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ＡＮＡ：Highlights of 1998 Fiscal Year

1. General

(1) Paid-in Capital：\72,142 million (as of March 31,1999)
(2) Number of Employees：14,484 (as of April 1,1999)
(3) Operating Revenues：\903 billion
(4) Operating Size：Domestic： 34 cities、92 routs、543 flights/day on average
International： 30 cities、46 routs、364 flights/day (March,1999)

2. Operating Status

(1) Number of Flights：219,826 (Domestic：200,012、International：19,814)
(2) Passengers carried：42.61 million
(3) Revenue Passenger Kilometers, RPK：55,060 million
(4) Available Seat Kilometers, ASK：85,553 million
(5) Overall Load Factor：64.4%

3. Introduction of New Aircraft Type, Opening of New Route

(1) Domestic：Introduction of A321, Haneda－Tottori (April 1998)
Night Flight in Summer Time, Haneda－Sapporo (July-August 1998)
Opening of Saga Airport、Haneda－Saga (B767-200,July 1998)
(2) International：Kansai－Fukuoka－Shanghai (B767-300,May 1998)
Kansai－Tianjin (China) (B767-300, May 1998)
Kansai－Xiamen (China) (B767-300,July 19
Narita－Honolulu (B767-300/B747,October 1998)
Kansai－Denpasar (B767-300,December 1998)
Narita－Shanghai(reopen) (B777-200,March 1999)

4. ANA FLEET (as of March 31,1999)

Aircraft Type	Fleet	Engine Type	Average Age (Year)	ICAO Annex 16 Chapter
B747SR	12	CF6-45A2/-50E2	18.4	3
B747-200B	4	CF6-50E2	11.9	3
B747-400	22	CF6-80C2B1F	5.5	3
B767-200	18	CF6-80A	14.0	3
B767-300	42	CF6-80C2B2/B6/B6F	7.5	3
A320	25	CFM56-5A1	6.0	3
A321	3	V2530-A5	0.7	3
B777-200	12	PW4074/4077	2.2	3
B777-300	4	PW4090	0.7	3
Total	142	－	8.1	－

NOTE: ANA Group (NCA、ANK) Fleet

(1) NCA (Nippon Cargo Airlines) Fleet (as of March 31,1999)

Aircraft Type	Fleet	Engine Type	Average Age (Year)	ICAO Annex 16 Chapter
B747-F	8	CF6-50E2	13.0	3

(2) ANK (Air Nippon Co.,Ltd.) Fleet (as of March 31,1999)

Aircraft Type	Fleet	Engine Type	Engine Type (Year)	ICAO Annex 16 Chapter
B737-200	4	JT8D-17	21.6	2/3
B737-500	14	CFM56-3C1	2.3	3
YS-11	7	DART Mk542-10	29.7	—

Chapter 1 Introduction

1-1 Main Movement in fiscal 1998

(1) Global Environment in general

The reduction goal of greenhouse gases in advanced countries was prescribed at UNFCCC (United Nations Framework Convention on Climate Change) , COP 3 (the 3rd Conference of Parties—Kyoto Conference) held in December 1997, which resulted in the government deciding "Outline concerning the Promotion of the Measures to cope with Global Warming" in June 1998. In addition, amended "The Law Concerning The Rational Use of Energy" was promulgated in June 1998, and so was "The law concerning the Promotion of the Measures to cope with Global Warming" in October 1998.

In Japan, the total number of the authentication acquisition of ISO 14001 "Environmental Management System", which standardizes the management system internationally for the environmental conservation, becomes 2043 at the end of April 1999. Its movement expands not only in big businesses but also in small businesses.

ANA started to reconsider existing "Environmental Management System", and settled on "ANA Environmental Concept" in May 1998. Also, we held the 4th "ANA Group Environmental Liaison Conference" in September 1998 to exchange information of each group company as well as to confirm the cooperation system on the conservation activity for global environment by the group company as a whole. First in-house training related to the environment, "Environmental Management Practical Training" was executed in March 1999.

(2) Aircraft Noise

In Japan the amendment of Civil Aeronautics Law in June 1994 is requiring Chapter 2 aircraft to be phased out by April 1, 2002 in line with ICAO (International Civil Aviation Organization) regulation (Annex 16) . All aircraft operated by ANA meet the most stringent noise regulation in accordance with ICAO Annex 16, Chapter 3 after the retirement of the last B737-200 in August 1992. However, several Chapter 2 aircraft still exist in ANK of ANA group.

ICAO CAEP (Committee on Air Environmental Protection) had been examining the further stringency in a present Chapter 3 standard. However, the recommendation to the ICAO board of directors was put off because that the consensus in each country was not obtained at this committee held in December 1995. Then Europe began to examine operating restriction on hushkitted Chapter 3 aircraft and to

examine a new classification of the standard.
In the European airport with an original noise restriction, there is a movement to reinforce the noise regulation value. Therefore, a big impact is forecasted for the airline companies that operate airplane with near maximum take-off weight for long air route.

At New Tokyo International Airport the noise suppression facility (for south wind) for the ground run-up of the aircraft engine was built by a joint investment of ANA, JAL, and NAA (Narita Airport Authority) in April 1999. It is expected that it is more efficient than the existing facility for the north wind, is possible to correspond to all types of airplanes, is possible to operate for 24 hours, and contributes to the noise reduction to the region greatly.

(3) Air Pollution

The situation of the air pollution in Japan is highly influenced by the automobile and so on. Especially it is the urgent business to improve the pollution by NOx and SPM (Suspended Particle Matter). As for NOx, the legislation of automobile NOx emission came into force in December 1993. From the city of Tokyo in August 1996 "Guidance Outline of Automobile NOx Emission Gross Weight Control" was issued to call on the business who uses trucks and so on above a certain scale for the voluntarily supervision of NOx emission control. Similar outlines are also issued in Osaka and Kanagawa prefecture.
The automobile emission control plan has been made and executed also in our company aiming at desired value in the outline that is "to reduce 10% by 2000 fiscal year based on the amount in 1997 fiscal year".

By the amendment of Air Pollution Control Law in March 1997, 3 materials of "benzene, trichloroethylene, tetrachloroethylene" were specified as the prior materials to be taken care of (the material of which emission or scatter must be restrained immediately) among the harmful air pollutant.
In March 1999 Cabinet Council decided to submit to the Diet "Proposal for the law concerning Pollutant Release and Transfer Register (PRTR) ".
By PRTR system, the transferred amount of the wastes containing the objective chemical materials to the processing traders also becomes the object of the understanding in addition to the emission amount of chemical materials.

The influence on the atmospheric environment by the aircraft is assumed about 1 to 3% though it differs depending on the atmospheric contaminant quality. ICAO is examining the reinforcement of NOx emission standard from the aircraft engine although the influence of the emission produced at the higher altitude has not

been well understood. In April 1998, ICAO agreed on the new control measure of the NOx emission standard to reduce by about 16% (at engine pressure ratio 30) from the present control value, and which is to be applied to the new type engine that will be forwarded first after December 31, 2003 (it doesn't apply to the engine to be manufacturing at present) .

(4) Waste and Recycling

The establishment and the amendment of The law concerning Material Recycling (October 1991) , Waste Disposal and Public Cleansing Law (July, 1992) , Tokyo City Ordinance (June 1992 and December 1996) and so on successively request the reduction of the waste. We are recycling our papers, empty cans and bottles in about 70 % in our company.

(5) Global Warming

COP 3 was held in Kyoto in December 1997, and the reduction goal of greenhouse gas in advanced countries with the legal restriction power was prescribed. Also "the Kyoto protocol" that urges the constant participation by the developing countries were adopted.

The amount of CO_2 emission in Japan in 1996 fiscal year was 337 million tons and its amount per person was 2.68 tons. The emission amount was increased by 1.2% compared with the previous year and increased by 1.0% per person.

In September 1996 Japanese 3 major airlines (ANA, JAL, JAS) have committed to achieve the target "By 2010, CO_2 emission per transport unit (ASK: Available Seat Kilometer) will be reduced by 10% from the 1990 level", according to the voluntary action plan (the goal quantity of the reduction of the CO2 emission and the concrete measure for the reduction, and so on) produced by The Federation of Economic Organizations.

In February 1998 as the Ministry of Transport requested Japanese airline industry the voluntary action plan to reduce CO2 emission, The Scheduled Airlines Association of Japan represents Japanese 10 scheduled airlines has committed to achieve the same target and measures to cope with global warming as the one submitted to The Federation of Economic Organizations.

The most effective global warming prevention measures of airline companies are to save the aircraft fuel. However, since the oil shock in 1973 ANA has been implementing all the fuel saving measures that are thought of and has reexamined the fuel reduction measures that we have implemented in the past to put more efforts to save the fuel.

"The Law Concerning The Rational Use of Energy" aiming to suppress the quantity of energy consumption as one of the global warming prevention measures was amended in June 1998, and was enforced in April 1999. Class II energy control specified plant in addition to the existing Class I energy control specified plant was designated by this amendment.
Four plants will be specified as Class II energy control specified plant in ANA.

In May 1999 the IPCC published a special report on Aviation and the Global Atmosphere that was based on the request of the ICAO. It assesses what is known about the effects of aviation on the earth's climate and on atmospheric ozone in the past and in the future. It also includes scientific, technological, social and economic issues associated with adverse effects of aviation.
The outline of IPCC special report is described in Chapter 5.

(6) Protection of Ozone Layer

The production of freon and trichloroethane was prohibited in January 1, 1996 and halon was in January 1, 1994 in compliance with "Montreal Protocol". It plans to make a total abolition of CFC alternatives in principle in 2020. In Europe there is also a movement that advances the date of CFC alternatives abolition.

As for the use of freon and trichloroethane etc. in ANA, they were abolished at the end of fiscal 1993 based on the abolition plan in 1990. The rain repellent system (securing view at the landing in rain) of the aircraft, for which freon 113 was used as injection material, was deactivated to prevent gas from discharging into atmosphere in 1998 fiscal year.

1.2 Air Transport and Global Environmental Issues

The environmental issues are classified as follows in figure 1-1. The issues to be especially related to the air transport in figure 1-1 are the following items.

① **Noise issue**: Although it is different from the global environmental issue, it is a issue to which a considerable improvement effort has been made as a issue not avoided in the airline industry up to the present.

② **Air pollution issue**: The influence of the aircraft on the atmospheric environment is assumed about 1 to 3% but the influence of the emission produced at the higher altitude has not been well understood yet. Every effort was focussed on the improvement of engine performance up to now.
The acid rain problem is thought to be caused rather by the automobile emission than by the aircraft engine.

① **Industrial Wastes Issue**： The issue of industrial wastes is not directly related to the air transport. However, the increase of industrial wastes by the business activity has been a social issue, which is necessary for us to concern as a matter of course as the business.

④ **Global Warming Issue**： For the aircraft that uses fossil fuel, it is the highest concern of the issue. Also, the influence of NOx emission in the troposphere is recently argued.

⑤ **Depletion of Ozone Layer Issue**： This issue is relating to the use of freon and halon for the aircraft maintenance work or aircraft equipment, and moreover there is an argument that NOx in the higher altitude destroys stratospheric ozone.

ANA takes these 5 items of ① to ⑤ as the environmental issues which concerns airline business in this report.

Figure 1-1 Classification of the environmental issues and their relation with Airline Business

1.3 ANA Environmental Concept

ANA settled on "ANA Environmental Policy" in May 1998, which shows "ANA's Attitude toward the Environment" as a company.

ANA Environmental Policy

『ANA's Attitude toward the Environment』

Basic Policy

We will pursue :

- protection of the environment
- effective utilization of limited natural resources
- awareness of the public good

Course of Action

1. We will evaluate the impact of our commercial activities on the environment, and persevere in our efforts to protect the environment.

2. We will observe environmental laws and regulations, and furthermore, think and act independently to protect the environment.

3. We will make our best endeavor to minimize the environmental impact arising from operations of the airline industry.

4. We will make every effort to save energy and resources, to recycle articles, and to reduce waste.

5. We will contribute to the communities in which we live and work, through participation in social activities on environmental protection.

6. We will educate employees so that each may pay much more attention to environmental protection.

Environment Preservation Committee

1.4 Process of Our Actions to Environmental Measure and Organizational system

(1) Process

① In November 1973 ANA established "Airport Department" as generalization/ adjustment department related to the environmental problems.

② In February 1974 ANA established "Environment Preservation Committee" as an advisory body of the president. The first committee was held in July of the same year, in which 4 professional Sub-committees were inaugurated that are "Aircraft Noise Issue Sub-committee", "Ground Noise and Air Pollution Issue Sub-committee", "Factory Waste Water Issue Sub-committee", and "General Evaluation Sub-committee".

