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Cosmic radiation during air travel: trends in exposure of aircrews and airline passengers

RO Blaauboer

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RIVM, P.O. Box 1, 3720 BA Bilthoven, telephone: 31 - 30 - 274 91 11; telefax: 31 - 30 - 274 29 71

Abstract

An unfavourable effect of flying is the enhanced exposure of both passengers and aircrew to cosmic radiation at high altitudes. This calls for research to obtain a clear picture of the radiation exposure of both groups.

On the basis of a detailed survey on passengers arriving at or departing from Amsterdam Schiphol Airport in the 1988-1997 period, estimates of individual effective dose for specific destinations and the collective dose for all passengers travelling through Amsterdam Schiphol Airport in the Netherlands were calculated. A computer model was used to calculate plausible flight profiles for various types of aircraft and flying distances. This was followed by calculations using the CARI model, which is also in use with the US FAA (Federal Aviation Association), to determine the dose for each flight profile.

Most of the flights were regional European flights, resulting in individual effective doses of 1-15 μSv. Individual effective doses from intercontinental flights to North America and the Far East were mostly found in the range of 30-60 μSv per flight. These values may vary up to ±15 % due to the solar cycle. The individual effective dose on a one-way flight averaged over all flights was approximately 18 μSv. A group consisting of 4000 frequent flyers may receive doses above 1 mSv a^{-1}, while within the special group of couriers individual effective doses of 10 mSv a^{-1} are possible. For aircrews, a dose range of 1.5-5.7 mSv a^{-1} was determined for 1000 block* hours of flying. In the Netherlands the average annual dose to non-flying individuals from all sources of ionising radiation was 2.5 mSv a^{-1}, while the average annual dose from cosmic radiation in particular was 0.28 mSv a^{-1}.

The collective dose for passengers flying through Schiphol increased from 230 to 600 manSv from 1988 to 2002. The collective dose for aircrews comprises about 6% of this dose. If a moderate growth in air transport of 4% per year is assumed, the collective dose will reach 1100 manSv in 2015.

* Flying time in block hours is defined here as the time between removing the blocks from the aircraft and placing them again at the destination

Preface

In the context of the radiation exposure analysis of the Dutch population, a study was conducted to analyse the doses resulting from aviation that a population is exposed to. This study was largely commissioned by the RIVM Board of Directors and finalised in the context of the analysis of the radiation dose received by the Dutch population for the account of the Directorate for Chemicals, Waste and Radiation Protection under the Directorate General of the Environment of the Ministry of VROM as part of the BEST project.

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Samenvatting

Vliegverkeer heeft nog steeds iets avontuurlijks en trekt dan ook veel aandacht. Toch is de wijze van vervoer inmiddels vrij gewoon met een totaal aantal jaarlijks vervoerde passagiers van meer dan een miljard wereldwijd.
Een belangrijk negatief effect op de beeldvorming hebben ongevallen. Echter, de kans op ongevallen neemt, gezien het tamelijk constante aantal slachtoffers enerzijds en de geweldige toename in het vliegverkeer anderzijds, nog steeds af. Een ander negatief gevolg van vliegverkeer is de blootstelling van mensen aan een verhoogde dosis kosmische straling, door de grote hoogte. Het dosistempo kan op een vlieghoogte van tien kilometer een factor 100 of meer hoger zijn dan op zeeniveau.

Enkele jaren geleden is door de Europese Commissie een richtlijn uitgevaardigd waarin ook voor de stralingsbescherming van vliegend personeel eisen zijn gesteld in de vorm van dosislimieten. Om een goed beeld te verkrijgen van de stralingsbelasting die deze groep ontvangt, maar ook voor een beter inzicht in de dosis voor het nog steeds groeiende aantal passagiers, is dit onderzoek uitgevoerd.

Op basis van een gedetailleerd overzicht van passagiers naar luchthaven van bestemming of afkomst is voor de periode 1988-1997 de individuele dosis voor specifieke reisbestemmingen en de collectieve dosis voor alle passagiers berekend, althans voor zover die de luchthaven Schiphol hebben aangedaan. Hiervoor is gebruik gemaakt van een vluchtprofiel model dat voor verschillende vliegtuigtypen en te vliegen afstanden een meest waarschijnlijk hoogte-tijd profiel oplevert. Met het CARI model, dat in de Verenigde Staten onder gezag van de FAA (Federal Aviation Association) wordt toegepast, is vervolgens voor die vluchtprofielen de dosis berekend.

Door het feit dat de meeste passagiers die Schiphol aandoen binnen Europa blijven, wordt de dosisverdeling deels bepaald door een ‘laag’ dosisbereik voor continentale vluchten van, afhankelijk van de afstand, 1-15 μSv per vlucht (enkele reis) en deels door een ‘hoog’ dosisbereik van circa 30-60 μSv per vlucht voor intercontinentale vluchten naar Noord-Amerika en het Verre Oosten. Onder invloed van de elfjarige zonnecyclus kan deze dosis per vlucht, afhankelijk van de bestemming, nog tot ±15 % variëren. De gemiddelde individuele dosis per enkele reis is bepaald op circa 18 μSv.

Een groeiende groep van vooral zakenmensen maakt veelvuldig gebruik van het vliegtuig. Circa 80.000 mensen, uit Nederland afkomstig, maakt jaarlijks meer dan tien retourvluchten en circa 4000 van hen ontvangen daarbij jaarlijks een dosis boven de 1 mSv. Binnen de speciale groep van koeriers zijn daarbij individuele jaardoses tot 10 mSv mogelijk.

Ook voor bemanningsleden is een dosisinterval vastgesteld. Bij een vliegtijd van 1000 blokuren[†] per jaar is dit 1,5 – 5,7 mSv. De individuele dosis is hierbij functie van de werkelijk gevlogen trajecten (de hoogste waarden voor Noord-Atlantische trajecten en de laagste voor regionale Europese vluchten) en het werkelijke aantal vlieguren.

[†] Vliegtijd in blokuren is hier gedefinieerd als de tijd tussen het moment dat de blokken voor de vliegtuigwielen worden weggehaald totdat deze op de bestemming weer worden geplaatst

In Nederland bedragen de gemiddelde jaarlijkse doses voor niet-vliegende inwoners als gevolg van alle bronnen van ioniserende straling en kosmische straling in het bijzonder respectievelijk 2,5 and 0,28 mSv a^{-1}.

De collectieve dosis voor passagiers via Schiphol is in de onderzochte periode van circa 230 tot 550 mensSv toegenomen. Bij een verwachte lichte groei van 4% per jaar zal dit verder toenemen tot 1100 mensSv in 2015. Uit recente gegevens volgt al een verdere toename tot 600 mensSv in 2002. Hiermee ligt het extra sterfterisico door kosmische straling in 2002 op een vergelijkbare hoogte als dat door ongevallen.

Summary

Still considered to be an adventuresome activity, aviation receives a lot of publicity, even though it has become a fairly common form of travel for over a billion passengers annually throughout the world.

Accidents in aviation generate a negative image. However, if we consider the fairly constant annual number of fatalities and the enormous growth in passenger transport, the chance of becoming involved in an accident is still declining. Another unfavourable effect of flying is the enhanced exposure of passengers and crew to cosmic radiation at high altitudes. The dose rate at an altitude of ten kilometres may mean a factor of 100 or higher than at sea level.

Several years ago the European Commission issued a radiation protection directive, which included the setting of dose limits for aircrews. This research was performed to obtain a clear picture of the radiation exposure of this group in particular, but also of the large and still growing number of passengers in general.

On the basis of a detailed survey on passenger streams arriving at or departing from Amsterdam Schiphol Airport in the 1988-1997 period, individual doses for specific destinations and the collective dose for all passengers travelling through Schiphol were calculated. A computer model was used to calculate plausible flight profiles for various types of aircraft and flying distances. This was followed by calculations using the CARI model, which is also in use with the US FAA (Federal Aviation Association), to determine the dose for each flight profile.

Because most of the passengers flying through Schiphol travel to or from another European airport, the dose distribution is partly determined by a 'low' dose range for continental flights of 1-15 μSv per one-way flight, depending on the distance. In addition there is a 'high' dose range of some 30-60 μSv per flight for intercontinental flights to North America and the Far East. Under the influence of the eleven-year solar cycle these doses per flight may vary up to ±15 %, depending on the destination. The average individual dose per one-way flight is approximately 18 μSv.

A growing number of mainly business people fall into the category of frequent flyer. Approximately 80,000 of them, living in the Netherlands, take more than ten flights a year. An estimated 4000 may receive individual doses above 1 mSv a^{-1}. Individual doses of 10 mSv a^{-1} are possible within the special group of couriers.

A dose range was also determined for aircrews. Assuming 1000 block hours[‡] of flying time, this range is 1.5 – 5.7 mSv per year. The individual dose is, of course, a function of the actual routes flown (highest for most of the trans-Atlantic flights and lowest for regional flights within Europe) and the actual number of block hours flown.

