# THE ENVIRONMENTAL IMPACT OF AERONAUTICAL ACTIVITIES LEGAL ASPECTS

by

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*I dedicate this thesis,*
*to my Parents for their support and understanding,*
*and to Frederic whom I would not have met*
*if I had not been writing it.*

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# ABSTRACT

The current level of aeronautical activities is a source of harmful environmental interference. Facing an ever increasing traffic, aviation authorities have started to regulate the activities of aircraft manufacturers and aircraft operators. Protection of the environment has been the object of many international conventions and national regulations a number of which are applicable to aeronautical activities.

The objectives of this thesis are to present first, measures taken by the air transport sector to address environmental issues related to its activities and, second, to assess the impact of general enviromental regulations on aeronautical activities.

Chapter I identifies the various type of damage caused by aircraft operations to the environment. After having defined the effect of aircraft pollution, the action of the International Civil Aviation Organization (ICAO) concerning aircraft noise and emissions of pollutants is analysed in Chapter II. The legal status of the atmospheric environment is presented in Chapter III as well as the legal measures relating to the monitoring of aviation-related pollution emissions taken at international and regional levels. Finally, Chapter IV describes national implementation of noise-related technical standards and airport noise-related restrictions and noise-related charges enacted by competent authorities.

# RÉSUMÉ

Le développement actuel des activités aéronautiques constitue une source d'interférences environnementales dommageables. Devant faire face à une croissance régulière du trafic, les autorités aéronautiques se sont mises à règlementer les activités des fabricants et des exploitants d'aéronefs. Par ailleurs la protection de l'environnement a fait l'objet de nombreuses conventions internationales et de législations nationales directement applicables à de telles activités.

Les objectifs de cette thèse sont de présenter, dans un premier temps, les mesures prises par le secteur du transport aérien afin de gérer l'impact environnemental résultant de ses activités, et dans un deuxième temps, d'évaluer la portée de la règlementation environnementale générale sur les activités aéronautiques.

En conséquence, le Chapitre I identifiera les dommages environnementaux causés par l'exploitation des aéronefs. Aprés avoir détaillé les effets de la pollution aéronautique, l'action de l'Organisation de l'Aviation Civile Internationale (OACI) concernant le bruit et les emmissions polluantes sera analysée dans le Chapitre II. Le statut juridique du milieu atmosphérique sera présenté dans le Chapitre III ainsi que les mesures juridiques prises aux niveaux international et régional, visant à contrôler les emmissions polluantes provenant des activités aéronautiques. Enfin, le Chapitre IV décrira les applications nationales des normes techniques sur le bruit, puis les règles d'exploitation et redevances

aéroportuaires liées au bruit adoptées par les autorités compétentes.

# TABLE OF CONTENT

# INTRODUCTION

Fifteen years ago, it was discovered that aviation contributes to a number of environmental threats. The high altitudes at which airplanes fly magnify the polluting effect of their emissions with regard to the ozone layer and global warming. Moreover, around airports, aircraft noise can seriously affect the well-being of individuals and communities.

Thus, in spite of their important contribution to economic progress, actors in the aeronautic field agree that the growth of aviation cannot be unrestricted. As the World Commission on Environment and Development puts it: "arriving at a commonly accepted definition of 'sustainable development' remains a challenge for all actors in the development process". This concept implies that a compromise between industrial advancement and the level of ensuing pollution be found. This compromise can be expressed not only in scientific and technical terms but also through legal principles. Existing laws and international regulations seeking to protect the environment from the negative impacts of aviation formalize this compromise.

This thesis will analyze the distinctive environmental impacts of aeronautical activities in order to select the legal terms which best define the issues and bring out the applicable norms.

Aeronautical activities covered will include neither military activities nor the problems specific to helicopters. The effects of aeronautical activities on the environment will only be examined when they have a polluting impact.

Chapter I will highlight the various repercussions of aeronautical activities on humans and ecosystems. Chapter II will describe the regulations adopted by the International Civil Aviation Organization

(ICAO) for the protection of the environment. Chapter III will deal with the status of the atmosphere in international law and with international measures aimed at preventing atmospheric emissions. In Chapter IV the regulations specific to the problem of airport noise will be examined.

# CHAPTER I
# IDENTIFICATION OF THE DAMAGE CAUSED BY AIRCRAFT TO THE ENVIRONMENT

Research was initially engaged on the effects of aircraft noise then, as scientists became more aware of the important role played by the ozone layer, attention was called to the impact of aviation on the atmosphere. Aircraft noise will be the object of the first and second paragraphs while atmospheric pollution will be examined in the third and fourth paragraphs.

## 1. Noise Pollution by Aircraft

The harmful repercussions of noise in both urban communities and the wilderness, compelled Vern O. Knudsen, founder of the Acoustical Society of America, to refer to it as "a slow agent of death"[1]. Far from being innocuous, it has become "an increasingly dangerous and disturbing environmental pollutant"[2], and aviation authorities are prompted to treat it as such. A presentation of problem of aircraft noise must begin with its definition and the means to measure it.

### a) Definition of Aircraft Noise

The Convention on International Civil Aviation (hereinafter Chicago Convention)[3] and the International Civil Aviation Organization (ICAO), established by the Convention, do not provide a general

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1- V. J. Yannacone & B. S. Cohen, *Environmental Rights and Remedies*, Vol.2 (Rochester, N.Y.: Lawyers Co-operative Pub. Co., 1972) at 383.

2- *Ibid.* at 374.

3- *Convention on International Civil Aviation*, 7 December 1944, 15 U.N.T.S. 295, T.I.A.S. No. 1591.

definition of aircraft noise[4]. We must therefore refer to the generally accepted definition of noise, also adopted by the United States Environmental Protection Agency (EPA), which is that noise is "an unwanted sound"[5].

Noise generated by a subsonic jet aircraft is produced by the engines themselves and by the contact of jet exhaust with ambient air[6] causing turbulences. The first engines to be installed on jet aircraft were "single-flow engines" (Caravelle, Boeing 707)[7]. The power they supply is generated by "the exhaust of gases exiting at super sonic speed"[8]. Now that "dual-flow engines with a high bypass ratio" have been developed, propulsion is obtained from the dynamics of hot and cold flows (Airbus, DC-10, B 747)[9]. The cold flow results from the injection of air across the front fan, which is driven by the turbine, and has the effect of a propeller. While the thrust of the engine is increased, this system is much quieter because the cold air surrounding the hot air is slower and masks the noise made by the latter[10]. This alternative is not available to supersonic jet aircraft as it would affect the performance of the aircraft[11]. Thus, these aircraft have much noisier engines. In 1970, supersonic jets were believed to make a noise of 124 PndB at take off, over 1500 ft on each side of the flight path, against 108 PndB for subsonic aircraft[12].

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4- G. H. Kaunda, The Proposed Multilateral Convention on Noise and Sonic Boom (LL.M thesis, McGill University, Montreal, 1976) at 16.

5- R.B. Bell & L.M. Bell, "Airport Noise: Legal Development and Economic Alternatives"(1980) 8 Ecology L.Q. 607 at 607.

6- R.Lorin & M. Wachenheim, "Noise and the Airport Environment" *ITA Magazine* (November 1986) 28.

7- *Ibid.*

8- *Ibid.*

9- *Ibid.*

10- *Ibid.*

11- J.R.Montgomery, "The Age of the Supersonic Jet Transport: Its Environmental and Legal Impact" (1970) 36 J. of Air L. 577 at 581-582.

12- Ibid. at 582.

Aircraft noise covers the full range of frequencies[13]. The front part of the engine produces a high pitched noise usually noticed during approach. The circulation of air in the fan makes the lower sounds[14].

b) Sound

Sounds are characterized by their intensity, their frequency and their duration. The frequency of a sound takes into account the pitch or the note of the sound and is measured in hertz[15]. High and low frequency do not travel in the same manner through air. High pitched sounds loose their intensity faster than the low ones[16]. The intensity or the "loudness" of a sound is measured in decibels (db)[17] and it will diminish as the distance from the source increases[18]. At the same time, from a subjective point of view, the intensification of the feeling of loudness is substantially more important than the rate of augmentation of the noise itself[19]. An increase of 10 dB will double the feeling of loudness. Thus an aircraft making a noise of 90 dB is perceived to be four times quieter than an aircraft making 110 dB[20].

In order to take the most displeasing elements of sounds into account, acousticians have developed the concept of "effective perceived noise level" (EPNdB)[21]. This unit of measurement

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13- *Ibid.*

14- *Ibid.*

15- Burns, *Noise and Man*, 2nd ed. (London: J. Murray, 1973) at 24.

16- *Ibid.* at 33.

17- The 1 bel standard has been divided in 10 steps which is the reason why the unit is the decibel: see Burns, *supra*, note 15 at 42.

18- *Ibid.* at 33.

19- D. V. Harper, "Regulation on Aircraft Noise at Major Airports-Past, Present and Future"(1988) 17 Transportation Law Journal 117 at 123.

20- *Ibid.*

21- Montgomery, *supra*, note 11 at 580-581.

attributes more weight to annoying high pitch sounds and recognizes the impact of duration[22].

c) Sonic Boom

The Sonic Boom Committee of ICAO has adopted the following definition of the sonic boom provided by the International Organization for Standardization (ISO 2249)[23]: "the acoustic event which is a manifestation of the shock wave system generated by an aircraft when it flies at a speed greater than the local ground velocity"[24].

Beyond the speed of sound, an airplane creates a field of shock waves forming a cone, which follows it[25]. The pattern is directed downwards and the waves hit the ground once and bounce off upwards. Hence, the audible effect is a double bang[26]. This disturbance is referred to as the sonic boom. The "sonic boom carpet" of a super sonic aircraft is affected by the aircraft height, its speed, wind strength, direction and temperature[27]. The surface area, on which the disturbance is experienced, can be 40 miles wide for an aircraft flying at 70,000 ft.[28].

The necessity to outline the problem of aircraft noise for the purpose of controlling it, came in the aftermath of scientific studies showing the detrimental effects of aircraft noise on humans, animals and their environment.

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22- G.A. Gratjios, Airport Noise Pollution: Legal Aspects (LLM thesis, McGill University, Montreal, 1990) at 8-9.

23- Kaunda, *supra*, note 4 at 19.

24- Sonic Boom Committee, *Report on the Second Meeting*, 1973, ICAO Doc. 9064 SBC/2 at 3-4.

25- Montgomery, *supra*, note 11 at 584.

26- Burns, *supra*, note 15 at 584.

27- Sonic Boom Committee, *supra*, note 24 at 3-7.

28- Montgomery, *supra*.,note 11 at 585.

## 2. Impact of Aircraft Noise

In addition to being a source of disorders in health and mental well-being of men and other animals, aircraft noise is known to have caused damage to land and property. Although the most spectacular instances, where harm was caused by aircraft noise, involve supersonic military flights, there is much to be said about the impact of subsonic aircraft. The effects of supersonic transportation will also be dealt with, since it is likely to gain importance in the near future.

a) Effects of Aircraft Noise on Humans

First, excessive noise impairs hearing[29]. The United States EPA believes that for 96% of the population, noise levels above 70 dB can induce a loss of hearing[30]. The noise produced by a four engine aircraft taking off will reach 115 to 120 dB[31]. In 1956, the United States Air Force required that its personnel wear ear protection when exposed to noise levels of 85 dB and beyond[32]. Exceptionally, an explosive sound will cause acoustic trauma and permanent nerve deafness[33].

Second, physicians have linked noise pollution with more serious physical illness, such as "heart disease and cardiovascular disfunction, migraine headaches, gastrointestinal disorders and allergies as well as endocrine and metabolic effects"[34]. A person subjected to a lot of noise may endure changes in blood circulation and heartbeat. Glands and other organs responding to nervous stimuli are also prone to disorders[35].

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29- Yannacone & Cohen, *supra*, note 1 at 379 - 381.

30- Bell & Bell, *supra*, note 5 at 609.

31- Gratjios, *supra*, note 22 at 8.

32- Yannacone & Cohen, *supra*, note 1 at 396.

33- *Ibid.* at 380.

34- Yannacone & Cohen, *supra*, note 1 at 381-382.

35- *Ibid.* at 382 note 4.

A physician alledged before the American Association for the Advancement of Science "that the human fetus may be damaged by noise pollution either directly by such violent noise as sonic boom, or indirectly by the mother's psycho-physiological reaction to excessive noise"[36]. Noise around Heathrow (Great Britain) and Osaka (Japan) airports, has been associated to the birth of underweight babies, birth defects and a greater number of still births[37]. Out of 100,000 babies born around Los Angeles International Airport, 1,183 to 1,190 suffer from "failure of brain development, defects in the formation of the spinal column, abdominal hernia, and, more commonly, cleft lip and cleft palate"[38]. In the rest of the county these infirmities and injuries affect only 737 to 868 new born babies out of 100,000[39].

Third, noise interferes with sleep. A report on the Awakening Effects of Simulated Sonic Boom and Subsonic Jet Noise states that even when the noise ceases hours before sleeping time, a subject will be disturbed by a ringing sensation preventing him from sleeping[40]. Groups at risk are elderly people, and those with mental illness or physical problems[41]. Contracting States have notified ICAO that 10% to 50% of those exposed to sonic boom have trouble sleeping, and that subjects are more adversely affected by such noises heard at night and in the early morning than during the day[42]. Because sleep is segmented in phases, it was recommended that noise levels be particularly cut down during the early part of

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36- *Ibid.* at 381.

37- Bell & Bell, *supra*, note 5 at 609.

38- *Ibid.* at 610.

39- *Ibid.*

40- Yannacone & Cohen, *supra*, note 1 at 387.

41- Committee on the Challenges of Modern Society, *International Bibliography - Studies and Programs on Community Response to Noise Arising from Aircraft*, North Atlantic Treaty Organization Publication (1986) at 60.

42- Sonic Boom Committee, *Report on the First Meeting* , 1972, ICAO Doc. 9011 SBC/1 at 4-6.

the night, whereas, in a phase of deep sleep, even loud noises will not wake up a sleeper[43].

Fourth, noise is a source of stress. Persons exposed to noise may be accumulating nervous tension unconsciously and become violent, unsociable or suffer mental collapse. According to the chief psychologist at New York's Queens Hospital Centre, a noisy environment will lessen a person's resistance to noise and increase his chances of developing a neurosis[44].

An investigation lead in the Netherlands on the feasibility of having a psychiatric hospital in the vicinity of an airport, reveals that the degree of annoyance is relatively high. Conversations with patients and group discussions are obstructed and there is loss of contact. Patients are irritated, restless, anxious and loose their concentration[45].

Fifth, noise impairs social activities, in that it interferes with communication. In an environment subject to noise levels of 84 db, two people have to shout in order to have a conversation[46]. Noise produced around London Heathrow is known to adversely affect the process of education in nearby schools[47].

b) Effects of Aircraft Noise on Animals

The ICAO reports on the effect of the sonic boom on animals are rather inconclusive. The Sonic Boom Committee stated in 1973 that neither farm animals, nor wild animals seem to be seriously affected by the sonic boom past a pronounced reaction of startle[48]. Nevertheless, it is reported that birds are markedly more disturbed

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43- U.K., Committee on the Problem of Noise, "Report presented to Parliament by the Lord President of the Council and Minister for Science" H.M. Stationary Off. (1964) at 7.

44- Yannacone & Cohen, *supra*, note 1 at 386.

45- Committee on the Challenges of Modern Society - Pilot Group on Aircraft Noise, *International Bibliography - Studies and Programs on Community Response to Noise Arising from Aircraft*, North Atlantic Treaty Organization Publication (1986) at 22.

46- Bell & Bell, *supra*, note 5 at 608.

47- Committee on the Problem of Noise, *supra*, note 43 at 11.

48- Sonic Boom Committee, *supra*, note 24 at 2-14.

by booms than mammals. During the breeding season, entire colonies of birds have been observed to abandon the site of incubation of the eggs. Sonic booms of high intensity also have the potential to crack eggs[49]. The Sonic Boom Panel mentions that the damages awarded for the loss of animals caused by the startle effect were not substantiated by controlled experiments[50]. Nevertheless, the Sonic Boom Committee referred to a claim arising out of the supersonic flights of Concorde over France. It concerns the death of embryos and the effect of the boom on egg-laying at a pheasant farm[51]. The Concorde overflights of the United Kingdom are also noted to have given rise to a claim for the loss of kits at a mink farm during the breeding season[52]. In addition of the Sonic Boom Committee conclusions on the manner in which the sexual behaviour of bulls could be affected were drawn following tests performed on just two bulls, and the study of the gestation of cows consisted in subjecting forty pregnant cows to twenty booms during the first month of gestation[53].
Results of experiments carried out on rats are less encouraging. After a prolonged exposure to noise, these animals had eaten their young, lost their fertility and turned homosexual. Noises of 150 dB eventually resulted in their death through heart failure[54].

c) Effects of Aircraft Noise on Property and Geological Configurations

Aside from the loss of property value suffered by owners in the proximity of airports, supersonic aircraft will occasionally cause direct damage to the structure of overflown constructions.

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49- Sonic Boom Committee, *supra*, note 42 at 2-8.

50- Sonic Boom Panel, *Report on the Second Meeting* , 1970, ICAO Doc. 8894 SBP/2 at 1-57.

51- Sonic Boom Committee, *supra* , note 42 at 2-9.

52- *Ibid.*

53- Sonic Boom Committee, *supra* , note 24 at 2-13.

54- Yannacone & Cohen, *supra*, note 1 at 390.

Sonic booms may induce vibrations in various types of structures[55]. Exposure to the sonic boom will have a cumulative effect likely to cause structural fatigue, and the probability that visible damage will ensue will depend on the age of the structure and its size[56]. Here, the number of claims filed was considered by ICAO to be an adequate element of measure of the extent of the damage caused[57]. Sonic Booms mainly destroy windows, glass, plaster and roofs[58]. Nevertheless, two complaints were filed in France, in 1971, for serious damage caused to walls, roofs and ceilings by three supersonic flights performed by Concorde[59]. The study of complaints lodged in the United Kingdom for damage done by the Concorde tends to show that the rate of complaints diminishes while overflights continue[60]. This suggests that the buildings damaged were already affected by structural fatigue and could be expected to fail ultimatly. Proper repairs could limit the number of such damages[61]. In Sweden, out of the 370 complaints resulting from supersonic overflights, only 52 were considered to be attributable to sonic boom[62]. Twenty-four cases were for damaged glass, two for plaster and four for fallen objects. The other incidents involved "internal finishes"[63]. The report states that "general environmental causes or inadequate design or maintenance" are the actual causes of most of the claims for sonic boom damage[64].

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55- Sonic Boom Panel, *supra*, note 50 at 1-44.

56- Sonic Boom Committee, *supra*, note 42 at 2-3_ 2-4.

57- *Ibid.* at 1-48.

58- Sonic Boom Committee, *supra* , note 24 at 2-9.

59- Sonic Boom Committee, *supra*, note 42 at 2-5.

60- Sonic Boom Committee, *supra*, note 24 at 2-10.

61- *Ibid.*

62- *Ibid.* at 2-9.

63- *Ibid.*

64- *Ibid.*

ICAO received no reports of avalanches triggered by military flights over mountainous areas. Yet, a study lead in the former U.S.S.R. showed that wet avalanches can be the result of "a pressure impulse at the time of an SST overflight"[65]. Avalanches triggered by the fall of a snow cornice started when the "applied impulse" is close to the "intrinsic frequency" of the cornice[66]. It was proven that the frequency of a sonic boom is sufficiently close to the intrinsic frequency of the system to be the cause of avalanches[67]. Thus, it was suggested that the flights of civil SST over mountainous areas be monitored[68].
Other studies, show that the development of aerial transportation over national parks could subject rare geological features to serious damage. The passage of two jet planes flying at supersonic speed was reported to cause the fall of a rock of 66,000 tons in Mesa Verde. Other instances of rock slides have been observed at Canyon de Chelly, Bryce Canyon, in Arizona and in the Death Valley, where 323 sonic booms were counted in 6 months[69].

Noise pollution is not the only consequence of aerial transportation. Gaseous effluents released by aircraft are another source of ecological damage. It is also alleged that they may seriously affect the ozone layer.

## 3. Chemical Pollution Caused by Aircraft

Atmospheric contaminants emitted by aircraft include the same types emitted by cars, trucks, and buses. The major gaseous pollutants are carbon monoxide, hydrocarbons, oxides of nitrogen,

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65- *Ibid.* at 2-11.

66- *Ibid.*

67- *Ibid.*

68- *Ibid.*

69- Yannacone & Cohen, *supra*, note 1 at 390.

and oxigenated organic compounds"[70]. In addition, airlines and aeronautical industries use electrical products, plastic composites and insulation, in addition to solvents for cleaning, degreasing and paint stripping, which contain chlorofluorocarbons (CFC's)[71].

a) Classification of the Pollutants Left by Aircraft in the Atmosphere

First, chemicals released are formed by the oxidation of hydrocarbons found in the fuel[72]. "Completeness of oxidation varies according to combustion conditions"[73]. When kerosene is burnt, molecules of hydrogen are converted into water vapour ($H_2O$) and carbon into carbon dioxide gas ($CO_2$)[74].

Second, the engine does not burn the totality of the fuel, hence, part of it is released unburnt in the atmosphere and contributes to "hydrocarbon pollution"[75]. Hydrocarbons are a "large group of molecules, that include methane, benzene and toluene"[76]. They are also refered to as Volatile Organic Compounds (VOCs)[77]. In addition, the reaction instead of forming only carbon dioxide, will also produce carbon monoxide (CO) and carbon particles(C)[78].

Third, the high temperatures at which the engine combustor functions have the effect of combining nitrogen, which constitutes 80% of the air, with oxygen to form nitric oxide (NO) and nitrogen

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70- *Report of the U.S. Secretary of Health, Education, and Welfare to the U.S. Congress: Nature and Control of Aircraft Engine Exhaust Emissions* (Washington: U.S. Government Printing Office, 1969) 6.

71- M. Jennings, "Coming Clean" *Airline Business* (October 1990) 26 at 30.

72- M. Barret, "Aircraft Pollution - Environmental Impacts and Future Solutions", WWF Research Paper (August 1991) at 6.

73- M. Pianko, "Air Transport and Atmospheric Pollution" *ICAO Bulletin* (August 1976) 15.

74- *Ibid.*

75- Barret, *supra*, note 72 at 3.

76- Jennings, *supra*, note 71 at 27.

77- G.Handle et al., eds., *Yearbook of International Environmental Law*, vol. 1 (London, Dordrecht, Boston: Graham & Trotman, 1990) at 327.

78- Pianko, *supra*, note 73 at 15.

dioxide ($NO_2$)[79]. These chemicals form part of the nitrogen oxides ($NO_x$)[80]. The burning of fossil fuels also produces nitrous oxide ($N_2O$)[81].
Finally, fuel is composed of a number of metals, lead, chlorine and sulphur[82]. "The sulphur in aviation fuel is oxidized to sulphur dioxide ($SO_2$) during combustion"[83]. All of these components form part of the particulate matter in jet aircraft exhaust and appear in the form of smoke[84].

Depending on the operation in which the aircraft is engaged, the pollutants released will vary. While the aircraft is taking off and climbing, the engine is burning almost all the kerosene injected, so the emissions of carbon monoxide and hydrocarbons are very small[85] and those of carbon dioxide more important[86]. During this phase, smoke may appear behind certain aeroplanes[87]. At the same time, the aircraft needs a lot of thrust and the temperature rises rapidly so the emissions of nitrogen oxides are considerable[88]. In cruise mode, the oxides of nitrogen emitted are "diluted, dispersed and transformed"[89]. Sometimes the aircraft will release kerosene;

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79- *Ibid.*

80- U.S. Senate, Committee on Aeronautical and Space Sciences, *The International Legal and Institutional Aspects of the Stratosphere Ozone Problem* by C.Q. Christol (Washington: U.S. Government Printing Office, 1975) at 40.

81- S.W. Matthews, "Is Our World Warming ? Under the Sun" *National Geographic* (Oct. 1990) 66 at 79.

82- Pianko,*supra,* note 73 at 16.

83- Barret, *supra,* note 72 at 6.

84- Pianko, *supra,* note 73 at 16.

85- *Ibid.*

86- Barret, *supra,* note 72 at 3.

87- Pianko, *supra,* note 73 at 16.

88- *Ibid.*

89- *Ibid.*

this is accounted for as vented fuel and emissions of hydrocarbon[90].