③ In July 1990 ANA established "Environmental Affairs" to actively grapple the problems including the global environmental problems by stepping forward from the conventional way of dealing with the occurrence source. ANA integrated a part of the sub-committees by the function and reorganized them to make "Aircraft Noise Issue Sub-committee", "Ground Noise and Pollution Issue Sub-committee", and "Resource Preservation Sub-committee".

④ In April 1993 ANA changed the title of "Resource Preservation Sub-committee" to "Global Environmental Measure Sub-committee".

⑤ In June 1999 ANA changed the title of "Environment Preservation Committee" to "Global Environment Committee", and 3 sub-committees of "Aircraft Noise Issue Sub-committee", "Ground Noise and Pollution Issue Sub-committee" and "Global Environmental Measure Sub-committee" to "Flight Operation Environmental Issue Sub-committee", "Ground Operation Environmental Issue Sub-committee" and "Global Environmental Issue Sub-committee" respectively.

(2) Organizational System

Figure 1-2 shows the location of "Global Environment Committee" and "Environmental Affairs" section in the organization.

(As of June 29,1999)

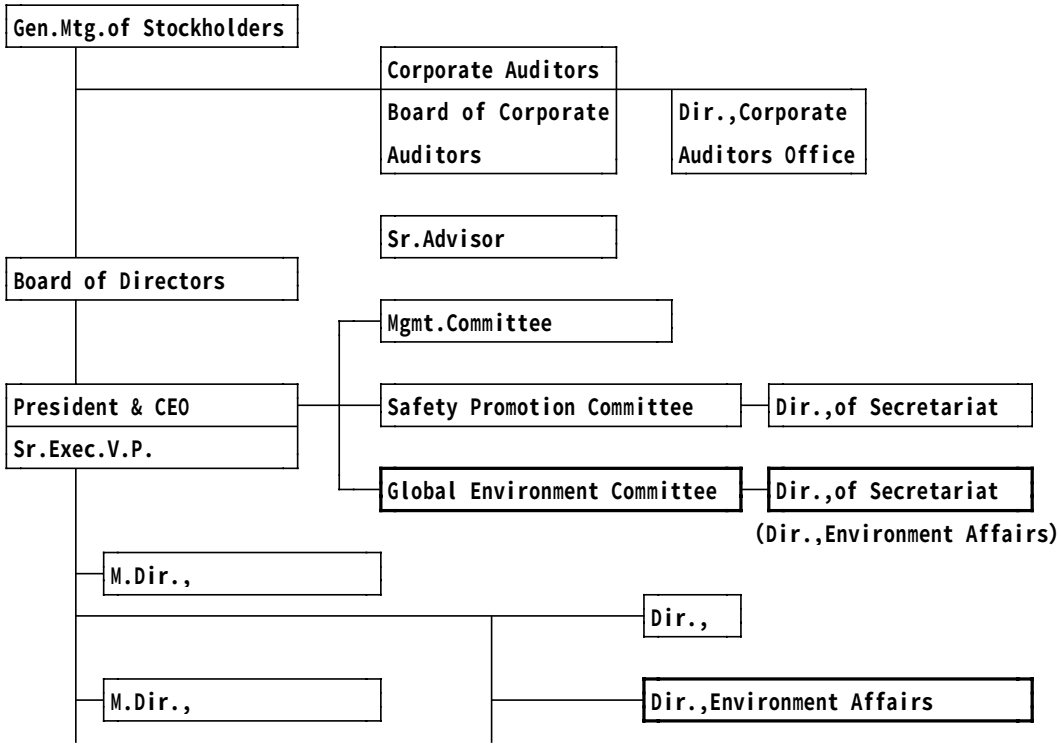


Fig.1-2 ANA Company Organization(Environment)

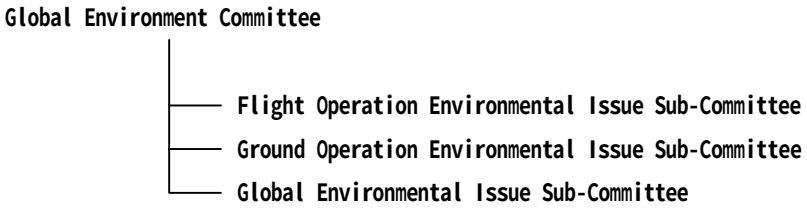


Fig.1-3 Global Environment Committee and Sub-Committee

1.5 Situation of Our Cooperation to Outside Organizations

The situation of our participation and cooperation to the outside organizations related to the environment is as in table 1-2 below.

Fiscal Year	Organization	Content
1990	Global Industrial and Social Progress Research Institute (GISPRI)	This group researches various issues concerning the global industrial culture. ANA registers the member, and has received the service of information and materials, etc. concerning domestic and world environment.
1991	Environmental Information Center	The business of this group is to spread and to offer an information of science and technology that affects the environmental conservation. The economic world backed up to establish the group. ANA cooperated when the group was established.
	Global Environmental Forum	This group is developing a scientific research of the global environmental issues, exchanging information, spreading the result of the research, supporting the environmental conservation activity, and developing international cooperation. ANA registers as a member and has received the service of information etc. concerning the environment.
	Japan Flower Promotion Center (JFPC)	This group (The Ministry of Agriculture, Forestry and Fisheries jurisdiction) succeeds to the idea of "International Flower EXPO", and aims at the spread of flowers and the promotion of national greening. ANA agrees to this idea and cooperates with this group.
1992	Japan International Forestry Promotion and Cooperation Center	ANA cooperates in this group (the Ministry of International Trade and Industry and the Ministry of Agriculture, Forestry and Fisheries jurisdiction) which promotes the national tree-planting campaign.
	IATA ETAF (Environmental Task Force)	ANA has participated in a regular conference since the 5th conference (May 1992) as an observer and has acquired the opinion and exchanged information. The first IATA international seminar about " Environmental impact by Air Transport" planned by ETAF was held at ANA hotel in Washington DC in March 1993. ANA also supported the seminar.
1993	International Noise Control Conference	ANA cooperated in the 23rd Inter Noise 1994 Yokohama held in Japan in 1994.
	Council on Life-Innovation	ANA participates in "Asian investigation committee concerning development and the environment" sponsored by Council on Life-Innovation.
1994	Global Environment Tokyo Conference	ANA agrees to and supports the purport of the global environment Tokyo conference held in October 1994.
1995	Oze Conservation Group	ANA agrees to and supports businesses to protect "Oze" and to conserve "Nikko Cedar Avenue".
	Nikko Cedar Avenue Conservation Fund	
1996	Green Purchasing Network	Member registration (February 1997) to the network where promotes prior purchase of commodity with few impacts to the environment.
1997	FCCC (Framework Convention on Climate Change) Conference	ANA donated contribution money to "COP 3 (3rd Conference of the Parties) " held in December in Kyoto.

Table 1-2 Situation of the cooperation to the outside organizations

Chapter 2 Noise

2.1 Airport Noise

Followings are airport noise issues.

(1) Aircraft noise (aircraft engine sound at landing and takeoff)

(2) Ground noise

① Engine ground running noise

② APU (Auxiliary Power Unit) running noise

③ GPU (Ground Power Unit) running noise

④ Others (ground support equipment operating noise, maintenance facility operating noise and so on)

To reduce the influence of noise, the condition of the airport establishment becomes a big factor. As an airline company, ANA will continue to consider minimizing noise disturbance.

2.2 Aircraft Noise

(1) Introduction of Quieter Chapter 3 Aircraft

Aircraft are certified against ICAO (Annex 16) standards. In the present standard, it is divided into two; Chapter 2 aircraft (aircraft which suits to the standard before the noise standard was reinforced) and Chapter 3 aircraft (aircraft which suits to the most severe standard at present after the noise standard reinforcement) .

All ANA's aircraft have fully complied with Chapter 3 requirement for the last 3 years (see Figure 2-1, Figure 2-2). Moreover, ANA has been continuing to introduce newer, quieter Chapter 3 aircraft like B777-300 and A321. In Japan, Certification to the quieter Chapter 3 standard will become a requirement by April 1, 2002.

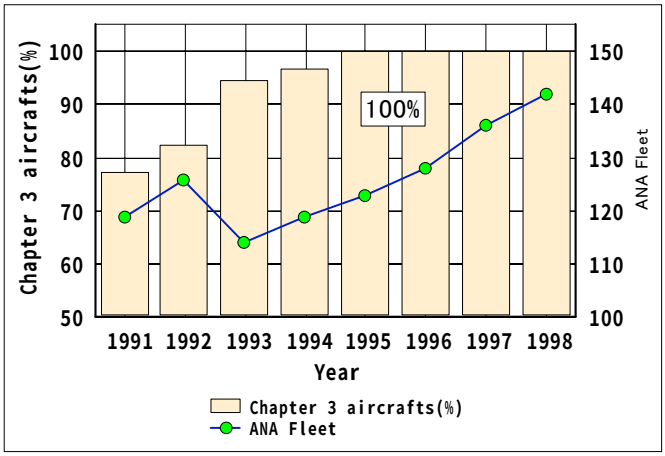


Fig.2-1 ANA fleet that conform to Chapter 3 standards

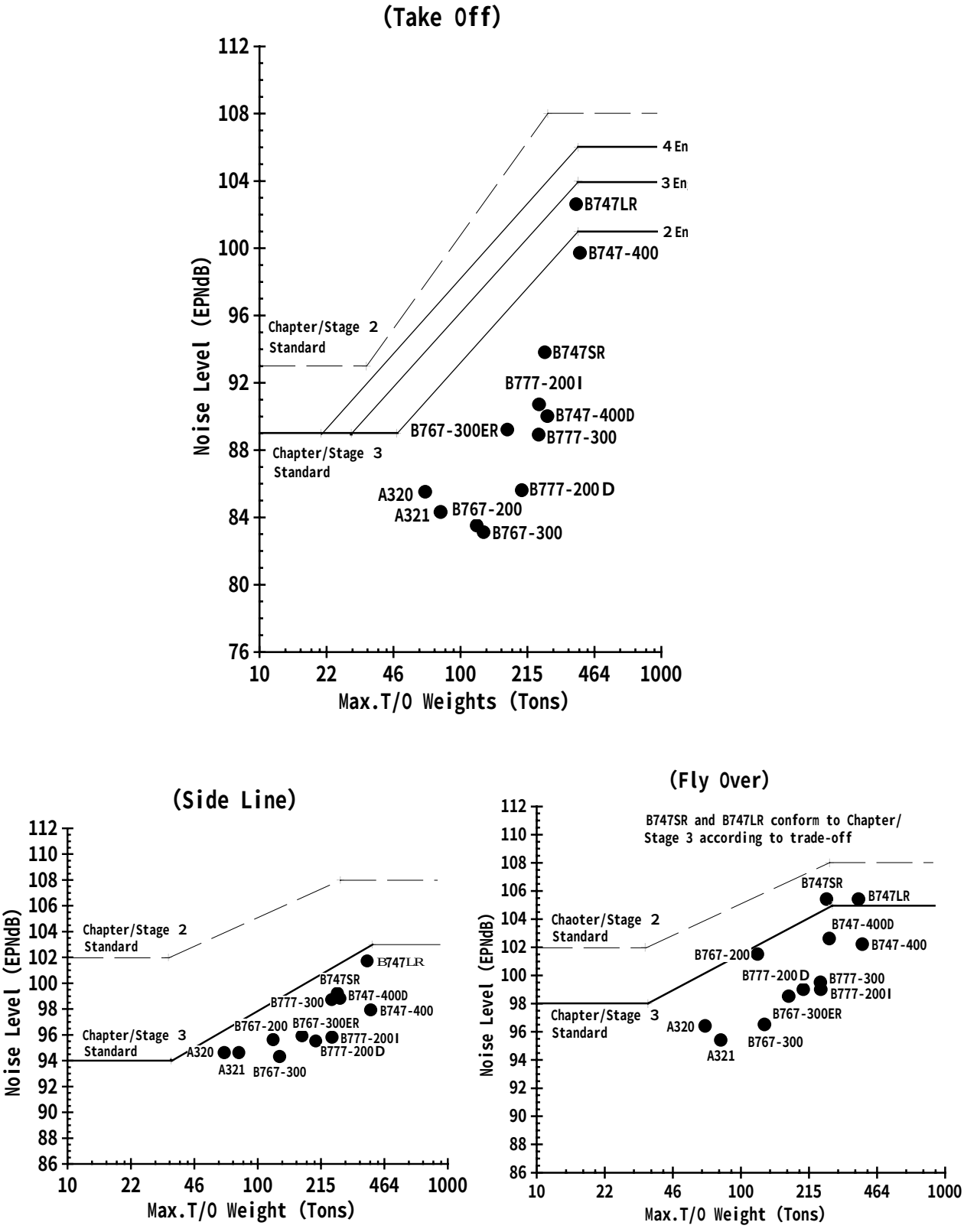


Fig.2-2 ANA Fleet Noise Level and ICAO Standards

(2) Change in Noise Contour

The area influenced by the same noise level has been reduced with the introduction of new quieter aircrafts. (refer to Figure 2-3).

