

Country:	SOUTH AFRICA	Major airport(s)	Other airports
		Johannesburg Capetown Durban	Port Elizabeth Bloemfontein + many other airports and strips

Land-use planning	Controlled areas are applicable to all airports. Local authorities are responsible for establishing controlled areas with respect to noise under the Environment Conservation Act, 1989. Recommended Practice SABS 0103 gives recommended noise levels but has no legal status. The South African noise metric is a calculated noisiness index (NI), projected for a period of 15 years after the local authority has made such designation, with a limit set at Leq 65 dB(A).
Type of measures used for most airports	— Comprehensive planning — Noise zoning — Building codes — Noise insulation programmes
Noise monitoring	Unknown
Noise insulation schemes	Recommended Practice SABS 0218 contains recommended sound insulation values for various adjoining areas. This document has no legal status.
Enforcement of noise zoning	Local authorities are responsible for enforcing their land-use measures.
Other land-use measures	Not applicable

Country:	SPAIN*	Major airport(s)	Other airports
		Madrid/Barajas Barcelona Malaga Palma de Mallorca Gran Canaria Tenerife (South + North)	Alicante Bilbao Santiago de Compostela Sevilla Valencia + some 20 island and smaller airports

Land-use planning	Applicable to all airports The state government is responsible for land-use planning. The Spanish noise metric is the Leq, with noise limits of 65 dB(A) by day and 55 dB(A) at night.
Type of measures used for most airports	— Comprehensive planning — Noise zoning — Noise insulation programmes (applied to Madrid/Barajas Airport) — Capital improvement planning Above measures are in force. For new situations, the transfer of development rights is also considered to be an effective measure.
Noise monitoring	A noise monitoring system is installed around Madrid/Barajas Airport. There are 17 positions near and under the departure and arrival paths. The monitoring system is used for future planning aspects.
Noise insulation schemes	In 1996, a noise insulation scheme was introduced around Madrid/Barajas Airport. All noise-sensitive buildings (houses, apartment blocks, schools, hospitals) within the Leq 65 dB(A) day-time noise zone and the Leq 55 dB(A) night-time noise zone will be noise-insulated. The total cost of the noise insulation scheme for Madrid/Barajas is estimated at Ptas 16 billion for in the next six years. For new buildings, the required indoor noise level through building codes is 40 dB(A) by day and 30 dB(A) at night.
Enforcement of noise zoning	In the future, tax increments will be applied to enforce land-use measures.
Other land-use measures	The costs of other land-use measures are unknown.

Country:	SWEDEN*	Major airport(s)	Other airports
		Stockholm/Arlanda	Ängelholm
		Stockholm/Bromma	Halmstad
		Göteborg/Landvetter	Jönköping
		Malmö/Sturup	Kalmar
		Luleå	Karlstad
			Kiruna
			Norrköping
			Ornsköldsvik
			Östersund
			Ronneby
			Skellefteå
			Sundsval
			Umea
			Visby

Land-use planning	Applicable to all airports Local authorities have the right and obligation to regulate land use around airports. This is done by physical planning and by building permits. Airports with scheduled air traffic and their surroundings are classified as sites of national interest. This implies that the Government, to a large extent, can classify areas surrounding the airport as unsuitable for housing for an indefinite period. In Sweden, the noise metric used for aerodromes is the FBN method (similar to the Ldn). The noise limit for housing, schools, hospitals, etc. is set at FBN 55 dB(A). Flight activities are subject to periodic reexamination. An independent environmental court stipulates the scope and terms of flight operations, normally for ten years.
Type of measures used for most airports	— Comprehensive planning — Noise zoning — Noise charges
Noise monitoring	Flight tracking systems are installed at Stockholm and Göteborg Airports.
Noise insulation schemes	Not applicable
Enforcement of noise zoning	When necessary, regional planning authorities will intervene against municipal decisions regarding housing around airports.
Other land-use measures	Not applicable