When the aircraft is engaged in ground operations or waiting for take-off, the formation of nitrogen oxides is almost negligible. However, the aircraft is not not operating in the most effective fuel combustion conditions, thus, carbon monoxide and hydrocarbons are produced[91].

During landing, there is also a disparity between the amount of fuel consumed and the level of combustion. But it is not as serious as when idling, hence the production of hydrocarbons and carbon monoxide is reduced[92]. Smoke may appear during this phase[93].

b) Measurement of Aircraft Emissions

The amount of pollutants emitted by an aircraft is expressed in terms of grams (g) per kilogram (kg) of fuel consumed and with reference to the engine rating. The unit determined is an "emission factor"[94].

When an aircraft is idle, the emission factor for carbon monoxide is 5; 20 for hydrocarbons; and 5 for nitrogen dioxide[95].

During approach, the factors are 5 for carbon monoxide; 2 for hydrocarbons; and 10 for nitrogen dioxide[96].

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90- Committee on Aircraft Engine Emissions, Report of the Second Meeting, 1980, ICAO Doc. 9304 CAEE/2 at 3-14.

91- Pianko, *supra,* note 73 at 16.

92- *Ibid.*

93- *Ibid.*

94- Barret, *supra*, note 72 at 3; "Military aircraft may have higher emission factors from those of civil aircraft ... (they) are operated for longer periods of time at high power levels with high emission factors and at very high altitudes. And, unlike civil aircraft, emissions are not regulated. Military aircraft may emit other substances. Renner (1991) reports that the B-2 Stealth bomber uses a fuel additive that reduces particle emission thereby making the plane less visible to radar. The effect of such additives on the atmosphere is not publicly known.": *Ibid.* at 4.

95- *Ibid.* at 3.

96- *Ibid.*

During cruise and take off, the factors are null for carbon monoxide and hydrocarbons, but are respectively 20 and 40 for nitrogen dioxide[97].

Considering the total aircraft fuel consumption in 1988 (with a 5% refinery loss), the global commercial aircraft emissions in tons for that year are estimated at[98]:

- Carbon dioxide:125,000,000 t
- Carbon monoxide: 271,000 t
- Soot: 3,000 t
- Nitrogen dioxide: 1,625,000 t
- Hydrocarbons: 141,000 t
- Water: 169,000 t
- Sulphur dioxide: 406,000 t

An environmental audit commissioned by Swissair, estimated that its fifty-five aircraft produced in 1989: 22,600 t of nitrogen oxides; 1,098 t of hydrocarbons; and 3,449 t of carbon monoxide[99].

However, world estimates based on fuel consumption are distorted due to the lack of information available on eastern Europe and the former U.S.S.R. This region is believed to account for 20% of the aviation fuel use[100].

c) Aircraft Pollution and the Particularities of the Atmospheric Environment

The atmosphere is "the gaseous fluid surrounding the Earth"[101]. There are two levels of atmospheric pollution by aircraft, depending on the altitude at which the aircraft is flying[102].

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97- *Ibid.*

98- *Ibid.* at 4.

99- M. Pilling, "Airlines Face Heavy Bill for Going Green" *Interavia* (May 1991) 9 at 10.

100- Barret, *supra*, note 72 at 2.

101- Christol, *supra*, note 80 at xi.

102- *Ibid.* at 39.

Most commercial subsonic aircrafts fly below 12 kilometres (km)[103].This marks the limit of the troposphere, "where all weather conditions manifest themselves"[104]. The stratosphere, located between altitudes of 8 km to 16 km[105], on the other hand, is a very stable area[106]. For this reason, pollutants released by supersonic aircraft designed to fly at 16 km. or higher in the ozone belt (32 km)[107] can remain at the altitude of injection for years[108] before the "global dynamics of the upper atmosphere spread them" ..."throughout the entire latitude zone in which they were injected"[109]. The tropopause is not at an equal distance from Earth all around. Over mid and high latitudes, the tropopause is closer to Earth than above the tropics, so a flight at a 10 km altitude will leave effluents for a longer period of time in the stratosphere above high latitudes than over the tropics[110].

Nations are actually displaying a renewed interest in supersonic air transport. European countries are considering the construction of a "Super-Concorde" capable of carrying 200 to 300 passengers, over distances of 10 000 km at a speed of Mach 3. The feasibility of this project with respect to environmental, technical and business issues is being studied by a consortium of airframe makers from France, Germany, Italy, Japan, the United Kingdom and the United States[111].

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103- D. Verguèse, "L'influence des vols supersoniques sur la stratosphère" *Le Monde* (25 April 1973) at 12.

104- Christol, *supra*, note 80 at xi.

105- *Ibid.*

106- Verguèse, *supra*, note 103 at 12.

107- Christol, *supra*, note 80 at xi & 39.

108- Matthews, *supra*, note 81 at 79; Christol, *supra*, note 80 at 39.

109- Christol, *supra*, note 80 at 39.

110- *Ibid.*

111- "Tupolev Seeks to Join Global Group's Study of Next Generation SST" *Aviation Week and Space Technology* (24 June 1991) 34.

The National Aeronautics and Space Administration (NASA) and the United States Air Force are also carrying out research for the development of a fully reusable hypersonic aircraft called X-30 or NASP (National Aerospace Plane). The latest options are leading to cruise flight regimes starting at Mach 6 [112]. With current technology, however, the emissions of nitrogen oxides of the hypersonic aircraft would be in the range of 40 g to 100 g per kg of fuel burnt. As an element of comparison, the Concorde Rolls-Royce-Snecma-Olympus power plants each produce about 20 g of oxides of nitrogen per kg. of fuel burnt[113].

Emissions of nitrogen oxides by aircraft have become a great concern of aviation authorities, governments and engine manufacturers. Industrials involved in aeronautical activities participate to the gathering of information on stratospheric chemical reactions through the financing of research projects. At the same time, constructors are developing environmentally efficient equipment. General Electric has begun testing a large turbofan engine, which will release less than half of the nitrogen oxides authorized under ICAO standards[114]. Rolls Royce is also planning to introduce by 1993, a combustor with low nitrogen oxides emissions. In both cases the reduction in the emission of these effluents will range from 30% to 40%[115]. There are numerous reasons to focus on the reduction of oxides of nitrogen. These will be discussed in the following paragraph.

## 4. Effect of the Various Aircraft Emissions

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112- E.H.Phillips, "Langley Develops Thermal Management Concept for Hypersonic Aircraft" *Aviation Week and Space Technology* (15 April 1991) 14.

113- S.W. Kandebo, "NASA Industry Propulsion Team Addressing HSCT Environmental Issues" *Aviation Week and Space Technology* (25 November 1991) 58.

114- B. Davidson, "Towards the Greener Engine" *Aerospace World* (September 1991) 13.

115- S.W. Kandebo, "Advanced Combustors Under Development to Cut Emissions in Conventional Engines" *Aviation Week and Space Technology* (25 Nov. 1991) 51.

The impact of the chemicals will be studied within the context of the various environments affected.

a) Effects at Ground Level and in the Tropopause

Carbon dioxide is a direct cause of global warming[116]. Carbon dioxide lasts up to one hundred years in the atmosphere[117]. It is responsible for about 50% of the man-made share of the global warming. Aviation does not account for more than 2.3% of the carbon dioxide emissions caused by the burning of fossil fuels. Consequently, in this respect, it can only be held responsible for 1.3% of the global warming caused by anthropogenic sources[118]. Amongst the hydrocarbons, methane represents 15% to 20% of man made additions to global warming. It only lasts ten years in the atmosphere, but it absorbs 20 to 30 times more heat than carbon dioxide[119].

Nitrous oxide, one of the oxides of nitrogen released by aircraft, "is 200 times as heat absorbent as $CO_2$" and can last up to 180 years in the atmosphere[120]. Five percent of the man-made greenhouse effect is attributed to this chemical[121]. Nitrogen oxides also generate low atmospheric ozone, which itself has a high "global warming potential"[122]. Aircraft are deemed to be responsible for 10% to 20% of tropopause ozone[123]. There is no comprehensive scientific study giving a precise indication of the percentage of global warming to which aircraft contribute by their emissions of nitrogen oxides. The altitude at which aircraft release nitrogen oxides is likely to increase the "global warming potential" of these

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116- Barret, *supra*, note 72 at 29.

117- Matthews, *supra*, note 81 at 79.

118- Barret, *supra*, note 72 at 7.

119- Matthews, *supra*, note 81 at 79.

120- *Ibid.*

121- *Ibid.*

122- *Ibid.*

123- *Ibid.*

chemicals 50 times in comparison with those produced by anthropogenic emissions on the surface[124]. "Adding the effect of tropospheric ozone" the "future global temperature rise" aviation is responsible for can rise "to between 2% and 38%"[125].

As fuel from the aircraft engine is combusted, water is produced. It is emitted in the form of steam[126]. At altitudes above 9 km, the air is so cold that only small amounts of water vapour can be absorbed. The water vapour freezes to form artificial ice crystals around suspended particles, namely nitric acid particles, which have themselves used sulphuric acid particles as seeds[127]. These clouds are called cirrus clouds. They let sunlight pass through them, but the heat from the ground is reflected back to earth. Supposedly, if cirrus clouds increase by 2%, Earth temperatures will rise by 1°c[128] .

The seriousness of the greenhouse effect implies that none of the sources of these gases can be neglected. Data recorded by the National Oceanic and Atmospheric Administration (NOAA) reveal that "the average temperature world-wide ... has gone up about half a degree Celsius - one degree Fahrenheit - since the late 1880's"[129]. Climatologists predict temperatures will rise by three to nine degrees in the next century[130]. If by 2050, the increase is of 3°c, plants and animals would be confronted with warmer weather conditions than any felt for the past 100,000 years[131]. This could result in the desertification of actual food producing regions. Storms and tornadoes could become more violent and forests are likely to decline. Wildlife will either migrate or perish[132].

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124- *Ibid.* at 30.

125- *Ibid.* at 7.

126- Barret, *supra*, note 72 at 6.

127- *Ibid.*

128- *Ibid.* at 7.

129- Matthews, *supra*, note 81 at 72.

130- *Ibid.* at 75.

131- *Ibid.* at 87.

132- *Ibid.* at 75-77.

Due to their acidic composition, nitrogen oxides cause acid rain and their chemical derivatives are a hazardous to wildlife, ecosystems and buildings[133]. Sulphur dioxide also plays a major role in the formation of acid rain and can cause odour problems at airports[134].

Carbon monoxide reduces the oxygen present in the blood stream and can cause death if its concentration is high. It is toxic to humans and animals[135].

Hydrocarbons contain carcinogenic compounds (benzene)[136].

Carbon particles escaping from the jet exhausts appear in the form of sooty deposits, which can alter the beauty of vegetation and spoil the taste of some edible fruits and vegetables[137].

b) Effects in the Stratosphere

The combination of water vapour with nitrogen oxides causes the formation of "polar stratospheric clouds", which have a very harmful effect on the ozone layer[138].

The ozone shield is located between 16 km to 32 km above the Earth[139]. It forms a screen against most of the ultra-violet radiation from the sun[140]. Without it, an excess of ultra-violet rays would result provoking "skin cancers, cataracts and immune deficiencies"[141]. Ultra violet radiations can affect the growth and the reproduction of phytoplankton, the base of the marine food chain"[142].

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133- Barret, *supra,* note 72 at 5.

134- Jennings, *supra,* note 71 at 27.

135- Pianko, *supra,* note 73 at 16.

136- Jennings, *supra,* note 71 at 27.

137- Pianko, *supra,* note 73 at 16.

138- O.B. Toon & R. P. Turco, "Polar Stratospheric Clouds and Ozone Depletion" *Scientific American* (June 1991) 68.

139- C.Q. Christol, *supra,* note 80 at xi.

140- Toon & Turco, *supra,* note 138 at 68.

141- *Ibid.*

142- *Ibid.*

At first, scientists believed that the main cause of ozone destruction was nitrogen compounds[143]. But, scientists from NASA's Jet Propulsion Laboratory and the National Oceanic and Atmospheric Administration (NOAA) found very little "reactive forms of nitrogen" in the ozone hole[144]. They advanced that the main cause of ozone depletion are chlorine compounds. The chlorine "enters the atmosphere as a component of chlorofluorocarbons (CFC)"[145]. CFC molecules are carried by winds "throughout the troposphere" and over the years they will attain an altitude of 30 km where sun rays will tear them apart[146]. Freed from the CFC molecules, the chlorine, associated with methane or chlorine nitrate, (chlorine monoxide and nitrogen dioxide) forms "chlorine reservoirs"[147]. The chlorine reservoirs are inert and do not destroy the ozone layer[148].

In 1986, it was suggested that some mechanism in the Antarctic, possibly linked to the presence of Polar Stratospheric Clouds (PSC), released the chlorine from the reservoirs[149]. Thus, "molecular chlorine" is allowed to dissociate into "highly reactive atomic chlorine" breaking the ozone apart and forming new chlorine atoms[150]. This chain reaction occurs during the spring, under the effect of the sun[151]. On the surface of PSCs, chlorine is activated and the "reactive nitrogen" which would normally neutralize it is used up[152]. Liberated from the reservoirs, one chlorine atom will

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143- Christol, *supra*, note 80 at 39-40

144- Toon & Turco, *supra*, note 138 at 69.

145- *Ibid.*

146- *Ibid.*

147- *Ibid.* at 69-70.

148- *Ibid.*

149- *Ibid.* at 70.

150- *Ibid.* at 73.

151- *Ibid.*

152- *Ibid.*

break down thousands of ozone molecules prior to being deactivated again.

Up until recently, nacreous clouds were the only sort of stratospheric clouds known to researchers[153]. They are formed in mountainous areas, at altitudes of 15 to 30 km, by wind patterns, when sudden cooling causes moisture to condensate around suspended particles[154]. But, in 1986, scientists of the Max Planck Institute and the Institute for Nuclear Physics (Germany) discovered the existence of stratospheric clouds consisting of frozen nitric acid[155]. The nitric acid in the clouds not only prevents nitrogen dioxide from joining chlorine particles to form chlorine reservoirs[156], but it entirely removes the nitrogen from the stratosphere by converting it into nitric acid[157]. The clouds "serve as a nitrogen sink"[158]. Cloud formation of this type occurs in the "polar stratosphere", during in the winter, at very low temperatures (195° kelvin)[159]. The nitric acid molecules form around sulphuric acid particles transported from the lower atmosphere to the stratosphere by "circulation patterns"[160].

Sulphate particles are found in aircraft effluents. In fact, a fleet of several hundred supersonic aircraft, flying every day at an altitude of 20 km, would increase by 20% the amount of large particles in the stratosphere[161].

Moreover, the combination of the nitrogen oxides and the water vapour produced by aircraft, is thought to result in the formation

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153- *Ibid.* at 71.

154- *Ibid.*

155- *Ibid.*

156- *Ibid.*

157- *Ibid.* at 73.

158- *Ibid.* at 71.

159- *Ibid.* at 71-72.

160- *Ibid.* at 72.

161- O.B. Toon et al., "Stratospheric Aerosol Modification by Supersonic Transport Operations With Climate Implications" (NASA Reference Publication 1058, 1980) at 1.

of nitric acid[162]. The extent to which aviation contributes to the formation of nitric acid clouds could be considerable, since in 1987, air traffic emitted a total of 3 million metric tons of nitrogen oxides. One million metric ton was left at altitudes of 9 km to 13 km[163].

Even when aircraft leave these chemicals in the troposphere, atmospheric circulation patterns can carry the particles to the stratosphere[164].

Aircraft effluents are a component of a third type of PSC, which form at even lower temperatures (190° kelvin) when the air cools slowly. These "water ice clouds" have the same chemical composition as nacreous clouds but have larger crystals[165]. Condensation occurs successively around sulphuric acid atoms and nitric acid particles. Like nitric acid clouds, slow cooling ice water clouds nest chain reactions which destroy all of the nitrogen[166].

The exact percentage of ozone depletion, which aviation is liable for, remains to be determined.

Aurora Flight Sciences is developing a high altitude aircraft, "Perseus A", able to sample the air at altitudes of 25 km and specifically adapted to be operated under polar conditions. The outcome of this project will determine the feasibility of developing a fleet of SST. The first flights are scheduled to begin in 1994[167].

Groups of researchers world-wide have been instructed to study the problem. These include: the United States National Academy of Science and the Climatic Impact Assessment Program (CIAP); the Committee on Meteorological Effects of Stratospheric Aircraft (COMESA) in the United Kingdom; the Research Committee on the

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162- Barret, *supra*, note 72 at 5.

163- *Ibid.*

164- Toon & Turco, *supra*, note 138 at 72.

165- *Ibid.*

166- *Ibid.* at 73.

167- M.A. Dornheim, "Perseus High - Altitude Drone to Probe Stratosphere for SST Feasibility Studies" *Aviation Week and Space Technology* (9 Dec. 1991) 36.

Consequences of Stratospheric Flights (COVOS) in France; and other groups in the former U.S.S.R., Canada, and Japan[168].
France has recently decided to create an Aircraft-Ozone Committee, in charge of both complementing the work achieved by COVOS and participating to the international exchange of information. The Committee will also address the problems of subsonic air traffic[169].
The EEC Commission is also promoting research on the impact of aerial traffic and has just published an invitation to tender[170].

Scientific research in the field is a necessary step prior to the development of technological means to halt the negative impacts of human industries on the environment. Nevertheless, the advancement of technology should not be envisioned as a substitute for the adoption of adequate protective measures.
In this respect, on 3 November 1990, at the issue of a meeting called by the World Meteorological Organization (WMO) and the United Nations Environmental Program (UNEP), seven-hundred scientists urged developed countries to significantly limit emissions of gases other than CFC's and other greenhouse gases not covered by the Montreal Protocol[171].
Another international organization showing considerable concern for the problem of atmospheric pollution is ICAO. This organization has developed technical standards for the protection of the environment, which will constitute the object of the following Chapter.

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168- J.P. Dufour, "Le débat sur l'effet des supersoniques sur la couche d'ozone est relancé" *Le Devoir* (6 January. 1992) 1.
169- *Ibid.*
170- *Ibid.* at 4.
171- P. Aldhous, "Two Declarations at Odds" (1990) 348 Nature International Weekly Journal of Science 7.

# CHAPTER II
# INTERNATIONAL STANDARDS SET BY ICAO

The technical standards dealing with noise emissions will be presented in paragraph 1. Then, standards related to emissions of pollutants will be examined in paragraph 2. Finally, paragraph 3 will analyse the standard setting policy in view of determining if it is an efficient means of environmental management.

## 1. Standards Concerning Noise Emissions

### a) Noise Certification of Aircraft

#### i - Historical Background of Annex on Aircraft Noise

The Chicago Convention of 1944 did not specifically provide for the establishment of Standards and Recommended Practices (SARPS) regulating the protection of the environment. Nevertheless, the preamble states that one of the aims of the Convention is to promote the development of aviation in "a safe and orderly manner". Moreover, article 37 assigns to ICAO the task of adopting appropriate measures for the safety, regularity and efficiency of aerial navigation. Finally, article 44 lists amongst the objectives of the organization the development of principles and techniques for the "safe and orderly growth of international civil aviation". For this purpose, the Organization has the duty to monitor "generally the development of international civil aeronautics."

Thus, in 1963, the Assembly of ICAO adopted a resolution requiring that noise emissions of supersonic aircraft be comparable to those of subsonic aircraft[1]. Then, following the London Conference on aircraft noise held in 1966, the Assembly of ICAO convened in Buenos Aeres and instructed the Council to organize an international conference under the umbrella of ICAO in order to

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1- R. Goy, "La lutte de l'OACI contre le bruit des aéronefs" (1976) 2 Environmental Policy and Law 72.

develop appropriate regulations to be included in an annex on noise[2]. Subsequently, the Council organized a Special Meeting on Aircraft Noise in the Vicinity of Airports, held in Montreal, in November and December of 1969. Thirty States and nine international organizations participated[3].

In 1970, the Committee on Aircraft Noise (CAN) was created within ICAO[4]. SARPS established on the basis of the guidelines set by the Montreal meeting[5], were adopted by the ICAO Council on 2 April 1971[6], by virtue of article 54(l) of the Chicago Convention. These measures were designated as Annex 16 on Aircraft Noise[7] and became applicable on 6 January 1972[8]. In June 1979, Annex 16 was renamed "Environmental Protection" and was arranged in two volumes Volume I on Aircraft Noise and Volume II on Aircraft Engine Emissions[9]. In 1983, the Council merged the CAN with the Committee on Aircraft Engine Emissions (CAEE) to form the Committee on Aviation Environmental Protection (CAEP)[10].

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2- *Ibid.*

3- *Ibid.*

4- G.A. Gratjios, Airport Noise Pollution: Legal Aspects (LLM thesis, McGill University, Montreal, 1990) 26.

5- *Ibid.*

6- *Environmental Protection - Annex 16 to the Convention on International Aviation, Volume I - Aircraft Noise*, 2nd. (Montreal: ICAO, 1988) at v [hereinafter Annex 16, Volume 1].

7- Gratjios, *supra*, note 4 at 26.

8- Goy, *supra*, note 1 at 73.

9- Gratjios, *supra*, note 4 at 28.

10- *Amalgamation of Committee on Aircraft Noise (CAN) and Committee on Aircraft Engine Emissions (CAEE)*, CAN Rec. 6/2, approved by ICAO Council, 110th Sess., ICAO Doc. 9419, CAN/7 (1983).

ii - Field of Application of Annex 16, Volume I

ICAO's approach to noise certification of aircraft has been "progressive and segmented"[11] .

Following the adoption of Annex 16 by the Council, the CAN worked on updating the SARPS originally enacted. Those approved by the Council were then incorporated in the Annex. Thus, the list of aircraft covered was only gradually established.

The applicability of the Annex depends on the characteristics of the aircraft (weight, type) and on whether the aircraft, its prototype, or a derived version had already been given a certificate of airworthiness on the date of entry into force of the amendment. A derived version of an aircraft is "an aircraft, which from the point of view of airworthiness, is similar to the noise certificated prototype but incorporates changes in type design which may affect its noise characteristics"[12].

Subsonic jet aircrafts were the first to be included in the Annex on Noise[13]. Originally, they had to weigh more than 5,700 kg. Annex 16 was not intended to apply to aircraft for which an application for an airworthiness certificate for the prototype was carried out before January 1969 and to aircraft with a bypass ratio of 2 or more, when a certificate for an individual airplane was issued before March 1972 [14]. Thus, when the annex was adopted existing aircraft were exempt, along with future aircraft produced on the model of current prototypes and wide body aircraft with a high bypass ratio, if their certification was issued before March 1972. As a consequence, even the first B747's would not come under

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11- Goy, *supra*, note 1 at 74.

12- *Amendment of Annex 16 - Definitions*, CAN Rec. 3/2, approved by the Council, 98th Sess., ICAO Doc. 9286 CAN/6.

13- Goy, *supra*, note 173 at 74.

14- A by-pass ratio refers to the "ratio of the mass flow through the by-pass ducts of gas turbine engine to the air mass flow through the combustion chambers calculated at a maximum thrust when the engine is stationary in an international standard atmosphere at sea level.": Annex 16, Volume I , *supra*, note 6 at 1.

these regulations[15]. Then the CAN conceived regulations applicable to those aircrafts which were not covered[16].
Accordingly, Annex 16 was amended by the Council of ICAO to include subsonic jets manufactured after January 1976 that are not noise-certified, subsonic jet aeroplanes weighing less than 5700 kg and light propeller aeroplanes[17] .
The revised version of the Annex on Aircraft Noise issued in October 1976, which entered into force on 6 Oct. 1977[18], was complemented with a Chapter III applicable to:
- subsonic jet aeroplanes with respect to which a submission for a certificate of airworthiness for the prototype was accepted on or after 6 October 1977[19];
- propeller driven aeroplanes over 5,700 kg with respect to which a submission for a certificate of airworthiness for the prototype was accepted between 1 January 1985 and 17 November 1988[20];
- propeller driven aeroplanes over 9,000 kg with respect to which a submission for a certificate of airworthiness for the prototype was accepted on or after 17 November 1988[21].

A proposal of the Committee on Aviation Environmental Protection to include a Chapter 10 dealing with propeller driven aeroplanes of maximum certified take-off weight of 9,000 kg was adopted by the ICAO Council on 4 March 1988 and came into force on 17 Nov. 1988[22]. The latest version of Annex 16, Volume I has been applicable since 17 November 1988[23].