In the Netherlands the average annual dose to non-flying individuals from all sources of ionising radiation is 2.5 mSv a^{-1}; average annual dose from cosmic radiation in particular is 0.28 mSv a^{-1}.

[‡] Flying time in block hours is defined here as the time between removing the blocks from the aircraft and placing them again at the destination.

The collective dose for passengers flying through Schiphol increased from 230 to 550 manSv during the period investigated. Assuming a moderate growth in air transport of 4% per year, the collective dose will reach 1100 manSv in 2015.
Recent calculations have already revealed a further increase to 600 manSv in 2002. As a consequence, the additional fatality risk from exposure to cosmic radiation in 2002 has become comparable to the fatality risk due to accidents.

1. Introduction

1.1 Problem definition

In recent years interest has arisen on the subject of the radiation dose due to air travel, especially with reference to air crews [1, 2, 3, 4, 5, 6]. This interest may be explained by the use of aircraft types that fly more efficiently at higher altitudes, but also by changes in policy, for instance, European regulations [7, 8, 9] and their applications in national laws [10]. For instance, a dose of 1 $mSv\,a^{-1}$ brings aircrews under radiation protection law and makes monitoring of individual doses mandatory. In the United States the emphasis is placed on informing aircrews, specifically pregnant crew members [11, 12]. The often marginal profits that are achieved in the industry are at odds with a temporary transfer of pregnant crew members to ground-based posts. New regulations therefore might affect working conditions. One other reason for the new interest in air travel is the reevaluation of the contribution made by the neutron component to the dose, giving this component more importance than assumed until recently [13, 14, 15].

In earlier work doses to aircrew and members of the general population were often estimated from much information on averages, for instance, flying distance and speed, dose rates at cruising altitudes, number of people departing or arriving at a national airport or even total number of people flying internationally [16]. A dose estimate was also given for the Netherlands [17] at the end of the 1980s.
Nowadays, more specific statistics on air travel are available and software that makes calculation of doses possible for every route imaginable is also readily obtainable. It is therefore now possible to make better estimates on doses received by both crew members and members of the general population.

1.2 Objectives

When estimating the dose at flight level several aspects are of importance or at least of interest. For describing the situation in the Netherlands the most important questions to be answered include:

- where do the passengers go?
- are there specific categories of (business) people ‘at risk’?
- what is the dose rate at specific flight levels or specific locations on the ground?
- what sort of doses should be expected?
- can a dose distribution be given for the population as a whole or for specific sub groups?
- what is the trend in dose rates (i.e. if it exists)?
- and how may the trend be compared to earlier assessments?
- how does the ‘cosmic dose risk’ compare with the risk of accidents?
- how many people living in the Netherlands actually travel by air and
- how often do they fly (included are the general population, crews and other categories of professionals like couriers)?

The aim of this research was to answer all or most of these questions and, based on the results, to obtain a clear understanding of the doses to which people are exposed.

1.3 An introduction to cosmic rays

The cosmic rays we experience on earth are the result of reactions of charged particles from space with various elements in the earth's atmosphere. These particles come predominantly from outside our solar system and possibly even from outside our star system. This so-called galactic component, possibly produced by supernovas, is quite constant in time. Besides galactic rays there is a contribution of far less energetic particles originating from the sun. This component is far more subject to variation and is most intense during so-called Solar Particle Events (SPE). The solar activity exhibits a cycle of 11 years. During this cycle the solar wind changes and the related magnetic field presses against the magnetic field of the earth, thereby modulating the contributions of galactic origin. These galactic particles are slightly more deflected from the earth, which has the unexpected result that during the solar maximum the dose due to cosmic rays on earth is lower than average and vice versa.

The number of particles that do enter the atmosphere, especially protons, α-particles and electrons, depend on magnetic latitude, since the magnetic field lines along which these particles move, converge on the magnetic poles of the earth. Furthermore, because the particles are slowed down by the atmosphere, altitude (or more accurately atmospheric pressure) is also of importance.
It is especially the high-energy particles that produce other particles during constant interactions in the atmosphere, for instance, neutrons, protons, pions and so-called heavy particles. Examples of the heavy particles are ^{3}H (tritium), ^{7}Be, ^{14}C and ^{22}Na, also called cosmogenic radionuclides. These radionuclides eventually give rise to inhalation and ingestion doses.
Particles from the sun are not energetic enough to play an important role at sea level, but at higher (flight) altitudes the SPEs may be the source of significant doses. However, the occurrence of these SPEs usually last less than a few hours and substantial SPEs only occur once every so many years.

At sea level the dose rate is determined by muons that are formed in the upper atmosphere. Most of the heavier particles, except a relatively small contribution from neutrons and cosmogenic radionuclides, have then disappeared through interactions. Opposite, at flight altitudes, i.e. 10 kilometres above sea level, the dose rate is determined by neutrons, protons, electrons and photons.

2. Methods and data

An important part of the research was the collection of information, particularly statistics on aircraft movements, numbers of passengers travelling through Schiphol Airport, flight data and airport location data. These data are further discussed in the following sections. Based on these data flight levels were modelled for different aircraft types using a method by Oksanen [18] and calculations performed with the dose model CARI, version 6 [12]. These results, along with the most important input data, are included in Appendix 5.

2.1 Passengers and destinations

To estimate the contribution to the collective effective dose of a flight to or from a specific location on earth, the number of passengers travelling on the flights have to be known. In the Netherlands the majority of all international flights, transporting some 40 million passengers in the 12 months previous to September 2001, connect to Schiphol Amsterdam Airport. Because of the size of the country there are not so many national flights (a few per cent) and aircraft do not reach flight altitudes that are of major importance for dose rates from cosmic radiation. Therefore all flights to and from other airports in the Netherlands, except for the connecting flights to Schiphol, are not further considered in this report.

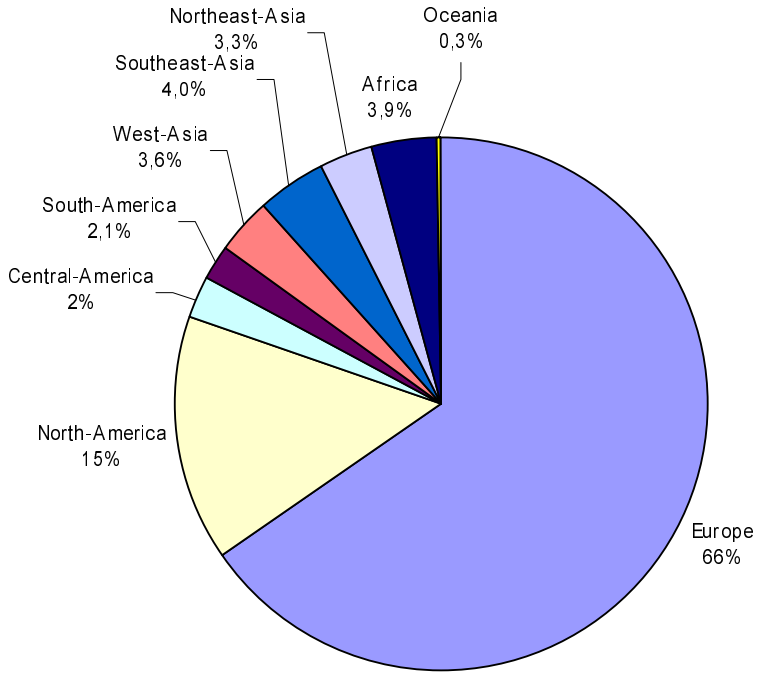

Figure 1 Departure from and arrival of passengers at Schiphol airport in 1997 [19].

Detailed information on departures and arrivals for 1988 through 1997 is available [19] through the Statistics Netherlands (CBS). Destination and departure points were compiled, along with the numbers of passengers. All destinations with at least 2000 passengers arriving and departing in a single year during this period were also included, resulting in a list of about 180 destinations for 1988, increasing to almost 240 in 1997, accounting for some 99% of all passengers. The 'largest size' destination has for a number of years been London Heathrow, with about 2 million passengers. As can be seen in *Figure 1*, most of the

passengers passing through Schiphol Airport arrive from or are transferring to another European airport. This subdivides the passengers into one large group, on European flights, with relatively low doses, and a smaller group on intercontinental flights, associated with higher doses.

Although the total number of passengers increased considerably (see Appendix 5), the slices of the pie (percentages) in *Figure 1* did not expand during the 10-year period recorded (1988-1997). Because specific destination information was not (yet) available in the research period for 1998 to the present, figures were scaled using the total growth in passenger numbers.

Information from the CPB (Netherlands Bureau for Economic Policy Analysis) [20] and the ICAO (Intenational Civil Aviation Organization) [21] was used for figures on aviation growth for the near future. The number of Dutch residents included in the group of passengers is discussed in section 3.3.2.