ANA participate in "Aircraft Noise Issue Sub-committee" and its working group that are formed by the government and the people combination, and continue the review work to improve the accuracy of the noise forecast program.

Fig.2-3 Noise Contour comparison

(3) Introduction of Noise Abatement Operational Procedure

Based on the examination of "Promotion Committee of Noise Abatement Operational Procedure", which was established by the united efforts of the government and the people in 1975, ANA introduced Noise Abatement Operational Procedure and have been improving it up to the present.

Also, the experimental operation of the procedure, that uses FMS (Flight Management System) in a terminal area to fly effectively avoiding densely built-up area, was executed in Haneda Airport from May to September 1998, and the operation toward the regular operation has been started since March 1999. It is scheduled to expand in another effective airport such as Itami and Fukuoka, etc.

(4) Flight Route at Kansai International Airport

The investigation flight has been implemented for the evaluation on the "ground route" which was introduced in December 1998. B-runway is scheduled in use in 2007.

(5) Reviewed Proposal of Osaka International Airport Noise Area

Noise area was judged to have been decreased remarkably by the improvement of the landing noise, the introduction of quieter jet aircraft, a functional share with Kansai International Airport and so on. Consequently, the Ministry of Transport brought up the reviewed proposal of Osaka International Airport Noise Area.

(6) Start of the 24-hour operation of Tokyo International Airport (Haneda)

The noise problem in Haneda Airport area was improved extensively by the use of the new C-runway beginning in March 1997. As a result, Tokyo International Airport became to be operated for 24 hours. In addition, the new B-runway is under construction aiming at the use beginning at the end of 1999 fiscal year.

2.3 Ground Noise

(1) Osaka International Airport

Sound isolating walls for the engine run-up were set up in 1971, which are still in use, also have been making an best effort to shorten the run-up time and the high power operation time as well as the APU operation time.

For the reduction of the ground noise, new facility for the engine ground run-up which is equipped with the large scale soundproof walls around is considered to build.

(2) New Tokyo International Airport (Narita)

① With the beginning of the operation of terminal 2, ANA consider an influence over the area near taxiway, and voluntarily refrain from operating APU at the time of ramp in and ramp out. As for our operation of APU, APU OFF operation has been our standard since 1992 from the viewpoint of ramp noise reduction according to a request from NAA as well as from the viewpoint of the fuel cut down (the reduction of CO2 emission). When the repair of terminal 1 was completed, NAA notified all the airlines "to implement APU OFF operation as much as possible from April 1, 1998" with a document from the viewpoint of the global warming prevention.

② The hanger type noise suppression facility (engine ground running noise) for the south wind was constructed by a joint investment of ANA, JAL, and NAA in April 1999, which is a part of the countermeasures on the aircraft noise. It is expected to be more efficient than the existing facilities for the north wind, to be possible to correspond to all kinds of airplanes, to be possible to operate for 24 hours, and to contribute to the region environmentally.

(3) Tokyo International Airport (Haneda)

① New run-up area was established in offshore area of Haneda and was started to operate in January 1994. The noise problem to the area was considerably eased by the operation of 7 spots in total.

② ANA built the new engine test cell in October 1995, which is considered to restrain low frequency noise, and also built an APU run-up facility aside in April 1998.

(4) Countermeasure on Noise of Maintenance Facilities and Vehicles

ANA is carrying forward the renewal of our vehicles to low noise type and 65 % of the AC power supply car ANA possess are low noise type. Also, ANA introduced 5 de/anti-icing vehicles of low noise type by 1998.

Chapter 3 Emissions

3.1 Air Pollution Issue

The pollutants are carbon monoxide (CO), hydrocarbon (HC), nitrogen oxides (NOx), sulfur oxides (SOx), dust, small particles and so on. Especially NOx from diesels, Suspended Particle Matter (SPM/DPM) and secondary pollutant of photochemical oxidant are recently considered as big issues.

3.2 Aircraft and Air pollution

It is supposed that the aircraft engine emissions hardly influences local air pollution because emissions becomes extremely rarefied due to the air diffusion effect in the atmosphere over 1,000 meter altitude. However, the aircraft engine exhaust could influence to ① the air pollution around the airport at the low altitude ② the destruction of ozone layer at the higher altitude, further more ③ the global warming. As for ①, according to the data of International Air Transport Association (IATA), the aircraft emissions contributes 1 to 3% of all the air pollution, that is quite small percentage compared to other emission sources such as automobiles and factories. ② and ③ will be explained in Chapter 5. The scientific findings report at this moment by United Nations IPCC (Intergovernmental Panel on Climate Change) was issued in May 1999.

The study and development of the aircraft emission reduction technique is remarkably improved in the past 30 years and emission quantity of HC, CO, and smoke have been substantially decreased. Figure 3-1 shows the change in every 10 years from 1960 to 1990 about the emission quantity per engine thrust with the Landing Taking Off (LTO) Cycle set by (ICAO) . HC and CO has been reduced substantially within 30 years. However, NOx shows not to be decreased. To have made a combustion chamber with a high temperature and a high pressure to improve the efficiency of engine combustion makes the reduction of NOx emission difficult.

Also, trying to suppress NOx emission results in the increase of the fuel consumption. It is our concern to balance both. Following methods have been researched to reduce NOx, and a part of them has been made practicable: multi-staged combustion chamber, pre-mixed rarefaction combustion method, concentration/rapid cooing/rarefaction combustion method, pre-mixed catalyst combustion method. Incidentally, the fuel used decides the sulfur oxides (SOx) emission. However, the influence on the air pollution (especially the acid rain problem) can be said very small because the aircraft_fuel (kerosene type) which is used at present contains equal or less than 0.01 % of sulfur (the standard is equal or less than 0.3 %).

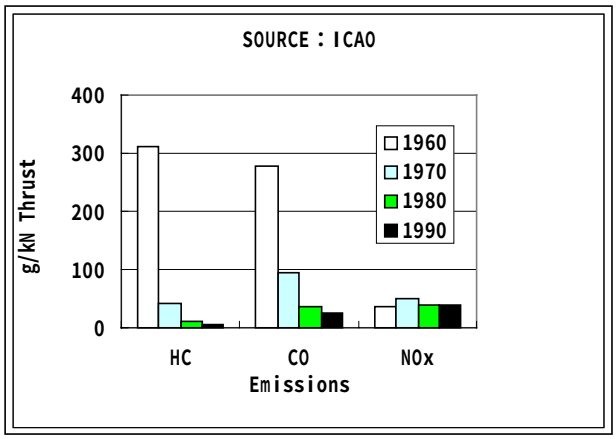


Fig.3-1 Progress of Engine Emissions

3.3 Aircraft Engine Emission Control

ICAO regulates HC, CO, NOx and smoke with Emissions certification system and Fuel emissions certification system according to the ANNEX 16, Part 2 "Aircraft Engine Emission" that became effective on February 18, 1982. After the revision some times, the newest present standard of NOx emission adopted the reduced standard amount by 20 % from that of 1986. This standard is supposed to apply to the engines produced with type certificate after December 31, 1995 and all kinds of engines produced after December 31, 1999. Moreover, in April 1998, ICAO CAEP agreed on the new regulation value plan, which cut down NOx standard by about 16 %(at engine pressure ratio 30) from the present regulation value, to apply to the new type engines shipped first after December 2003(not applicable to engines being produced at present).

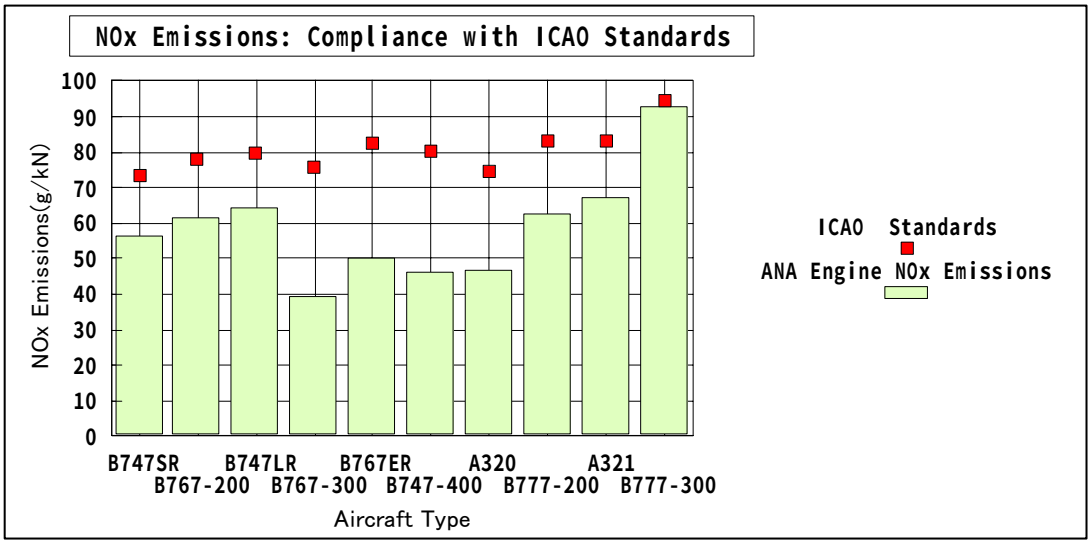
In Japan, a part of Civil Aeronautics Law was amended in April 1996, that the aircraft engine emission was added to the inspection standard of Airworthiness Certificate, and was enforced in October 1997.

3.4 Present Situation of ANA and its attitude

(1) Aircraft and related matters

The most effective way to reduce the harmful aircraft emission is to introduce an improved new engine. As a result of our having actively introduced the latest aircraft, the improvement of the emission is remarkable in this 20 years. Figure 3-2 shows the contrast of the emission quantity of aircraft engines ANA possess with the ICAO standard value. The engines being used at present in our company, excluding a few engines produced in a small scale, meet the emission standard of ICAO.

In order to restrain the emission in the operation, we practice following matters besides introducing the latest engines: decreasing the operational time of engines as much as possible, reducing the use of Auxiliary Power Unit (APU) by utilizing the ground facilities, shortening time of ground engine run-up by improving the maintenance work procedure, executing a practical flight training with a simulator, and cutting time of ground run-up training.



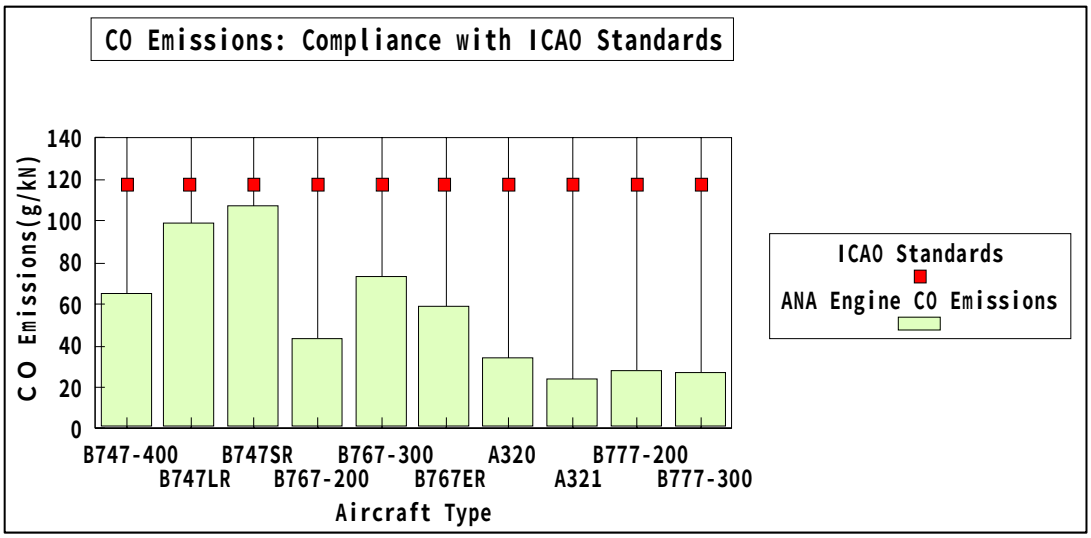
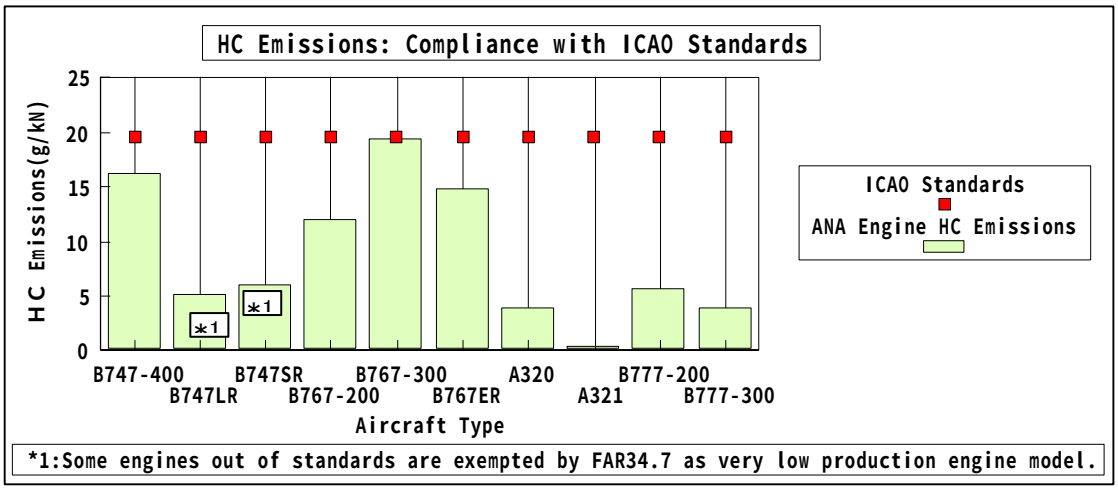