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15- NASA, *Report on Transport Jet Aircraft Noise Abatement in Foreign Countries:Growth, Structure, Impact* (July 1980) 28.

16- Gratjios, *supra*, note 4 at 26.

17- *Ibid.* at 26-27.

18- *Ibid.* at 27.

19- Annex 16, Volume I, *supra* , note 6 at 5.

20- *Ibid.*

21- *Ibid.*

22- *Ibid.* at viii.

23- *Ibid.*

Chapters 2 and 3 impose that all subsonic jet aeroplanes whose designs were accepted after 1 January 1969 be certified according to their standards[24]. This resulted in the classification of subsonic airplanes in three groups[25]:

- Non-noise certificated aeroplanes: those which received a certificate of acceptance for their prototype before 1 January 1969, such as the B707, DC-8, DC-9, Caravelle, B727, B737, VC-10, Trident, BAC 1-11 etc.
- Aeroplanes having to meet the standards of Chapter 2: those whose prototypes received their certificate of acceptance between 1 January 1969 and 6 October 1977. In this group we find the DC-10, Tristar, most of the different types of B747, and the Airbus A 300. In addition, belong to this group the aeroplanes of group 1, which were manufactured after 1 January 1976, and older ones, which have been modified to meet the standards of Chapter 2 also belong to this group.
- Aeroplanes having to meet the Chapter 3 standards: those whose prototypes received their certificate of acceptance after 6 October 1977. This category includes the B757, B767, BAe 146, and the A 320. Some of the aircraft coming within the scope of Chapter 2 also meet the more stringent noise requirements of Chapter 3. This is the case of the Airbus A 300, Tristar and B737-300.

Supersonic aircraft are covered in Chapter 4 of Annex 16 (Volume 1). The Chapter applies to all civil supersonic aeroplanes, including their derived versions, which were a certificate of airworthiness for the prototype prior to 1 January 1975, and a certificate of airworthiness for the individual aircraft issued after 26 November 1981[26]. The Annex also provides for the noise certification of

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24- Technical Committee, *Noise -Related Developments in European Communities and in ICAO*, ECAC Doc.TECH/16-WP/3 (22/05/89) at 5.

25- *Ibid.*

26- Annex 16, Volume I, *supra*, note 6 at 9.

future supersonics, namely those for which a certificate of airworthiness for the prototype was issued after 1 January 1975[27].

iii - Provisions of the Annex on Noise Certification

The legal aspects of noise certification are the same for all aircraft, even if the technical standards vary within the different categories[28].

Regarding subsonic aircraft, noise certification is granted or validated by the State of registration, when proof is shown that the aircraft complies with the specifications of Annex 16, Volume 1[29]. Most countries empower their civil aviation authorities to issue noise certificates. The US Federal Aviation Administration (FAA), however, devolves this power to aircraft manufacturers[30]. Frankfurt airport has often noted that this noise certificate is appended on a reversible placard in the flight deck, which gives to the same aircraft a Chapter 2 and a Chapter 3 designation. This is to the advantage of airlines which want to avoid noise related charges applicable to the noisier aircraft (Aircraft certified under Chapter 2 of Annex 16 Volume 1)[31].

ICAO regulations do not specify which documents contain the noise certificate. Annex 16 states that "the documents attesting noise certification may take the form of a seperate Noise Certificate or a suitable statement contained in another document approved by the State of Registry and required by that State to be carried in the aircraft"[32]. The insertion of the noise certificate in a document defined by the Annexes could provide some guidance on its legal

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27- *Ibid.*

28- Goy, *supra*, note 1 at 73.

29- Annex 16, Volume I,*supra*, note 6, art. 1.2.

30- I. Verchère, "Old 747's provoke Euro Noise Row" *Interavia Aerospace Review* (September 1992) at 65.

31- *Ibid.*

32- Annex 16, Volume I, *supra*, note 6 at 2.

regime. The noise certificate could be included in either of the three documents listed: the certificate of airworthiness, the operations manual and the airplane flight manual.

Another legal question arises out of the attempts made by ICAO to transfer certain duties from the State of registration to the State of the actual operator of the aircraft. This transfer could be based on the amendment to the Chicago Convention, adopted by the Assembly on 6 October 1980[33]. This amendment, referred to as article 83 bis, allows the State of registry to transfer all or part of its obligations under articles 12, 31 and 32(a) of the Chicago Convention[34]. These obligations include the issuance of a certificate of airworthiness of the aircraft. Since Annex 16 Volume 1 does not require that noise certification be the object of a separate document, if the noise certificate was included in the certificate of airworthiness, the legal duty to issue it would most likely be automatically transferred to the State of the Operator, pursuant to article 83 bis.
The combination of these documents is not inconceivable, since both have the similar function of attesting that an aircraft is fit for air navigation. Further legal support in favor of this amalgamation is found in article 29 of the Chicago Convention and in Annex 6 on Operation of Aircraft[35], which both require that the certificate of airworthiness and the noise certificate be on board the aircraft. However as presently drafted, Article 83 bis has not been ratified

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33- M.Milde, "Chicago Convention - 45 Years Later: A Note on the Amendments" (1989) 14 A.A.S.L. 203 at 211.

34- G.F. FitzGerald, "The lease, Charter and Interchange of Aircraft in International Operations - Article 83 bis of the Chicago Convention on International Civil Aviation", 6 A.A.S.L. (1981) 49 at 50.

35- *Operation of Aircraft - Annex 6 to the Convention on International Civil Aviation, Part I - International Commercial Air Transport - Aeroplanes*, 5th ed. (Montreal: ICAO, 1990) Article 2.13 [hereinafter Annex 6, Part I].

by the two thirds of the Contracting States required to amend the Chicago Convention under article 94(a)[36].

In the meantime, the ICAO Assembly adopted Resolution A 23-13 to resolve the question of the transfer of duties[37]. It urges the State of registry to transfer to the State of the operator the duties arising out of the Annex 6. Under Annex 6, the State of registry is to ensure that aircraft are operated according to a specified code of performance[38]. The Annex also mentions a series of documents which must be on board the aircraft. This list includes the operations manual, the aeroplane flight manual and the noise certificate[39]. However, none of the provisions of Annex 6 actually refer to the issuance or the validation of the noise certificate. Therefore, the obligation to have the noise certificate on board, found in Annex 6, can not be combined with Resolution 23-13 to justify a transfer of the duty to perform the noise certification to the State of the operator.

A transfer of duties could not result from the inclusion of the noise certificate in the operations manual because Annex 6 already attaches the duties pertaining to the operations manual to the State of the operator[40]. Hence, the State of registry can not include the noise certificate in such a document and transfer the issuance of both to the State of the operator pursuant to Resolution 23-13. Therefore, there is little practical advantage to be drawn from the combinationof the noise certificate and the operations manual.

At its second meeting, the ICAO Committee on Aviation Environmental Protection (CAEP) proposed to amend Chapter I,

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36- "This amendment requires 98 ratifications": Milde, *supra*, note 33 at 211.

37- *Lease, Charter and Interchange of Aircraft in International Operations*, ICAO Ass. Res. A23-13, 34th Sess., ICAO Doc. 9558 (1989).

38- Annex 6, Part I, *supra*, note 35, art. 5.1.1.

39- *Ibid.*, art. 6.2.3 & 6.13.

40- *Ibid.*, art. 4.2.1.1.

Annex 16 (Volume 1), in order to include in the airplane flight manual the information found in the noise certificate[41]. This document covers the information specified in Annex 8 to the Chicago Convention, namely operating limitations for the safe operation of the aircraft, operating information and procedures defined in Annex 6 and, performance information regarding the various aeroplane configurations and powers. Neither Annex 6 nor Annex 8 give a precise indication of who issues or approves the airplane flight manual. However, Annex 6 puts on the State of registry the duty to ensure that the aircraft is operated safely[42]. Moreover, the flight manual is often associated with the certificate of airworthiness[43], which is the responsibility of the State of registry[44]. As a consequence, it is likely that the duty to issue the noise certificate would become the responsibility of the State of the operator if it was included in the aeroplane flight manual, due to the combined effects of Annex 6 and Resolution 23-13.
As it is, the CAEP has taken note that crucial information on aircraft noise, usually required by airports, is often not kept on board. Incorporating the content of the noise certificate in the flight manual would ensure the availability of this information[45].

The CAEP has proposed to reform the requirements pertaining to the content of the noise certificate. Instead of mentioning the State of registry, the document would mention the nationality and the registration marks of the aircraft[46]. The manufacturer's serial

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41- Committee on Aviation Environmental Protection, *Report on the Second Meeting*, 1991, Agenda Item 3, ICAO Doc. CAEP/2-WP/97; reviewed by the Air Navigation Commission for presentation to session of the Council opening in May 1992, ICAO Doc. AN-WP/6648 (1992).

42- Annex 6, Part I, *supra*, note 35, art. 5.2.4.

43- *Ibid.* 5.2.3.

44- *Convention on International Civil Aviation - Article 31*, 7 December 1944, 15 U.N.T.S. 295, T.I.A.S. No. 1591 [hereinafter Chicago Convention].

45- Committee on Aviation Environmental Protection, *supra*, note 41 at 3-11.

46- *Ibid.* at 3-A-1.

number, the maximum mass at which the aircraft is noise compliant and the instalment of a device to render the aircraft noise compliant must also be communicated[47]. For a number of aircraft the certificate must provide the average noise levels at the reference points for which compliance with the standards was shown[48]. In addition to the manufacturer's type and model designation, indication of the engine type and model, or the propeller type and model, would be required. Finally, a new provision would require that reference be made to the amendment number, chapter and paragraph of the Annex according to which the aircraft was certified[49].

Noise certificates established on the basis of standards at least as stringent as those of the Annex must be considered valid among Contracting States. The certificates can be suspended or revoked if the aircraft ceases to comply with the Annex[50].

The techniques adopted in 1971 for the noise certification of subsonic aircraft were perfected in the second edition of Annex 16, issued in October 1976[51]. In November 1976, this later version of Annex 16 underwent changes in order to take into account the number of engines for the determination of allowable noise levels. These changes were incorporated in a third edition of Annex 16 on Aircraft Noise, which came into force on 10 Aug. 1978[52]. The procedures were further modified in 1981, 1983, 1985, 1988[53]. Many recommendations proposed during the second meeting of the CAEP will soon be the object of a report from the Air Navigation Commission to the ICAO Council for the amendment of Annex 16.

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47- *Ibid.*

48- Ibid. at 3-A-1 & 3-A-2.

49- *Ibid.*

50- Annex 16 , Volume I, *supra*, note 6, art. 1.4.

51- NASA, *supra*, note 15 at 30.

52- *Ibid.*

53- Annex 16, Volume I, *supra*, note 6 at viii.

These amendments would, *inter alia*, reform the noise evaluation methods for Chapter 3 aircraft[54].

The reference procedures take into account the speed of the aircraft, its weight, and atmospheric conditions. Aircraft are categorized according to their maximum weight at take-off (MCWT). In each category, any decrease in the mass of the aircraft results in a reduction of the permissible noise level until a certain level weight is reached under which the noise limit remains constant. The noise level is measured in Effective Perceived Noise Decibels (EPNdB)

The noise is to be measured in three locations:

- The microphones located on the lateral measurement point are fixed on a line parallel to the runway centre line, at 650 m from it (Chapter 2) or at 450 m (Chapter 3). The point is located where the noise level is at its maximum during take-off. The noise is measured from a series of flybys, over a range of heights, to determine the peak lateral noise. However, Annex 16 allows the use of equivalent procedures found in an Environmental Technical Manual (ETM)[55]. This document describes a flyby at 1000 ft as an alternative procedure[56]. The lateral measurement point is sometimes referred to as the sideline measurement point.
- The flyover measurement point is fixed on the centre line of the runway, at 6500 m from the start of roll. It is sometimes called the take-off measurement point.
- The approach measurement point is located at 120 m above the centre line of the runway, at 2000 m. from the threshold.

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54- Chapter 2 aircraft is " a subsonic jet aircraft which has been certificated to meet the noise level requirements prescribed in ICAO Annex 16, Volume 1, Chapter 2, but does not meet the requirements of ICAO Annex 16, Volume 1, Chapter 3"; A Chapter 3 is "a subsonic jet aircraft which has been certified to meet the noise level requirements prescribed in ICAO Annex 16, Volume 1, Chapter 3": *Economic Implications of Future Noise Restrictions on Subsonic Jet Aircraft*, ICAO Circular 218-AT/86 (1989).

55- Annex 16, Volume I, *supra*, note 6, art. 2.6.2.3 & 3.7.6.

56- Committee on Aviation Environmental Protection, *supra*, note 41 at 3-10.

The Annex allows "trade-offs" when excess noise at one of the points is compensated for by noise decreases at other points.
The following charts will summarize the main characteristics of the standards set in Chapters 2 and 3:

**Lateral Point:**

| Chapter 2 | Chapter 3 |
|---|---|
| 1.1. MCWT of 272,000 kg or more<br>a) by-pass ratio of 2 or more, and prototype certified before 1 March 1972, or;<br>b)by-pass ratio of less than 2, and individual aircraft certified before 1 January 1976:<br>**108 EPNdB** down to **102 EPNdB** at MCWT of 34,000 kg.<br><br>1.2. MCWT of 400,000 kg or more of derived versions of the above, when change in design certified after 26 November 1981:<br>**106 EPNdB** down to **97 EPNdB** at MCWT of 35,000 kg. | 1.1. MCWT of 400,000 kg or more<br>**103 EPNdB** down to **94 EPNdB** at MCWT of 35,000 kg. |

**Flyover Point:**

| Chapter 2 | Chapter 3 |
|---|---|
| 2.1. MCWT of 272,000 kg or more of aircraft designated in §1.1:<br>**108 EPNdB** down to **93 EPNdB** at MCWT of 34,000 kg.<br><br>2.2. MCWT of 324,000 kg or more of aircraft designated in §1.2 with<br>a) Two engines or fewer<br>**104 EPNdB** decreasing with the mass down to **93 EPNdB**;<br>b) Three engines<br>**107 EPNdB**, decreasing with the mass down to **93 EPNdB**;<br>c) Four engines or fewer<br>**108 EPNdB**, decreasing with the mass down to **93 EPNdB**. | 2.1. MCWT of 385,000 kg or more<br>a) Two engines or fewer<br>**101 EPNdB**, decreasing by 4 EPNdB with the mass down to **89 EPNdB**;<br>b) Three engines<br>**104 EPNdB**, decreasing with the mass as in §a down to **89 EPNdB**;<br>c) Four engines or more<br>**106 EPNdB**, decreasing with the mass as in §a down to **89 EPNdB**. |

**Approach Point:**

| Chapter 2 | Chapter 3 |
|---|---|
| 3.1. MCWT of 272,000 kg or more for aircraft mentionned in §1.1: Same standards as at lateral point.<br><br>3.2. MCWT of 280,000 kg or more of aircraft mentionned in §1.2: **108 EPNdB** down to **101 EPNdB** at 35,000 kg. | 3.1. MCWT of 280,000 kg or more: **105 EPNdB** down to **98 EPNdB** at 35,000 kg. |

The difference between the Chapter 2 aircraft and Chapter 3 aircraft in terms of noise emitted is considerable[57].
A study carried out for the EEC Commission on the abatement of nuisance caused by air transport reveals that a Chapter 2 B727-200, with a gross weight of about 190,000 lbs, will emit a 90 EPNL heard over 75.29 square km. By comparison, a Chapter 3 B757, with a gross weight of about 200,000 lbs, will make a noise of the same intensity but with a footprint of 11.22 square km only[58].

With respect to supersonic aircraft, there are no specific standards applicable. Following the third meeting of the CAN, the Council of ICAO had agreed that the noise standards applicable to subsonic aircraft should serve as guidelines to minimize the noise levels of future supersonic aircraft below the approach path, below the take-off path, and at the side of the aeroplane during take-off and

57- Technical Committee, *supra*, note 24 at 5.

58- *Ibid.* at 7.

climb[59]. It was also decided that noise levels of the Concorde and the TU-144 should be as low as possible and that any progress achieved by manufacturers in this respect be communicated to ICAO[60]. Later on, the CAN acknowledged that noise levels of current supersonic aircraft are well above the standards for subsonic jets[61]. The CAN also decided to put pressure on manufacturing States for future supersonics. The latest version of the recommendation originally drafted concerning supersonic aircraft results from the work of the sixth CAN meeting[62]. It is now included in Chapter 4 of Annex 16 Volume 1. The amendment provides that, using the noise measurement method prescribed in Chapter 2, existing supersonic aircraft and their derived versions cannot exceed the noise emissions of the first certificated aircraft of the type[63].

The Annex also provides that the standards of Chapter 2 may be used as guidelines for future supersonic aircraft[64]. The CAEP, however, has proposed that the paragraph dealing with supersonics certified to be airworthy after January 1975 be amended to use the standards of Chapter 3 as a reference[65].

Annex 16 was recently the object of criticism from Members of the European Civil Aviation Conference (ECAC)[66]. The controversy

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59- *Guidance on Noise Standards for Future Supersonic Transport Aeroplanes*, CAN Rec. 3/1, approved by Council, 79th Sess., ICAO Doc. 9063 CAN/3 (1973).

60- *Noise Requirements for Concorde and TU-144*, CAN Rec. 3/2, approved by Council, 79th Sess., ICAO Doc. 9063 CAN/3 (1973).

61- Committee on Aircraft Noise, *Report on the Fourth Meeting*, 1975, ICAO Doc. 9133 CAN/4 at 6-2.

62- Committee on Aircraft Noise, *Report on the Sixth Meeting*, 1979, ICAO Doc. 6286 CAN/6.

63- Annex 16, Volume I, *supra*, note 6, art. 4.1.2.

64- *Ibid.*, art. 4.2.

65- Committee on Aviation Environmental Protection, *supra*, note 6 at 4-A-1.

66- The European Civil Aviation Conference convened in 1954 in Strasbourg and became a permanent body as of 1955. This institution counts twenty three member States and

arose out of the different possible interpretations of paragraph 3.3.2.3 of Chapter 3 when read in conjunction with paragraph 3.5[67]. The former provision prohibits that the noise levels at lateral and flyover points be "separately optimized at the expense of each other" during test flights. The latter provision allows that excesses in noise levels "at one or two points" be compensated "by corresponding reductions at the other point or points". Encouraged by this more lenient measure, certain States have allowed that older aircraft fitted with hushkits (B707, B727 and DC8) cut back their power during the measurement of lateral noise, so they can just barely meet the Chapter 3 standards[68]. This practice can lead to a reduction of the lateral noise level by 1 EPNdB. Other States on the contrary, believe that Chapter 3 requires that noise measurements be done at full take-off power[69]. ICAO was asked to resolve the matter. The CAEP accordingly proposed to emphasize in paragraph 3.6.3. the importance of putting the aeroplane in the highest noise configuration:

"This configuration includes all of those items listed in 5.2.5. of Appendix 2, that will contribute to the noisiest continuous state at the maximum landing mass in normal operation"[70].

In addition, ECAC criticises the fact that most tests measuring noise at the lateral point are carried out following the alternative procedure rather than at the height at which the aircraft produces the maximum noise level[71]. The CAEP recognizes that small errors are introduced if the flyby height is standardized to 1000 ft[72].

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works in collaboration with ICAO. However it holds its own meetings, follows its own agenda and establishes its own working programs: N.M. Matte, *Treatise on Aeronautical Law*, 3rd. ed. (Toronto: Carswell, 1981) at 268.

67- Technical Committee, *Chapter 3 Noise Certification of Old Aeroplanes*, ECAC Doc. TECH/18-WP/4 (20/2/91) at 1.

68- *Ibid.* at 2.

69- Committee on Aviation Environmental Protection, *supra*, note 6 at 3-10.

70- *Ibid.* at 3-A-4.

71- Technical Committee, *supra*, note 67 at 2.

72- Committee on Aviation Environmental Protection, *supra*, note 6 at 3-10.

Noise made by aircraft with a bypass ratio below 2 can be reduced by 0.6 dB. Nevertheless, available data is insufficient to restrict the use of the alternative procedure to aircraft with a high bypass ratio. Moreover, the certifying authorities have a discretionary power to choose the reference procedure used[73].

b) Operating Restrictions

Annex 6 to the Chicago Convention requires that aircraft be operated in compliance with the standards of Annex 16 Volume 1. Consequently, the masses of the aircraft at take-off and landing can not exceed the maximum masses at which compliance to the noise standards was shown[74].

In addition, the Procedures for Air Navigation Services and Aircraft Operations (PANS-OPS), adopted by the ICAO Council, in their volume on Flight Procedures, include a Chapter on noise reductions[75]. PANS do not have the status of standards and recommended practices. They are proposals of operating procedures applicable world-wide. First, it is suggested that preference be given to runways and routes which prevent overflights of noise sensitive areas. Exceptions are provided for in order to meet safety requirements. Then, the Manual provides instructions on how to minimize noise levels during take-offs and landings. It covers the angle of the flight and the height of the aircraft, turn angles, speed, thrust and the position of the flaps. Usually, the procedures require a high thrush up to an altitude of 1000 to 3000 ft, with high angle take-off and no turns below 500 ft, followed by an engine cut back. Acceleration resumes at 300 ft. Some airports in the United States have imposed cutbacks in engine power at altitudes of 400 ft, in order to reduce complaints from neighbours of the airport. This was strongly criticized by the Air Line Pilot Association (ALPA) which contends the measures are

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73- *Ibid.*

74- Annex 6, Part I, *supra*, note 35, par. 5.2.7. (d).

75- *Operating Procedures for Air Navigation Services, Volume 1 Flight Operations*, ICAO PANS, Doc. 8168-OPS/611 Vol.1 (1986).

unsafe because the aircraft can not be stabilized under 1000 ft. The Association believes that "standardization is the key to airline safety" and wants "standardized procedures at a reasonable altitude"[76]. The pilots also content that proper land use planning by local governments would have avoided having to use these procedures.

c) Airport Planning

ICAO Assembly Resolution 28/3 called for the development of "an integrated approach to the problem of aircraft noise, including land use planning procedures around international airports, so that any residential, industrial or other land use that might be adversely affected by aircraft noise is minimal"[77].

The CAEP pointed out in 1986, that an integrated approach required the determination of an international procedure for developing noise contours [78]. Subsequently, guidelines were developed and incorporated in Circular 205 approved by the Council on 11 March 1987[79].

At the same time, Annex 16 Volume 1 was amended to refer to Circular 205.

Guidelines on possible land uses in the vicinity of airports were established within the Airport Planning Manual, particularly in its section on "Land Use and Environmental Control"[80]. It is a

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76- J. R. Wilson, "Safety Before Less Noise, Say Pilots" Jane's Airport Review (September 1991) at 53.

77- *Possible operating restrictions on subsonic jet aircraft which exceed the noise levels in Volume 1, Chapter 3 of Annex 16 - Article 5*, ICAO Ass. Res. A28/3, ICAO Doc. A 28-WP/27 P/10 at 2-1.

78- Committee on Aviation Environmental Protection, *Report of the First Meeting.*, 1991, Agenda Item 3, ICAO Doc. 9499 CAEP/1 at 3-19.

79- *Recommended Method for Computing Noise Contours around Airports.*, ICAO Circular 205-AN/1/25 (1988).

80- *Airport Planning Manual, Part 2 Land Use and Environmental Control*, ICAO Doc. 9184-AN/902 Part 2 (1985).

Technical manuals which provides States with information for a better implementation of existing SARPS[81].

It promotes the growth of civil aviation in accordance with the interests of communities neighbouring airports and those of the natural environment[82].

The Manual defined certain planning policies to adapt land uses around airports to airport activities. While they are establishing a comprehensive planning framework, authorities are asked to consider the use of the surrounding terrain for residential, industrial, commercial, agricultural purposes, taking into account the compatibility of the activity with aircraft noise[83]. Most agricultural uses are considered to be compatible with except poultry and mink breeding[84]. The Manual calls for special care when land uses involve the presence of water areas, farm land and trash dumps, due to the fact that they will attract birds. The placement of a highway, beneath the approach and climb out paths of aircraft, in replacement of residential areas, avoids noise problems in the most critical areas. It facilitates access to commercial, industrial and recreational sites, likely to be located around airports[85]. Industrial development in the vicinity of airports is one of the most favoured options. It is compatible with the high ambient noise level. Close economic links can be developed between the airport and nearby industries[86]. The least favoured option is the development of dwellings and community facilities such as hospitals and schools. Nevertheless, planning cannot solve the problems of the older airports. Although sound and air conditioning can considerably reduce indoor noise, their installation is extremely complex in old constructions. Moreover,

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81- *Ibid.* on cover page.