Country:	SWITZERLAND	Major airport(s)	Other airports
		Zurich/Kloten	7 regional airports
		Geneva/Cointrin	24 local airfields
		Basel/Mulhouse (operated jointly by Switzerland and France)	+ numerous heliports/helipads

Land-use planning	Applicable to all aerodrome categories (civil and military), according to the National Aviation Act and Environmental Protection Law Local authorities are required to incorporate airport noise zones and land-use measures into local plans. The noise metric is the NNI for the major airports. In simplified formula, it reads: Ipn – 80 + 15logN The legal limit values for land-use measures are: 45 NNI: new noise-sensitive developments are not allowed 55 NNI: existing noise-sensitive buildings are to be insulated 65 NNI: no noise-sensitive buildings are allowed In 1997 to 1998, the NNI method was replaced by a Leq method with limit values of 55, 60, 65 and 70 dB(A). The noise metric for regional and small airfields is already the Leq method. Noise contours are based on forecast noise levels with a time horizon of 10 to 15 years.
Type of measures used for most airports	— Comprehensive planning, including environmental impact assessment (EIA) for airport improvements with effect on noise climate — Noise zoning is applicable to all aerodrome categories — Building codes include noise insulation for noise-sensitive buildings in legal noise zones — Acquisition/relocation and easement/transaction assistance are applied to some cases for very highly exposed sites — Noise barriers are applied in some cases to shield noise from certain ground activities (such as engine testing) — Noise monitoring and flight tracking systems are installed around all major airports — Noise charges are raised from the airlines for each landing (on top of the landing fee) to recover the costs of the insulation programmes and to encourage the use of less noisy aircraft during the evening and night periods Comprehensive planning, noise zoning and, in some cases, land acquisition and relocation are considered the most effective measures for controlling the use of land around airports, especially in new cases. Land-use planning around Zurich/Kloten and Geneva/Cointrin Airports is considered to have had limited effect because the areas were already well-developed at the time of the introduction of the noise zones (around 1980).

	In 1997, the Swiss Supreme Court gave landowners the right to claim compensation for the reduction in value of their properties. It was estimated that this would cost the airport operators CHF 1 to 2 billion (5 to 10 times the cost of soundproofing the houses). It seems clear that the airports will not be able to bear these costs.
Noise monitoring	Noise monitoring systems are installed around Basel/Mulhouse, Geneva/Cointrin and Zurich/ Kloten Airports.
Noise insulation schemes	Noise insulation programmes are financed by the house owners, if the houses were built after the establishment of noise zones. Only limited insulation costs were financed by airports so far (excluding hospitals, schoolhouses, and churches). Large-scale insulation programmes have not yet been started. A noise insulation programme around the major airports based on the new Leq contours probably started in 1997. These noise insulation schemes affected about 30 000 to 50 000 persons, depending on the scenario under the proposed Leq schedules. The costs of the new insulation schemes were estimated at CHF 5 500 to 6 500 per person. In the national building code, conditions for new buildings are a minimum building shell damping index (Ia = 50 dB) or (new) window damping index (R'w = 40/35/30).
Enforcement of noise zoning	Noise zones are published and subject to a consultation and approval process. They are directly applicable to building authorizations and communal planning. Noise monitoring systems are installed around all major airports. There is no direct link with land-use planning. Noise monitoring has primarily a political significance. Monitoring is used to verify and adjust noise contours.
Noise charges	Noise-related landing charges to encourage the use of less noisy aircraft.
Other land-use measures	The cost of other land-use measures is not known.

Country:	UNITED KINGDOM	Major airport(s)	Other airports
		London/Heathrow London/Gatwick London/Stansted Manchester Glasgow	Aberdeen Belfast Birmingham Bristol Cardiff East Midlands Edinburgh Leeds/Bradford London/City London/Luton