Fig.3-2 ANA Fleet Engine Emissions and ICAO Standards



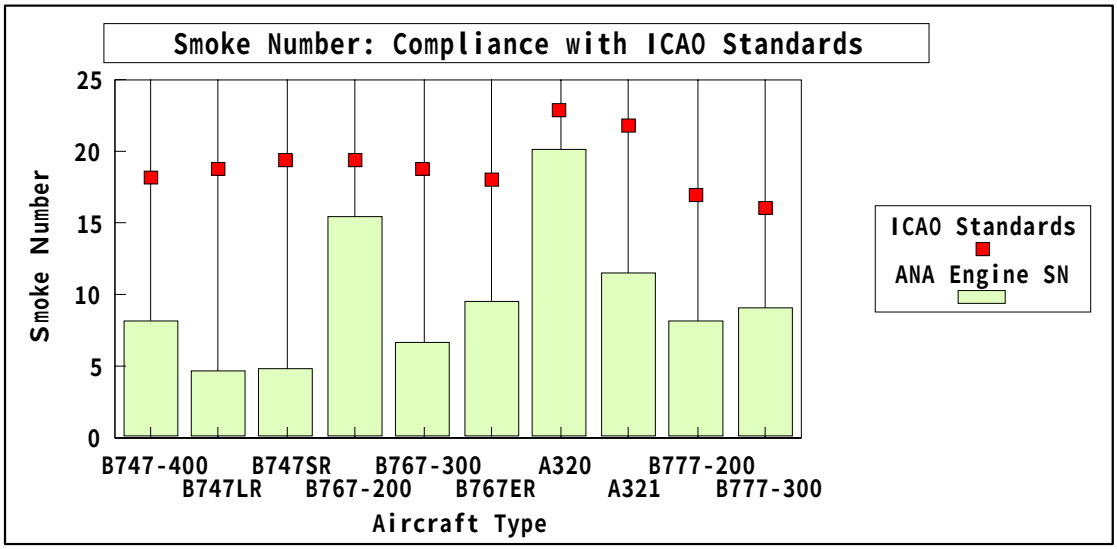


Fig.3-2 ANA Fleet Engine Emissions and ICAO Standards

(2) Ground Vehicles and related matters

There are about 2,000 or more vehicles of various kinds (ground support equipment car, airport handling car, tag car, AC power supply car, forklift and so on) that our group companies use in the airport throughout the country. ANA is making an effort for introducing low-pollution vehicles and renewing those to the latest vehicles with lesser harmful emissions in permissible range. ANA possess 79 low-pollution vehicles in total as of March 1997 such as the battery type (storage battery), the natural gas type, the hybrid type and so on.

According to the automobile NOx control measures of Tokyo (Guidance Outline of Automobile NOx Emission Gross Weight Control), ANA has submitted the automobile NOx emission gross weight control plan since 1998 fiscal year, and have been

executing the plan for "reducing the emission 10% by 2000 fiscal year based on the value of 1997 fiscal year".

Nagoya Airport Motor Service Co. Ltd. introduced a natural gas vehicle as a new low pollution vehicle in April 1996 to use as liaison vehicles for maintenance in the airport. This was the second case to introduce a natural gas vehicle within ANA group following ANA Motor Service Co. Ltd. in 1994.

(3) Examination of Low VOC (volatile organic compound) Paints for Aircraft Exterior

Because VOC is emitted from paints, we introduced 6 airplanes that are painted with new low VOC paint (polyurethane) at the production line, and started its evaluation in 1998 fiscal year. In addition, we are researching on the paints with better performance.

(4) Fuel Dump due to Unexpected Landing

The weight of the aircraft might be reduced by throwing the fuel away in order to make an airplane land safely in the case of the unexpected landing due to aircraft system malfunction and/or a sudden passenger illness. The number of fuel dumps by ANA aircraft in the fiscal 1998 is 3 cases about 137 kiloliters. Figure 3-3 shows the change of the number of fuel dumps and its quantity. Airport authority and other rules specifies the location and its altitude to throw fuel away, avoiding a town area. The fuel thrown away at the higher altitude becomes vaporized and diffused, which doesn't effect air pollution and marine pollution.

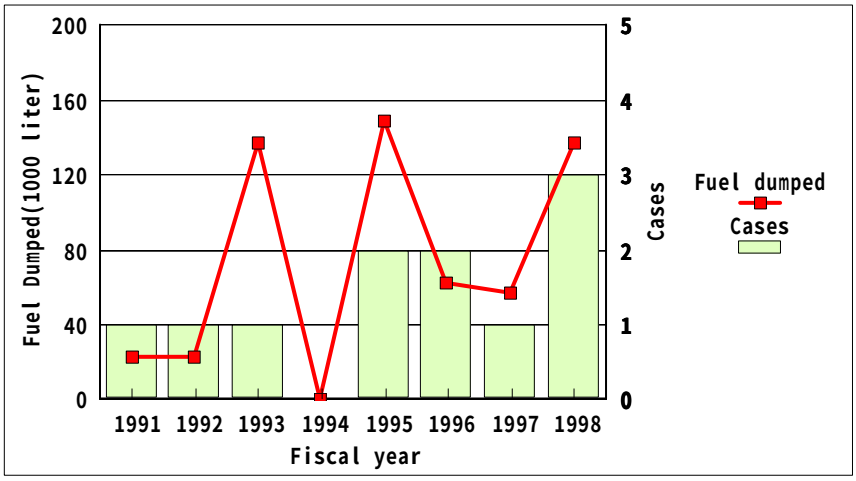


Fig.3-3 Fuel Dumps

Chapter 4 Waste and Recycling

4.1 Air transport and Emission

The emission related to the air transport is classified below.

(1) Aircraft engine emissions

(2) Waste disposal or drainage/waste water from the facility and so on with the maintenance work of the aircraft

(3) Garbage from the aircraft cabin

(4) Garbage from the offices

"Aircraft Engine emissions" is taken up in "Air Pollution" in Chapter 3.

4.2 The main legal regulation about the waste disposal

(1) Waste Disposal and Public Cleansing Law (executed in 1992)

(2) The legislation of recycling (executed in 1991)

(3) The law of recycling for containers and packing (executed in 1997)

(4) Tokyo ordinance concerning waste disposal and recycling (executed in 1992)

(5) Tokyo ordinance to charge for the waste (enforced in 1996)

4.3 Our Situation

(1) Office Wastes

The municipal wastes are properly managed and disposed under Tokyo guidance in our facilities and offices where are the crew training center area and each maintenance center (maintenance factory) in the maintenance area by drafting plans of the waste reduction and recycling and using manifests (shipload list system). The quantity of the municipal waste disposal in Haneda area in 1998 was about 1,707 tons. The change of the quantity of the municipal waste disposal in Haneda area is shown in figure 4-1.

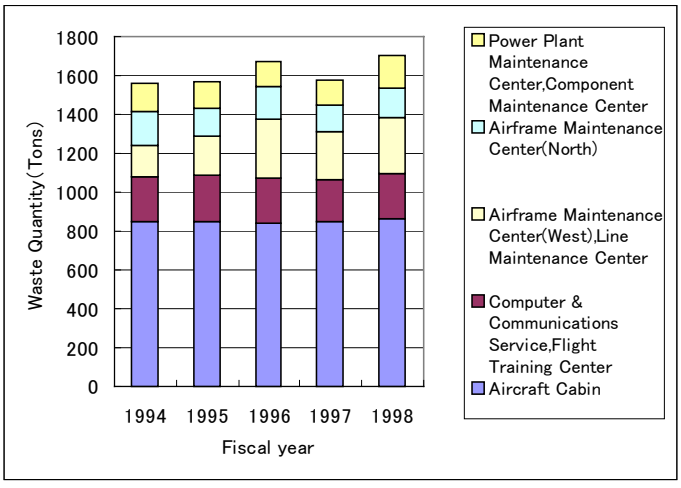


Fig.4-1 General Wastes (Haneda Area)

① Situation of the use of papers

The quantity of the papers to use on the business in the whole company is approximately 300 million sheets (about 1,200 tons) in a letter size paper. The gross weight of copy papers used in Tokyo area (head office building, Haneda airport area) in the fiscal 1998 was about 2,400 sheets (about 96 tons) in a letter size paper.

② Situation of the use of the recycled paper

The offices using recycled papers for copies are about 50 % of all but the main offices are using it with concerted efforts. The publication using recycled papers are; time table, company telephone books, executive lists, "flight safety review" journals, personnel service news, management news, computer output papers, maintenance work cards and so on. As for the use of recycled papers for maintenance work cards, it acquired for the first time in our company the ECO-mark authorized by the Foundation of Japan Environment Association.

③ Recycling of papers, cans and bottles and situation of enforcing the energy conservation

Each office recycles papers, cans, and bottles by itself, and public buildings except the headquarters do in cooperation with other enterprises. 85% of the offices enforce classified collection of papers and 63% of the offices recycle cans and bottles. 91% of the offices enforce the energy conservation.

④ Recycling of air ticket stubs

Because a used air ticket stub has a magnetic tape, it was considered not to be able to recycle and was disposed by fire, but in July 1996 we changed it to the dissolution process that makes it possible to recycle the stubs. Approximately 100 tons of air ticket stubs in a year are utilized for the recycling.

⑤ Other recycling

A passenger seat headrest cover, nickel cadmium battery for OA equipment and so on are collected separately and are utilized for the recycling.

(3) Industrial wastes and Special Management Wastes

In our company each maintenance center (maintenance factory) in the maintenance headquarters emits the industrial wastes and the special management wastes, which are properly disposed by the use of the manifest (shipload list system). Table 4-1 shows the waste quantity according to the kinds of the industrial wastes and the special management wastes in 1998 fiscal year. The change of the waste

quantity according to the kinds in the industrial wastes and the special management wastes is shown in figure 4-2. About 19.9% of the total waste quantity have been recycled, that leads to cut down the wastes.

Materials	Waste Quantity (Tons)	
Sludge	134. 6	
Oil Wastes(*)	78. 7	(*)Recycled Materials
Acid/Alkali Wastes	1. 9	: 60. 3 Tons
Plastic Wastes	50. 8	Recycled Rate
		: 19. 9%
Metal Wastes(*)	9. 8	
Inflammable Oil Wastes (*)	14. 6	
Strong Acid/Alkali Wastes	9. 3	
Noxious Materials	1. 4	
Total	303. 1	

Table4-1 Industrial Wastes/Special Industrial Wastes Quantity(Fiscal Year 1998)

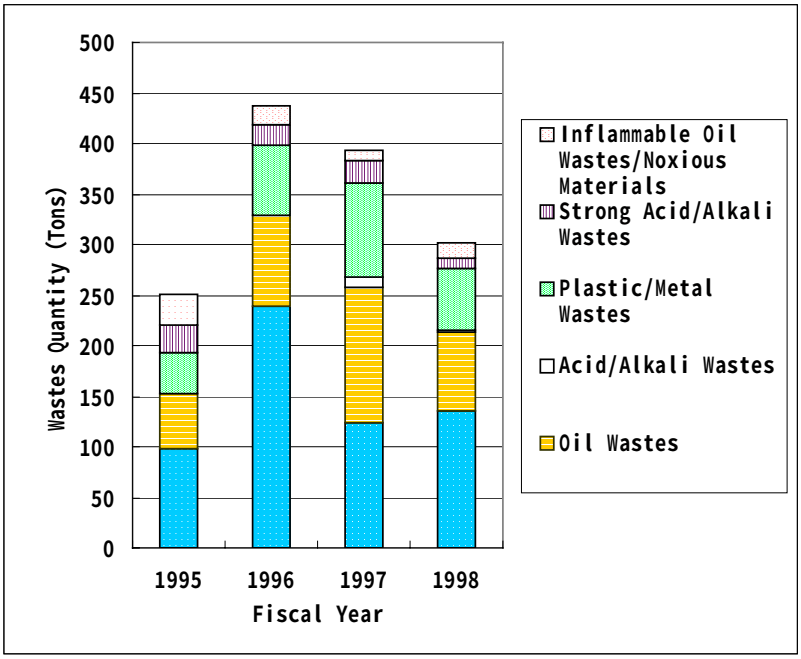


Fig.4-2 Industrial Wastes/Special Industrial Wastes Quantity

① When the aircraft weighing is conducted, changing the procedure to which measures without making a fuel tank empty reduces fuel disposal quantity (about 8.5 tons for a year) . Narita Maintenance Center plans to reduce the industrial wastes by effectively utilizing the aircraft fuel (was necessary to dispose as the special management industrial wastes) which is discharged by the maintenance work as boiler fuel of hanger (about 10,000 liters a year) .