82- *Ibid.* at 2-1.

83- *Ibid.* at 2-12 _ 2-15.

84- *Ibid.* at 2-12.

85- *Ibid.* at 2-13.

86- *Ibid.* at 2-14.

outdoor activities of residents in the vicinity of airports remain affected[87].

The Manual advocates attempts to control land use through planning and zoning rather than through easements and purchase agreements, which are expensive and offer no concrete solution[88]. The authority in charge should have jurisdiction at a national level because a better result is achieved when decisions are detached from local development pressures and politics. Since most local governments wish to benefit from more tax revenues, they tend to favour the construction of residential areas near airports even though those land uses are not compatible[89].

## 2. Standards Concerning Emissions of Pollutants

### a) Historical Background of Annex 16, Volume II

ICAO regulations on vented fuel, smoke and gaseous emissions for subsonic aircraft date back to 1977, when a circular on the "Control of Aircraft Engine Emissions" was passed[90]. The first meeting of the Committee on Aircraft Engine Emissions (CAEE), created that same year, perfected the Circular. In 1980, the Circular was withdrawn and replaced by material found in Annex 16, Volume II[91]. Then, the Committee on Aviation Environmental Protection (CAEP), which replaced the CAEE in 1980, further improved measurement techniques for gaseous emissions[92].

### b) Documents of Certification

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87- *Ibid.* at 2-15.

88- *Ibid.* at 2-27.

89- *Ibid.* at 2-28.

90- *Environmental Protection - Annex 16 to the Convention on International Aviation, Volume II - Aircraft Engine Emissions* 1st ed. (Montreal, ICAO,1981) at 5 [hereinafter Annex 16, Volume II].

91- *Ibid.*

92- Committee on Aviation Environmental Protection, *supra,* note 41 at 5-A-2 - 5-A-16.

Annex 16, Volume II, Part II provides for the certification of aircraft which comply with its requirements. The authority in charge of performing this task is not precisely designated. Since Part II refers to the whole aircraft, this authority would most likely be the one delivering the certificate of airworthiness. The legal problems attached to the delivery of this certificate were previously covered in the paragraph on noise certification.

Annex 16, Volume II, Part III refers to the certification of engines only. The responsibility of enforcing these measures is upon the certificating authority designated by domestic legislation.

Both the fuel venting certificate and the emissions certificate can be separate documents, or form part of other documents approved by the certificating authorities. Certificates issued according to standards at least as stringent as those of the Annex are valid in all Contracting States.

The document attesting emissions certification must mention the name of the certificating authority, the manufacturer's type and model designation, as well as relevant modifications of the engine, the rated output, the reference pressure ratio and statements indicating compliance with the standards of Volume II. In addition, paragraph 2.4.1 of Chapter 2 and paragraph 3.4.1 of Chapter 3 require three sets of general information on engine characteristics, test results and data derived from these results.

c) Scope of Annex 16, Volume II

Activities covered are the discharge of fuel and emissions of smoke, unburnt hydrocarbons, carbon monoxide and oxides of nitrogen. Vented fuel contributes to the total output of hydrocarbons, hence it is covered both by Annex 16, Volume II, Part II on Vented Fuel and Annex 16, Volume II, Part III on Emissions Certification[93].

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93- Annex 16, Volume II, *supra*, note 90.

Sulphur dioxide emissions were not standardized, because they are conditioned by fuel composition rather than by the engine itself. Therefore, they are controlled by fuel specifications[94].

Annex 16, Volume II, Part II on Vented Fuel is applicable to aircraft powered by turbine engine, manufactured after 18 February 1982[95]. By focusing on the date of manufacture, this part of Annex 16 covers aircraft models which will already have received a certificate for the prototype. Thus, it applies to all turbine powered aircraft manufactured after the date mentioned above, regardless of whether the aircraft type was certified prior to the entry into force of the provisions on vented fuel.

Annex 16, Volume II, Part III on Emissions Certification is applicable to engines classified according to their use. Chapter 2, Part III covers all turbojet and turbofan engines allowing transport at subsonic speeds[96].

Paragraph 2.1.1 allows certifying authorities to exempt engines for which the type certificate of the first basic type was issued before January 1965, as well as their derivative versions. Furthermore, there are restrictions regarding the applicability of the paragraph on smoke emissions. Emissions of this type are restricted for engines manufactured after January 1983.

Finally, with respect to the other pollutants, restrictions apply to engines with a thrust power at take-off of over 26.7 kilonewtons (kN)[97]. They must have been manufactured after January 1986.

The CAEP, at its last meeting, favoured a wide range of application of the provisions on Emissions Certification contained in Annex 16, Volume II, Part III. It was proposed that Chapter 2 be made applicable to "engines designated for applications that otherwise would have been fulfilled by turbo-jet and turbofan engines"[98].

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94- *Ibid.* in Appendix 4.

95- Annex 16, Volume II *supra* , note 90, art. 1.1.

96- *Ibid.* at 13.

97- *Ibid.* at 14.

98- Committee on Aviation Environmental Protection, *supra,* note 41 at 5-A-1.

The CAEP also wishes to amend the condition of applicability of Chapter 2 with respect to emissions of oxides of nitrogen. A distinction could be made depending on whether the engines belong to a category in which the first individual production model was made before or after 31 December 1995, and on whether the date of manufacture of the individual engine was before or after 31 December 1999[99].

Chapter 3 of Annex 16, Volume II, Part III applies to turbo-jet and turbofan engines allowing propulsion at supersonic speeds, manufactured on, or after 18 February 1982[100].

d) Measurement of Engine Emissions

Pollutants emitted are measured during a landing and take-off (LTO) cycle including such operations as take-off, climb, approach and taxiing.

Only low altitude operations were considered to have a significant impact on the environment, due to their proximity to airports. Hence, the cruising mode was not taken into account. The problem of aircraft pollution at higher altitudes has recently received more attention in the international community. In this context, the CAEP is likely to consider the adoption of standards for aircraft emissions above 900 m in order to protect the ozone layer and global climate[101].

Engines are tested at a static test facility in given atmospheric conditions. Power settings applicable to each operation are also specified in the Annex. The characteristics of the probes measuring smoke and gaseous emissions are mentioned respectively in Appendixes 2 and 3 of Annex 16, Volume 2.

The CAEP has put forward a proposal for the improvement of the smoke analysis system[102]. In addition, since more recent engines

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99- *Ibid.*

100- Annex 16, Volume II, *supra* , note 90 at 16.

101- Committee on Aviation Environmental Protection, *supra,* note 41 at 5-6 and 7-2.

102- *Ibid.* at 5-A-2.

produce no visible smoke, the CAEP will consider the replacement of the currently used filter stain method by a more appropriate one[103].

Measurements of gaseous emissions are performed according to parameters listed in Appendix 3. The fuel composition used for engine testing is given in Appendix 4.

e) Expression of Pollution Limits

The Chapter II of Annex 16, Volume II requires that engines be designed in a manner which prevents fuel from being discharged "from the free nozzle manifolds" as a result of an engine shutdown following normal flight or ground operations.

Part III of Annex 16, Volume II sets limits of smoke and gaseous emissions. The emission limits are expressed using a parameter taking into account the mass of a pollutant emitted during a reference cycle, divided by the engine's rated thrust in sea level, static ISA conditions, expressed as a function of the pressure ratio[104]. The reference pressure ratio is a parameter based on the performance of the engine. It establishes a relation between emission limits and the useful capability of the polluting source. It allows a comparison of engines and shows the variations entailed by the different engine features such as the thermodynamic cycle and combustor variables[105].

Lately, the CAEP expressed reservations concerning the use of a single parameter for future standards of aircraft emissions in the upper atmosphere. This formula would not allow a distinction between the effects of the different pollutants, in view of their various life-span and the different effects of nitrogen oxides at different altitudes[106]. Therefore, the Committee will consider the

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103- *Ibid.* at 5-6.

104- Committee on Aircraft Engine Emissions, *Report of the First Meeting.*, 1978, ICAO Doc. 9259 CAEE/1 at 3-21.

105- *Ibid.*

106- Committee on Aviation Environmental Protection, *supra,* note 41 at 5-6.

adoption of a series of emission parameters covering all phases of the flight and all pollutants.
The CAEP has proposed a modification of $NO_x$ emission standards. When the first individual production model of an engine will be made after December 1995, and the individual engine will be manufactured after December 1999, the $NO_x$ emission standard will be more stringent[107].
Engines for which the stages of manufacture are anterior to these dates are subject to the previous $NO_x$ emission standards.
With respect to supersonic jet engines, regulatory levels are determined for the same pollutants[108].
The CAEP seems eager to promote the adoption of a very stringent environmental program for the protection of the stratosphere. It particularly focused on the potential problems caused by the emissions of nitrogen oxides. Consequently, it calls attention to protocols and conventions for the protection of the atmospheric environment. ICAO expected that the outcome of the United Nations Conference on Environment and Development, held in Brazil in June 1992, would provide some guidance on the environmental policies which States are willing to undertake[109].

Standards for the protection of ecological systems, or ecostandards, establish a meaningful criteria of illegal pollution. They are the fruit of a combination of political, scientific and environmental factors. Their effectiveness relies for the most part on their process of adoption and the legal consequences attached to their breach[110]. The study of the effectiveness of ecostandards set by ICAO will be the object of the next paragraph.

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107- *Ibid.* at 5-A-2.

108- Annex 16, Volume II, Part II, Chapter 3, *supra* , note 90 at 16.

109- Committee on Aviation Environmental Protection, *supra,* note 41 at 5-7.

110- A. L. Springer, *The International Law of Pollution: Protecting the Global Environment in a World of Sovereign States* (Westport, Connecticut & London, England: Quorum Books, 1983) at 90.

## 3. Critical View of the Standard Setting Policy

a) Flexibility of the Legal Regime of Ecostandards

It is crucial that the system of norms managing the environment be able to respond adequately to its evolution and to technological changes[111]. Standards set by ICAO effectively meet these requirements. Gradually, this practice evolved to allow the establishment of standards on subjects which were not specifically mentioned in the basic treaty. The Chicago Convention of 1944 provides for the simplified adoption of new standards and recommended practices promulgated as Annexes[112].

Standards are drafted by experts who best know the technologies involved and their impact on ecosystems. The draftsmen meet periodically in standing committees which report to the Air Navigation Commission (ANC) and to the Air Transport Committee (ATC). The ANC and the ATC, in turn submit the proposals of amendments to the ICAO Council[113]. Under article 90 of the Chicago Convention, the amendments must be approved by a "vote of two-thirds of the Council". This was interpreted to refer to the two-thirds of the total membership of the Council, which now counts 33 members. Thus, an Annex and the amendments reviewing it require 22 affirmative votes[114]. Technical standards adopted within the Organization do not require ratification by Member States and they are more immediately effective. The norms are constantly updated as scientific information come in. This procedure of adoption by-passes the slow and cumbersome process of negotiation of international treaties, at the end of which most standards are usually outdated. Moreover, implementation of the standards is ensured by technical authorities of participating

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111- P. Contini and H. Sand, "Methods to Expedite Environment Protection: International Ecostandards" (1972) 66 A.J.I.L. 37 at 38.

112- *Ibid.* at 41 - 42.

113- T. Buergenthal, *Law-Making in the ICAO*, (N.Y.: Syracuse University Press, 1969) at 62-64.

114- *Ibid.* at 64-65.

states rather than political authorities. Thus, a system of direct co-operation is established between international and national administrative entities[115]. This flexibility ensures the success of the standards and best accommodates environmental problems.

b) ICAO Standards in the Hierarchy of International Norms

The ICAO Council defined standards and recommended practices when it adopted Annex 9 for the facilitation of international air transport.

Standards are "any specification, the uniform observance of which has been recognized as practicable and as necessary to facilitate and improve some aspects of international air navigation, which has been adopted by the Council pursuant to Article 54(l) of the Convention, and in respect of which non-compliance must be notified by States to the Council in accordance with Article 38."

Recommended Practices are "any specification, the observance of which has been recognized as generally practicable and as highly desirable to facilitate and improve some aspects of international air navigation, which has been adopted by the Council pursuant to Article 54(l) of the Convention, and to which Contracting States will endeavour to conform in accordance with the Convention"[116].

The technical standards set by ICAO are not binding *ab initio*. Once the SARPS are adopted by the Council, article 38 of the Chicago Convention allows Member States to avail themselves of the possibility to denounce the standards within a certain time period, in order to avoid having to implement them. At the expiry of the prescribed period, the standards become mandatory for participating States which must bring their own legislation in accordance with the SARPS[117].

What would be the significance of this provision if ICAO was to develop standards for high altitude aircraft emissions?

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115- Contini & Sand, *supra*, note 111 at 47.

116- Buergenthal, *supra*, note 113 at 61.

117- *Ibid.* at 88-94.

Article 12 refers only to norms falling in the category of rules of the air. This article could not be used to give a more general scope to ICAO's technical ecostandards. The Convention itself does not contain any rule of the air, and up to now only flight rules found in Annex 2 have been applied over the high seas. However, there is no legal basis restricting the application of article 12 to Annex 2[118]. The Council could declare that flight rules adopted by ICAO for ecological purposes come within the scope of article 12. As of now however, ICAO ecostandards are not compulsory over the high seas.

In spite of their apparent mandatory nature, ICAO standards still have a precarious status in international law, and their impact on State responsibility is weak. Technical standards addressing private entities are not self executing, because they require that Member States take action to impose their implementation. Moreover, state responsibility incurred for acts and omissions of persons under their jurisdiction requires the existence of an international obligation to suppress the private act in question. In the absence of such an executory obligation, a state will not be liable for failing to exercise due diligence in doing so[119].
Generally, the breach of a specific obligation imposed by treaty may entail state responsibility. However, the purely legal clauses in ecostandards are expressed in such vague terms that it is difficult to establish their violations under treaty law. Ecological standards are still considered to be rules of "soft" international law and state responsibility can only result from the violation of internationally recognized rules of "hard" law. Yet, despite the absence of precise legal commitments, ecological standards are elements of proof of international legal thresholds of prohibited pollution[120]. In this respect, treaty standards evidence the existence of an advanced

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118- *Ibid.* in note 140 at 80-85.

119- J. Willisch, *State Responsibility for Technological Damage in International Law* (Berlin: Duncker & Humblot, 1987) at 76-78 and 133-134.

120- *Ibid.* at 150.

standard of due diligence which states are required to observe in preventing persons under their jurisdiction from causing transnational environmental harm. Accordingly, States in accepting to prevent pollution and co-operating on environmental issues have implicitly acknowledged their common need to protect each other's territory from environmental damage. In doing so, they agree to observe a greater higher standard of diligence among each other than the one imposed by general international law[121].

Moreover, the legal value of ICAO SARPS on aircraft engine emissions is likely to be strengthened when the provisions on the protection of the marine environment, found in the 1982 United Nations Convention on the Law of the Sea [hereinafter UNCLOS], become effective[122]. Article 212(1) requires States to adopt laws and regulations, applicable in their national airspace and to aircraft of their registry which are necessary for the prevention and control of marine pollution from or through the atmosphere. In doing so, States must ensure that "internationally agreed rules, standards and recommended practices and procedures and the safety of air navigation" are considered.

The general reference to SARPS clearly implies that ICAO norms contributing to the reduction of marine pollution must be given full effect when States adopt regulations on air pollution. Norms on vented fuel must be taken into account. The standards applicable to aircraft effluents are also encompassed because they contribute to global warming and the destruction of the ozone layer, and thus ultimately harm the marine environment.

Nevertheless, the UNCLOS of 1982 does not go as far as vesting international organizations dealing with marine pollution with quasi-legislative powers[123]. Nor does the Convention impose co-operation among States in ad hoc conferences or within international organizations in order to fight international air

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121- *Ibid.* at 81.

122- *United Nations Convention on the Law of the Sea*, 7 October 1982, UN Doc. A/CONF 62/122 and Corr. 1 to 11.

123- Willisch, *supra.*, note 119 at 137.

pollution. Article 212(3) merely requests that States "endeavour to establish global and regional rules, standards and recommended practices and procedures to prevent, reduce and control such pollution"[124]. States are granted leeway not to adopt a global policy against air pollution and the protection of the atmosphere on an international basis is still precarious.

c) Necessary Political Consensus Regarding Environmental Policies

The process by which ecostandards are adopted does not afford States an opportunity to re-affirm their political commitment in environmental matters. Since emphasis is put on the adoption of the standards within a limited period of time, efficiency problems arise when the standards have to be accepted[125]. The system suffers from a lack of general consensus over environmental questions. Because ICAO is primarily an organization concerned with industrial aspects of international exchanges, it is not equipped to resolve environmental controversies. The disputes mainly oppose industrialized countries to countries which are less developed. The crisis was highlighted when the latter countries called for an extraordinary session of the ICAO Assembly, held in 1990. Their objective was to bring to the fore the problems related to the strict implementation of the standards of Chapter 3 of Annex 16, Volume I in Europe, the United States, Australia and New Zealand. The matter was never discussed since the Assembly mainly concentrated on resolving the problems caused by the Gulf War.
ICAO is not an adequate arena for the establishment of guidelines of general scope concerning the protection of ecosystems affected by air transport. The absence of an international consensus on the effects of aircraft emissions in the upper atmosphere prevents the CAEP from developing more stringent emissions standards for subsonic and supersonic aircraft[126]. On the other hand, this Organization is better equipped than any other entity to analyse,

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124- UNCLOS, *supra,* note 122, art. 212.

125- Springer, *supra,* note 110 at 105.

126- Committee on Aviation Environmental Protection, *supra,* note 41 at 7-2.

co-ordinate and control pollution emissions from aircraft. Its action is nevertheless impeached by the absence of forum where states could constantly affirm their political commitment to protect the environment on an international basis. Such an organization would put pressure on states to re-evaluate domestic advancements of environmental protection. It would effectively promote a global and harmonized approach to environment management. It would supervise the activities of the specialized agencies in charge of enforcing protective measures applicable to their industrial sector. Already, the United Nations Environmental Programme (UNEP), the World Health Organization (WHO), the World Meteorological Organization (WMO) and non governmental organization have provided fora for discussing environmental issues[127]. Nevertheless, these organizations still need to be given a greater access to information and more decision making powers[128]. "The global community, especially the United Nations and UNEP must take the responsibility to organize and co-ordinate international cooperation, including cooperation among developed countries, developing countries, and co-operation between developed and developing countries"[129]. "The biosphere is an integrated unified whole"[130], but the pollution problem is shared by environments subject to segregated jurisdictions. Thus, there is need for a body with international jurisdiction, in charge of establishing guidelines for the control of pollution sources.

The next Chapter will explore legislations and international measures which have so far been put in place to govern the utilization of the atmospheric environment.

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127- D.B. Magraw, "Global Change and International Law" (1990) 1 Colorado J. Int. Env. L.& Pol'y 1 at 5.

128- *Ibid.*

129- Cheng Zheng-Kang, "Equity, Special Considerations, and the Third World (1990) 1 Colorado J. Int. Env. L. & Pol'y 57 at 67.

130- Magraw, *supra*, note 127 at 1.

# CHAPTER III
# PROTECTION OF THE AIR AND THE MARINE ENVIRONMENT FROM AIRCRAFT POLLUTION

Norms of aircraft pollution form part of a network of principles and regulations defining the relationship between States and the natural environment. The legal regimes vary depending on whether or not a specific area is under national jurisdiction. An important area of international law has been dedicated to defining State sovereignty over natural elements. The study of the legal status of the atmosphere will be the object of the first paragraph. The following paragraphs will give an overview of the legal measures for monitoring pollution emissions in the atmospheric environment at international and regional levels.

## 1. Scope of State Sovereignty and Legal Status of the Atmosphere

### a) Horizontal Delimitation of National Airspace

At the end of World War I, primarily for security reasons, all States were determined to extend their sovereignty over the airspace superjacent to their territory. Consequently, the principle emerged in the Paris Convention of 1919, that the airspace follows the regime of the subjacent territory[1]. Article 1 of the Chicago Convention also states that "...every State has complete and exclusive sovereignty over the air space above its territory"[2]. This principle applies to all States and not just Contracting Parties.
Pursuant to the Convention on the Territorial Sea and the Contiguous Zone of 1958, State sovereignty extends to the air

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1- I. Vlasic, The Grant of Passage and Exercise of Commercial Rights in International Air Transport - The Development of Principles and Rules (LL.M. Thesis, McGill University, 1955) 76.

2- *Convention on International Civil Aviation*, 7 December 1944, 15 U.N.T.S. 295, T.I.A.S. No. 1591 [hereinafter Chicago Convention].

space above territorial waters[3]. However, neither this Convention nor the other two relevant Conventions adopted in 1958, namely the Convention on the High Seas and the Convention on the Continental Shelf[4], have stipulated the width of territorial sea. Originally most coastal States claimed a territorial sea as wide as the reach of a canon ball, namely 3 nautical miles[5]. Some States, however established different widths, such as U.S.S.R. and Iceland which claimed 12 nautical miles[6]. Then, a few States extended their territorial waters to several hundred nautical miles on the basis of their claims over the continental shelf. The Continental Shelf Convention does not support such claims[7]. According to the Convention on the Territorial Sea and the Contiguous Zone, both the territorial waters and the contiguous zone may not exceed 12 nautical miles in width[8]. Before and after 1958 a number of States claimed a territorial sea of 3 nautical miles following the American position and an exclusive fisheries zone of 9 nautical miles. But Brazil, Equator, Panama and Peru maintained their claims of 200 nautical miles. They were followed by African and Asian countries while Europe struggled over Iceland's claims. Such extensions were not accepted by the United States and others[9].

The United Nations Convention on the Law of the Sea of 1982 [hereinafter UNCLOS] sets at 12 miles the breadth of the territorial

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3- *Convention on the Territorial Sea and the Contiguous Zone*, 29 April 1958, 15 U.S.T. 1608, T.I.A.S. 5639.

4- *Convention on the High Seas*, 28 April 1958, 450 U.N.T.S. 82 [hereinafter High Seas Convention]; *Convention on the Continental Shelf*, 499 U.N.T.S. 311 [hereinafter Continental Shelf Convention].

5- P. Reuter, *Droit International Public*, 5e éd., Paris, Presses Universitaires de France, 1976 at 294.

6- *Ibid.*

7- *Ibid.*

8- Convention on the Territorial Sea and the Contiguous Zone, *supra*, note 3, art. 24(2).

9- Reuter, *supra* note 5 at 295-296.

sea[10]. The Convention has not yet obtained the sixty ratifications required for its entry into force[11]. However, the great number of participants (168) to the Third United Nations Conference on the Law of the Sea as well as the important number of votes in favor of the UNCLOS evidence a general consensus necessary for the emergence of a rule of customary international law[12]. Moreover, when the United States adopted the 12 nautical mile width in 1988, they proclamed they were acting "in accordance with international law" and, they believed the rule is binding[13]. Thus, the practice of States supports the conclusion that the 12 nautical mile width forms a part of customary international law.

Article 46 of the UNCLOS also recognizes the existence of archipelagic States constituted by "groups of islands, interconnecting waters and other features so closely interrelated as to form an intrinsic geographical, economic and political entity, or which historically had been regarded as such"[14]. The Convention allows such States to enclose into their territory, waters which would otherwise belong to the high seas within a line up to one-hundred nautical miles long "joining the outmost points of their outermost islands and drying reefs"[15]. According to article 49 of the UNCLOS, the airspace over enclosed waters is subject to

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10- *United Nations Convention on the Law of the Sea*, 7 October 1982, A/CONF. 62/122 and Corr. 1 to 11, art. 3 [hereinafter UNCLOS].

11- "Law of the Sea" (1982) 36 Yearbook of the U.N. 178 at 237 [hereinafter Law of the Sea]; Forty-five ratifications and accessions are listed in *Multilateral Treaties Deposited with the Secretary General - Status as of 31 December 1991* ( New York: U.N. Publication, 1991) at 770-771.

12- The Conference adopted the UNCLOS by 130 votes against four and seventeen abstentions. One hundred and seventeen States signed the Convention on the day it was opened for signature: M.Milde, "United Nations Convention on the Law of the Sea - Possible Implications for International Air Law" (1983) 8 A.A.S.L. 167 at 169-170.

13- M.N. Leich, "Limits of the Territorial Sea" (1989) 83 A.J.I.L. 349.