2.2 Aircraft movements

The total flight duration is an important parameter for obtaining the right flight profile (i.e. flight levels, flight duration, aircraft type, possible stopovers etc., see section 2.5). For instance, the required amount of fuel based on factors such as flight duration (depending on distance, weather and traffic) is calculated, and the optimal flight levels or vertical profile are planned for the type of aircraft concerned. Total flying times used here are taken from the KLM World Timetable [22]. For the destinations not serviced by KLM, information is taken from several other sources and timetables, for example, sources from Schiphol Airport itself [23, 24, 25, 26]. Flight times with references are included in Appendix 5, *Table 5*.

2.3 Detailed flight data

It is fairly difficult to obtain straightforward information on flight profiles. Pilots make use of different flying altitudes instead of cruising speed at one altitude only. The airplanes flying east make use of other flight levels than those flying west. For short distances pilots will more often fly at lower altitudes than for intercontinental flights. Different countries have different requirements on routes flown in their airspace. Furthermore, every type of aircraft has its optimum flying altitude, depending on weight and fuel consumption, which, in turn, again depends on distance flown. Weather conditions may have an impact on the flight profiles, just as wars fought down below. All these parameters lead to flight profiles that may differ considerably, even for trips to the same destination.
We can conclude here then that some reasonable choice will have to be made on how to define the flight profile from airport A to airport B. See section 2.5 for a method of flight level modelling as a function of distance and type of aircraft.

2.4 Detailed location data

Besides information on distance of the trip and type of aircraft, airport location data is needed for a proper calculation of the effective dose using the CARI model (see section 2.6). These data, collected from various sources [27, 28, 29] include airport code (using IATA or ICAO coding), geographical coordinates and height above sea level. The location data have been included in Appendix 5, *Table 5*.

2.5 Flight level modelling

As mentioned earlier, it is fairly difficult to obtain straightforward information on flight profiles for all kinds of reasons. However, Oksanen [18] introduced a way to model these flight profiles for a number of aircraft types (i.e. DC9, DC10, MD11 and MD80, all McDonnell Douglas planes, and the Airbus A300). He made fits to the optimum flight levels using information from the so-called aircraft performance manuals, confining himself to the aircraft types used by Finnair in the mid-1990s. These aircraft types were/are used on the following routes:

DC9	: short regional flights
MD80	: medium distances in Europe
A300	: long distances in Europe
DC10 and MD11	: long distances (intercontinental)

Inspection of manufacturer information on other aircraft types has led to the conclusion that as far as range and flight level profiles are concerned, the DC9 can be compared with the Fokker 50/70, the MD80 with a Boeing 737 and the DC10 with the Boeing 747-400. See *Figure 2* for some examples of flight level modelling. Appendix 4 further explains and illustrates the fits as given by Oksanen.

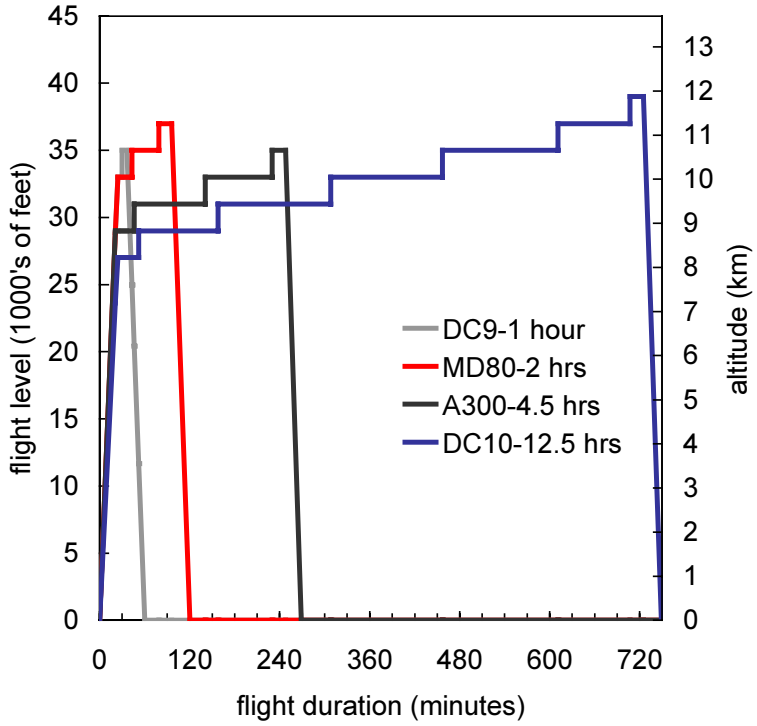

Figure 2 *Examples of some results of flight level modelling for four aircraft types and some typical examples of flight duration. For comparison flight levels are presented in kilometres and feet, although in aviation only 'feet' is used.*

Flight profiles were fitted using this method for the various flying times to all evaluated destinations (see section 2.2). For all these destinations the following aircraft types and relative flying times were assumed:

- up to 90 minutes - DC9
- from 90 up to 180 minutes - MD80
- from 180 up to 300 minutes - A300
- more than 300 minutes - DC10

The part of the flight not on a certain flight level is supposed to have taken place on the ground, i.e. taxiing along the runway or taking off and landing. For flights with a stop somewhere, the aircraft is selected for total flying time, excluding the time during stop(s). For instance, the flight Amsterdam Schiphol to Abu Dhabi International takes 7 hours and 25 minutes (excluding the stop at Dubai); therefore the aircraft type selected is a DC10. The separate trajectories: Amsterdam Schiphol to Dubai International, and Dubai International to Abu Dhabi International, take 6 hours and 40 minutes and 45 minutes, respectively. Nevertheless for both trajectories a DC10 is assumed. A possible consequence is that during short stretches, the DC10 will not gain as much altitude as a smaller plane might, and that starting and landing are, in effect, connected with 'ground level'. This then becomes a low flight level that is not further evaluated in the dose rate calculations. An example of such a flight is the one to Larnaca (Cyprus) in 4 hours and 10 minutes and the connecting flight with the same plane to Paphos (Cyprus) in 20 minutes.
In contrast, the flight from Amsterdam to Tampa (Florida) International has a stopover in Newark before flying on to Tampa. In this case the aircraft type selected for the second stretch is connected with the flying time of this stretch. This means selecting a DC10 for Amsterdam – Newark and an MD80 for Newark – Tampa.

2.6 Dose calculation

The CARI computer model[§] was used for calculating the effective dose due to galactic radiation, the major component of cosmic radiation on earth. This model, in use by pilots and other crew members through the Federal Aviation Administration (US-FAA), is available for calculations [30].
Applying the model, it is possible to calculate the effective dose for an individual during all imaginable types of air travel, if so desired for any specific month of the year. Monthly calculations are possible because of the availability of the heliocentric potential, as input papameter, on a monthly basis (see *Figure 3*). The heliocentric potential is an interplanetary magnetic field index functioning as a measure of the solar activity. Although some variation occurs throughout the year, a yearly averaged value for the heliocentric potential is adequate for the modelling purposes (yearly dose and monthly data on air travel not readily available) described here. See entry for an input file description for the CARI model below:

Format	**Example** (Amsterdam-Edinburgh with an MD80)
Label 1 (max.20 characters)	AMS-Edinburgh
Date mm/yyyy (if mm=00 then yearly averaged)	00/1997
Airport of departure (ICAO code)	EHAM
Airport of arrival (ICAO code)	EGPH
Number of flight levels	3
Minutes to first flight level	24
Flight level 1 (in feet), flight duration (min.)	33000, 6
Flight level 2 (in feet), flight duration (min.)	35000, 23
Flight level 3 (in feet), flight duration (min.)	37000, 17
Minutes from last flight level	24
_____	
Label 2 …..	AMS-Gothenborg

[§] The CARI version 6 model, 15 December 2000

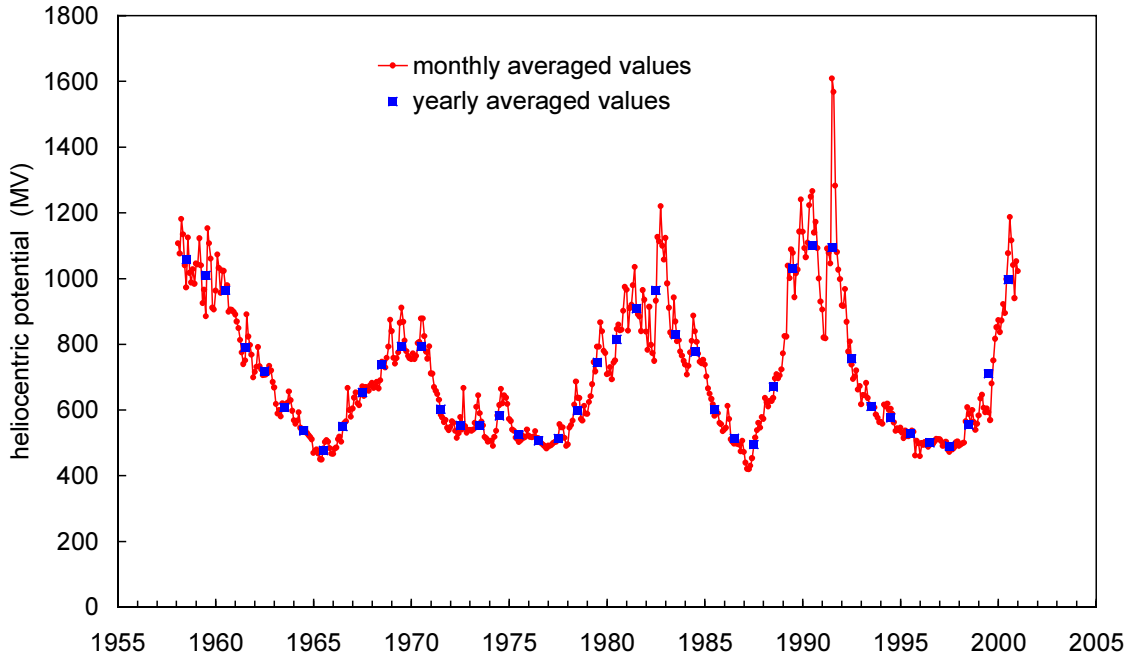

Figure 3 *Heliocentric potential during about the past 40 years. Monthly as well as yearly averaged values are given [30]. The solar cycle of 11 years is clearly visible.*