② The active carbon (charcoal) to be used for the aircraft air-conditioning system and for the water processing of hangar had been disposed in the regular exchange but recycling it reduces the disposal quantity (about 2 tons annually) .

③ In ANA Power Plant Maintenance Center, acid and alkaline coating-remover had been used to remove the coating of the engine parts. The facility was changed to the one with the super high-pressure water in 1998 fiscal year, so that about 30% or less of the amount of special control industrial waste was able to be reduced.

④ New Paint Remover (Stripper)
A new non-chlorine painting remover, by which the content of a chlorine organic solvent became about 1/3 of the old one, has been developed. In 1998 fiscal year approval of the aircraft manufacturer was acquired, the evaluation examination with a real aircraft was done, and the following two effect were confirmed. The reduction in the quantity consumed by the improvement of the stripping duration and the effect in reduction of the waste by the improvement of the procedure. The examination for the production line will be continued.

① Although PCB (polichlorinated biphenyl) containing and PCB deposit substances, of which the disposing method hasn't been legally found yet, haven't been newly produced, the cumulative quantity of PCB storage becomes about 4 tons in the end of 1998 fiscal year. The early development of the disposal and treatment method to make PCB harmless is waited. PCB as an endocrine disrupting chemicals is planned to be an object substance in Pollutant Release and Transfer Register system.

⑥ The waste article of the aircraft battery (nickel-cadmium type) cell was produced by about 5 tons in 1998 fiscal year, which are recycled by separating metal through the commissioned trader.

(3) Medical Wastes

The medical waste disposed from our health care center is processed properly by the commissioned professional trader. The amount of the waste and the waste fluid in 1998 fiscal year was 1,580 liters, and had 218 kilograms abandonment of the X rays films. The amount of the waste was increased because the number of examinees for employment as cockpit crew and cabin attendant were increased in 1998 fiscal year. Figure 4-3 shows the transition of the waste quantity.

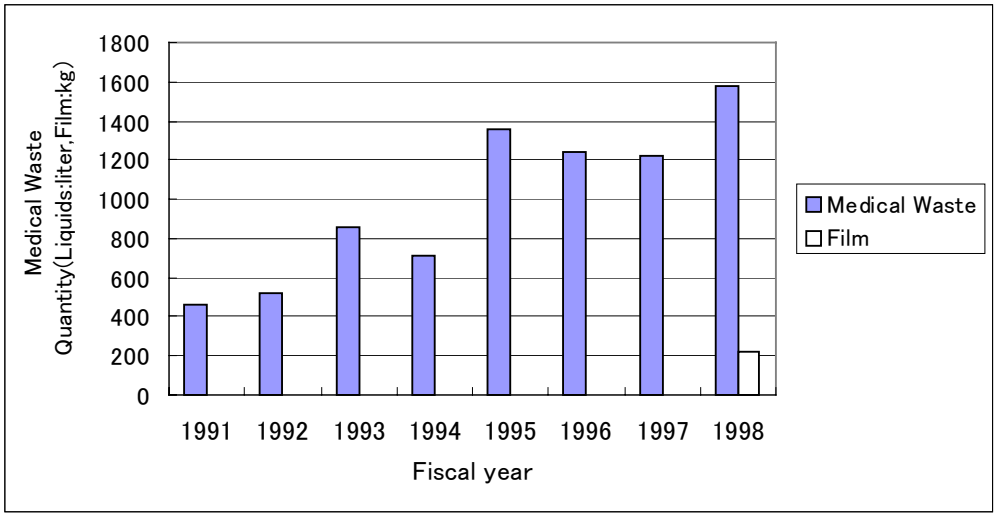


Fig.4-3 Medical Wastes Quantity

(4) Waste Water Disposal

There are 3 kinds of waste water disposed, that are facility waste water to use for aircraft maintenance, washing water to clean aircraft surface and processing water used in winter as aircraft de-/anti-icing fluid to clear away snow and/or ice on the aircraft surface, to prevent the ice and to defrost in ramp area.

① Maintenance facility waste water

There have been no problems in the regular inspection by the local self-government body, the inspection by a facility maintenance company and the independent voluntary inspection by a public organization. The factory waste water quantity in the fiscal 1998 was 19,629 tons. The change of the waste water quantity is shown in figure 4-4. In Narita Maintenance Center the rain water reserved in the underground water tank utilizing the hangar roof and used circulated water approximately 6,000 tons a year is also used for cleaning aircraft surface and as service water in the facility. Moreover, the construction plan is set on to increase rain water use capacity.

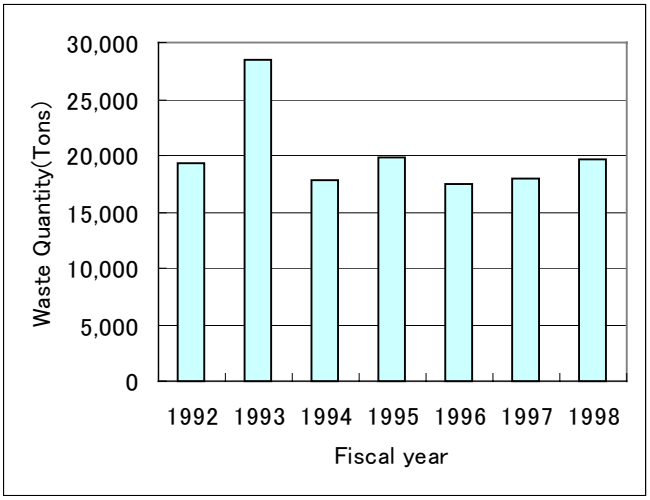


Fig.4-4 Wastewater Quantity (Maintenance Center)

② Drainage from aircraft surface cleaning

Aircraft surface cleaning is done within a hangar or in a specified are in the airport. ANA is aiming at reducing the drainage amount produced by aircraft surface cleaning as much as possible. It is properly processed as the hangar drainage when the cleaning is done in the hangar and also in the designated area. Approximately 12,450 tons of water was used to clean aircraft surface (No.2 cleaning) in the fiscal 1998. The change of the waste water quantity is shown in figure 4-5.

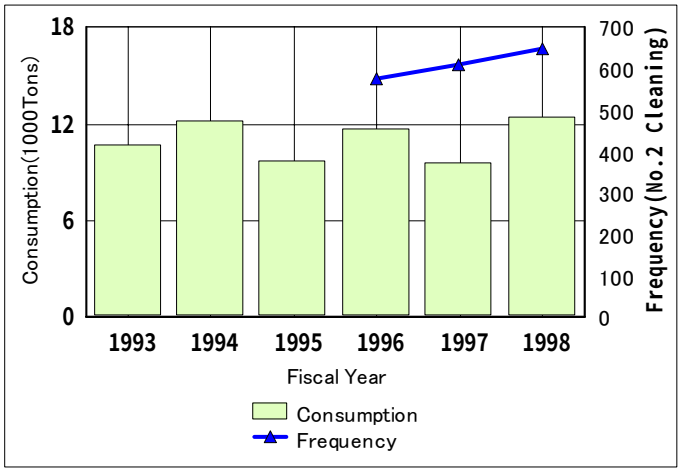


Fig.4-5 Aircraft Water Washing Results

③ Drainage by aircraft de-/anti-icing work

The substances containing ethylene glycol or propylene glycol are mainly used as aircraft de-/anti-icing fluid. It is diluted with water before work and with

snow dissolving into water. By flowing into the river, such substances sometimes temporarily aggravate BOD (biochemical oxygen requirement) and/or COD (chemical oxygen requirement) which are the environmental standard items on the water quality. The number of aircraft de-/anti-icing work in winter of 1998 fiscal year was executed to 2,821 in total including in local airports, and about 1,039 kiloliter of de-/anti-icing fluid was used. The transition of the amount of the waste fluid is shown in Figure 4-6.

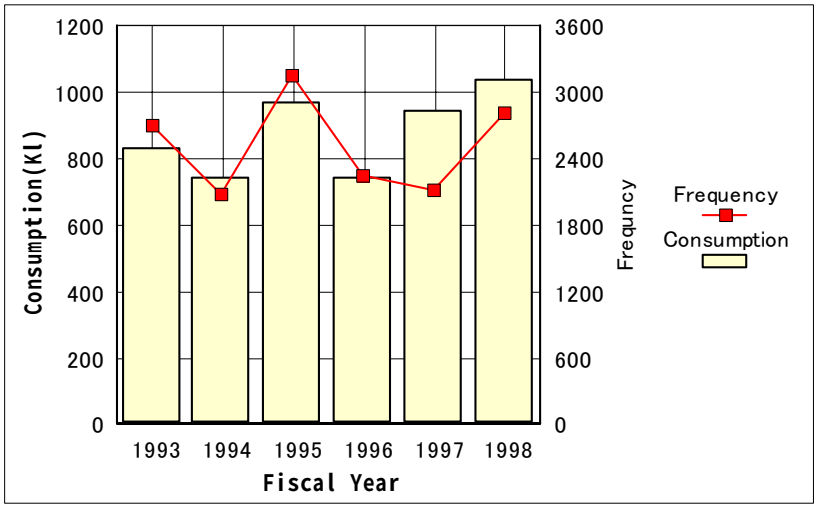


Fig.4-6 Aircraft Anti-Icing/De-Icing Results

ANA will continue to execute, research and examine following 3 points as main items in order to improve water pollution.

(a) To decrease the quantity for use of the de-/anti-icing fluid and to dilute in use as much as possible

Type IV de-/anti-icing fluid which the holdover time (anti-icing duration) was improved to about twice, was introduced in winter of 1996 fiscal year. It contributes to the decrease at the quantity consumed. In addition, the nozzle for the defrosting work that the amount of the exhalation can be adjusted was arranged in five airports by the winter of 1998 fiscal year. It contributes to the reduction of the quantity consumed in the fluid sprinkle work.

(b) To examine the introduction of de-/anti-icing fluid with no pollution or low pollution

In winter of 1996, Type IV de-/anti-icing fluids mainly composed of ethylene glycol which holdover time was improved to about twice was introduced in addition to existing Type I and Type II de-/anti-icing fluids mainly composed

of propylene glycol.
In winter of 1997, Type IV de-/anti-icing fluids mainly composed of propylene glycol which would affect less of deterioration of BOD (Biochemical Oxygen Demand) or COD (Chemical Oxygen Demand) which are environmental standard item of water quality was introduced. As a result, all de/anti-icing fluid to be used in ANA became the one mainly composed of the propylene glycol. In winter of 1998, the use of propylene glycol base Type IV de-/anti-icing fluid has been expanded to all domestic bases.

(c) To examine the collection and recycling method of waste liquid besides the de-icing pad method, the following collecting methods are objects of the examination. The absorption method to collect the liquid by roller car made of the sponge, vacuum clean-up method and the installation of the waste liquid dams (oil fence) etc.

(4) **Introduction of non-chlorine flaking the paint off agent for aircraft**

ANA and Gage Products Company in the United States have jointly developed non-/low-chlorine aircraft paint remover which is different from the chlorine aircraft paint remover used so far in September, 1997. Technological approval for the use of the non-chlorine paint remover which does not include dichloromethane was acquired for the first time in the world from the aircraft manufacturer, the Boeing company. The new fluid, which was improved in the durability of exfoliation, was expected the large reduction of the amount of the exhaust waste because of the improvement of the procedure besides the quantity consumed to be reduced. The result was excellent as we expected even by the trial of actual aircraft painting work. The examination will be continued aiming at the real operation in near future.