14- Law of the Sea, *supra*, note 11 at 194.

15- *Ibid.*

the sovereignty of the archipelagic State[16]. The question of whether the concept of archipelagic State forms a part of customary international law remains to be answered. The recognition that Indonesia is an archipelagic State by the U.S., which is not a party to UNCLOS, is evidence that the concept is beginning to be given legal value[17].

Corollaries to exclusive sovereignty of States over their airspace are the right to regulate aerial operations and the right to control access[18]. Article 11 of the Chicago Convention requires that "subject to the provisions of this Convention,....aircraft engaged in international air navigation" comply "with the laws and regulations of a contracting State relating to the admission to or the departure from its territory....or to the operation and navigation of such aircraft while within its territory"[19]. The necessity of obtaining prior authorization to enter national airspace depends on whether or not the flights are scheduled.

When the flights are not scheduled, Article 5 of the Chicago Convention[20] provides that contracting States may not subject the entry of an aircraft of another contracting State to prior authorization, unless the aircraft is "engaged in the carriage of passengers, cargo or mail for remuneration or hire"[21].

With regard to scheduled international air services, Article 6 makes prior permission compulsory when the aircraft is engaged in scheduled international air services. The rights to overfly without making stops and to land for non commercial purposes were granted on a multilateral basis for aircraft engaged in

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16- *Ibid.*

17- M.N. Leich, "Straits Used for International Navigation" (1989) 83 A.J.I.L. 359.

18- Department of the U.S. Air Force, cited by I.Vlasic, Public International Air Law Course Material (Institute of Air and Space Law, McGill University, 1990) [unpublished].

19- Chicago Convention, *supra*, note 2, art. 11.

20- *Ibid.*

21- Regarding military aircraft, however, authorization to enter national airspace must be expressed in some prior agreement between the sovereign States: Department of the U.S. Air Force, *supra*, note 18.

scheduled flights in the International Air Service Transit Agreement[22]. The Agreement came into force on 30 January 1945, and in 1977 it had been ratified by 92 States[23]. The rights to carry out commercial aeronautical activities are generally granted on a bilateral basis.

Beyond the limit of territorial waters, is the continuous zone[24], an area in which States may exercise certain jurisdictional powers aimed at preventing "infringement of its customs, fiscal, immigration or sanitary regulations within its territory or territorial sea"[25]. The UNCLOS sets the breadth of the contiguous zone at 24 nautical miles from the coast, namely 12 miles from the limit of territorial waters[26].

It is arguable that sanitary regulations encompass environmental laws. A State probably would act within its rights by intercepting in the contiguous zone aircraft flying towards its territory which did not comply with the environmental regulations in force.

This would meet the concerns of that part of the doctrine which considers that the definition of national security, up to now limited to military considerations, should be extended to encompass threats to a State's environment. "A more expansive conception of security issues is now needed, one that includes the role of global environmental problems with international implications"[27]. "These problems, including acid precipitation, Arctic haze, ozone depletion, species extinction, and climatic change, have the potential to threaten international relations, behavior, and security"[28].

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22- *International Air Service Transit Agreement*, 7 December1944, ICAO Doc. 7500.

23- N.M. Matte, *Traité de droit aérien - aéronautique*, 3e éd., Paris, Editions Pedone, 1980 at 222.

24- Convention on the Territorial Sea and the Contiguous Zone, *supra*, note 3, art. 24.

25- *Ibid.*

26- Law of the Sea, *supra*, note 11 at 192.

27- P.H. Gleick, "Global Climatic Change and International Security" (1990) 1 Colo. J. Int'l Envtl. L. & Pol'y 41 at 42.

28- *Ibid.* at 41.

Finally, the UNCLOS of 1982, provides for an exclusive economic zone (EEZ) in which coastal States enjoy sovereign rights over economic activities and natural resources and have jurisdiction over the "protection and preservation of the marine environment"[29]. The breadth of the zone, measured from the baseline used to establish the width of the territorial sea, is 200 nautical miles[30]. UNCLOS considers three types of jurisdictions:

- the jurisdiction of the state of registry (national jurisdiction)
- the jurisdiction of states within their airspace (territorial jurisdiction)
- the jurisdiction of the state where the discharges occured (coastal state jurisdiction)

These states are vested by UNCLOS with different subject matter jurisdictions.

Does a coastal State's regulatory authority in environmental matters extend to the EEZ?

Article 61 of the Convention on the protection of living resources in the EEZ links protective measures to the threat of over exploitation[31]. Article 73 has a broader scope: "The coastal State may, in the exercise of its sovereign rights to explore exploit, conserve and manage the living resources in the exclusive economic zone, take such measures, including boarding, inspection, arrest and judicial proceedings, as may be necessary to ensure compliance with the laws adopted by it in conformity with this Convention" [32]. But the Convention, in its Articles 212 and 222, restricts jurisdiction over aircraft which have violated marine pollution and environmental standards to the State in the airspace of which the aircraft is flying and the State of registry[33]. Article 216 on the other hand provides for coastal State jurisdiction in cases where the marine environment of the territorial waters, the

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29- Law of the Sea, *supra* , note 11 at 195.

30- *Ibid.*

31- UNCLOS, *supra*, note 10.

32- *Ibid.*

33- *Ibid.*

EEZ or the continental shelf is polluted by dumping[34]. *A contrario* we can conclude that a coastal State may not exercise its jurisdiction to regulate aircraft pollution matters in the EEZ when they are "a consequence of their construction or equipment"[35]. As a consequence, under UNCLOS, "enforcement measures against foreign aircraft and their crews, including prosecution and punishment, may not be based on a violation committed in the airspace above the EEZ or the high seas since the Convention excludes coastal state regulatory jurisdiction over those areas"[36]. Thus the Convention does not address problems faced by coastal States due to aircraft fuel consumption in the EEZ. Nor does it deal with the possible modifications of a coastal State's climate and with the potential depletion of the ozone layer caused by aeronautical activities. Finally the Convention does not consider atmospheric disturbances caused by the passage of space shuttles in the EEZ[37].

These environmental hazards are the object of other international agreements under which States may agree to prosecute violators wherever the harmful acts are perpetrated[38].

b)Vertical Delimitation of National Airspace

There is no regulatory regime specifically designed for the protection of the outer space environment[39]. However, Article IX of the Outer Space Treaty of 1967[40] provides in general terms for the protection of terrestrial and outer space environments.

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34- *Ibid.*

35- K. Hailbronner, "Freedom of the Air and the Convention on the Law of the Sea" (1983) 77 A.J.I.L. 490 at 511-512.

36- *Ibid.*

37- *Ibid.*

38- *Ibid.*

39- H.A. Baker, *Space Debris: Legal and Policy Implications* (Dordrecht, Boston, London: Martinus Nijhoff Publishers, 1989) 74 and 95.

40- *Treaty on Principles Governing the Activities of States in the Exploitation and Use of Outer Space of Outer Space Including the Moon and Other Celestial Bodies,* 27 January

In the context of the actual division of sovereign rights over the lower atmosphere, however, it is necessary to differentiate outer space from national airspace.

International agreements did not set a boundary between national airspace and outer space[41]. The United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) has been the forum for lengthy debates over this question[42]. States are divided among functionalists and spatialists. Functionalists disapprove the adoption of a boundary. They attach importance to the purpose of the activity in order to distinguish aeronautical activities from astronautical activities[43]. "The concepts of freedom of space and state sovereignty must be understood as indicating a functional freedom and a functional sovereignty" rather than having an abstract significance[44]. However, the future development of aerospace planes such as the X-30, capable of reaching orbit, will make the purpose of the activity difficult to determine[45].

Spatialists favor the adoption of a criteria for the establishment of a boundary[46]. Some suggested that one of the layers of the stratosphere be selected to mark the limit between airspace and outer space[47]. But the layers are not at the same altitude around the earth and their position also varies with the time of the day[48]. Reference to a specific pressure or density of the atmosphere does

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1967, adopted in Resolution 2222 (XXI), 19 December 1966, 610 U.N.T.S. 206, T.I.A.S. 6347 [hereinafter Outer Space Treaty].

41 - Outer Space Treaty, *supra*, note 39, art. 2.

42- N.M. Matte, ed., *Space Activities and Emerging International Law* (Montreal: Centre for Research of Air and Space Law - McGill University, 1984) 383 - 386.

43- *Ibid.* at 380.

44- *Ibid.* at 381.

45- R.J. Hannigan & D.C. Webb, "Global Impacts of the NASP Program: The NASP - Derived Launch Vehicle", 41st Congress of the International Astronautical Federation, IAF Paper 90-381 (1990) 1.

46- Matte, *supra*, note 42 at 383.

47- *Ibid.* at 381.

48- *Ibid.* at 377.

not designate a homogeneous limit either. Another proposal sought to fix the limit of airspace at the maximum altitude at which a vehicle can benefit from atmospheric lift. But it was not specified whether the lift of reference should be the one from which an object derives its support, as an aircraft does up to 50 km, or whether lift is sufficient to characterize airspace when the object derives control from its action, as the space shuttle does up to 80 km[49]. Finally it was thought that the upper limit of airspace is the altitude of the lowest perigee of a satellite. At this time, the lowest orbit achieved by an artificial satellite is 80 km, but this limit could be reduced in the future[50].

Since none of the theories mentioned above could separate airspace subject to sovereign rights from outer space, Belgium proposed the adoption of an arbitrary boundary fixed at 100 km above sea level[51]. Then, in 1979, the Soviet Union submitted to the Legal Subcommittee of COPUOS a working paper stating that: "The region above 100 (110) kilometers altitude from the sea level of the earth is outer space"[52]. The International Law Association had expressed a similar view in 1978 at its fifty-eight conference held in Manila: "...the space at and above the altitude of about 100 km above sea level has been growingly acknowledged by states as well as by experts in the field of outer space activities as outer space"[53]. Yet, certain States claim exclusive rights over parts of the geostationary orbit located at 36,000 km above their territory, whereas others, such as Germany, the United Kingdom and the

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49- *Ibid.*

50- *Ibid.* at 378.

51- B. Cheng, "The Legal Regime of Airspace and Outer Space: The Boundary Problem Functionalism *Versus* Spatialism: The Major Premises" (1980) 5 A.A.S.L. 323 at 326.

52- *Ibid.*

53- Report of the Fifty-Eight Conference of the International Law Association (1978) cited by I. Vlasic, Public International Air Law Course Material (Institute of Air and Space Law, McGill University, 1990) [unpublished].

United States, maintain there is no immediate need for a boundary[54].
As a matter of fact, the desirability of establishing such a boundary for the purpose of regulating the environment is questionable.

c) Development of the Concept of Common Heritage of Mankind in Environmental Law

In effect, the principal object of environmental law is not the protection of sovereign airspace or free outer space but the protection of a global medium. While national airspace and outer space are geographical zones, the atmosphere is an ecological system characterized by the mobility of its components, which just like water circulate freely from nationally owned areas to international areas. Thus, pollution occasioned in this medium calls for a special treatment which does not attach so much importance to the separation of sovereignties[55]. Environmentalists have suggested that the atmosphere be declared *res communis humanitatis* or common heritage of mankind. States would only have partial property rights over the atmosphere and could exercise their police powers[56]. The concept was used for the first time in the Antarctic Treaty of 1959[57]. The preamble of the Treaty states that freedom of scientific investigation and co-operation among States in Antarctica are in "the interests of science and the progress of all mankind"[58]. Thus, the Antarctic benefits from a special status. Only peaceful activities are allowed and military

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54- Cheng, *supra*, note 51 at 326.

55- C. de Klemm, "Les éléments de l'environement en droit positif" in A. Kiss, ed., *L'écologie et la loi, le statut juridique de l'environnement* (Paris: Editions L'Harmattan, 1989) 51 at 72.

56- *Ibid.*

57- *The Antarctic Treaty*, 1 December 1959, 402 UNTS 71, 54 AJIL (1960); The Antarctic Treaty entered into force on 23 June 1961: J. Willisch, *State Responsibility for Technological Damage in International Law* ( Berlin: Duncker & Humblot, 1986) 107.

58- *Ibid.*

maneuvers are prohibited[59]. Furthermore Article 3 of the Treaty urges States to share scientific observations and personnel and to exchange information on scientific programs. Finally, States may not make new claims to territorial sovereignty in the Antarctic[60]. The concept of "common concern of mankind" has since worked its way into environmental treaties and enhanced the adoption of global management policies[61]. The Protocol on Environmental Protection to the Antarctic Treaty recognizes that "the development of a comprehensive regime for the protection of the Antarctic environment and dependent and associated ecosystems is in the interest of mankind as a whole"[62]. Antarctica is designated as "a natural reserve, devoted to peace and science"[63]. The Protocol establishes principles for the conduct of activities in the Antarctic. Adverse effects on climate, weather patterns and significant changes in the atmospheric terrestrial or marine environments should be avoided[64]. A procedure of environmental impact assessment is set out in Annexes[65]. Antarctic Treaty Consultative Meetings define a comprehensive program for the protection of the Antarctic environment[66]. Decisions are adopted on the basis of scientific data reported by a Committee for Environmental Protection thereby created[67]. This regime is a more detailed version of the one drafted with respect to the high seas in

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59- Antarctic Treaty, *supra*, note 57, art. 1.

60- *Ibid.*, art. 4(2).

61- A. Kiss, "The International Protection of the Environment" in R.St. MacDonald & D.M. Johnston, eds, *The Structure and Process of International Law: Essays in Legal Philosophy, Doctrine and Theory* (The Hague, Boston: Martinus Nijhoff Publishers, 1983) at 1082.

62- *Protocol on Environmental Protection to the Antarctic Treaty*, opened for signature until 3 October 1992, 30 I.L.M. 1461 (1991).

63- *Ibid.*, art. 2.

64- *Ibid.*, art. 3 (b).

65- *Ibid.*, art. 8

66- *Ibid.*, art. 10(1).

67- *Ibid.*, art. 11.

the UNCLOS. Article 145 of this convention provides that the Authority, established under Article 156, concerns the adoption of measures for "the prevention, reduction and control of pollution and other hazards to the marine environment"[68].

Conservation measures which apply regardless of the limits of territorial sovereignty have also been adopted with regard to elements of the environment which are exclusively under national jurisdiction[69]. Such measures have been adopted with respect to the protection of a specific element of the atmosphere: the ozone layer. Located at 32 km above the earth's surface[70], the ozone layer is below the 100 km frontier, which is deemed to separate airspace from outer space. Thus it is within the scope of States' territorial sovereignty. It has nevertheless been agreed in the Vienna Convention for the Protection of the Ozone Layer of 1985 that activities likely to affect the ozone layer be monitored by an independent body[71]. The Convention establishes a Conference of the Parties in charge of *inter alia* analyzing scientific data on the ozone layer, promoting the harmonization of policies "for minimizing the release of substances causing or likely to cause modification of the ozone layer", and suggesting appropriate action to be taken[72]. The Convention entered into force on 22 September 1988[73].

Actually, to qualify an environmental problem as a "common concern of mankind" implies that "special implementation techniques are used" by which contracting States defer the task of

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68- UNCLOS, *supra*, note 10.

69- Kiss, *supra*, note 61 at 1083.

70- U.S. Senate, Committee on Aeronautical and Space Sciences, *The International Legal and Institutional Aspects of the Stratospheric Ozone Problem* by K. Q. Christol (Washington: U.S. Government Printing Office, 1975) at 32.

71- *Vienna Convention for the Protection of the Ozone Layer*, 22 March 1985, 26 I.L.M. 1516 (1987) [hereinafter Vienna Convention of 1985].

72- *Ibid.*, art. 6.

73- G. Palmer, "New Ways to Make International Environmental Law" (1992) 86 American Journal of International Law 259 at 262.

managing the environment of an area to an international body especially created for this purpose[74]. The development of such a regime with regard to areas under State jurisdiction is a novelty in the law of nations[75].

Nowadays, as concerns for the ozone layer and global warming grow, the atmosphere is increasingly being dealt with as a priority issue in environmental protection. The atmosphere is being envisaged either as a transmitter of pollution or as a the ecosystem affected by the noxious substances. These measures often directly refer to air transportation and have the potential of significantly affecting the future of aeronautical activities.

## 2. Pollution of the Marine Environment Through the Atmosphere by Aeronautical Activities

### a) Protective Measures of Universal Scope

Efforts made by States to protect the global environment on a multilateral basis have all been enhanced by the guidelines found in the Stockholm Declaration on the Human Environment[76].
One of the first Conventions to prohibit dumping from aircraft was the London Convention on the Dumping of Wastes at Sea of 1972[77].

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74- Kiss, *supra*, note 61 at 1082-1083.

75- *Ibid.* at 1082.

76- *Stockholm Declaration of the United Nations on the Human Environment*, 16 June 1972, U.N. Doc. A/CONF. 48/14, 11 I.L.M. 1416 [hereinafter Stockholm Declaration]; V.P. Nanda, "Stratospheric Ozone Depletion: A Challenge for International Environmental Law and Policy" (1989) 10 Michigan International Law Journal 482 at 494.

77- *Convention on the Dumping of Wastes at Sea*, 13 November 1972, 11 I.L.M. 1291 (1972) [hereinafter London Convention of 1972]; The Convention entered into force on 30 August 1975 and by 31 December 1984, the number of Parties to it was fifty-four: Willisch, *supra*, note 57 at 91-92.

In Article 1, the Parties to the Convention undertake "to prevent the pollution of the sea by the dumping of waste and other matter that is liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate sources of the sea". The Convention applies to "all marine waters other than the internal waters of States"[78], which means it applies to territorial waters. The London Convention is one of the first to have given priority to the "equal protection of common interests" over State sovereignty[79].

Two types of dumping related to aviation are defined in Article III. The first is the willful disposal of waste from an aircraft. The second is the disposal of aircraft. But, the disposal of wastes resulting from "the normal operations of...aircraft" does not come under the Convention. An exemption is also provided for by Article V, when dumping was necessary to protect human life and the aircraft, but such incidents must be reported pursuant to Article 5 of the Convention.

Three types of rules are applicable to different pollutants. Wastes listed in Annex I, called the "black list", may not be dumped[80]. Chemicals listed in Annex II, called the "gray list", may be disposed of in the sea provided a special permit to do so has been issued[81]. Wastes listed in Annex III can be disposed of when a general permit is issued[82]. A Special permit is one granted cases by case in accordance to certain criteria given in Annexes II and III[83] . A general permit is granted in advance considering the criteria set out in Annex III[84].

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78- London Convention, *supra*, note 77, art. III(1).

79- Kiss, *supra*, note 61 at 1082.

80- A. Springer, *International Law of Pollution: Protecting the Global Environment in a World of Sovereign States* (Wesport, London: Quorum Books, 1983) 98.

81- *Ibid.*

82- London Convention, *supra*, note 77,art. III(5).

83- *Ibid.*, art. IV(1).

84- *Ibid.*, art. III(6).

In addition, the Parties agree to engage in the prevention of marine pollution, within appropriate international bodies, by combating *inter alia* pollution by hydrocarbons and by "wastes generated in the course of operation of aircraft"[85].

The permits are delivered by national authorities designated by each Party[86].

According to Article VI(2), with respect to aircraft, a State has jurisdiction to issue a permit in three cases:

- When the wastes are loaded in its territory;
- When the wastes are loaded on an aircraft of it registry or flying its flag if the loading occurs in a non-party State.

Jurisdiction of the State where the dumping occurred is referred to in Article VII. It stipulates that enforcement of the Convention is ensured by the two States mentioned above and by States having jurisdiction over the aircraft engaged in dumping.

Pursuant to this Article, "... aircraft entitled to sovereign immunity under international law" are not covered by the Convention. The doctrine of sovereign immunity applies to acts of a State, which are inherent to its sovereignty and to those performed for the accomplishment of a public service, as well as to the material means which are affected to such activities[87]. Thus, the London Convention exempts State aircraft, within the meaning of the Chicago Convention, along with aircraft engaged in postal services. But actually States are put under an obligation to ensure that such aircraft "act in a manner consistent with the object and purpose of this Convention..."[88].

The UNCLOS of 1982 contains very broad rules for the protection of the marine environment. Article 194 requires that States take "individually or jointly as appropriate, all measures consistent with [the] Convention that are necessary to prevent, reduce and control

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85- *Ibid.*, art. XII.

86- *Ibid.*, art. VI(1).

87- P. Mayer, *Droit international privé*, 3e éd., Paris, Montchrestien, 1987 at 206-207.

88- London Convention, *supra*, note 77, art. VII.

pollution of the marine environment from any source"[89]. Different types of pollution are provided for. Articles 212 and 222 deal with marine pollution conveyed through the atmosphere.

Article 212(1) imposes on States a general obligation to "adopt laws and regulations to prevent, reduce and control pollution of the marine environment from or through the atmosphere, applicable [*inter alia* ] to the air space under their sovereignty and to...aircraft of their registry, taking into account internationally agreed rules and standards and recommended practices"[90]. Reference to the safety of air navigation in Articles 212 and 222 suggests that environmental measures give way to the rules of safety.

To this end, States are asked to act within international organizations or diplomatic conferences for the establishment of global and regional rules as well as standards and recommended practices[91]. Consequently, not only does the UNCLOS incorporate all the ecostandards previously set for the protection of the marine environment through the atmosphere, but it provides for the adoption of very comprehensive future standards[92]. Every State is required "to prescribe pollution standards for its own national aircraft wherever they may be and for all aircraft flying within its own airspace"[93].

Pursuant to Article 222, enforcement of the rules established under Article 212 and of the international norms and standards adopted by international organizations and conferences for the protection of the marine environment from pollution conveyed by the atmosphere must be ensured by States "within their airspace and with regard to aircraft of their registry"[94]. Jurisdiction to act

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89- UNCLOS, *supra*, note 10.

90- *Ibid.*, art. 212 (1).

91- *Ibid.*, art. 212(3).

92- Willisch, *supra*, note 57 at 125.

93- Hailbronner, *supra*, note at 511.

94- Law of the Sea, *supra*, note 11 at 228.

under the Convention, hence, "rests with the state of registry of the aircraft or the state exercising its sovereign rights within its airspace"[95].

Conflicts could arise if the State where the aircraft wants to operate has adopted the UNCLOS but not the State of registration of the aircraft. The Chicago Convention solves this problem by giving priority to the law of the territorial sovereign. Article 11 of the Chicago Convention stipulates that aircraft comply with "the laws and regulations of a contracting State relating to the admission or departure from its territory of aircraft engaged in international air navigation or to the operation and navigation of such aircraft while within its territory"[96].

The State of registration of the aircraft is not necessarily the State which has an effective control over the airplane. The adoption of Article 83 bis of the Chicago Convention would remedy the inconvenience of putting all of the rights and obligations pertaining to the aircraft in the hands of the State of registry when this State has no longer an effective control over the aircraft[97]. This transfer could operate with respect to environment-related provisions of the Chicago Convention but not to obligations arising out of the UNCLOS. Thus, if Article 83 bis were adopted, there would be a dual jurisdiction of the State of registry and the State of the operator of the aircraft in environmental matters.

With respect to discharges from a vessel, Article 218 grants the port State (where the ship is at berth) the power to investigate such act, when it has occurred outside its waters, upon request of the flag State, the State having sovereignty over the waters where it occurred or a State affected by the dumping (coastal State)[98]. There is no equivalent provision with regard to aircraft. But coastal State jurisdiction over cases of aircraft dumping is stipulated in Article 216 (1)(a). When the dumping occurred in its territorial

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95- Hailbronner, *supra*, note 35 at 511.

96- Chicago Convention, *supra*, note 2.

97- See Chapter II.

98- Law of the Sea, *supra*, note 11 at 228.

waters, in its EEZ, or onto its continental shelf, Article 216 gives the coastal State jurisdiction to enforce applicable regulations found in the UNCLOS as well as other "applicable international rules and standards established through competent international organizations" or conferences for the protection of the marine environment[99]. Hence the UNCLOS encompasses conventions dealing with aircraft dumping at sea established on a regional basis.

"Aircraft owned or operated by a State and used, for the time being, only on government non-commercial service" are excluded from the scope of the provisions on environmental protection[100]. The Chicago Convention of 1944 includes in the category of State aircraft those "used in the military, customs and police services"[101]. Aircraft which are "on government non-commercial service" can include aircraft engaged in postal services[102]. Nevertheless, States are asked to adopt measures to the effect that these aircraft "act in a manner consistent" with the Convention, in so far as it does not impair the operational potential of the aircraft nor go beyond what is "reasonable and practicable"[103]. It is questionable whether this attempt to subject military aircraft to environmental legislation will have any practical value, since none of the technical characteristics of the aircraft have to be modified.