See Appendix 5, *Table 5*, for ICAO codes and total flying time and Appendix 4 for the calculated flight level profile. Because the number of passengers for every destination is available on a yearly basis, the yearly averaged heliocentric potential is selected (in the above example, for the year 1997). Because of the various steps in flight level during the trip, a flight from airport A to B is not symmetric in time for the return trip. At the same time the dose rate along the route is not constant. For this reason, the dose was calculated for both the outward flight and the return trip, and then averaged. Doses during taxiing, take-off and landing (the 24 minutes in the example above) are not evaluated. This is because they contribute only marginally (when plane is almost at cruising altitude) to the total flight dose.

3. Results

Since the research was geared to dose-rate distributions for various specific groups of exposed individuals (passengers, crews, so-called frequent flyers like couriers) the results of the calculations have also been differentiated. After a general introduction to cosmic rays (section 3.1), we will differentiate between dose rates for different destinations (section 3.2). This will be followed by an account of the consequences this has for the individual doses to aircrew, passengers and, more specifically, to frequent flyers (section 3.3) and the collective doses of these groups (section 3.4).
In section 3.5 the trends and variations in dose rates and collective dose as a result of the solar cycle and increase in air transport are further illustrated and, finally, in section 3.6, results are compared with other methods and measurements.

3.1 Doses from cosmic rays

The cosmic rays we experience on earth are initiated by charged particles from space. They are captured in the magnetic field around the earth. The number of particles that do enter the atmosphere, especially protons, α-particles and electrons, therefore depend on magnetic latitude. Highest concentrations are found at the (magnetic) poles as may be seen from the higher than average dose rates at the poles in *Figure 4*, since the magnetic field lines along which these particles move, converge on the magnetic poles of the earth. Furthermore, because they are slowed down by the atmosphere (also altitude) or more accurately, atmospheric pressure is of importance (*Figure 5*).

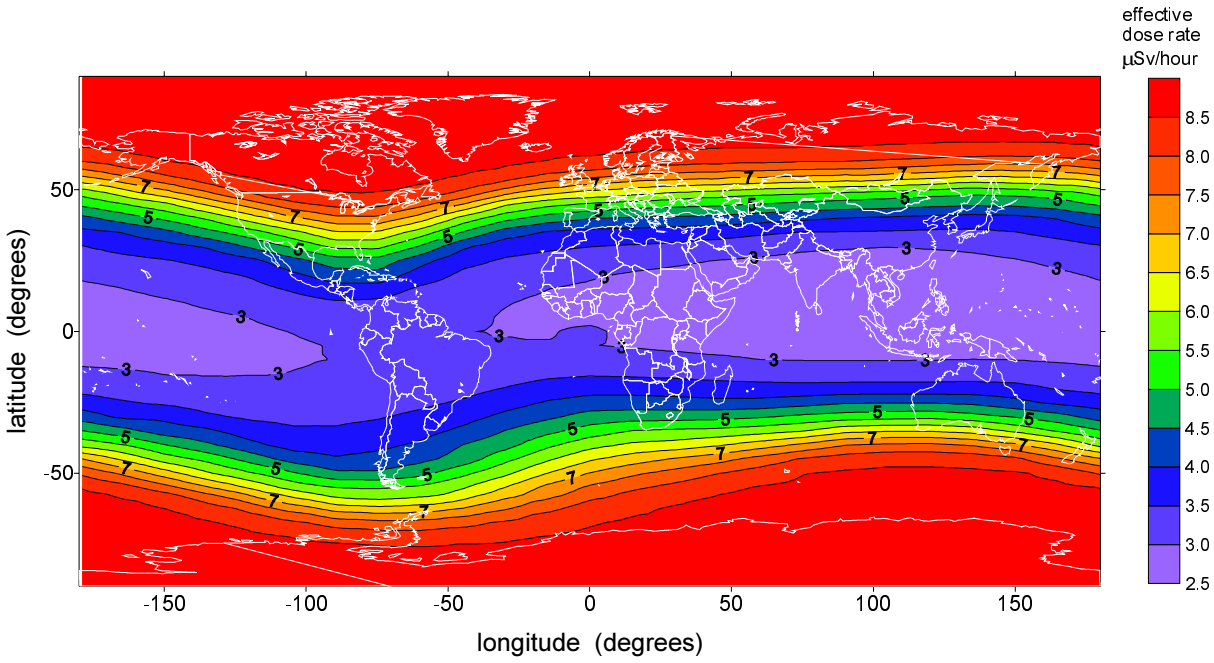

Figure 4 *Effective dose rate as calculated with CARI-v6 for a typical flight altitude of 39,000 feet (about 11.9 km) in 1997 for different geographic latitudes and longitudes. By comparison, the dose rate at sea level amounts to about 40 nSv h^{-1}.*

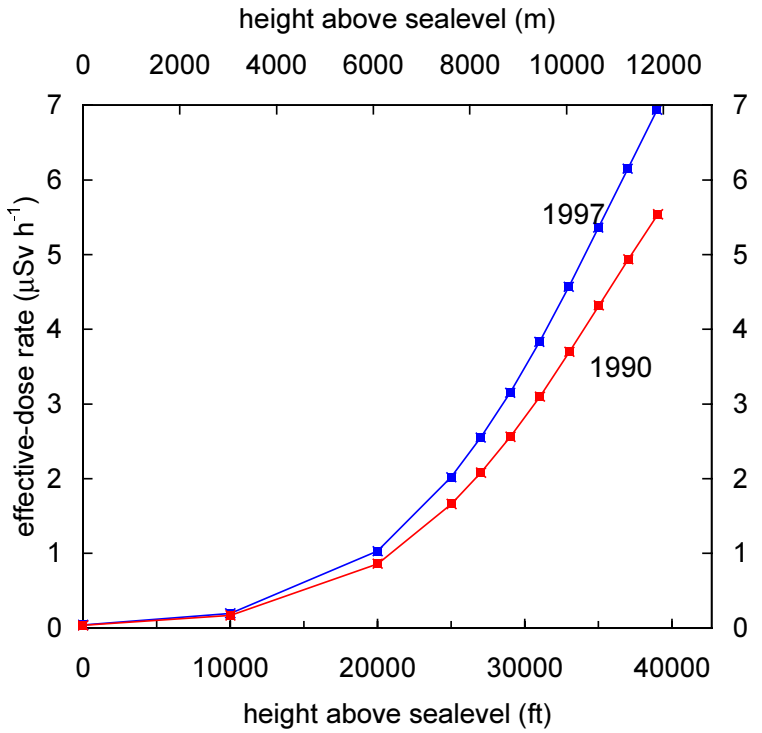

Figure 5 *Effective dose rate as calculated with CARI-v6 for different altitudes above sea level at Bilthoven, a small town in the centre of the Netherlands, for the years 1990 and 1997. These two years represent the respective solar maximum and minimum during a recent solar cycle.*

As mentioned earlier, the dose rate at sea level is determined by muons that are formed in the upper atmosphere. Most of the heavier particles have then disappeared through interactions. However, at flight altitudes, that is at 10 kilometres above sea level, dose rate is determined by neutrons, protons, electrons and photons. This radiation spectrum is so much different from the one on earth that convenient personal dosimeters to monitor aircrews have not yet become available, although these are under development [5, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40]. However, effective doses may be calculated using one of several software packages available.

3.2 Dose rates and destinations

As one of the larger airports in the world, Schiphol is frequented by a large number of airlines that serve several hundred destinations worldwide. For all these destinations effective doses were calculated for a one-way trip, i.e. averaged over the outbound and return flights for 1988-1997. Results of these calculations can be found in Appendix 5.