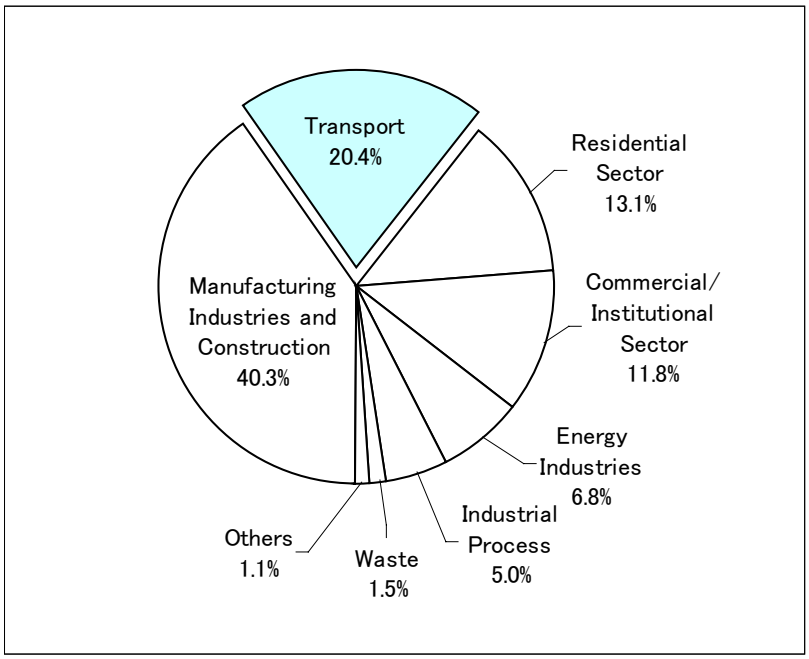
Chapter 5 Global Warming

5.1 Global Warming Issue

Since the late 19th century, global mean temperature has increased by 0.3 to 0.6°C according to the report of IPCC (Intergovernmental Panel on Climate Change) in 1995. Due to the accumulation of greenhouse gases until present, the temperature is expected to be increased by about 1°C in around 2050. In addition, it is estimated that global mean temperature will be increased by 1 to 3.5°C and the mean sea level will rise by 15 to 95 cm by the end of the 21st century if greenhouse gases keep increasing at the present increase rate.

In the protocol concluding a treaty of the COP3 (United Nations Framework Convention on Climate Change, the 3rd Conference of Parties) held in Kyoto in December 1997, the reduction target of greenhouse gases in each advanced country with a legal restriction power was prescribed, and the constant participation by the developing counties was urged.
As for Japan, the target, which reduces 6% of the average emission amount of greenhouse gases between 2008 and 2012 from its level in 1990, was set. "Energy consumption efficiency improvement", "Understanding and actions of the people", "Technological development and its spread", and "International cooperation" are to be examined as the measures.

Taking a look at the amount of the CO_2 emission of each categories in Japan in 1995 fiscal year, an industrial section is 40.3%, the public welfare section is 24.9%, and the transportation section is 20.4% (refer to Figure 5-1). The public welfare section and the transportation section are increasing in its amount as a recent tendency compared with the industrial section where the emission amount is decreasing by the conservation of energy measures. It is shown that the emphasis of a social economic structure moves from production to consumption, and the resource is used for the convenience of daily life and amenity.



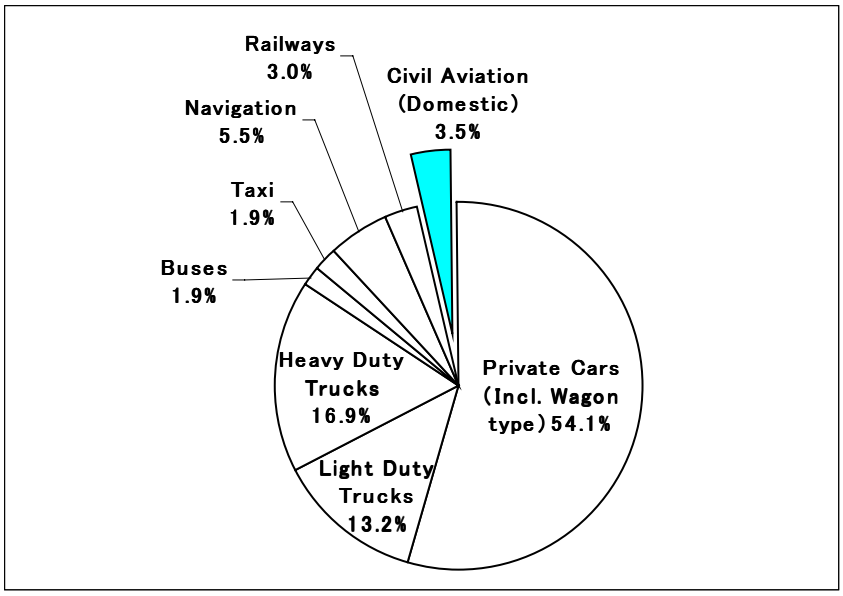
CO_2 Emission Sources (Fiscal Year 1995)

Fig.5-1 CO_2 Emission Inventories All Over Japan

5.2 Relationship between Air Transport and Global Warming

CO_2, NOx (it increases tropospheric Ozone) , H_2O, CFC and HCFC are greenhouse gases emitted along with air transport. CFC and HCFC will be described in Chapter 6, Protection of ozone layer. The amount to be used in the airline company is not only very small but the restriction based on Montreal protocol has already been effective so that it does not have to be a big problem to be assumed.

The amount of CO2 emitted by the aircraft in the world is said about 3% of the total amount of CO2 emission from the fossil fuel according to statistics of ICAO. The emission ratio of CO2 by airlines in Japan accounts for 3.5% of the transportation sections. It is only 0.7% or less among entire domestic CO2 emission. Therefore, the contribution to the global warming by airlines can be said as quite little.(refer to Figure 5-2)



Transpot Sector Details (Year 1995)

Fig.5-2 CO_2 Emission Inventories All Over Japan

5.3 Active Plan by Airline Industry

In September 1996, the Federation of Economic Organizations had requested all domestic industries to make a plan for independent course of action (the target value of the CO2 emission reduction and the concrete measures for the reduction etc.) concerning the environmental protection. Three major airlines (ANA, JAL and JAS) set the target value of CO2 emission reduction that is "By 2010, CO2 emission per transport unit (ASK : Available Seat Kilometer) will be reduced by 10% from the 1990 level". Followings are the main works in the concrete measure to achieve the goal. Promotion of adoption of new type aircraft and switching equipment and materials to new type aircraft, Adoption of FANS (Future Air Navigation System), and execution of daily service consuming as little fuel as possible etc.

In February of 1998, there was a request to make a Voluntary Plan to Arrest Global Warming Prevention from the Ministry of Transport so that Scheduled Air Transport Service Association of Japan represents Japanese 10 scheduled airlines has arranged and submitted a plan which was almost the same content as the one submitted to Federation of Economic Organizations. The plan will be regularly reviewed and revised in the future.

5.4 Transition and Current State of Fuel Saving Measures of ANA

(1) The emission amount of carbon dioxide

The amount of CO2 emitted along with the operation of the aircraft in our company in 1998 fiscal year is about 2.13 million tons in terms of carbon converted amount.

The aircraft fuel consumption has no choice but will increase because the growth of passenger traffic is forecasted to increase more and more in the future. In the current state that we have no suitable substitution except the fossil fuel, the airlines company should effectively use the fuel, that is to carry the customer efficiently with lesser energy.

Figure 5-3 shows the transition of the amount of CO2 emission for each Available Seat Kilometer (ASK). The number of ASK increases greatly as the demand of passenger traffic increases but the amount of CO2 emission per ASK shows the tendency to decrease.

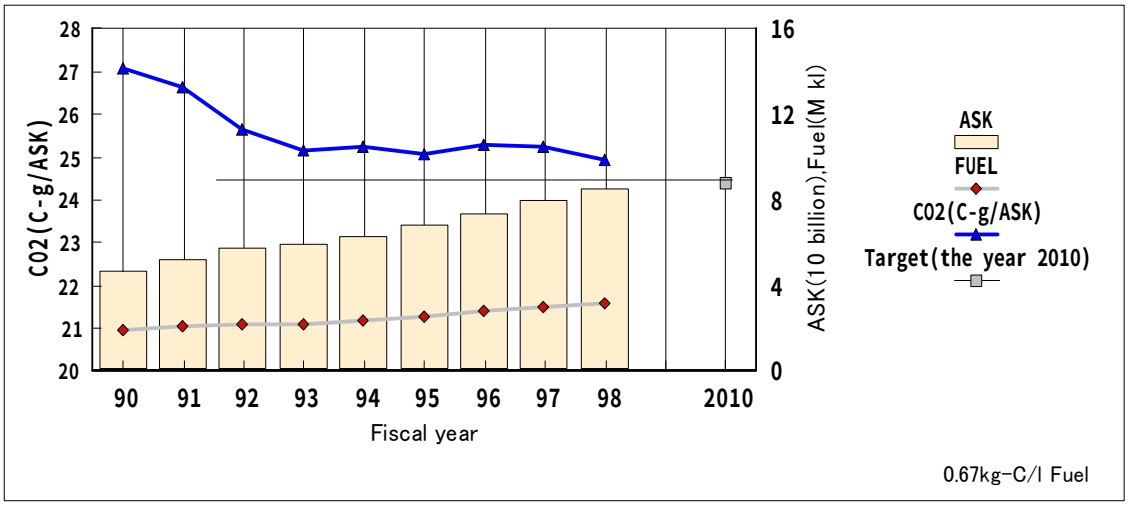


Fig.5-3 CO_2 Emission per Available Seat-Kilometer (ASK) by Aircraft Operation

(2) The Fuel Efficiency

The transition of the fuel efficiency of ANA fleet (fuel consumption per ASK) is shown in Figure 5-4(Overall, domestic, and international). The fuel quantity consumed increases with ASK expansion too, but it is understood that the fuel efficiency improves by about several % every year. Because of joining new routes and so on, the fluctuation is violent depends on each fiscal year in the international service. However, the decrease is remarkable in the domestic service. The improvement of such fuel efficiency was achieved by the combination of the fuel saving measures and the introduction of a new model to be described next section.

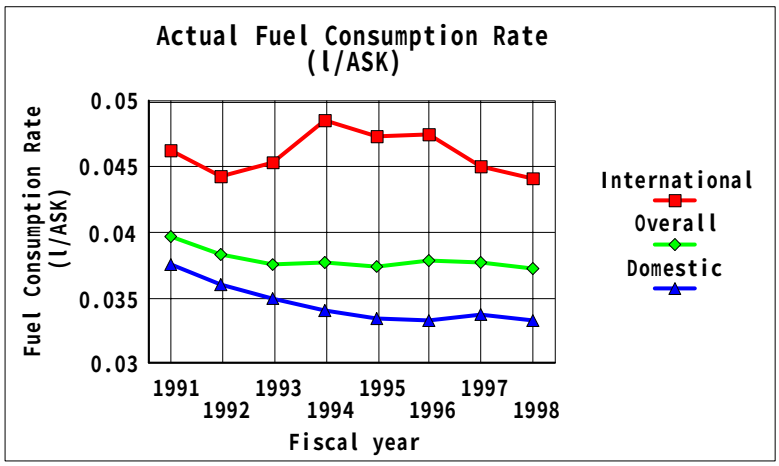


Fig.5-4 Actual Fuel Efficiency

(3) Introduction of New Generation Aircraft

The most effective method to reduce CO_2 emission, that is, to cut down the fuel consumption is achieved by introducing fuel efficient new generation aircraft. Using the latest engine technology, it adopts an efficient engine with high by-pass ratio, the improved wing shape etc. to decrease the air resistance and reduced weight by the use of composite materials etc. Figure 5-5 shows how CO_2 emission has been reduced by introducing a new model aircraft. The model name is shown from the left to the right in order of the introduction period.