The UNCLOS also contains provisions pertaining to marine pollution from land-based sources which encompasses airport

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99- UNCLOS, *supra*, note 10, art. 216.

100- *Ibid.*, art. 236.

101- Chicago Convention, *supra*, note 2,art. 3.

102- Matte, *supra*, note 23 at 504.

103- UNCLOS,*supra*, note 10, art. 236.

pollution of underground waters[104] and of the atmosphere[105]. Although this issue will not be extensively covered in this thesis, it will nevertheless be mentioned in the analysis of conventions of regional scope.

b)Protective Measures of Regional Scope

The London Convention, which promotes co-operation in the fight against marine pollution, was itself drafted on the model of a convention of regional scope concluded in Oslo in 1972[106]. The Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft applies to the high seas and territorial seas located in the Atlantic and Arctic Oceans with the exclusion of the Baltic Sea[107]. Though the Convention was intended for States invited to participate in the Conference on Marine Pollution held in Oslo in 1971, namely riparian States, Article 22 invites other States to accede to the Convention. The Oslo Convention seeks to prevent the harmful effects of hazardous substances on human health, living resources, marine life, amenities and the legitimate uses of the sea. The dumping of substances listed in three Annexes is either prohibited, in the case of Annex 1, or conditioned by the delivery of an authorization. Article 19 defines dumping as the disposal of substances from *inter alia* an aircraft where such dumping is not derived from the normal operation of the aircraft. According to Article 8 the restrictions do not apply when dumping

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104- Cases of pollution of the soil and underground waters by infiltration of chemicals and fuel used at airports are fairly common: B. Walters, "Neutralizing de-icing contaminants" *Jane's Airport Review* (March 1991) at 22.

105- UNCLOS, *supra*, note 10, art. 194, 207 and 213.

106- A. Kiss, *Droit international de l'environnement*, Paris, Editions Pedone, 1989 at 160.

107- *Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft*, 15 February 1972, 11 I.L.M. 262 (1972) [hereinafter Oslo Convention]; The Oslo Convention entered into force on 7 April 1974 and counts 13 Parties: Willisch, *supra*, note 57 at 95.

is caused by force majeure when the safety of humans or of the aircraft is at stake.

The main difference between the two Conventions lies in the creation by the Oslo Convention of a Commission of Representatives which is more precisely defined than its counterpart in the London Convention and has a much more active role[108]. Pursuant to article 9, in cases of emergency where it would be too dangerous to dispose of a substance listed in Annex 1 on land, the Commission is empowered to propose appropriate alternative means of storage. In the context of the Commission's mission, the alternative will be the dumping of wastes at sea. The Convention does not define cases of emergency, and the Commission's decisions in these matters are mere recommendations. Hence a Party can justify the dumping of the most dangerous substances using Article 9 and depart from the aim of the Convention[109]. According to article 15, jurisdiction to ensure compliance with the Convention lies with the State of registry of the aircraft, the State where the substances which are to be dumped are loaded and the State in who's territorial sea the dumping occurred. Although Article 15(6) omits to mention aircraft when excluding vessels entitled to sovereign immunity from the application of the Convention, it is not likely that aircraft entitled to sovereign immunity come under the prohibitions of the Convention.

Other regional Conventions were modeled on this pattern. The Convention on the Protection of the Marine Environment of the Baltic Sea Area[110] "was adopted during a diplomatic conference hosted by Finland in March 1974 and entered into force in

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108- *Ibid.* at 163.

109- *Ibid.* at 97.

110- *Convention on the Protection of the Marine Environment of the Baltic Sea Area*, 22 March 1974, 13 I.L.M. 546 (1974) [hereinafter Helsinki Convention].

1980"[111]. The Helsinki Convention is more stringent than the previous regional conventions for the protection of the marine environment. Article 3 imposes on the Parties a "fundamental obligation ... to individually or jointly take all appropriate ... measures ... to abate and prevent pollution and to protect and enhance the marine environment"[112]. Thus Article 9 bans dumping from aircraft except in cases of emergency and regarding dredge debris[113]. The Convention, however, does not apply to military aircraft[114]. With regard to pollution from airports, Article 6 of the Helsinki Convention applicable to land-based pollution calls the parties' attention to their obligation to control emissions of substances found in Annex II[115]. The list covers *inter alia* chromium, copper, lead, nickel, elemental phosphorus, persistent halogenated hydrocarbons and substances which adversely affect the taste and the smell of products of the sea or of the water or which interfere with the legitimate uses of the sea. Annex III lists measures for the treatment of sewage or water to prevent contamination of the sea. The provisions of the Helsinki Convention regarding airborne pollution in general remain insufficient to protect efficiently the Baltic Sea. The parties are merely required to "endeavor to use the best practicable means to prevent harmful substances and materials from being introduced"[116]. This can be explained by the sensitive nature of atmospheric pollution which generally originates in foreign territories[117].

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111- J. Brunnée, "The Baltic Sea Area and Long-Range Atmospheric Pollution _ How Regional Cooperation Fits Into the Larger Picture" (1991) 36 McGill L.J. 853 at 864.

112- *Ibid.* at 867.

113- *Ibid.* at 868.

114- *Ibid.* at 867.

115- Helsinki Convention, *supra*, note 110, art. 8.

116- *Ibid.*

117- Brunnée, *supra*, note 111 at 870.

One of the more elaborate conventions dealing with sea pollution transmitted through the atmosphere is the Convention for the Protection of the Mediterranean Sea against Pollution of 1976 and its Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft[118]. It was drafted on the basis of a model established by the United Nations Environmental Program (UNEP)[119]. The Barcelona Convention institutes a framework for the co-operation of member States and for the adoption of Protocols prescribing standards of implementation of the Convention in several areas of pollution[120]. The technical provisions of the Barcelona Dumping Protocol are very similar to those of the London Convention. The dumping of matter listed in Annex I is prohibited[121]. The dumping of substances listed in Annex II is subject to the delivery of a special permit by competent national authorities[122]. All other wastes may be dumped into the Mediterranean sea if a general permit to do so was granted by competent national authorities[123]. The lists of substances found in Annexes I and II are however more expansive than those of the London Convention. The Barcelona Convention also contains provisions applicable to airports located near the Mediterranean coast. It prescribes that parties "prevent, abate and combat pollution .... caused by discharges from rivers, coastal establishments ... or emanating from any other land-based sources within their territories."[124]. The Protocol for the Protection of the

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118- *Convention for the Protection of the Mediterranean Sea against Pollution* and *Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft*, 16 February 1976, 15 I.L.M. 285 (1976) [hereinafter Barcelona Convention and Barcelona Dumping Protocol].

119- Brunnée, *supra* note 111 at 872.

120- Barcelona Convention, *supra*, note 118, art. 4 (2).

121- Barcelona Dumping Protocol, *supra* , note 118, art. 4 .

122- *Ibid.*, art. 5.

123- *Ibid.*, art. 6.

124- Barcelona Convention, *supra*, note 118, art. 8.

Mediterranean Sea Against Pollution from Land-Based Sources[125] requires the Parties to eliminate certain substances. The list of substances covers orgahalogen and phosphate substances which could seriously affect the use of certain detergents and de-icing substances. Emissions of *inter alia* zinc, copper, lead and inorganic phosphorous have to be limited. Finally the parties are asked to adopt standards of lead content in gasoline[126].
The Athens Protocol does not deal extensively with atmospheric pollution. Nevertheless Article 4 (1)(b) of the Protocol states that its provisions will be made applicable to atmospheric pollution from land based sources according to an Annex which is to be adopted The draft of the additional annex submitted to the Parties to the Barcelona Convention in 1990 covers atmospheric pollution from land-based sources in the transportation field. Thus the standards found in the Athens Protocol will be made applicable to this form of pollution.

The Convention for the Protection of the Natural Resources and Environment of the South Pacific Region is the latest agreement to have been drafted on the model established by UNEP[127]. It has two Protocols. One deals with pollution caused in cases of emergency and the other covers aircraft dumping[128]. The Protocol for the Prevention of Pollution of the South Pacific Region by Dumping[129] resembles the London Convention. Pursuant to the Convention, the parties have a general obligation "to prevent, reduce and control pollution ... from any source, and to ensure sound environmental

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125- *Protocol for the Protection of the Mediterranean Sea Against Pollution from Land-Based Sources*, 17 May 1980, 19 I.L.M. 869 (1980) [hereinafter Athens Protocol].

126- Brunnée, *supra*, note 111 at 872.

127- *Convention for the Protection of the Natural Resources and Environment of the South Pacific*, 25 November 1986, 26 I.L.M. 38 (1987) [hereinafter Nouméa Convention].

128- *Ibid.* in art. 5(3).

129- *Protocol for the Prevention of Pollution of the South Pacific Region by Dumping*, 25 November 1986, 26 I.L.M. 38 (1987).

management and development of natural resources ..."[130]. Article 7 of the Convention which deals with pollution from land-based sources provides that the parties must "prevent, reduce and control pollution ... caused by ... discharges emanating from rivers ... coastal establishments ... or any other source in their territory"[131]. Article 9 calls upon the parties to take action for the prevention and control of pollution "resulting from discharges into the atmosphere from activities under their jurisdiction"[132].

A significant amount of the marine pollution is transported through the atmosphere. With regard to the Baltic Sea experts have stated that out of the 500.000 tons of nitrogen depriving the water of its oxygen, 45% of it enters the sea through the atmosphere, either via rain or by direct absorption of the water[133]. The atmosphere was also said to transport a considerable amount of heavy metals into the Baltic Sea. The problem is that airborne pollutants originate in part in States which are not members to the regional conventions. This emphasizes again the necessity of organizing a comprehensive system of State cooperation in environmental matters. Cooperation on a large scale basis was observed when States faced the problem of the depletion of the ozone layer.

## 3. Pollution of the Atmosphere by Aeronautical Activities

### a) Protective Measures Adopted on a World-Wide Basis

The protection of the ozone layer was the object of a four year struggle by the United Nations Environmental Program (UNEP) to

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130- Nouméa Convention, *supra*, note 127, art. 5(1).

131- *Ibid.*, art. 7.

132- *Ibid.*, art. 9.

133- Brunnée, *supra*, note 111 at 862.

define the grounds on which industrial would agree to act [134]. At the time scientific evidence of the ozone depletion problem and its alleged causes were still contested[135]. The outcome of UNEP's efforts was the Vienna Convention for the Protection of the Ozone Layer, which was signed on 22 March 1985[136]. The parties' general obligations under Article 2 of the convention are to "take appropriate measures ... to protect human health and the environment against adverse effects resulting or likely to result from human activities which modify or are likely to modify the ozone layer". The Convention then establishes a scheme for the adoption of Protocols to the Convention and Annexes to the Convention and the Protocols[137]. When no consensus is reached the Convention departs from the unanimous vote requirement. It allows that protocols, amendments and annexes to the Convention be adopted by a two-thirds majority of the parties present and voting subject to approval by all the Parties. With regard to amendments and annexes to the protocols, the majority rule is the same, but approval by all the parties is not even required. The parties have six months to notify their disagreement with the protocol or the annex after which the amendment will become effective for all the parties[138]. The flexibility of the system allows a progressive adoption of standards necessary for environmental protection without proceeding through the burdensome diplomatic channels. The Vienna Convention treaty system can nevertheless be threatened by withdrawals[139].

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134- M.E. Somerset, "An Attempt to Stop the Sky from Falling: The Montreal Protocol to Protect Against Atmospheric Ozone Reduction" (1988) 15 Syr. J. Int'l L.& Com. 391 at 393.

135- Palmer, *supra*, note 73 at 274.

136- Vienna Convention, *supra*, note 71, entered into force on 22 September 1988: Palmer, *supra*, note 73 at 262.

137- *Ibid.*, art. 9 and 10.

138- *Ibid.*, art. 10(2)(b) and (c).

139- Palmer, *supra*, note 73 at 275.

By 1987, as it was clear that further action was needed, the Montreal Protocol on Substances that Deplete the Ozone Layer was attached to the Vienna Convention[140].

The Montreal Protocol provides for a progressive reduction of the consumption and the production of CFCs from 1989 to 1999[141]. By 1999 and for years to come, States must have reduced by 50% their use of CFCs. Amounts are calculated on the basis of the 1986 consumption and production levels for each State. With regard to developing countries, Article 5 provides for a more lenient regime when the level of consumption of the controlled substances is less than 0.3 kg per year. Article 4 of the Protocol progressively bans imports and exports of controlled substances from and to non member States. Moreover the parties are required to incorporate in an annex a list of products containing controlled substances[142]. Any State which has not objected to the annex within one year of its becoming effective will be prevented from importing those products from a non member State[143]. Within five years of the entry into force of the Protocol similar steps are to be taken with regard to the import of products manufactured with but not containing controlled substances[144].

The aerospace industry is concerned about those measures since it uses CFCs to clean electronic products[145]. Moreover CFCs are used in aerosols, refrigerators, plastic composites and insulation[146].

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140- *Montreal Protocol on Substances that Deplete the Ozone Layer*, opened for signature in Montreal on 16 September 1987, 26 I.L.M. 1550 (1987) [hereinafter Montreal Protocol], entered into force on 1 January 1989: Palmer, *supra*, note 73 at 263.

141- *Ibid.*, art. 2.

142- *Ibid.*, art. 4(3).

143- *Ibid.*

144- *Ibid.*, art. 4(4).

145- M. Pilling, "Pollution Laws Multiply", *Interavia Aerospace Review* (May 1991) 26.

146- M. Mead, "Coming Clean", *Airline Business* (October 1990) 26 at 27.

Controlled substances also include certain halons used in fire extinguishers[147].

According to Article 6 of the Protocol, starting 1990 and every four years thereon, the parties are to assess the efficiency of the control measures found in Article 2 by considering scientific, environmental, technical and economic data[148]. On the basis of their findings, Article 2(9)(a) states that the Parties may make adjustments to the standards of production and consumption of the controlled substances. The modifications should be adopted upon unanimous agreement of the Parties, but in the absence of consensus Article 2 (9)(c) offers the possibility of adopting the improvements with only a "two-thirds majority vote of the Parties present and voting representing *at least fifty percent of the total consumption of the controlled substances of the Parties* "[149]. Controlled substances include halons[150] but there is no time table for the reduction of halons in the Montreal Protocol. In order to add new substances the normal voting procedure applies[151].

In light of the more recent discoveries regarding the ozone layer depletion, it soon became clear that the Montreal Protocol did not sufficiently fulfill its protective role[152]. Thus on 2 May 1989, in the Helsinki Declaration on the Protection of the Ozone Layer, governments of the European Communities pleaded for a complete phase-out by 1990 of the CFCs listed in the Montreal Protocol, for the adoption of a process of elimination of halons and for the

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147- *Ibid.*

148- Palmer, *supra*, note 73 at 275.

149- *Ibid.*

150- Montreal Protocol, *supra*, note 140, art. 1 and Annex A.

151- Palmer, *supra*, note 73 at 275.

152- *Ibid.* at 274.

inclusion of more ozone depleting substances in the phase-out process[153].

The Adjustments to the Montreal Protocol on Substances that Deplete the Ozone Layer adopted in London in 1990 responded to the need for a more stringent legislation[154]. However with respect to CFCs, the London Amendments are more lenient than the Montreal Protocol for the period of time extending from 1 July 1991 to 1 January 1995. The limit on consumption and production of the CFCs covered by the Montreal Protocol is 150% of the 1986 levels[155]. Then, the limit drops to 50% from 1 January 1995 to 1 January 1997. From 1 January 1997 to 1 January 2000 only 15% of the levels of the CFCs consumed and produced in 1986 are authorized. Starting 1 January 2000 there should be no consumption or production of those CFCs[156]. A similar phase-out process is adopted with respect to halons covered by the Montreal Protocol. Their elimination starts on 1 January 1992 and is completely achieved by 1 January 2000. The London Amendments also provide for the elimination of other fully halogenated CFC's. The phase-out process based on 1989 levels of consumption and production starts on 1 January 1993 and ends on 1 January 2000 when none of these substances are authorized[157]. The London Amendments add to the list of substances to be eliminated: carbon tetrachloride and methyl chloroform[158].

With regards to ulterior adjustments, the London Amendments refine the voting rule found in the Montreal Protocol in order to

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153- *Helsinki Declaration on the Protection of the Ozone Layer*, 2 May 1989, 28 I.L.M. 1335 (1989).

154- *Adjustments to the Montreal Protocol on Substances that Deplete the Ozone Layer*, 29 June 1990, 30 I.L.M. 537 (1991) [hereinafter London Amendments].

155- *Ibid.* in Annex I, sec. A(2).

156- *Ibid.* in Annex I, sec. A(5)

157- *Ibid.* in Annex II, sec. K.

158- *Ibid.* in Annex II, sec. L.

add weight to the voting power of developing countries[159]. Thus the two-thirds majority vote must now represent "a majority of the Parties operating under paragraph 1 of Article 4 present and voting and a majority of the parties not so operating present and voting"[160].

However, problems may arise if a party disagrees with one of the amendments adopted. The London Amendments now allow withdrawal from the Protocol after a State has implemented its obligations to reduce CFCs under the amended Article 2 for a period of four years[161]. Furthermore certain States have postponed ratification of the Montreal Protocol until financial arrangements are established to accommodate developing countries[162]. In September 1991, the Vienna Convention had been ratified by eighty countries, the Montreal Protocol by seventy-three and the London Amendments by five[163]. But the urgency of actions to be taken is such that one wonders if there should not be a stronger international organization to promote the interests of the environment and arrange for its protection while taking into account the discrepancies between industrialized countries and developing countries. Moreover the various multilateral agreements in force today do not "provide an adequate framework for a legal regime for the atmosphere", and none deals specifically with the problem of global warming[164].

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159- Palmer, *supra*, note 73 at 275.

160- London Amendments, *supra*, note 154 in Annex II, sec. H.

161- Palmer, *supra*, note 73 at 275.

162- *Ibid.* at 276.

163- *Ibid.*

164- N. Bankes, "Legal Prescriptions for an Atmosphere That Will Sustain the Earth" in J.O. Saunders, ed. *The Legal Challenge of Sustainable Development: Essays from the Fourth Institute Conference on Natural Resources Law* (Calgary: Canadian Institute of Resources Law, 1990) 155 at 169.

The Toronto Conference on the Changing of the Atmosphere, sponsored by UNEP and the World Meteorological Organization (WMO), recognized in June 1988 the necessity of developing "a comprehensive global convention as a framework for the protocols on the protection of the atmosphere"[165]. And in December 1988, the General Assembly of the United Nations stated in Resolution 43/53 that "climate change affects humanity as a whole and should be confronted within a global framework so as to take into account the vital interests of all mankind"[166]. UNEP, the WMO and the Intergovernmental Panel on Climate Change are asked to co-operate for the establishment of a "possible future international convention on climate"[167].

The creation of an organization in charge of protecting the atmosphere or the reinforcement of existing ones finds support with the twenty-four signatory States of the Declaration on the Protection of the Atmosphere[168]. The Hague Declaration proclaims the necessity of protecting the interests of humanity as a whole and of finding solutions on a world-wide basis. At the same time the Declaration emphasizes the responsibility of developed countries in the pollution of the atmosphere and reminds states that they have a duty to assist developing countries being seriously affected by atmospheric changes. In order to protect our vital interests, the Declaration calls for the implementation of existing principles as well as the "development of new principles of international law including new and more effective decision-making and enforcement mechanisms"[169]. One of the primary concerns of the environmental organization will be global warming. It will develop standards for the protection of the atmosphere and it will ensure

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165- *Ibid.* at 170.

166- *Ibid.*

167- *Ibid.*

168- *Declaration on the Protection of the Atmosphere*, 11 March 1989, 28 I.L.M. 1308 (1989) [hereinafter Hague Declaration].

169- *Ibid.*

compliance with these standards. Where unanimous consent is not obtained, the organization will be entitled to resort to any decision making process available[170]. As a consequence, a nation would be obliged to follow a rule even if it did not agree to it. "Acceptance that nations can be bound without their consent opens the door to a quite different legal context from that in which international law has developed. It offers the prospect of fashioning an international legislative process for global environmental issues"[171].

b) Protective Measures Adopted Within a Regional Framework

The Organization for Economic Cooperation and Development (OECD) was the first to report the seriousness of transboundary air pollution in Europe[172]. Acid deposition has affected over six million hectares of forest land in Europe and 18,000 of Sweden's 85,000 lakes[173]. The OECD found that most of the acid deposition found in half of the countries under observation came from foreign sources[174]. Consequently the OECD established principles regarding state responsibility for transboundary air pollution[175]. Amongst these principles is the "Polluter Pays Principle" (PPP) which states that the cost of pollution control should be borne by the industry that causes the pollution rather than by States[176]. With respect to aircraft emissions it is possible to determine the proportion of pollutants emitted by an airline in much the same way that Swissair

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170- *Ibid.*

171- Palmer, *supra*, note 73 at 278.

172- A. Fraenkel, "The Convention on Long-Range Transboundary Air Pollution: Meeting the Challenge of International Cooperation" (1989) 30 Harvard Int. L. J. 447 at 453.

173- *Ibid.* at 449-450.

174- *Ibid.* at 453.

175- *OECD Council Recommendation on Implementing a Regime of Equal Right of Access and Non-Discrimination in Relation to Transfrontier Pollution*, adopted by OECD Council on 17 May 1977, 442nd Sess., reproduced in 16 I.L.M. 977 (1977).

176- Fraenkel, *supra*, note 172 at 454.

was able to have its activities audited by environmental experts[177]. It is more difficult however to establish a link between the global emissions of an airline and the damage suffered by one State.
The OECD also made recommendations regarding the manner in which States should engage in consultations and exchange information on transfrontier pollution[178]. Although the Principles are not binding they provided guidance for the draft of a multilateral treaty on transboundary air pollution.

The process of adoption of the first multilateral convention specifically addressing the problem of transboundary air pollution started in 1975 during a Conference on Security and Cooperation in Europe held in Helsinki[179]. On this occasion President Leonid Brezhnev called for cooperation in the fields of energy, transportation and the environment. Scandinavian countries took this opportunity to propose that a treaty on transfrontier pollution be adopted. This treaty was negotiated within United Nations' Economic Commission for Europe (ECE) which groups all of the European countries as well as Canada and the United States[180].

The Convention on Long Range Transboundary Air Pollution is an umbrella convention for the development "through international co-operation" of "an extensive program for the monitoring and evaluation of long-range transport of air pollutants, starting with sulfur dioxide and with possible extension to other pollutants"[181]. Article 1 of the Convention defines long range transboundary air pollution as:

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177- M. Pilling, "Airlines Face Heavy Bill for Going Green", *Interavia Aerospace Review* (May 1991) 10.

178- T.M. Shoesmith, "Transfrontier Pollution" (1978) 19 Harvard Int. L. J. 407 at 408.

179- Fraenkel, *supra*, note 172 at 454.

180- G. Wetstone & A. Rosencranz, "Transboundary Air Pollution in Europe: A Survey of National Responses" (1983) 9 Columbia J. Env. L. 1 at 4-5.

181- *Convention on Long Range Transboundary Air Pollution*, 13 November 1979, 18 I.L.M. 1442 (1979) [hereinafter Geneva Convention].

"air pollution whose physical origin is situated wholly or in part within the area under the national jurisdiction of one State and which has adverse effects in the area under the jurisdiction of another State at such a distance that it is not generally possible to distinguish the contribution of individual emission sources or group of sources".

This definition seems to preclude any kind of attribution of responsibility of an individual polluter[182]. The Parties agree to proceed with exchanges of information and consultations and to develop policies to combat the discharge of air pollutants which may adversely affect man and his environment[183]. Consultations at an early stage are provided for in Article 5. They are to be held upon request between States which suffer from long-range transboundary air pollution and "Contracting Parties within which and subject to whose jurisdiction a significant contribution to long-range transboundary air pollution originates or could originate"[184]. Article 6 on air quality management does not go as far as imposing limits to emissions. Parties are asked to develop policies and strategies and control measures to combat air pollution. The measures adopted should refer to "the best available technology which is economically feasible"[185]. It is also advocated in Article 7 that States cooperate for the development of technologies participating to the reduction of sulfur and other air pollutants. Information is exchanged within the Executive Body created under Article 10 of the Convention[186]. "The Executive Body, which meets annually, was given a broad mandate to determine the direction of work needed to implement the Convention"[187]. The work program of the Executive Body is supported by a permanent Secretariat in

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182- Kiss, *supra*, note 106 at 206.