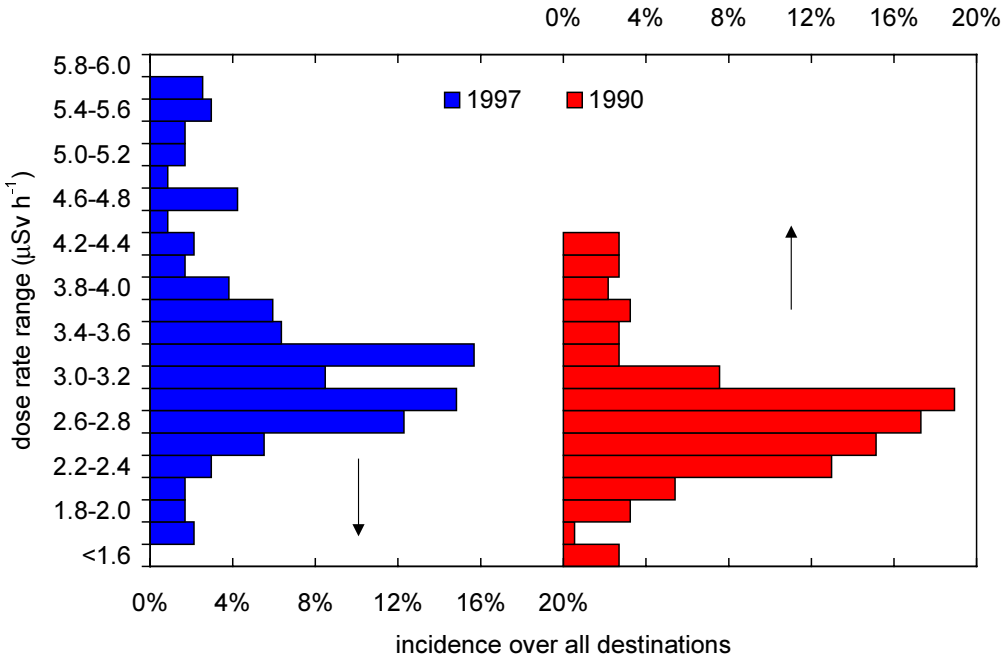

Figure 6 *Distribution of average effective dose rates over all destinations (not all flights!) reached from Schiphol Amsterdam Airport. The years shown are for maximum (1990) and minimum (1997) solar activity during the previous solar cycle. Dose rate intervals is 200 nSv h^{-1}.*

In *Figure 6* effective dose rates are summarised for all destinations for two 'extreme' years during solar maxima and minima. Because most of the destinations are in Europe (within a few flying hours), climbing and descending are relatively important. Climbing and descending together take roughly one hour and only the flying time on cruising altitude determines the overall dose (see *Figure 5*). Therefore, average dose rates on short distances will be highly affected by climbing and descending. Regional flights of up to one hour give dose rates up to 2 μSv h^{-1}. Dose rates for continental flights of up to four hours are in the range 2 – 3.5 μSv h^{-1} in 1990 and 2.4 – 4.5 μSv h^{-1} in 1997, and intercontinental flights range from 2 – 4.3 μSv h^{-1} in 1990 to 2.4 – 5.7 μSv h^{-1} in 1997. These last two ranges depend heavily on the hemisphere the destination is in. For instance, calculated average dose rate for the almost 20-hour flight from Amsterdam to Sydney (Australia) is 2.8 μSv h^{-1} for 1997, while this is 5.6 μSv h^{-1} for the less-than-12-hour flight from Amsterdam to Calgary (Canada). All flights that pass the equator encounter a 'low' dose rate area (see *Figure 4*).
Dose rates at high altitudes for supersonic flights (18 km) were in the range, 10 – 12 μSv h^{-1} during measurements from 1976-1983 and 1988-1990 [16]. However, by way of compensation, flights are shorter than at conventional altitudes (10-12 km) and aircrews generally fly fewer hours. Furthermore, supersonic flights are not scheduled at Schiphol and therefore will not be further considered.
Most of the reasoning above also holds for the total dose during flights (*Figure 7*). Regional flights (less than one hour) result in individual doses of 2 μSv at the most. For continental flights of up to four hours effective doses per one-way trip are 2 – 11 μSv for 1990 and 2.5 - 14 μSv for 1997. Doses for intercontinental flights range from 10 – 68 μSv for 1990 and 12 – 84 μSv for 1997.

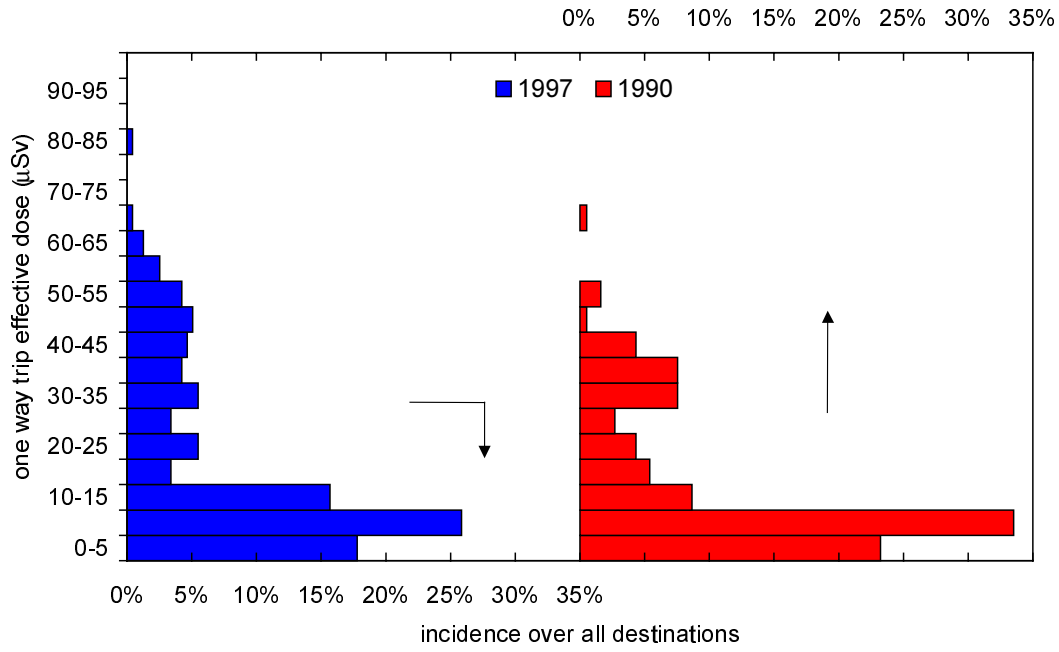

Figure 7 *Distribution of average effective dose per one-way trip for all destinations (not all flights!) reached from Schiphol Amsterdam Airport. The years shown are for maximum (1990) and minimum (1997) solar activity during the previous solar cycle. Dose intervals is 5 µSv.*

3.3 Individual doses

The exposed population may be split into the professionally exposed group (aircrews) and passengers. The focus on aircrews is important because they receive relatively high doses, and because EU and national directives have been developed especially for this group. In the large numbers of passengers some specific sub-groups may be found that are of importance for radiation protection purposes.

3.3.1 Aircrew

For members of an aircrew, that is pilots, flight engineers and cabin crew, there are two important parameters: the number of flying hours or block[**] hours per year and the specific flight schedules. It is clear that for local or regional flights, doses will not be as high as for intercontinental flights. Even average dose rates are lower because of the relative weight of climbing and landing in the total flying time. See also under section 3.2.

For local flights inside the Netherlands dose rates of less than 2 µSv per (block)hour have been calculated. Generally, for flights within Europe, dose rates of approximately 3 µSv h^{-1} are calculated, although this may be somewhat higher for northerly locations like Helsinki or St. Petersburg (see *Figure 4*). See also section 3.2 and Appendix 5, *Table 6*, for specific locations. Responsible for relatively high dose rates and doses are the flights to destinations in North America and East Asia (i.e. the upper parts of *Figure 6* and *Figure 7*).

[**] Flight time in block hours is defined as the time after the blocks are removed from the aircraft until they are in place again at the destination.

Assuming yearly flight hours to be 1000 block hours for aircrews of commercial airlines, a dose range of 2 – 5.7 mSv a^{-1} can be calculated as the individual dose in 1997 (extreme ranges in *Figure 6*), depending on the routes flown from and to Amsterdam. However, it should be noted that 1997 was a year with a solar minimum. For 2002 this dose will range from about 1.5 – 4.7 mSv for the same number of block hours. See also section 3.4.1. This effect of the solar cycle is illustrated in *Figure 8* where the effective dose of a one-way flight from Amsterdam to Houston (Texas) is presented for a number of years.

Although dose rates are lowest during a solar maximum, SPEs may give rise to high dose rates during a flight. As mentioned earlier, these dose rates may reach several mSv per hour! However, they are generally not that active. For high altitude flights, for instance, with the Concorde, these dose rates may be of some significance. For astronauts these doses pose a problem outside the earth's atmosphere, especially if the objective is flying to Mars on a two-year mission.