Land-use planning	Applicable to all airports. Land-use planning in the United Kingdom is based on government advice to local authorities. Local authorities are not always bound to follow this advice, but planning decisions can be called in by the Minister. Local authorities have the means to enforce what is eventually decided. U.K. land planning advice applies differently for existing and new situations. The noise metric is the Leq16H method. Night operations are regulated by summer/winter quota at London/Heathrow, Gatwick, Stansted and Manchester. At other airports, night operations may be restricted by planning conditions or by voluntary means agreed with local communities. The limit values for land-use measures vary for each airport. Noise contours are based on forecast noise levels. The time horizon is not specified, but it is related to relevant airport development proposals. The noise contours are reviewed/updated as necessary. Any compensation scheme for real estate owners in relation to airport noise has to be financed by the airports.
Type of measures used for most airports	— Comprehensive planning, including environmental impact assessment (EIA) for airport developments with effect on noise climate — Noise zoning is applicable to all airports, based on government guide lines — Building codes are applied to all new buildings, but not specifically airport-related — Noise insulation programmes are applied, if appropriate, at specific airports related to specific developments[1] — Noise barriers are applied, if appropriate, at specific airports related to specific developments[2] — Noise monitoring and flight tracking systems are installed around London/Heathrow, London/Gatwick, London/Stansted, London City, Birmingham, Glasgow, Leeds/Bradford, Luton and Manchester Airports[3] — Noise-related airport charges are raised from the airlines for each landing. Additional financial penalties are raised for breaking noise limits at London/Heathrow, Gatwick, Stansted and Manchester

1. Where applicable, regarded as good noise mitigation measures (rather than controlling use of land).
2. Where applicable, regarded as good noise mitigation measures (rather than controlling use of land).
3. Noise monitoring could be used to enforce planning conditions at a particular airport, e.g. London City.

Noise insulation schemes	Since 1966, noise insulation schemes have been carried out around London/Heathrow; subsequent programmes followed at other airports when appropriate, related to the development of the airports. The Government specifies the noise insulation programmes for London/Heathrow and London/Gatwick (and indirectly London/Stansted). Other airports may have noise insulation programmes required by planning conditions or agreed on a voluntary basis. Other airports that have had noise insulation programmes include Birmingham, Leeds/Bradford, London City, Luton, and Manchester. The number of houses in these insulation schemes is unknown. These programmes are financed by the airport operators. For London/Stansted, the boundaries of the insulation programme are 66 dB(A) Leq16h day, 57 dB(A) Leq8h night and 90 SEL night. They may vary for other airports.
Enforcement of noise zoning	Local authorities can enforce the agreed measures through the planning system which includes legal procedures for enforcement. Operations which do not comply can in theory be closed down.
Other land-use measures	The cost of other land-use measures is unknown.

Country:	UNITED STATES	Major airport(s)	Other airports
		40 airports among the largest 100 airports in the world	+ thousands of smaller ones
Land-use planning	Local authorities are responsible for land-use planning. The U.S. Federal Aviation Administration (FAA) has a programme available for U.S. airport operators to undertake a comprehensive study of airport-related noise and to develop an airport noise compatibility programme to reduce noise and non-compatible land use. This is called "*Airport Noise Compatibility Planning*" under U.S. Federal Aviation Regulation Part 150. The recommended noise metric is the Ldn method, with Ldn 65 dB(A) as the limit for land-use planning purposes. Noise contours are calculated based on forecast noise levels.		
Type of measures used for most airports	— Comprehensive planning, including environmental impact assessment (EIA) for all airport development with effect on the noise climate — Noise zoning — Subdivision regulation — Transfer of development rights — Easement acquisition — Building codes — Noise insulation programmes — Land acquisition and relocation — Transaction assistance — Real estate disclosure — Noise barriers — Capital improvement planning — Tax incentives — Noise-related airport charges The measures listed are used by local authorities in various combinations around airports throughout the United States.		
Noise monitoring	Most larger airports have monitoring systems.		
Noise insulation schemes	Numerous insulation programmes are applied around airports.		
Enforcement of noise zoning	In some cases, for instance, the John Wayne Airport in Orange County/California, very stringent measures exist and are enforced by restrictions on numbers of aircraft per period, noise levels and deviation from flight tracks. Some other airports only penalize unauthorized deviations from flight tracks.		
Other land-use measures	Not applicable		

APPENDIX 4
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