183- Geneva Convention, *supra*, note 181, art. 2, 3 and 4 .

184- *Ibid.*, art. 5.

185- *Ibid.*, art. 6.

186- *Ibid.*, art. 8.

187- Fraenkel, *supra*, note 172 at 457.

Geneva[188]. Pursuant to Article 9, the Parties are invited to give full effect to the measures adopted at the end of the Conference on Security and Cooperation in Europe establishing the Co-operative Program for the Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe (EMEP)[189]. The EMEP network now counts ninety-five sampling stations and "...EMEP has vastly improved the scientific basis for linking air pollution to its effects on the environment"[190]. In 1990, thirty-two States were Parties to the Geneva Convention[191], which entered into force in March 1983[192].

The implementation of EMEP required the signature of a Protocol to the Geneva Convention in 1984[193]. This Protocol organized the long term financing of EMEP after UNEP ceased to contribute in 1984.

In 1982, Sweden hosted a Conference on Acidification of the Environment during which it was stated that "any reduction of the acidifying emissions of sulphur and nitrogen compounds will be beneficial to the environment"[194]. Subsequently two protocols were signed to meet these objectives. Similarities with the Montreal Protocol are noticeable since the protocols on sulfur and nitrogen

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188- *Ibid.*

189- T.A. Heywood, "Environmental Modification - Convention on Long-Ramge Transboundary Air Pollution" (1980) 21 Harvard Int. L. J. 536 at 538.

190- Fraenkel, *supra*, note 172 at 460.

191- *Multilateral Treaties Deposited with the secretary General-Status as of 31 December 1990*, UN Publication ST/LEG/SER.E/9 at 837.

192- Fraenkel, *supra*, note 172 at 456.

193- *Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution, on Financing the Monitoring and Evaluation of Air Pollutants in Europe*, 28 Septembre 1984, 24 I.L.M. 484 (1985); 27 I.L.M. 701 (1988); The Protocol came into force on 28 January 1988, see: Fraenkel, *supra*, note 172 at 458.

194- Weston & Rosencranz, *supra*, note 180 at 5.

oxides also feature "special internal implementation mechanisms based on reporting requirements and review procedures"[195].

The Protocol on sulfur emissions signed in Helsinki in 1985 requires that the Parties reduce their annual emissions of sulfur dioxide ($SO_2$) "by at least 30 per cent as soon as possible and at the latest by 1993, using 1980 levels as the basis for calculation of reductions"[196]. In addition the Parties are to carry out research on the necessity of further restraining emissions of sulfur[197]. Since aircraft release sulphur dioxide into the atmosphere, emission restrictions provided for in the Helsinki Protocol may result in a greater stringency of applicable standards.
The Executive Body is to be informed of the Parties' annual emissions of sulfur dioxide and of the methods of calculation adopted by States[198]. Moreover the Executive Body is given a yearly report drafted by EMEP regarding sulfur levels, transboundary fluxes and deposition of sulfur particles in the countries covered by the EMEP program[199].

Not all of the 32 Party States to the Geneva Convention ratified the Helsinki Protocol. The largest emitter of sulfur dioxide in Europe, the United Kingdom, did not sign the Protocol[200]. The United Kingdom argues that the causation link between the acidification of lakes in Scandinavia and its own emissions can not be

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195- G. Handl, "Environmental Security and Global Change: The Challenge to International Law" (1990) 1 Yearbook Int. Env. L. 3 at 6.

196- *Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 Per Cent - Article 2*, 8 July 1985, 27 I.L.M. 707 (1988) [hereinafter Helsinki Protocol].

197- *Ibid.*, art. 3.

198- *Ibid.*, art. 4.

199- *Ibid.*, art. 5.

200- *Multilateral Treaties Deposited with the secretary General-Status as of 31 December 1990*, UN Publication ST/LEG/SER.E/9 at 841.

established[201]. The United States have adopted a similar position and did not sign the Helsinki Protocol either[202]. The Protocol was nevertheless ratified by a sufficient number of States and entered into force on 2 September 1987[203].

The accuracy of the measurements made by EMEP depends on the precision of the information transmitted by States. Unfortunately methods for evaluating emissions vary among States. Moreover some countries do not separate emission data according to the different sources, or they send only partial information regarding their emissions[204]. The efficiency of the Helsinki Protocol also suffers from the lack of coordinated national reduction schemes. Although States have a general obligation to cut national emissions of sulfur dioxide, they remain free to choose which emissions to reduce. "Thus, emissions which have more transboundary impact may not be the ones a country chooses to reduce"[205]. Furthermore, the choice of a 30% reduction was arbitrary, and it is already believed that more cuts will be needed to combat acidification[206]. The choice of 1980 as a reference year is just as arbitrary. It wrongly advantages States which had not proceeded with reductions before 1980, since other States which had reduced their emissions before 1980 will still have to make drastic cuts[207].

The Protocol on emissions of nitrogen oxides (NOx) was signed in Sofia in 1988[208]. It requires that States limit their national

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201- Fraenkel, *supra*, note 172 at 462.

202- *Ibid.*

203- *Ibid.* at 469.

204- *Ibid.* at 470-471.

205- *Ibid.* at 471.

206- *Ibid.* at 470.

207- *Ibid.*

208- *Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution Concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes*, 31 October 1988, 28 I.L.M. 212 (1989) [hereinafter Sofia Protocol].

emissions of nitrogen oxides to their 1987 levels by the end of the year 1994 at the latest[209].
The Sofia Protocol was ratified by the required number of 16 States and entered into force on 14 February 1991[210]. However, the United States which are a party to this Protocol, informed other Parties that unless a follow-up protocol is adopted by 1996 they will likely withdraw from the Sofia Protocol[211].

This Protocol is of importance for aeronautical activities due to the concern caused by aircraft NOx emissions. Within two years after the date of entry into force of the Protocol, the parties must apply national emission standards to *inter alia* "new mobile sources in all major source categories based on the best available technologies which are economically feasible"[212]. New mobile sources are defined in Article 1 of the Sofia Protocol as any "motor vehicle or other mobile source which is manufactured after the expiration of two years from the date of entry into force of the present Protocol". Thus aircraft manufactured after 14 February 1993 could be subject to standards established under Article 2(1) and 2(2)(b) of the Sofia Protocol. This measure has been greeted with reluctance by some States, because it could imply that fewer vehicles may be used[213]. Since Article 2(3) of the Protocol provides that by 1 January 1996 the Parties are to have established a timetable for further reductions of NOx emissions, this is even more likely to happen.
The Parties may also adopt a stricter policy than what is required by Article 2[214]. Switzerland, for instance, plans to reduce its NOx

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209- *Ibid.* in art. 2(1).

210- W.J. Kakebeeke, "Air and Atmosphere" (1990) 1 Yearbook Int. Env. L. 93 at 94.

211- *Multilateral Treaties Deposited with the secretary General-Status as of 31 December 1990*, UN Publication ST/LEG/SER.E/9 at 842.

212- Sofia Protocol, *supra*, note 208, art. 2(1)(b).

213- Fraenkel, *supra*, note 73 at 472.

214- Sofia Protocol, *supra*, note 208, art. 2(4).

emissions to their 1965 level by 1995. As a result, Swissair expects to have to cut services to meet regulatory requirements[215].

Further reductions will not be calculated on a flat rate basis as under the Helsinki Protocol. The Sofia Protocol approaches reductions on the basis of critical loads[216]. Critical levels correspond to the maximum level which an affected environment can sustain. Once "target levels of acceptable depositions" are established, they are to be "translated into needed emission reductions, using models currently employed by EMEP"[217]. This approach takes into account the absorption capacity of the environment and opens the door to State cooperation on a solid environmental basis[218]. Further reductions will not be contingent on financial considerations, and the aeronautical industries will have to face the problems caused to the environment by their activities in a fair manner[219].

As we have seen earlier, the impact of aeronautical activities on the environment is not limited to pollution by chemicals. Communities around airports increasingly suffer from aircraft noise and States and municipalities were pressed to find remedies to this nuisance. The next Chapter will explore regulations adopted to deal with the problem of aircraft noise.

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215- Pilling, *supra*, note 177 at 11; In addition, a Swissair official prophesizes that airlines will have to pay pollution taxes in the coming years. Such a tax is likely to be levied with respect to carbon emissions, *ibid.*; "Rio Brings Carbon Tax Closer", *Interavia Aerospace Review* (August 1992) at 14.

216- Fraenkel, *supra*, note 172 at 474.

217- *Ibid.*

218- *Ibid.* at 475.

219- *Ibid.*

# CHAPTER IV
# PROTECTION OF THE ENVIRONMENT FROM AIRCRAFT NOISE

With the increase in air traffic and the multiplication of law suits filed against airports and airlines[1], attention was drawn to the implementation of noise certification standards adopted in Europe and in the United States. States were prompted to give effect to American noise standards and to those of Annex 16 to the Chicago Convention, Volume 1[2] according to fixed timetables. The economic impact of fleet renewals magnified the problem into a world-wide controversy between countries with considerable traffic at their airports and less developed countries. This issue will be examined in the first and second paragraphs of this Chapter, while the third paragraph will be an overview of aircraft noise related measures adopted by airports to accommodate nearby communities and avoid law suits.

## 1. Implementation of Noise Certification Standards in Europe

In Europe, authorities competent to adopt measures pertaining to aircraft noise are the European Civil Aviation Conference (ECAC)[3]

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1- See L. Rapp, "Liability for Noise Disturbance", *ITA Magazine* (March, April 1988) at 27 for an overview of the actual state of French jurisprudence.

2- *Environmental Protection - Annex 16 to the Convention on International Aviation, Volume I - Aircraft Noise*, 2nd. (Montreal: ICAO, 1988) at v [hereinafter Annex 16, Volume 1].

3- In 1991, ECAC had 28 members namely, Austria, Belgium, Bulgaria, Cyprus, Czechoslovakia, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Monaco, Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden, Switzerland, Turkey, United Kingdom, Yugoslavia: *ECAC Press Release - ECAC takes further steps to protect the environment from noisy aircraft*, 27 May 1991, No. 121E.

and the European Economic Community (EEC)[4]. ECAC acts by way of recommendations while the EEC adopts environmental directives[5]. EEC directives require the adoption of national implementing measures. However, an individual may invoke the direct application of an EEC directive in court in a case against a public authority[6]. The implementation of the directive is granted:
a) when the date on which the EEC Member State should have translated the directive in national legislation is expired, and;
b) when the provisions of the directive are sufficiently clear and precise[7].
In case of conflict between the ECAC and EEC aircraft noise policies, a State member of both organizations must give priority to the EEC rule because it has greater legal force.

Measures giving effect to ICAO standards can be distinguished between those which restrict the addition of noisy aircraft on national registers and those which limit the operation of noisy aircraft at airports of a noise affected geographical zone.

a) Restrictions Attached to the Registration of Aircraft
i - The "Non-Addition to Register" Rules Adopted by the EEC
On 20 December 1979, the EEC Council adopted the Directive on the limitation of noise emissions from subsonic jet aeroplanes[8], amended in 1983 by the Directive modifying Directive 80/51 on

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4- The EEC has 12 members which are: Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, United Kingdom.

5- L. Krämer & P. Kromarek, "Le droit communautaire de l'environnement: mai 1988 - decembre 1989" 1990, 1 R.J.E. 81-105.

6- A.C. Geddes, "Environmental Directives and direct effect in UK national law" (1990) 6 Law Society's Gazette 27.

7- *Ibid.*

8- *Council Directive on the limitation of noise emissions from subsonic jet aeroplanes* , 20 Decembre 1979, 80/51 EEC JO L 18/26 [hereinafter Directive 80/15].

the limitation of noise emissions from subsonic jet aeroplanes[9]. Directive 80/15 requires that all civil aircraft registered in EEC Member States be noise certified[10]. Moreover, aircraft which are not noise certified must have been removed from service by 31 December 1986[11]. The amending Directive prevents aircraft registered outside of the EEC, which have not been noise certified, from landing in the Community after 1 January 1988[12]. Any exemption granted to operators showing economic hardship was to cease on 31 December 1989[13].
The EEC Commission has been alerted that Ostend (Belgium) and Marseilles (France) continue to allow non certified aircraft to use their airports, and it is taking action against both municipalities before the European Court of Justice[14].

In Directive 89/629 on the limitation of noise emissions from civil subsonic jet aeroplanes[15], the EEC Council implements the noise specifications found in Annex 16, Volume 1, Chapter 3 [hereinafter Chapter 3].
Aircraft covered are those with a maximum weight at take-off of over 34,000 kg and with a passenger capacity of 20 seats or more[16]. The Directive prevents States from entering on their registers after 1 November 1990, aircraft which do not comply

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9- *Council Directive to modify Directive 80/51 on the limitation of noise emissions from subsonic jet aeroplanes*, 21 April 1983, 83/206 EEC JO L 117/15 [hereinafter Directive 117/15].

10- Directive 80/15, *supra*, note 8, art. 1.

11- *Ibid.*, art. 5.

12- Directive 117/15, *supra*, note 9, art. 1(7).

13- *Ibid.*

14- D. Woolley, "Plans for Withdrawal of Noisier Jet Aircraft Take Shape", *Airport Forum* (May 1991) 44.

15- *Council Directive on the limitation of noise emissions from civil subsonic jet aeroplanes*, 4 December 1989, 89/629 EEC, JO L 363/27 [hereinafter Directive 89/629].

16- *Ibid.*, art. 1.

with Chapter 3[17]. After this date, Member States will be able to dispute the entry of a Chapter 2 aircraft on the registers of another EEC State[18]. These restrictions also apply to aircraft which have been the object of a leasing agreement after 1 November 1990, even if there is no modification of an EEC register[19]. However, a Chapter 2 aircraft which was already on the register of an EEC State by 1 November 1990 may be transferred within the Community[20]. Exemptions granted by Member States cover[21]:

- Aeroplanes of historic interest;
- Aeroplanes registered in a non-Member State, used by a national of a EEC country, before 1 November 1989, by virtue of a lease contract or purchase hire agreement[22];
- Aeroplanes which were temporarily removed from a EEC register because they were leased to a non-Member State[23];
- Aeroplanes replacing an accidentally destroyed aircraft, when no compliant aircraft is available and "provided that the registration of the replacement aeroplane is carried out within the year following the destruction in question"[24];
- Aeroplanes with a high by-pass ratio[25].

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17- *Ibid.*, art. 2 (1).

18- *Ibid.*

19- *Ibid.*, art. 3; see also: Technical Committee, *Sixteenth Meeting: Noise -Related Developments in European Communities and in ICAO,* ECAC Doc.TECH/16-WP/3 (22/05/89) at 17.

20- Directive 89/629, *supra,* note 15, art. 2(2); Technical Committee, *supra,* note 19 at 17.

21- Directive 89/629, *supra,* note 15, art. 4.

22- It seems that the agreement must have been in effect before 1 November and that it is still in effect when the transfer of registration occurs, but this situation is not likely to occur very often: R. Gimblet, "UK Implementation of EEC Directive on Aircraft Noise", *Lloyd's Aviation Law* (15 December 1990) 1 at 2.

23- This exemption allows EEC countries to continue leasing to non-noise regulated countries their Chapter 2 aircraft during off-peak seasons: *Ibid.* at 2.

24- Directive 89/629, *supra,* note 15, art. 4(d).

25- *Ibid.*, art. 4(e).

Other exemptions are granted for a period of three years, renewable for periods of maximum two years, and must expire by 31 December 1995[26]. They cover aeroplanes leased from a non-Member State on a short term basis if the operator can show proof that this practice is common in his trade and that the pursuit of his activities is at stake. This type of exemption can also be granted to operators with economic difficulties.
EEC Member States were requested to give effect to Directive 89/629 by 30 September 1990[27]. Thus the implementing national regulations were to become effective by 1 November 1990. The United Kingdom implemented the Directive through an Air Navigation Order on Noise Certification on 1 November 1990[28]. The Order is more stringent than the Directive itself since it provides that an aircraft which was recorded on the British register before 1 November 1990, then was taken out and put back on the register after this date, comes under the restrictions of the Order[29]. Moreover, the Order covers the transfer of aircraft from the register of one Member State to another, whereas this is not encompassed by the Directive which deals with the non addition of Chapter 2 aircraft to EEC registers globally[30].

Aeroplanes covered by Directive 89/629 include the BAC 1-11, the B-727, the B-737-200, the B-707, the DC-9 and some B-747[31]. They will have to be installed with hush-kits. However this option is not a panacea. First, the cost of hush-kitting a B-727 is USD 1.75 million, and it costs USD 3 million for a B-737-200[32]. Second, these devices add considerable weight to the aircraft. The weight added

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26- *Ibid.*, art. 5.

27- *Ibid.*, art. 7.

28- *Air Navigation Order on Noise Certification (U.K.)*, SI NO - 1990/1514.

29- Gimblet, *supra*, note 22 at 2.

30- *Ibid.*

31- P. Flint, "Too Much of a Good Thing?", *Air Transport World* (December 1990) at 40-41, and Woolley, *supra*, note 14 at 44.

32- Woolley, *supra*, note 14 at 44.

to a DC-8 is 10 tons and 6 tons to a B-707. Thus the amount of payload has to be reduced[33]. The other option available is to have the aircraft equipped with new engines. The fuel consumption should not increase by more than 4 percent and only 700 lbs will be added to the aircraft[34]. The cost of having a twin jet re-engined by Rolls-Royce is USD 10 million[35]. This approach was chosen by the Danish airline, Sterling Airways, for its fleet of 727 re-engined by Valsan[36]. This technical alternative adds to the value of the aircraft and is worthwhile if the life-time of the aircraft is long enough to generate a good return on investment[37].

ii - The Non-Addition to Register Rule Adopted by ECAC

In June 1988, ECAC adopted Recommendation ECAC/13-2 prohibiting the registration of Chapter 2 aircraft after 1 October 1990[38]. Hence an air carrier may not bring in a European State an aircraft which is not certified as meeting the standards found in Chapter 3 in view of having it inscribed on the national register so as to operate it in Europe. However the restriction does not cover aircraft already registered in Europe.

Recommendation ECAC 13/2 differs from EEC Directive 89/629.
First, the ECAC noise policy applies to all subsonic jet aircraft, including those weighing less than 34,000 kg and with low by-pass engines[39].
Second, transfers of non-compliant aircraft from the register of one ECAC Member State to another come under Recommendation

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33- "Beginning of Chapter VI", *Aerospace Review* (January 1990) at 6.

34- *Ibid.*

35- Woolley, *supra*, note 14 at 44.

36- *Ibid.*

37- K. Daly, "The Silent Revolution" *Flight International* (14-20 August 1991) 20 at 21.

38- "Chapitre 3 de l'Annexe 16: Une reglementation qui fera du bruit", *Aviastro* (April 1990) at 17, and Technical Committee, *supra*, note 19 at 1.

39- *Ibid.* at 16.

ECAC 13/2[40]. ECAC, as opposed to the EEC, considers that transactions relating to civil aircraft are governed by the principles of free trade and are subject to the General Agreement on Tariffs and Trade (GATT). Thus, no difference should be made between intra-European transactions and those of a European State with a non-European State.

Third, leasings are not covered by the Recommendation and ECAC asks its Member States to ensure that aircraft carriers do not use leasing arrangements to circumvent noise regulations[41].

Finally, ECAC does not deem necessary to provide for a five year exemption[42]. With regard to aircraft under on-going leasing arrangements, ECAC exempts them if the agreement was entered into before the cut-off date for addition to registers, namely 1 October 1990[43].

By the year 1989, European States became eager to find rapid solutions to the problem of airport noise. Hence, they were frustrated by the absence of consensus within ICAO regarding the elimination of Chapter 2 aircraft[44]. However, the 27th session of the ICAO Assembly held in October 1989 failed to adopt a deadline for banning Chapter 2 aircraft and the adoption of a time-table was postponed until the Extraordinary session of the Assembly in October 1990. Meanwhile 18 of the 28 members of ECAC informed the Assembly that they would not wait long before setting a time-table of their own[45]. At the same time the EEC planned the adoption of its own Directive to impose operating restrictions on Chapter 2 aircraft[46].

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40- *Ibid.* at 17.

41- *Ibid.*

42- *Ibid.*

43 *Ibid.* at 18.

44- "Europeans May Yet Go on Alone on Chapter 3", *Airports International* (April 1990) at 23.

45- *Ibid.*

46- *Ibid.*

b) The Elimination of Aircraft not Meeting the Standards of Chapter 3

i - Phase-out Measures Adopted Within the Framework of ICAO

On 26 October 1990, the Extraordinary Assembly of ICAO approved European proposals and adopted Resolution A28-3 on "Possible operating restrictions on subsonic jet aircraft which exceed the noise levels in Volume I, Chapter 3 of Annex 16"[47]. The wording of the Resolution is very flexible and achieves a compromise between the divergent interests defended within ICAO. Guidelines restricting the use of subsonic jet aircraft meeting the certification standards of Chapter 2, but not those of Chapter 3, are established.

Schedules for the elimination of Chapter 2 aircraft should not cover a period of time inferior to seven years, and they should not begin before April 1995[48]. States are urged to guaranty Chapter 2 aircraft with a life-span of at least 25 years after the date of issuance of the first individual certificate of airworthiness[49]. Moreover, the operation of aircraft powered by high by-pass ratio engines and wide body aircraft should not be restricted before the end of the seven year period, i.e. 1 April 2002 at the earliest[50]. The first exemption covers the Soviet aircraft Ilyushin IL-76[51].
Wide body aircraft are characterized by their "twin aisle configuration" with "more than six seats abreast when in passenger service"[52]. An aircraft with a diameter of at least 5 meters is

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47- C. Lyle, "The Noise Issue", *ICAO Journal* (November 1990) at 7.

48- *Resolution 2/1 renamed Resolution A28/3, relating the "Possible operating restrictions on subsonic jet aircraft which exceed the noise levels in Volume I, Chapter 3 of Annex 16" - Article 2(a)(b),* ICAO Assembly, A28-WP/27 P/10 2-1 at 2-2.

49- *Ibid.*, art. 2(c).

50- *Ibid.*, art. 2(d).

51- Lyle, *supra*, note 47 at 7.

52- ICAO Council OR, 130th Sess., Subj. no. 15-5, ICAO Doc. C-Min 130/20 (1990).

deemed to be a wide body aircraft[53] This second exemption covers 286 Chapter 2 B747[54] as well as the Ilyushin IL-86[55].

Chapter 2 aircraft will not be banned everywhere. On the basis of ICAO's study on the "Economic Implications of Future Noise Restrictions on Subsonic Jet Aircraft", a distinction is made between noise restricted areas and non-noise restricted areas[56]. The use of Chapter 3 aircraft will only be compulsory in noise restricted areas namely Australia, ECAC Member States, Japan, New-Zealand and the United States. In those countries, the number of aircraft affected by the ban in 1995 is estimated at 2,400. In 2002 the normal attrition of fleets will bring this number down to 1,462[57]. In non-noise restricted areas, Chapter 2 aircraft will be freely operated and only 219 narrow-body aircraft will have to be prematurely replaced in 1995 and 105 in 2002[58]. Moreover due to the normal attrition of Chapter 2 aircraft it is estimated that only 1,129 of them will be in service in non-noise restricted areas in 1995 and only 754 in 2002[59].

On the basis of the guidelines set by ICAO, ECAC decided on a final noise policy[60]. The timetable provides for the full termination of Chapter 2 operations by 1 April 2002. This is to be achieved over a period of seven years starting 1 April 1995. Thus ECAC adopted

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53- *Ibid.*

54- *Economic Implications of Future Noise Restrictions on Subsonic Jet Aircraft*, ICAO Circular 218-AT/86 (1989) at 15.

55- Lyle, *supra*, note 47 at 7.

56- Economic Implications of Future Noise Restrictions on Subsonic Jet Aircraft, *supra*, note 54 at 1.

57- U. Wickrama, "ICAO Study Estimates Economic Impact of Newly Adopted Noise Resolution", *ICAO Journal* (November 1990) at 9.

58- *Ibid.* at 10.

59- *Ibid.* at 9.

60- ECAC, Release 121E (27 August 1991), "ECAC Takes Further Steps to Protect the Environment from Noisy Aircraft" (27 August 1991).