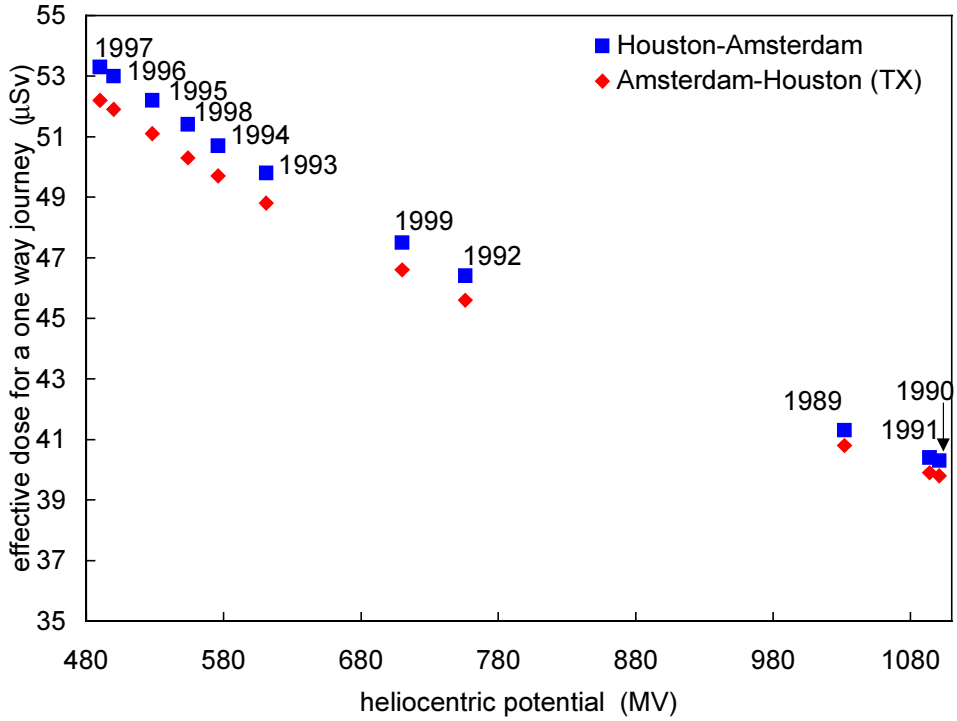

Figure 8 *Effective dose for a one-way flight from Amsterdam to Houston and the other way around. The large differences between years are due to the solar cycle. The differences seen in between the different flight directions are caused by fuel consumption, generally making it more efficient for an aircraft to climb until the landing stage is set in. If the plane flies northward (in this case, Amsterdam) it will encounter higher dose rates at the end of the journey than when it goes southward (Houston).*

The actual dose received by airline personnel depends, of course, on the actual number of hours flown. This may be regulated by law and is different for pilots from different countries. Furthermore, aircrews flying on private (business) jets might receive doses that are somewhat higher because they are sometimes assigned flight levels above those of the commercial airlines. The more individually specific dose is calculated in the Netherlands for each flight

using the computer generated flight plan and CARI-6M[††]. This information is linked with the names of the crewmembers and has been stored in the national dose register, NDRIS, for occupationally exposed workers since October 2001.

3.3.2 Passengers

From the transport of passengers to the various destinations (*Figure 1*), it is clear that many of the commercial flights in question are within Europe. Most of these flights take place over short distances and are in a temperate (dose-rate) region; this means that flight doses will be relatively low.
Figure 9 and *Table 1* present the distribution of doses among all passengers. A significant percentage (ca. 70%) of all passengers, especially those travelling to European destinations, receives effective doses per flight of less than 15 μSv. Some 20% of them received doses in 1997 in the range of 40 – 60 μSv per flight.

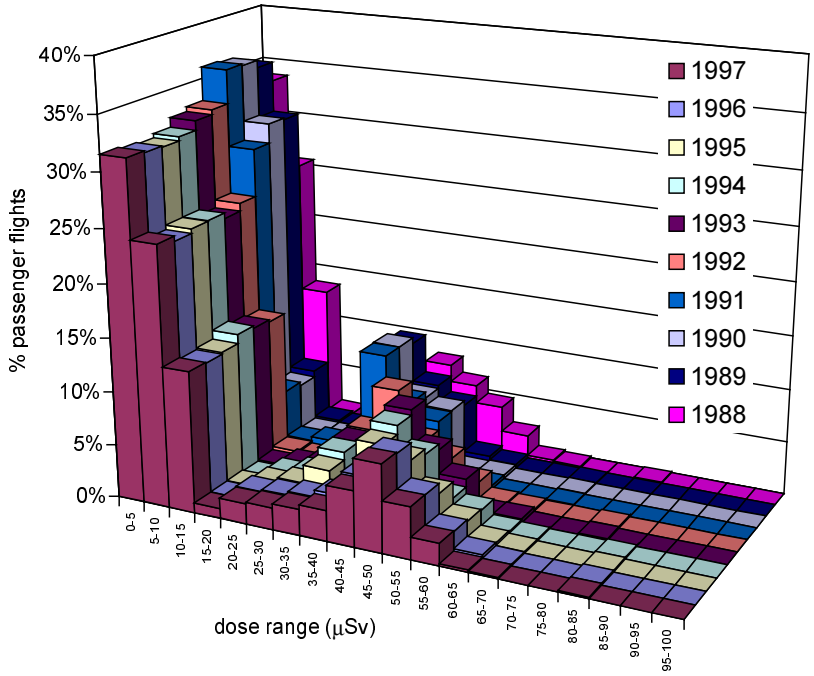

Figure 9 *Dose distributions over all passenger flights (one-way) between 1988 and 1997 from and to Schiphol Amsterdam Airport. Most of the passengers will also make a return trip and thereby double their dose.*

These relatively high doses hold primarily for passengers flying to or from North America and East Asia. As best seen in the figure, there is a shift to lower doses during a period of maximum solar activity (around 1990).

Apart from the passengers flying through Amsterdam, there is, of course, also a group of Dutch residents flying to other destinations from other airports of departure. For instance, they might take the train to Brussels and get onto a flight there or they might travel within another country or between countries using local air transport that does not connect to Amsterdam. If they have no connecting flights to or from Amsterdam, these people do not

[††] CARI-6M is equal to CARI v6, but, additionally, can split a flight into separate legs that deviate from a great circle route

show up in the statistics given here. Collective doses from air transport for the Dutch population are therefore underestimated. However, how large the underestimation is, is difficult to determine.

Besides passengers that travel only once a year (still the largest group of passengers), a growing number of people are making more frequent use of airlines. From information about Schiphol for 1999 [41], 35% of the passengers travelling through Amsterdam were shown to live in the Netherlands. Further results on frequency of flying are presented in *Table 2*.

Table 1 *Dose distribution (%) over all passenger flights (one way) between 1988 and 1997 to and from Schiphol Amsterdam Airport (see also Figure 9); The average dose for a round trip is shown in the bottom row (rounded off to the nearest integer).*

Dose range (μSv)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0-5	33.5	35.3	35.9	36.0	32.9	32.5	31.6	31.2	31.4	31.5
5-10	25.5	30.6	30.7	28.9	24.5	23.8	24.3	24.2	23.8	24.3
10-15	13.3	6.1	5.5	5.8	13.6	13.8	14.0	13.2	13.1	13.2
15-20	1.2	1.5	1.2	1.3	1.3	0.9	0.8	1.0	0.9	0.9
20-25	0.5	1.3	1.2	1.7	1.1	1.5	1.7	1.8	2.0	1.9
25-30	2.3	1.5	1.3	1.6	2.1	2.2	2.2	2.3	2.2	2.1
30-35	2.0	10.6	11.1	11.1	4.8	4.6	4.7	3.9	2.5	2.4
35-40	8.0	6.9	6.6	7.1	9.1	2.8	2.0	2.3	3.2	2.9
40-45	6.3	5.3	5.7	5.6	4.8	8.7	8.2	7.4	5.4	5.2
45-50	4.6	0.7	0.2	0.3	3.6	5.4	5.9	6.5	8.1	8.2
50-55	2.2	0.4	0.3	0.3	1.8	3.1	2.4	3.9	4.8	4.8
55-60	0.3				0.3	0.3	1.7	1.8	2.0	2.1
60-65	0.1				0.1	0.4	0.3	0.4	0.4	0.2
65-70		0.1	0.1	0.1			0.1	0.1	0.1	0.1
70-75										
75-80	0.1				0.2	0.1				
80-85							0.1	0.1	0.2	0.1
Average dose in round trip (μSv)	31	28	27	28	31	33	33	35	36	35

Table 2 *Survey results on frequency of flying at Schiphol airport in 1999 [41] and assumed numbers of flights by frequent flyers in 1997*

Number of trips in previous 12 months	People surveyed (%)	Assumed number of flights per year	Number of Dutch in group[(1)]
First flight	17	1	923,000
1 – 3 flights	34	3	Ca. 615,000
4 – 10 flights	26	7	Ca. 202,000
More than 10 flights	23	15	Ca. 83,000
Total	100		Ca. 1,823,000

(1) 35% of all travellers were living in the Netherlands; frequency of flying of this subgroup is assumed comparable to that of all passengers.