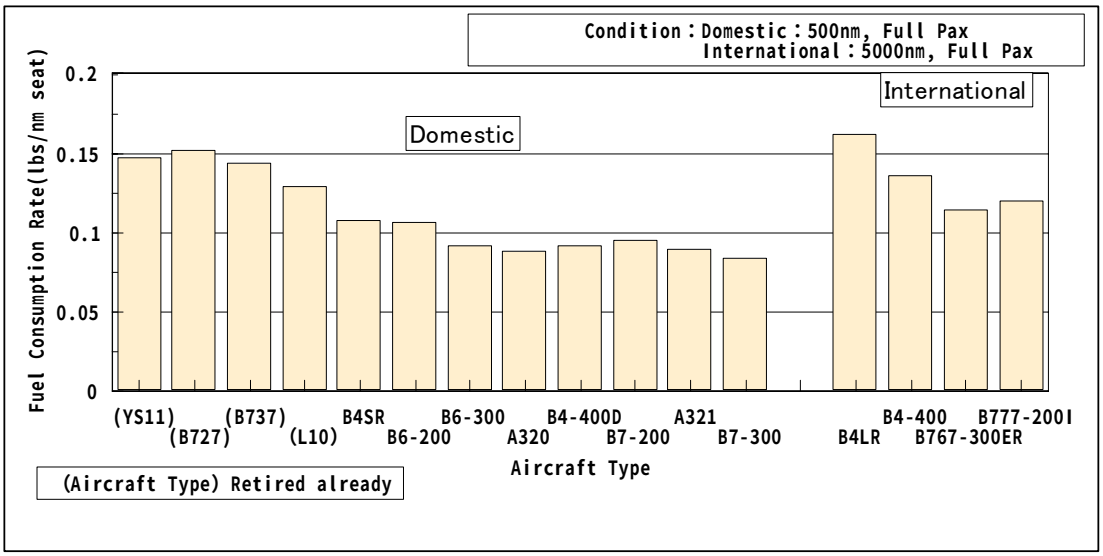


Fig.5-5 ANA Fleet Fuel Efficiency Comparison

(Note) ANA Fleet Introduction and Retirement

Aircraft Type	(Engine Type)	Introduction	Retirement
YS-11	RR DART543-10/10K	1965	1991
B727-200	JT8D-17	1969	1990
B737-200	JT8D-17	1969	1992
L1011	RB211-22B	1974	1995
B747SR	CF6-45A2	1979	—
B767-200	CF6-80A	1983	—
B747LR	CF6-50E2	1986	—
B767-300	CF6-80C2B2	1987	—
B747-400	CF6-80C2B1F	1990	—
A320	CFM56-5A1	1991	—
B777-200	PW4074,PW4077	1996	—
A321	V2530-A5	1998	—
B777-300	PW4090	1998	—

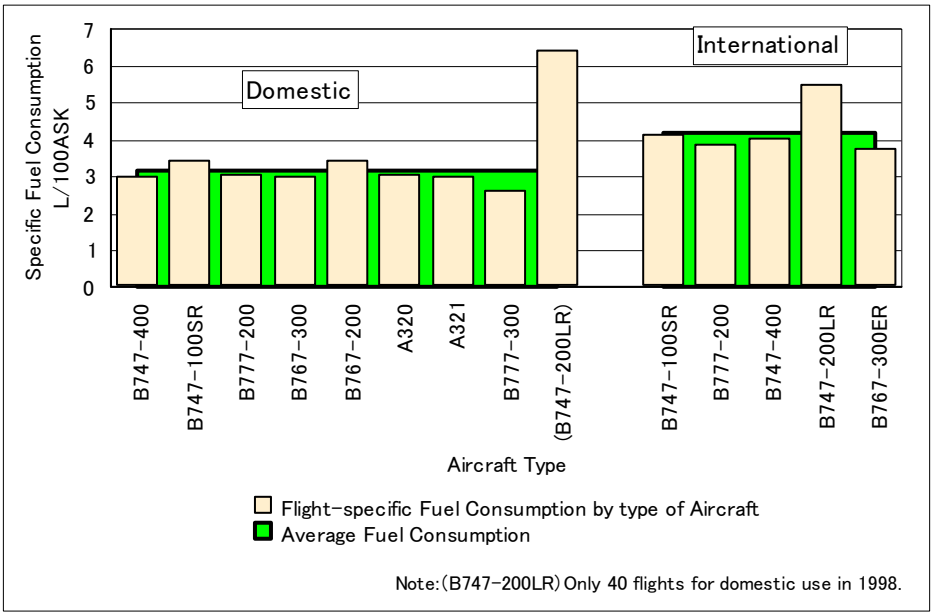


Fig.5-6 Flight-specific Fuel Consumption by Type of Aircraft in 1998

(4) The Fuel Saving Measures

All thought fuel saving measures were examined from the first oil crisis in 1973 and also from the second oil crisis in 1979 in ANA, and a lot of measures had been introduced. In addition, in 1994 fiscal year these measures were reviewed, and in 1996 fiscal year the fuel saving by reducing the airplane weight was examined. Table 5-1 shows the main fuel saving measures.

Table 5-1 The main fuel saving measures

No.	Fuel saving measure items	Contents
1	Suitable approach and departure method for Kagoshima airport	Improvement of departure and approach method To revise SID(Standard Instrument Departure method) and STAR(Standard Arrival Route), and to shorten the route in order to reduce the fuel consumption.
2	Profile Descent to new Chitose airport RWY01	
3	Selection of suitable approach method and shortening radar inducement route in Kumamoto airport	
4	Improvement of radar inducement route in Fukuoka airport	
5	Change of Matsuyama airport departure route	
6	Passing through the test and training area of the Air Self Defense Forces	To shorten the route distance by passing the area on weekends (Saturday, Sunday, and national holiday) in which the Air Self Defense Forces do not train.
7	Select the best cruise speed	To save the fuel by optimizing the cruise speed.
8	Select the best cruise altitude	To save the fuel by optimizing the cruise altitude. As the altitude is raised, the efficiency improves at 1% per 1000 feet.
9	Delayed Flap Approach	To delay the use of the flap with a lot of air resistance when approaching the airport in order to reduce the fuel consumption.
10	Use of low flap angle	To use a low flap angle that decreases the air resistance in order to save the fuel.
11	The best bleed air management (Reduced Pack Flow Operation)	Air for the air conditioner is taken from the engine. By optimizing the amount of taking this, the lowering of efficiency of the engine is minimally suppressed, which in turn saves the fuel.
12	Unnecessary engine shut down when taxiing in	Stopping unnecessary engines after the landing to ramp in leads to save the fuel.
13	Delayed Engine Start Procedure B767	To make one engine start during push back, and the other while removing flags after push back. As a result, it saves the fuel and the departure time can be shortened.
14	Standardization of Max. Climb Thrust (MCLT) use	To stop the use of delayed thrust, and to use the thrust with which the higher altitude can be reached early with the efficient fuel consumption.
15	The best effect approach	An effective approach by the idling pass planning leads the fuel saving.
16	Optimization of the loading fuel	Reviewing the fuel loading standard and improving its operation leads the fuel saving.
17	Engine start during push back	The aircraft used to be pushed out to the taxiway after all engines are started. But from now on the engines will start going during push back.
18	Expansion of reducing APU (Auxiliary Power Unit) operation	Delaying the time of the APU start before the departure and after the landing will save the fuel.
19	Reducing APU use	Not to use APU until right before the departure (so far operated in ramp area during en-route) . To expand its operation to other airports.

20	Washing the engine in clear water (CF6-45 Engine)	The decreasing compression efficiency is recovered by washing the compressor with clear water and by taking off the dirt of the compressor blades.
21	Modification of Thrust Reverser Nacelle Seal (CF6-45 Engine)	Thrust reverser and the seal around nacelle are improved and added in order to prevent the air leakage, that will improve the efficiency of the thrust of the fan.
22	Controlling the position of center of gravity	In general, the fuel saving of about 0.05% can be expected once the center of gravity moves backward by 1%.
23	Using a simulator for flight training	The flight training is done with the simulator instead of actual flight. Using the simulator for the co-pilot promotion training at the right seat. Using the simulator at the periodical check.
24	Using a simulator for maintenance training	The maintenance crew training for the engine run-up is done with the simulator, and it saves the fuel.
25	Removal of Brake Cooling Fan	Fans are removed for weight reduction by examining the necessity in operation.
26	Removal of Rain Repellent System	Depletion of ozone layer related problem. This system was removed by examining the necessity in operation.
27	Execution of Economy Re-clear method	The purpose of the re-clear method is expanded not only to the former payload relief, but also to the reduction of the amount of the loading fuel(weight saving).
28	Tankering	The tankering becomes an increase of the weight of the airplane. Evaluate carefully the expenses and effects when the tankering is executed.
29	Removal of APU No.2 generator	One generator is good enough in the domestic operation so that parts are removed from some airplanes (Weight reduction of 45 kg is accomplished). Comparative study of modification expenses and effect of fuel saving.
30	Lightening cargo containers	Development of container made of carbon fiber.
31	Reduction in loading of drinking water	Reduction in loading of the drinking water is examined in the international flight.
32	Removal of drinking water cooler	Removal of cooler which is not in use. Reduction of about 40 lbs.
33	Other weight reduction measures	Reducing the amount of equipped blankets. Lightening trays for wagon. Removal of a drinking water tank. Lightening seat cushions. Lightening seats for passenger. Lightening carpets. Replacement to lighter life jackets. Review of necessary number of knives and forks. Review of necessary number of wet towels. Changing the wet towel made from the fabric to the paper. In-flight articles are loaded at each station. Reduction of cockpit manuals. Reduction of the number of spare in-flight magazine "Kingdom of Wing". The reduction of in-flight magazine (weekly magazine etc.). The reduction of ice and dry ice. Lightening servicing cart.

Table 5-1 The main fuel saving measures

(5) Fuel Saving in daily operation

The airport congestion is also a cause of a fuel consumption increase. The waste fuel is consumed by holding over the airport and go-around at landing (re-doing of the landing) . At Haneda airport where is crowded most in Japan for example, 148 go-arounds took place in total of all airline operation in 1994. There are

many reasons for the go-around, 43 % is due to the shortage of the interval between a preceding aircraft caused by its delay of the breaking away from the runway. If each aircraft make a prompt breakaway from the runway, it is expected to be improved traffic flow. ANA is always bearing the followings in mind.

① Before landing, understand the capable distance for stopping and the distance to the taxi-way.
② After landing, decelerate smoothly to break away from a runway at a safe speed without the delay.
③ When departing, prepare for the lineup at once after the preceding aircraft begins take-off roll.
④ Work in the cockpit after the take off permission will be finished in a short time as possible.

Excluding above, "Intersection take-off" and "Rolling take-off" are appropriately executed.
APU (Auxiliary Power Unit) OFF operation is conducted successfully at considerably high rate, and fuel saving amount is very large. ANA continues to make an effort to keep this method.

(6) As for the Airport Congestion

The airport congestion is one of the big obstacles to consume fuels effectively. Moreover, the length of the distance from the spot to the runway also produces a big influence on the fuel consumption.
The completion of the second terminal of Narita International Airport and a new C runway of Haneda made an increase of the time to taxi. The taxiing time before and after the using of Haneda new C runway (March, 1997) was investigated. As a result, the taxi-out time increased about three minutes on the average at the take off to the north in winter (January, 1997：12.6 minutes versus January, 1998：15.7 minutes) . However, the taxi-in time has been shortened from 6.7 minutes to 5.7 minutes oppositely at the same season.

(7) Conservation of Energy other than Aircraft Fuel

Even though it is insignificant amount compared with the fuel consumption of the aircraft itself, consideration of the reduction measures of various energy that ANA uses in each ground facilities are important as well. The energy conservation activities of ANA for electric power, gas, water and fuel consumed by facilities and offices, and ground vehicle fuel used have been developed. The transition of the amount of the electric power consumption in Haneda area is shown in Figure 5-7 as one example.

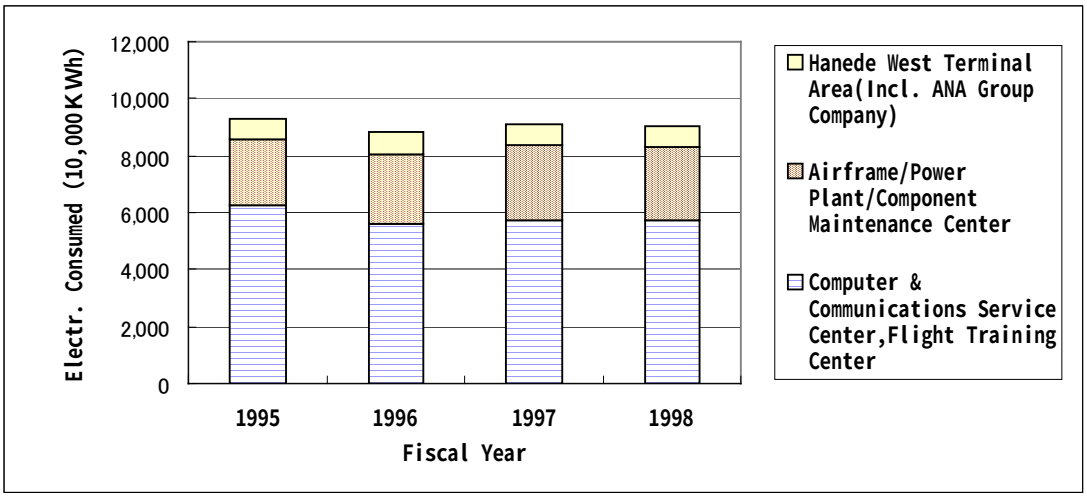


Fig.5-6 Electricity Consumption (Haneda Area)

5.6 IPCC Special Report 「Aviation and the Global Atmosphere」 (May 1999)

The IPCC published a special report on Aviation and the Global Atmosphere, in response to a request by the ICAO, to assess the effects of aviation on the earth's climate and atmospheric ozone. The report also examines scientific, technological,social and economic issues associated with various options to mitigate adverse effects of aviation on climate and atmospheric ozone.
The brief overview of the report is as follows.