ICAO's most stringent scenario. Moreover, in a Recommendation adopted on 2 July 1992, ECAC aligns its policy on the EEC measures phasing-out Chapter 2 aircraft[61].

In order to cooperate with countries having economic difficulties, States are urged to negotiate specific bilateral, regional and inter-regional agreements[62]. These arrangements should be concluded in view of exempting Chapter 2 aircraft belonging to operators of developing countries, if they can show proof that a purchase order or a leasing contract was entered into for their replacement by Chapter 3 aircraft and if the first date of delivery of the aircraft has been accepted[63].

Thus, ECAC and the African Civil Aviation Commission (AFCAC) signed a Memorandum Of Understanding (M.O.U.) in Montreal, on 26 October 1990[64]. The M.O.U. provides that Chapter 2 subsonic jet aircraft from AFCAC countries, powered by low by-pass engines, with a passenger capacity of 20 or more, and a take-off weight of at least 34,000 kg will be able to operate in ECAC countries beyond 1 April 1995. Exemptions regarding these aircraft will be granted if they are of historic interest, if the nature of their operation justifies a temporary exemption, or if they are flying in Europe to undergo technical repairs[65]. Such exemptions will also be granted beyond 1 April 2002 to subsonic jet aircraft of equivalent size fitted with high by-pass engines[66]. A different type of exemption may be granted with regard to the former type of aircraft. The operator must demonstrate that one of the following conditions is satisfied[67]:

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61- ECAC Recommendation 14-2, 2 July 1992, adopted at the 21st Session.

62- Resolution A28/3, *supra*, note 48, art. 3(b).

63- *Ibid.*

64- African Civil Aviation Commission, Circular Letter No. 91/01, E. Lombolou, Secretary of AFCAC, 11 January 1991.

65- *Ibid.* in par. (a) and (c).

66- *Ibid.* in par. (b) and (c).

67- *Ibid.* in par. (d).

- the pursuit of its activities would be affected to an unreasonable extent (but one aeroplane cannot benefit from such an exemption for more than three years);
- an order was placed before 1 April 1994 for the replacement of such aircraft by a Chapter 3 aircraft;
- an order was placed for the modification of the aircraft.

In the last two cases, the aircraft operator must accept the earliest date for delivery.

Furthermore, European countries may not request that an African operator dispose of its large Chapter 2 aircraft fitted with low by-pass engines "at a rate equivalent to more than 10% of its total subsonic jet fleet per annum"[68]. Finally, when economic hardship is shown, this type of Chapter 2 aircraft registered in developing countries will continue to be allowed to operate "insofar as the annual number of movements by those aeroplanes into any ECAC/EC aerodrome does not exceed the number they made in a year to be chosen by AFCAC between 1986 and 1990"[69].

ii - Measures Adopted by the EEC

On 2 March 1992, the EEC Council adopted a Directive on the limitation of the operation of Chapter 2 aeroplanes[70]. The new Directive institutes a timetable for the gradual withdrawal of aircraft not meeting Chapter 3 standards. After 1 April 1995, EEC Member States are required to ensure that civil aircraft with a maximum take-off weight of more than 34,000 kg and a capacity of at least 20 seats, fitted with low by-pass engines comply with the standards of Chapter 3[71]. Chapter 2 aircraft fitted with high by-pass engines will not be exempt from operating restrictions beyond 1 April 2002[72]. Moreover Chapter 2 aircraft which have not been in

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68- *Ibid.* in par. (e).

69- *Ibid.* in par. (f).

70- *Council Directive on the limitation of the operation of Chapter 2 aeroplanes,* 2 March 1992, 92/14/EEC.

71- *Ibid.*, art. 1&2.

72- *Ibid.*, art. 2(2).

service for more than 25 years after the date of issuance of their first certificate of airworthiness may be used after 1 April 1995[73]. After 1 April 2002 such aircraft can benefit from three annual exemptions[74], but in principle they are banned after this cut-off date[75]. Other types of exemptions are granted until 1 April 1997. Beneficiaries of these exemptions are:

- operators facing economic hardship[76] ;
- operators who have ordered hush-kitting equipment before 1 April 1994[77];
- operators who ordered a replacement aircraft before 1 April 1994[78].

In addition, an operator may not be required to rid itself of Chapter 2 aircraft at "an annual rate equivalent to more than 10% of their total civil subsonic jet fleet"[79]. Finally, Member States may temporarily allow Chapter 2 aircraft to land at their airports in exceptional cases[80]. Such temporary exemptions are also granted when aircraft are to be repaired or checked for maintenance[81].

With respect to Chapter 2 aircraft of developing nations, the first deadline of 1 April 1995 shall not apply if such aircraft were operated by them in the Community airports throughout the year 1990. The number of annual movements permitted at a Community airport must not exceed the "number achieved by that airline's

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73- *Ibid.*, art. 2(1)(b).
74- *Ibid.*, art. 3(1).
75 - *Ibid.*, art. 2(2).
76- *Ibid.*, art. 3(2).
77- *Ibid.*, art. 4.
78- *Ibid.*, art. 5.
79- *Ibid.*, art. 6.
80- *Ibid.*, art. 7(a).
81- *Ibid.*, art. 7(b).

Chapter 2 aeroplanes in the 12 months ending 31 December 1990."[82].

## 2. Implementation of the American Noise Certification Standards

In the United States, the power to noise certify aircraft rests with the Federal Aviation Administration (FAA) pursuant to the 1968 Noise Certification Amendment to the Federal Aviation Act of 1958[83]. In order to obtain an FAA noise certificate, an aircraft must comply with the standards set forth in the Federal Aviation Regulations (FAR) part 36[84]. With respect to aircraft employed in foreign air commerce operated to and from the United States, the 1991 revision of the general operating flight rules provides that compliance with the noise standards of Annex 16 will suffice when they "achieve results equivalent to those achievable under 14 CFR part 36"[85]. Like ICAO, the FAA established three types of noise standards named Stage 1. Stage 2 and Stage 3[86]. The Stage 2 noise levels were established in 1969 and Stage 1 is any noise level above these standards. The Stage 3 noise levels were promulgated in 1977 and apply to aircraft for which a certificate has been requested after 5 November 1975[87].

### a) Definition of American Standards

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82- *Ibid.* in Annex 1.

83- J. Lesser, "The Aircraft Noise Problem: The Past Decade - Still Federal Power and, at Least for a While Longer, Local Liability" (1981) 13 Urban Lawyer 287 at 289.

84- *Ibid.* at 290.

85- 56 F.R. 8642, section 91.801(c) (28 February 1991); 56 F.R. 4864, section 91.801(c) (25 September 1991).

86- D.V. Harper "Regulation on Aircraft Noise at Major Airports, Past , Present and Future" (1988) 17 Transportation L. Jo. 117 at 148.

87- *Ibid.*

The amount of variables involved render difficult a comparison of FAR 36 with Annex 16 Volume 1. Although the noise limits are the same disparities in cutback allowances, in the use of trade-offs or in the position of a measurement point result different classifications of the same aircraft[88].

During the certification process, aircraft noise is measured in three places[89]:
- for takeoff at 21,325 ft (6,500 m) from the start of the roll,
- for approach at 6,562 ft (2000 m) from the threshold on a line in the center of the runway,
- for the sideline at 1,476 ft (450 m) from the center line of the runway on a line parallel to it.

The noise standards are the following[90]:

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88- *Transport Jet Aircraft Noise Abatement in Foreign Countries: Growth, Structure, Impact* (July 1990), NASA CR 152,356 at 34.

89- 14 CFR part 36 App. C, section C36.1 (1991).

90- *Ibid.*

**For Take-off:**

| Stage 2 | Stage 3 |
|---|---|
| 1.1.For maximum weights of 600,000 lbs. or more: **108 EPNdB** reduced to **93 EPNdB** for a weight of 75,000 lbs or less. | 1.1. For aircraft of a maximum weight of 850,000 lbs or more, (a) with more than 3 engines: **106 EPNdB** down to **89 EPNdB** for a weight of 44,673 or less, (b) with 3 engines: **104 EPNdB** down to **89 EPNdB** for a weight of 63,177 lbs and less, (c) with fewer than 3 engines: **101 EPNdB** down to **89 EPNdB** for weights of 106,250 lbs and less. |

**For Sideline:**

| Stage 2 | Stage 3 |
|---|---|
| 2.1. For maximum weights of 600,000 lbs or more: **108 EPNdB** down to **102 EPNdB** for weights of 75,000 lbs and less. | 2.1. For maximum weights of 617,300 lbs or more: **103 EPNdB**, decreasing by 4 EPNdB with the mass down to **94 EPNdB** for weights of 77,200 lbs and less. |

**For Approach:**

| Stage 2 | Stage 3 |
|---|---|
| 3.1. Same as in 2.1. | 3.1. For maximum weights of 617,300 lbs or more: **105 EPNdB** down to **98 EPNdB** for weights of 77,200 lbs or less. |

Stage 1 aircraft had to be eliminated by 1985[91]. Then, the elimination of Stage 2 aircraft was directed by the Congress through the Airport Noise and Capacity Act of 5 November 1990[92]. The Statute forbids the operation in the United States of stage 2 aircraft weighing more then 75,000 lbs after 31 December 1999.

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91- Harper, *supra*, note 86 at 150.

92- 56 F.R. (25 September 1991) 48628.

Nevertheless, the Secretary of Transport is given the power to grant waivers until 31 December 2003[93], although exemptions postponing compliance until 2003 will be rare[94].

Pursuant to the Statute, the FAA published a Notice of Proposed Rulemaking (NPRM) formalizing compliance schedules and procedures[95]. The final amendments to the general operating and flight rules were promulgated on 25 September 1991, after review of the comments on the proposed legislation[96].

The mode of compliance is substantially different from what was recommended by ICAO in Resolution A28-3[97]. The American legislation applies to aircraft with a maximum weight of 75,000 lbs and provides no exemptions for wide body airplanes with a high by-pass ratio. Aircraft are not guaranteed a 25 year lifespan. Compliance is organized around the concept of "base level" which is "the number of owned or leased Stage 2 airplanes that were listed on an operator's operations specifications on anyone day in 1990" and it includes "those Stage 2 airplanes returned to service after lease to a foreign airline"[98].

b) Compliance Schedule

The FAA leaves American air carriers with the option of phasing-out their Stage 2 aircraft or phasing-in their Stage 3 aircraft. Operators should reduce their base level by 25% after 31 December 1994, 50% after 31 December 1996, 75% after 31 December 1998 and entirely after 31 December 1999[99]. Otherwise,

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93- *Ibid.*

94- C.P. Fotos, "National Noise Policy Guarantees Quieter Airports by Ende of Decade", *Aviation Week & Space Technology* (November 1991) 62 at 63.

95- 56 F.R. (28 February 1991) 8626.

96- 56 F.R. (25 September 1991) 48628.

97- Resolution A28/3, *supra*, note 48.

98- 56 F.R. (25 September 1991) 48633.

99- *Ibid.* at 48628.

they will bring the number of Stage 3 aircraft in their fleet to 55% after 31 December 1994, 65% after 31 December 1996, 75% after 31 December 1998 and 100% after 31 December 1999[100].

Waivers from an interim compliance date are granted by the Secretary of Transport[101]. Applicants must show that the waiver is in the public interest, namely that compliance would be too onerous and "would affect competition or service to small communities"[102]. An American carrier can also obtain a waiver from the final compliance date if, by 1 July 1999 at least 85% of the applicant's fleet conforms to the Stage 3 standards and provided that a firm order for the delivery of Stage 3 replacement aircraft has been placed. The operator must also demonstrate that the waiver will be in the public interest. These waivers shall be valid only until 31 December 2003[103].

With respect to foreign air carriers, compliance is based on the number of Stage 2 operations in the United States rather than on the number of stage 2 aircraft in their fleets[104]. The compliance schedule is the same than for American carriers. It was originally proposed in the NPRM that a foreign airline with two or fewer Stage 2 aircraft operating in the United States in 1990 be allowed to disregard the compliance schedule[105]. However, this exemption was canceled by the regulation[106].

c) Entry and Non-Addition Rule

The Airport Noise and Capacity Act restricts the use in the United States of Stage 2 aircraft purchased by U.S. nationals after 5

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100- *Ibid.* at 48629.

101- *Ibid.*

102- *Ibid.* at 48639.

103- *Ibid.*

104- *Ibid.* at 48629.

105- 56 F.R. (28 February 1991) 8643.

106- 56 F.R. (25 September 1991) 48637.

November 1990[107]. But some Stage 2 aircraft in this category are eligible for operation. Moreover a U.S. owned airplane that was leased to a foreign airline can enter the United States within 6 months of the expiration of the lease[108]. In addition a lease agreement in force on 25 September 1991 for the hire of a foreign owned Stage 2 aircraft to an American carrier can be executed in the United States until its expiration[109]. Stage 2 aircraft exported from the United States to a foreign country are allowed to fly into the United States after 5 November 1990 for purposes of maintenance, but these maintenance flights will not be authorized after 31 December 1999[110].

Legislation over aircraft noise are often adopted at international and at national levels in order to achieve a greater harmonization of the restrictions. Airports, however, remain liable to nearby communities for the damages caused by aircraft noise[111]. Thus U.S. courts have recognized the right of airports, acting as proprietors, to protect themselves from law suits by regulating the use of their facilities[112]. The following paragraph will present the type of measures adopted by airports to restrict aircraft noise.

## 3. Airport Access Regulations

### a) Airports' Authority to Regulate in the United States

According to Section 1108(a) of the Federal Aviation Act only the Federal Government is competent to legislate over the United States airspace[113]. Subsequently, the FAA was given authority to

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107- *Ibid.* at 48629.

108- *Ibid.*

109- *Ibid.*

110- *Ibid.* at 48632.

111- Harper, *supra*, note 86 at 134.

112- *Ibid.*

113- L.L. Blackman & R.P. Freeman, "The Environmental Consequences of Municipal Airports: A Subject of Federal Mandate?" (1987) 53 Jo. of Air L. and Com. 375.

organize the "efficient utilization of such airspace"[114]. Thus, many local attempts to regulate aircraft noise at municipal airports were canceled by courts. In *City of Burbank* v. *Lockheed Air Terminal* [115], the U.S. Supreme Court ruled that a City Council's decision over an airport noise matter was pre-empted by federal legislation[116]. However, the Court did not contest the "right of a State or a local public agency, as the proprietor of an airport, to issue regulations or establish requirements as to the permissive level of noise which can be created by aircraft using the airport"[117]. "The question of local authority to regulate the environmental side effects of the use of federally controlled airspace" became the subject of a considerable controversy.

In 1990, the Airport Noise and Capacity Act established "a program for reviewing airport noise and access restrictions on the operations of Stage 2 and Stage 3 aircraft"[118]. Pursuant to this Statute, the FAA added a new part (part 161) to the Federal Aviation Regulations entitled "Notice and Approval of airport Noise and Access Restrictions"[119]. Regulations concerning aircraft operational procedures, such as the designation of preferential runways, noise abatement approach and departure procedures and profiles are already subject to the approval of the FAA and are not covered by the Act[120]. Noise abatement procedures applicable to runups and taxiing are exclusively adopted by the airport proprietor and are only covered if they cut down the number of

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114- Federal Aviation Act, Pub L. No. 85-726, 72 Stat. 731, cited by Blackman & Freeman, *ibid.*

115- *City of Burbank* v. *Lockheed Air Terminal*, 411 U.S. 623 (1973).

116- Blackman & Freeman, *supra*, note 113 at 379.

117- *Ibid* at 380.

118- 56 F.R. (25 September 1991) 48661.

119- 14 C.F.R. part 161.

120- 56 F.R. (25 September 1991) 48700.

hours during which aircraft can operate or limit the number of operations[121].

The FAA regulation provides that an airport operator wishing to restrict access to its airport must apply to the FAA for approval. The FAA has 30 days to determine whether the application is complete and 180 days to approve or reject the restriction[122].
The FAA will review access restrictions enclosed in agreements between the airport proprietor and aircraft operators[123]. Other restrictions subject to approval are those proposed after 1 October 1990 which limit the operation of Stage 2 and Stage 3 aircraft. Amendments to existing restrictions will be examined if they reduce or limit Stage 2 or Stage 3 aircraft operations or if they affect aircraft safety[124]. However, restrictions which were adopted before 1 October 1990 will not be subject to the FAA's review power[125]. Moreover, the FAA has no control over local actions finalizing the last steps of a staged program to restrict airport access for noise reasons, when the program was initiated in 1988 and in effect on 5 November 1990[126]. This exemption encompasses the noise abatement program proposed by the San Francisco Airport Commission in 1988 which is to be executed from 1989 to 1999[127]. According to the plan, Stage 2 aircraft operations are banned between 1:00 and 6:00 o'clock and this curfew will be extended each year until 1993. In addition, by January 1989, 25 % of aircraft operations must be at Stage 3 noise levels, 50% in January 1994 and 75% in January 1999.

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121.- *Ibid.*

122.- *Ibid.* at 48795.

123.- *Ibid.* at 48700.

124.- *Ibid.* at 48701-48703.

125.- *Ibid.* at 48700.

126.- *Ibid.*

127.- Harper, *supra*, note 86 at 138.

Failure to comply with the regulations of 14 C.F.R. part 161 will result in the termination of an airport's eligibility for airport grant funds and its inability to levy passenger charges[128].

b) Noise Related Airport Measures

i- Measures Restricting Aircraft Movements

In 1989, Innsbruck Airport in Austria imposed a total ban of Chapter 2 aircraft to take effect in the Spring of 1990. At the end of 1989, Chapter 2 aircraft could only fly into the airport between 9:00 and 18:00 o'clock. Concurrently at Salzburg, the airport's operating hours were between 7:00 and 21:00 o'clock[129]. Manchester Airport instigated a "night jet policy" in 1986 by limiting the number of Chapter 2 aircraft to 84% at first, down to 25% to this date[130]. By 1995 night slots will no longer be allocated to Chapter 2 aircraft.

In the United States, some 400 airports have established noise related restrictions. The San Francisco Airport Commission has banned B-707 equipped with hushkits[131]. Fourteen airports have curfews and six have set maximum decibel limits. The airport near Boston has selected a system based on a "noise per seat index" which limits the number of allowable decibels in proportion of the aircraft's passenger capacity[132].

Despite the recent measures adopted to phase out the noisier aircraft by the year 2000, major airports remain unsatisfied with the level of stringency of the regulations. Officials at Manchester airport "do not believe that current environmental legislation

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128- 56 F.R. (25 September 1991) 48709.

129- "Austria First to Ban Chapter 2 Jets" *Airport Forum* (April 1989) 19.

130- R.Gould, "Opening a New Chapter" *Jane's Airport Review* (September 1992) 48 at 51.

131- J.W. Young, "Aircraft Noise: Will It Muffle Airline and Airport Development?" *Airport Forum* (April 1989) 8.

132- *Ibid.*

provides the level of protection demanded by the public"[133]. European airports put the noise problem in terms of environmental capacity and productivity. Operators of Munich 2, Europe's newest airport, allege that the airport's productivity would double if B-737-300's replace the noisier B-727-200 while environmental problems would be reduced[134].

ii- Noise Related Charges

Noise taxes are levied to discourage air carriers from using noisy aircraft and to cover expenses engaged for soundproofing community buildings and houses. They also finance the rehousing of persons living close to airports[135].

In France, a "Tax for the abatement of phonic nuisances" was provided for by ministerial decree in 1984[136]. The nuisance tax is calculated on the basis of the landing fees. Aircraft are divided into five groups according to the noise they make. Classification is based on the aircraft's deviation from a "reference noise" which is the maximum noise permissible under Chapter 2 of Annex 16 Volume 1[137]. Group 1 includes non-noise certificated aircraft which are no longer in activity. Group 2 encompasses aircraft which have a noise level inferior to the reference noise by only 9 EPNdB. Group 3 aircraft have a noise level lower than reference noise by no less than 9 EPNdB and no more than 18 EPNdB. Group 4 aircraft are under the reference noise by no less than 18 EPNdB and

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133- Gould, *supra,* note 130 at 49.

134- P.J. Hogan, "Why Airports Want a 2000 Ban" *The Avmark Aviation Economist* (February/March 1990) 13 at 14.

135- J. Plaignaud, "Survey and Definition of Current Aeronautical Charges" *ITA Studies* (1977), 1-6 at 18.

136- *Decret no 84-28 du 11 Janvier 1984 modifiant les articles R 224-1 et R 224-2 du Code de l'Aviation Civile et relatif à la création d'une redevance complementaire à la redevance d'atterissage, dite Redevance pour l'atténuation des nuisances phoniques*, J.O., 15 January 1984, R.F.D.A. 1984 at 64.

137- *Transport Jet Aircraft Noise Abatement in Foreign Countries: Growth, Structure, Impact* (July 1980), NASA CR 152,356 at 82.

no more than 27 EPNdB. Group 5 aircraft are under the reference noise by more than 27 EPNdB[138]. Each group is attributed a rate. In 1980, the rate for non certified aircraft was 20% of the landing fee, while the rate for aircraft in Group 3 ranged from 5-10%[139].

The Netherlands has also been very active in developing noise related landing charges[140]. The amounts payable are calculated using a formula which includes data from both Annex 16 and FAR 36.

In Germany, the amounts charged for noise emissions depend on the noise certification of the aircraft pursuant to Chapters 2 and 3 of Annex 16 Volume I[141]. The smallest fees are paid by Chapter 3 aircraft. A controversy arose between Frankfurt Airport and U.S. air carriers who were displaying Chapter 3 noise certificates to pay smaller noise charges although, the reverse side of the noise certificate showed that at certain weights the aircraft was only Chapter 2 compliant[142].

iii- Airport Noise Monitoring and Control

Noise measurement devices play a big part in the enforcement of airport restrictions. The Flight and Noise Monitoring System (FANOMOS) developed ten years ago by the Netherlands is able to track routes flown by aircraft flying in and out of the airport in order to determine if the pilots followed the assigned flight path[143]. Manchester airport uses this system to enforce its stringent anti-noise night policy initiated in 1986 which designates specific night corridors. FANOMOS is coupled with a newer system developed in Australia which can monitor noise levels and provide

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138- *Ibid.*

139- *Ibid.* at 83.

140- *Ibid.* at 183.

141- *Ibid.* at 132.

142- I. Verchère, "Old 747's Provoke Euro Noise Row" *Interavia Aerospace Review* (September 1992) at 65.

143- Gould, *supra*, note 130 at 49.

other noise related data such as noise contours[144]. The central computer is linked to 16 monitoring stations installed in the nearby towns and countryside and to a radar tracking incoming and outgoing aircraft. Thus, the computer can immediately establish noise contour maps and noise footprints. When the computer identifies an offending aircraft, the airport fines the airline. The fine is set at 50% of the landing fee and the $100,000 generated per year are redistributed by the airport for the noise isolation of nearby communities. Soon "the system will include modules which will feed in meteorological and air pollution data, creating a complete computerized environmental management system"[145].

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144- *Ibid.*

145- *Ibid.* at 51.

# CONCLUSION

The International Civil Aviation Organization (ICAO) foresees that demand for civil aviation will double within the next ten years. Thus, the Organization plans to concentrate on limiting the adverse impact on the environment of this upsurge in aeronautical activities. Should its efforts prove to be ineffective, ICAO warns that the "day may come when the need to protect our environment may make it necessary to place restrictions on the future growth of civil aviation".

So far available data have not permitted an accurate assessment of the interferences attributable to aviation. There is a need for more scientific research of the atmosphere and its chemistry and for the development of computerized environmental models. Such models could give a more accurate account of the interactions between aircraft emissions and the atmosphere, and place this information in the context of the global environment. Moreover, a greater precision in scientific data would help determine liability for environmental damages and would make States more aware of their responsibilities.

A global view of environmental issues is also necessary to establish protective legal models. Legal principles and regulations must be adapted to meet the needs of environmental protection. Conventions governing the oceans, the atmosphere and other environmental matters should be compatible to take into account interactions between the different eco-systems. Technological and environmental quality standards should be constantly adapted to technological changes and the evolution of the environment. Finally, new legal concepts must be developed to reflect the ever-changing natural environment.

Such a task cannot be entrusted to an array of entities. Only a strong international organization specialized in environmental matters would have the means, the competence and the power of persuasion to serve global environmental interests. Such an organization would work in close collaboration with relevant specialized agencies of the United Nations and national administrations already involved in environmental protection as well as with those State organs responsible for regulating industries adversely affecting the environment. The future of effective environmental management lies in the development of a structure capable of treating the environment from a global perspective.

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