Although most of the Dutch passengers encountered at Schiphol airport are flying more frequently, their total number is still lower than that of the passengers taking one trip. No information was available on the destinations of frequent flyers, but every month a return trip

from Amsterdam to a city in North America is surely not an extreme case. In *Figure 10* it can be seen that these frequent flyers may easily receive annual doses of more than 1 mSv (expected range 0.15-1.5 mSv a^{-1} and on average 0.5 mSv a^{-1}). See Appendix 5, *Table 6*, for specific cities. Most of these 83,000 (Dutch) frequent flyers probably stay within Europe for their business, as is the case for all passengers. In Germany, with five times as many inhabitants as the Netherlands, some 20,000 persons are expected to receive annual doses exceeding 1 mSv [16]. Although very uncertain, this would imply that some 4000 (Dutch) frequent flyers would exceed the 1 mSv per year.

However, most of the (more) frequent flyers (more than one return flight) will still receive annual doses below 1 mSv. The number of frequent flyers from abroad (more than 10 flights annually) is more difficult to determine, because they surely will not always travel to Amsterdam. Therefore their total number will be somewhere between 150,000 (all flights through Amsterdam) and 2.3 million (just one flight to Amsterdam). With the increase of air travel, the group of business travellers, not under dosimetric control, will also increase. The European Commission has recognised this problem and recommended that although air couriers and other exceptionally frequent flyers are not mentioned in Article 42 of the Basic Safety Standards [7], 'employers of such individuals should make arrangements for determining doses similar to those made by airlines for their staff' [42].

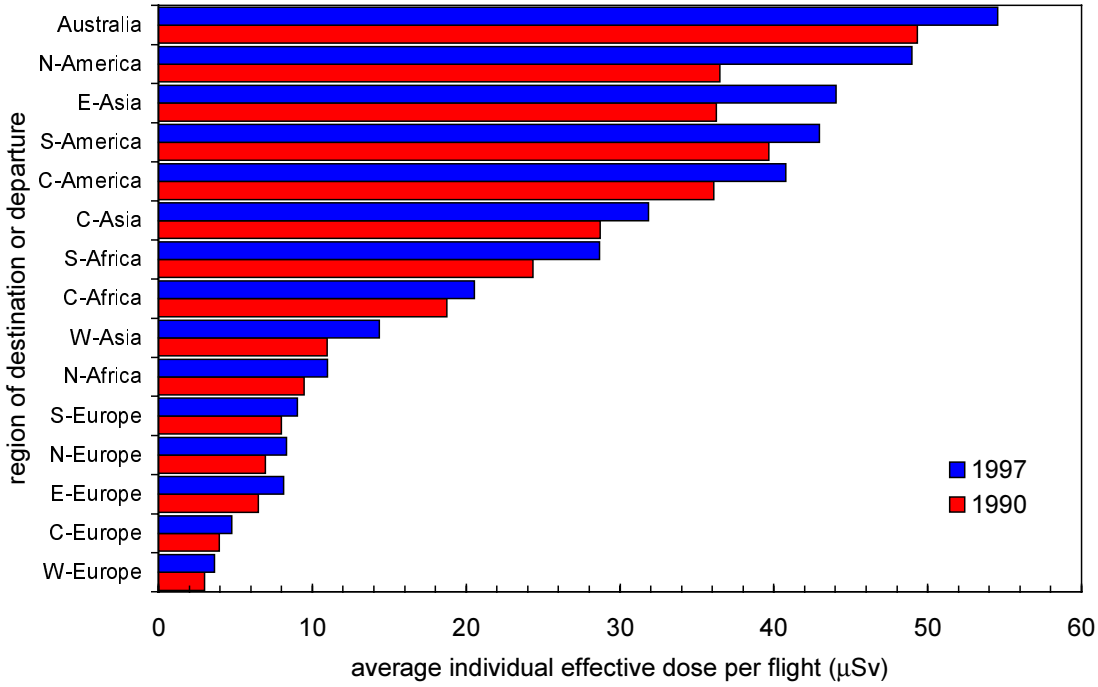

Figure 10 Average individual effective dose for a one-way flight from Amsterdam to airports in various regions of the world for the years 1990 (solar maximum) and 1997 (solar minimum)

In the Netherlands annual doses to individuals from all sources of ionising radiation, i.e. natural radiation sources like radon and cosmic radiation, but also medical applications are on average about 2.5 mSv a^{-1} [17, 43]. The average annual effective dose from cosmic radiation at ground level is approximately 0.28 mSv a^{-1}.

3.3.3 Couriers

Within the group of frequent flyers there is a special subgroup of so-called couriers. This category, still in its infancy, consists of individuals delivering special parcels across the world. It is quite possible for these couriers to fly 1200 hours or more annually, which is far more than most aircrews fly. Average annual effective doses for individuals from this group are expected to be in the range of 6 – 10 mSv [16].

3.4 Collective doses

Collective dose is a way of comparing more generally the dose implications of various exposures. For the occupationally exposed, this provides insight into the radiological effects of their work, and for the general population, it offers the opportunity to compare the risks of radiological exposures to those of various other agents.

3.4.1 Aircrew

Of all aircraft movements at Schiphol airport in 1999, about 45% were made by Dutch carriers. The collective dose for crew members on these carriers (about 11,000) in 2002 was estimated at 16 manSv [44]. The total collective dose for aircrews using the Amsterdam airport can then be estimated at about 36 manSv for 2002 or some 6% of the collective dose to passengers (see 3.5.2). Based on the number of passenger kilometres performed (3.7% of the worldwide performance in 1997, see 3.4.2) this amounts to about 1000 manSv for aircrews worldwide in 2002. UNSCEAR estimated 800 manSv for the year 2000 [16].

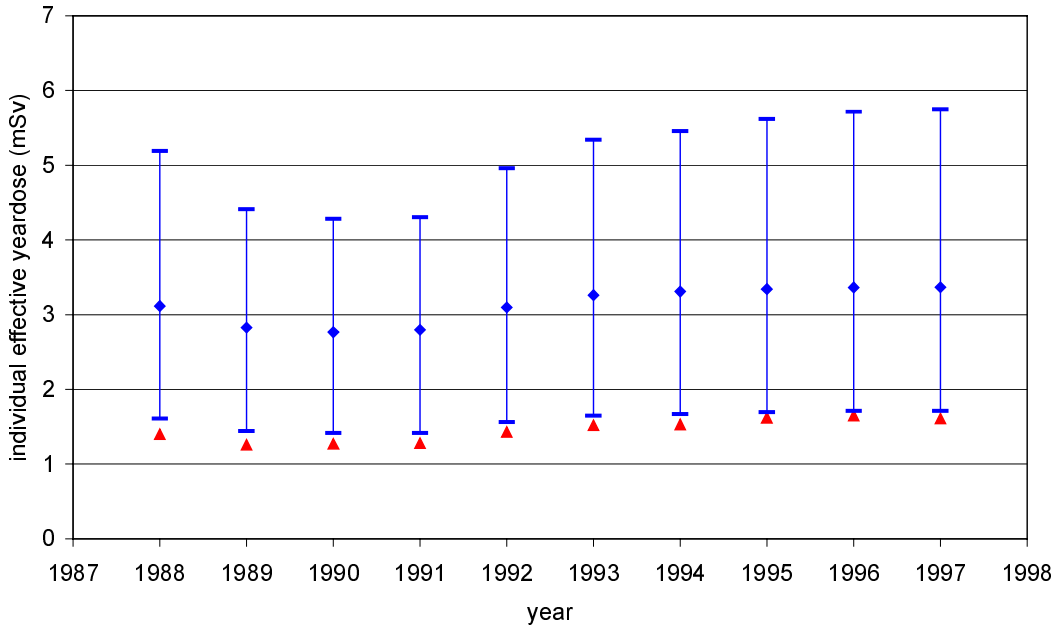

Figure 11 *Individual dose range for crew members for 1000 block hours; minimum, maximum and average doses are shown in blue; the average dose, scaled from the 'measured' dose for the year 2002, is shown in red. A block of 500 working hours would seem on average to be in better agreement with this data.*

The collective dose to aircrews heavily depends, of course, on the number of crewmembers on board, which differs per aircraft type, airline, distance etc. If we assume a direct linear relationship between average numbers of passengers and aircrew members, then the 6%, as mentioned, might be a reasonable percentage. *Table 3* presents these estimated collective doses for crew members for 1988-1997.

From the data in this table and the calculated minimum, maximum and average doses over all the calculated destinations, it would seem that an average of 500 block hours is in better agreement with the working hours of the crew members (see *Figure 11*) than the 1000 used in the exemplifying calculations on the individual dose in section 3.3.1.