(1) In response to a request by the ICAO, IPCC assesses the effects of aircraft on climate and atmospheric ozone, both in the past and in the future(2050).

(NOTE) IPCC Second Assessment Report, published in 1995, estimated reaching approximately 1.4 times the CO_2 concentration levels in 1994 by the end of the 21st century, if CO_2 emissions were maintained at 1994 levels, the rise in global average surface air temperature from 1 to 3.5 ℃ and the rise in sea level from 15 to 95 ㎝ by 2100 relative to 1990.
IPCC Second Assessment Report estimated also stabilization scenarios that assumes policy measures are enacted which begin to reduce CO_2 emissions in the year 2000 relative to business as usual with eventual stabilization of the CO_2 concentration at 550 ppm by 2150 (current CO_2 concentrations are about 360 ppm).

(2) Global passenger air travel, as measured in RPK, is projected to grow by 3.1 to 4.7% per year in average between 1990 and 2050, whereas total aviation fuel use (CO_2 emissions) is projected to increase by 1.7 to 3.8% per year.

(3) The range of increase in total aviation carbon dioxide emission to 2050 would be 2.6 to 11 times the value in 1992.

(4) Emissions of carbon dioxide by aircraft were about 2% of anthropogenic carbon dioxide emissions in 1992 and will be 3% of the projected total anthropogenic carbon dioxide emissions in 2050.The best estimate of the radiative forcing, the perturbation to the energy balance of the earth-atmosphere system, in 1992 by aircraft is about 3.5% of the total radiative forcing by all anthropogenic activities. Radiative forcing by aircraft in 2050 will be about 5% of the radiative forcing by all anthropogenic activities.(the effects of possible changes in cirrus clouds is not included)

(5) Over the period from 1992 to 2050, the overall radiative forcing by aircraft(excluding that from cirrus clouds)is a factor of 2 to 4 larger than the forcing by aircraft carbon dioxide alone. The overall radiative forcing for the sum of all human activities is estimated to be at most a factor of 1.5 larger than that of carbon dioxide alone.

(6) CO_2 : The range of increase in aviation emissions to 2050 would be 1.6 to 10 times the value in 1992.

(7) NOx : The NOx emissions from subsonic aircraft in 1992 are estimated to have increased ozone(O_3) concentrations at cruise altitudes in northern mid-latitudes. Aircraft NOx emissions are expected to decrease the concentration of methane(CH_4) that are global in extent. Global average radiative forcing are of similar magnitude and opposite in sign, but the net regional radiative effects are not cancelled.

(8) Water vapor(H_2O) : Water vapor is a greenhouse gas. For subsonic aircraft this effect is smaller than those of other aircraft emissions such as carbon dioxide and NOx. For high speed civil transport(HSCT) aircraft, although there is considerable uncertainty, additional radiative forcing due to accumulation of stratospheric water vapor is estimated as supersonic aircraft consume more than twice the fuel per passenger-km.

(9) Contrails : Contrails are triggered from the water vapor emitted by aircraft and their optical properties depend on the particles emitted or formed in the aircraft plume and on the ambient atmospheric conditions. Contrails tend to warm the Earth's surface, similar to thin high clouds. In 1992, aircraft line-shaped contrails are estimated to cover about 0.1% of the Earth's surface on an annually averaged basis with larger regional values. The contrail cover is projected to grow to 0.5% by2050. The radiative effect of contrails is similar to that of CO_2 and O_3, but still uncertain.

(10) Cirrus Clouds : Extensive cirrus clouds have been observed to develop after the Formation of persistent contrails. The mechanisms associated with increases in cirrus cover are not well understood and need further investigation. An increase in cirrus cloud cover tend to warm the Earth's surface.

(11) Sulfate (SOx) and Soot Aerosols : The aerosol mass concentrations in 1992 resulting from aircraft are small relative to those caused by surface sources. Increase

in soot tend to warm while increases in sulfate tend to cool the Earth's surface. The direct radiative forcing is small compared to those of other aircraft emissions.

(12) Impacts of Supersonic Aviation : Supersonic aircraft consume more than twice the fuel per passenger-km compared to subsonic aircraft. The radiative forcing of civil supersonic aircraft is estimated to be about a factor of 5 larger than that of the displaced subsonic aircraft. The addition of a fleet of civil supersonic aircraft is assumed to begin operation in the year of 2015 and grow to a maximum of 1,000 aircraft by the year of 2040, which is projected to add a further 40% Increase of radiative forcing. Most of this additional forcing is due to Accumulation of stratospheric water vapor.

(13) Aircraft and Engine Technology Options : A 40 to 50% improvement in fuel efficiency is projected by 2050. The typical aircraft and engine life expectancy,25 to 35 years, have to be taken into account when assessing the improvement rate. (Substantial aircraft and engine technology advances are already incorporated in the aircraft emissions scenarios used for climate change calculations)

(14) Operational Options : Improvement in air traffic management(ATM) and other operational procedures could reduce aviation fuel burn by between 8 and 18% (The Air traffic management improvements are already incorporated in the aircraft emissions scenarios used for climate change calculations).
The large majority(6 to 12%) of these reductions comes from ATM improvements which it is anticipated will be fully implemented in the next 20 years.

(15) Regulatory, Economic, and Other Options : Policy options to reduce emissions further include more stringent regulations, environmental levies(charges and taxes), emission trading, modal shift(substitution of aviation by rail and coach)and so on. Some of these approaches have not been fully investigated or tested in aviation and their outcomes are uncertain.

Chapter 6 Ozone Layer Protection

6.1 Deepletion of Ozone Layer

The materials that deplete ozone layer includes freon, halon, methylchloroform, trichloroethane, carbon tetrachloride and so on. Freon is used as cooling agent in refrigerators or freezers, and in air conditioning units, expander of polyurethane foam, and cleaning agent of electronic parts. There are two classified freon that are specific chrolofluorocarbon (CFC) with the restriction as a depletion of ozone layer material and HCFC (hydrochrolofluorocarbon) , HFC (hydrofluorocarbon) developed as CFC alternatives. HCFC is still an object of the restriction because it still depletes ozone layer though the ozone depletion potential is smaller than CFC (it influences global warming, too) . HFC does not deplete ozone but it is the object of the reduction as a greenhouse gas because the global warming potential is large.

Though Halon is used for the fire extinguisher agent, the ozone depletion potential is higher than that of chrolofluorocarbon.

6.2 Montreal Protocol

"Montreal protocol" concerning the material which deplete the ozone layer was adopted in 1987 from the necessity to protect the ozone layer, and in 1992 the date of the restriction reinforcement and the production abolition was advanced. The production of halon was abolished in the end of 1993, chrolofluorocarbon and trichloroethane were by the end of 1995 and CFC alternatives were by the end of 2019.

6.3 Relation between Aircraft and Ozone Layer Depletion

The influence to ozone with the emission from the aircraft engine is not well understood but it is said that NOx emission from the aircraft engine will increase ozone in the troposphere. United Nations IPCC (Intergovernmental Panel on Climate Change) has been trying to bring together the influence on climate and atmospheric ozone by the aircraft emission from a technical viewpoint, and it was issued as Special Report "Aviation and the Global Atmosphere" in June, 1999.

Fluorocarbon and related chemical substances are used by the aircraft equipment and the maintenance work. Halon is used for the fire extinguisher installed in the aircraft although it is not actually used as long as a fire does not occur in the aircraft. However, one has to avoid making halon discharge needlessly in the atmosphere by the leakage from the fire extinguisher or at extinction training by cockpit crew and cabin attendant.

(1) Restricted Materials which relate to Aircraft and Correspondence of ANA

① Specific fluorocarbon and trichloroethane used on aircraft maintenance

In 1994 the total abolition of using them was completed according to the reduction plan planned in 1990 (Refer to Figure 6-1). Alternative of cleaner was positively introduced instead of fluorocarbon while reducing its quantity consumed by introducing the fluorocarbon cleaning solution collection device, reproducing the fluorocarbon solution, or reusing it. The use of trichloroethane was changed to use the alkaline cleaning agent.

② Measures to Halon Discharged by Extinction Training

The extinction training of cockpit crew and cabin attendant that had used an actual fire extinguisher was changed to the training method that uses a mock fire extinguisher and water fire extinguisher instead of the halon fire extinguisher, in addition to the use of videos. The mock fire extinguisher for training is almost equal to the halon fire extinguisher installed in the aircraft in its shape, weight, the handling method, and the jet duration time of the extinction agent and also has the extinction ability so that the needless discharge of halon in the atmosphere would be avoided.

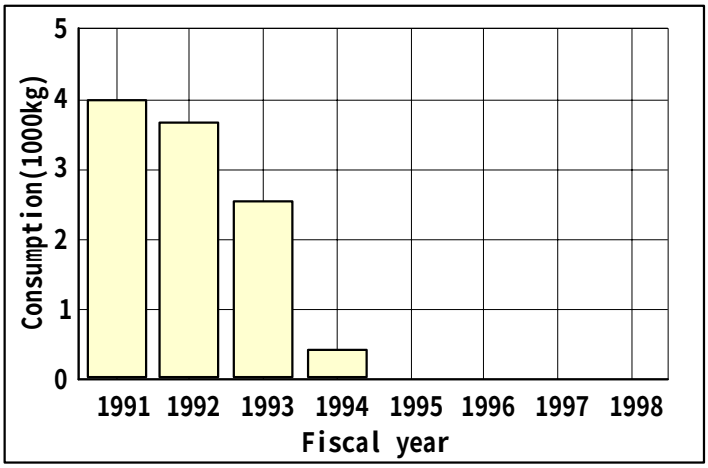


Fig.6-1 Ozone Depletion Materials Use

③ Correspondence by Maintenance of Fire Extinguisher

Collection equipment of halon was introduced into the maintenance consignment company of the fire extinguisher, and the effective reuse system of halon was established. As a result, it became possible to decrease the amount of the fluorocarbon leakage at the maintenance work within 2 %, and savings of halon became easier than before. The amounts of present possession are about 14 ton.

④ **Correspondence to restricted materials such as fluorocarbon used for aircraft equipment**

Removal of the water cooler equipped in the aircraft is underway because it is currently not used. The air chiller refrigerant is being changed to HFC134 from the restricted material CFC-12. Moreover, in the overhaul consignment company, the collection of emitted HFC134 and CFC-12 is executed. The amount of present possession is about 0.2 ton.

CFC-113 was used for injection material of cockpit rain repellent system, however, in 1998 fiscal year ANA has deactivated all the cockpit rain repellent system to minimize the use of ozone depletion materials.

⑤ **Correspondence of Refrigerant Fluorocarbon used for Air Conditioner of Maintenance Vehicle**

Switching to CFC alternatives of refrigerant is positively advanced in accordance with the renewal of vehicles

.

⑥ **Correspondence to Halon Fire Extinguisher Used in the Building**

Because other fire extinguisher having the same performance as halon fire extinguisher has not been developed yet in the current state, the use of the halon fire extinguisher is indispensable in order to suppress the damage as minimum as possible when a fire actually occurs. ANA ha been managing to avoid careless discharges except in case of the emergency.

Abbreviations

APU	Auxiliary Power Unit
AESA	Atmospheric Effects of Stratospheric Aircraft Flyer
ATEC	Association of Air Transport Engineering and Research(Japan)
BOD	Biochemical Oxygen Demand
CAEP	Committee on Aviation Environmental Protection
CFC	Chlorofluorocarbons
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
COD	Chemical Oxygen Demand
DPM	Diesel Particles Matter
ECAC	European Civil Aviation Conference
EU	European Union
FANS	Future Air Navigation System
FCCC	(Unite Nation) Framework Convention on Climate Change
FIP	Federal Implementation Plan
GSE	Ground Support Equipment
GPS	Global Positioning System
GWP	Global Warming Potential
HC	Hydrocarbon
HCFC	Hydrochlorofluorocarbons
HFC	Hydrofluorocarbons
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
LTO	Landing/Take Off cycle
NASA	National Aeronautics and Space Administration
NO_2	Nitrogen dioxide
NOx	Nitric oxides
N_2O	Nitrous oxides
O_3	Ozone
ODA	Official Development Assistance
ODP	Ozone Depletion Potential
PRTR	Pollutant Release and Transfer Register
SO_2	Sulfur dioxide
SOx	Sulfur oxides
SPM	Suspended Particle Matter

SST	Super Sonic Transport
UNEP	United Nation Environmental Program
VOC	Volatile Organic Compound
WECPNL	Weighted Equivalent Continuous Perceived Noise Level

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