3.4.2 Passengers

Although individual flight doses have not changed that much in recent years, apart from the modulating effect of the solar cycle, the number of people taking one or more flights per year increased almost exponentially. This can be illustrated by *Table 3*, showing a doubling in the number of passengers in the period considered (1988-1997). The so-called total number of passenger kilometres performed (passengers x kilometres flown by them - see also Appendices 3 and 5, *Table 8*) amounted to 96 billion for 1997, which is about 3.7% of the total number of passenger kilometres flown in the world for that year [45]. Based on this percentage, the total collective dose worldwide due to air travel by passengers in 1997 can be estimated at some 15,000 manSv.

Table 3 *Calculated collective dose for all destinations included in Appendix 5, Table 9 and estimated collective doses for all passengers (including all destinations not calculated as in Appendix 5 but scaled from calculated dose) and aircrews (6% of collective dose for passengers). Numbers pertaining to aircrew are only indicative and scaled to the total number of passengers transported.*

year	Calculated collective dose (manSv)	No. passengers Schiphol (x 1000)	Collective dose all passengers (manSv)	Collective dose aircrews (manSv) (no. crew members)
1988	223	14,665	228	14 (8800)
1989	211	15,423	214	13 (9300)
1990	217	16,267	221	14 (9800)
1991	222	16,243	225	14 (9800)
1992	282	18,753	287	18 (11,300)
1993	337	20,777	340	21 (12,500)
1994	381	23,083	385	23 (13,900)
1995	426	24,861	433	26 (15,000)
1996	481	27,263	487	30 (16,400)
1997	539	31,021	548	33 (18,700)

From *Figure 12* it is clear that, although most flights through Amsterdam are within Europe, the major contribution to the collective dose is by flying to or from cities in North America. The large increase between 1990 and 1997 (for all destinations) is determined by the increase in passenger numbers and not that much by differences in the solar cycle.

In recent years frequent flyers (more than 10 flights a year) determine 23% of the collective dose. As mentioned previously, a number of these passengers will appear more than once in the statistics. Especially the Dutch frequent flyers, because they start and end most of their journeys at Schiphol airport, were probably members of a smaller group of some 83,000 in 1997 (see section 3.3.2) with a collective dose of about 45 manSv. Within this group only some 4000 will have exceeded the 1 mSv individual dose, with a group dose of between 5 and 10 manSv.

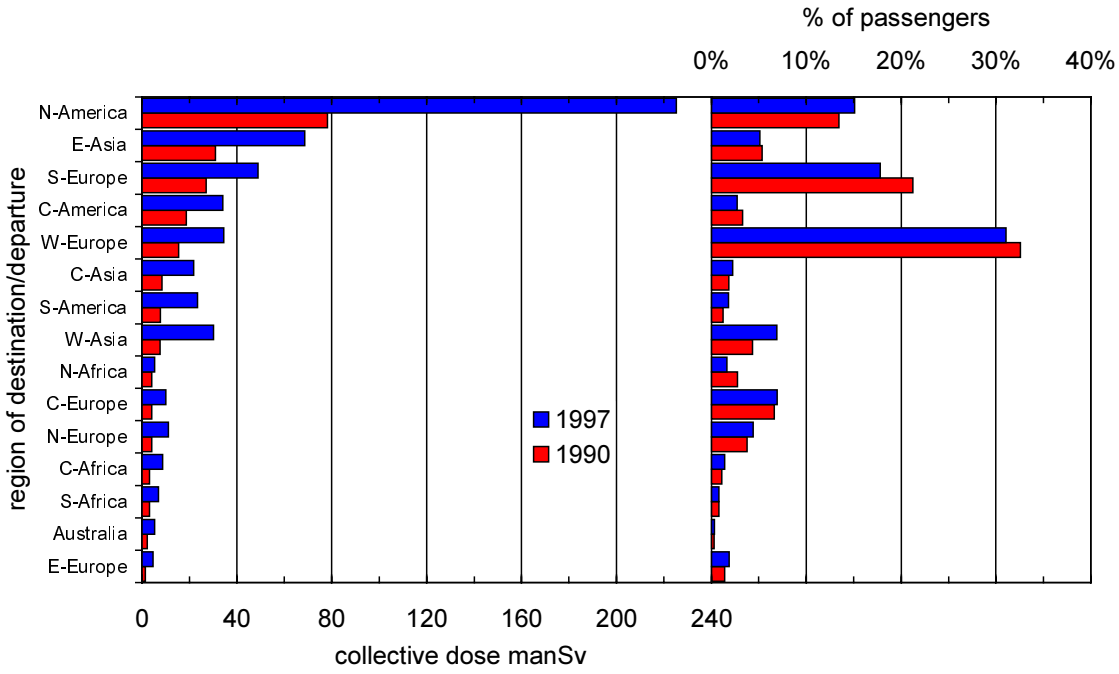

Figure 12 Collective effective dose received by passengers travelling through Schiphol Airport in 1990 (solar maximum) and 1997 (solar minimum). The largest contribution comes from passengers flying to cities in North America.

3.4.3 Couriers

The collective dose for couriers is quite difficult to determine, because their numbers are unknown, not to mention their destinations. Since their missions form a quite expensive postal service, their total number will probably not be that large. Apart from this, although it is certainly possible, it is not likely that couriers will travel their whole working lives. This makes any measures based on radiation protection principles less pressing. The collective dose for this subgroup of frequent flyers probably does not exceed the 1 manSv maintained in the Netherlands.

3.5 Future dose trends

As may be apparent from the above, there are two major factors influencing the collective dose of aircrews and passengers alike: the sun with its 11-year cycle and the number of passengers.

3.5.1 Solar cycle

As mentioned in section 3.1, the dose rate due to cosmic radiation at sea level is only marginal compared with that at flight levels. The same holds for the dose rate variation as a consequence of the solar cycle at sea level. In *Figure 13* these variations are presented for a period of more than 40 years. At 39,000 feet the effective dose rate may vary by several thousands of nSv h^{-1}, while this is only up to about four nSv h^{-1} at sea level between months of maximum and minimum solar activity. However, in years when dose rates are 'low', the annual dose at sea level may be some 35 µSv less than in years of 'high' dose rates. To put this into perspective, this dose is about the same as you would receive on an average return flight.

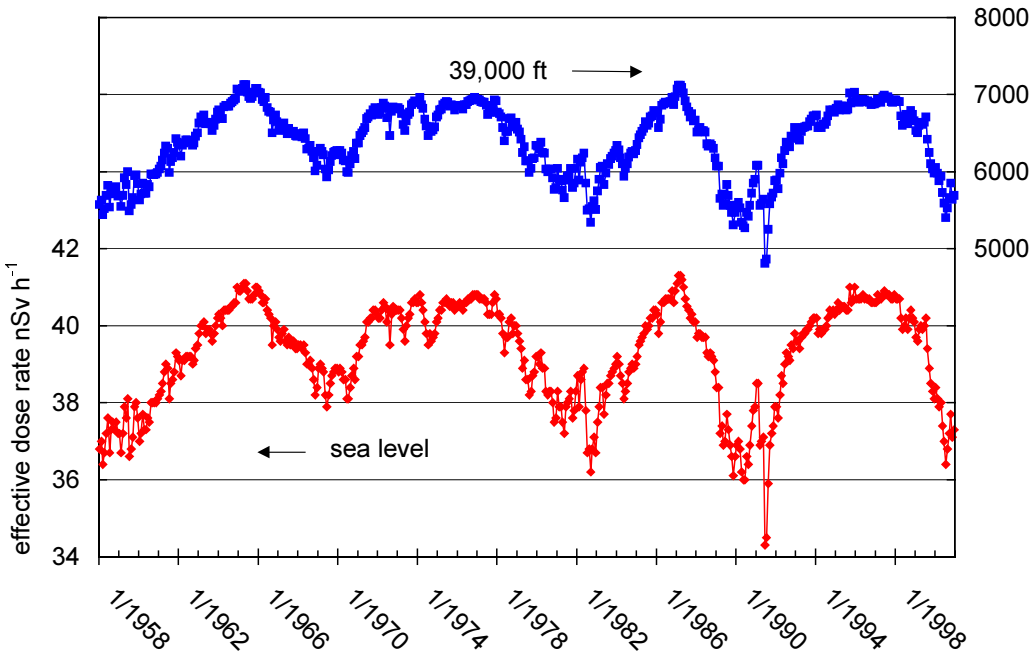

Figure 13 *Monthly data on effective dose rate at sea and flight levels (39,000 feet) as calculated for Bilthoven using CARI. Although both curves are fairly similar, one must be careful to check the difference in magnitude as shown on the y-axes.*

A better view of these variations at flight levels is given in *Figure 14*. The collective dose per million passenger trips is apparently correlated with the heliocentric potential, as given in *Figure 3*. If the distribution of passenger flights around the world going from or to Amsterdam does not change (or, in other words, if the relative growth in passenger numbers is equal over the years for all destinations), this linear fit is then a useful conversion coefficient for use in calculating expected collective doses from the past and for the near future. However, this only applies if the total number of passengers arriving and departing from Amsterdam are known. This linear fit may be different for other airports depending on their geographic locations and the network of connections.

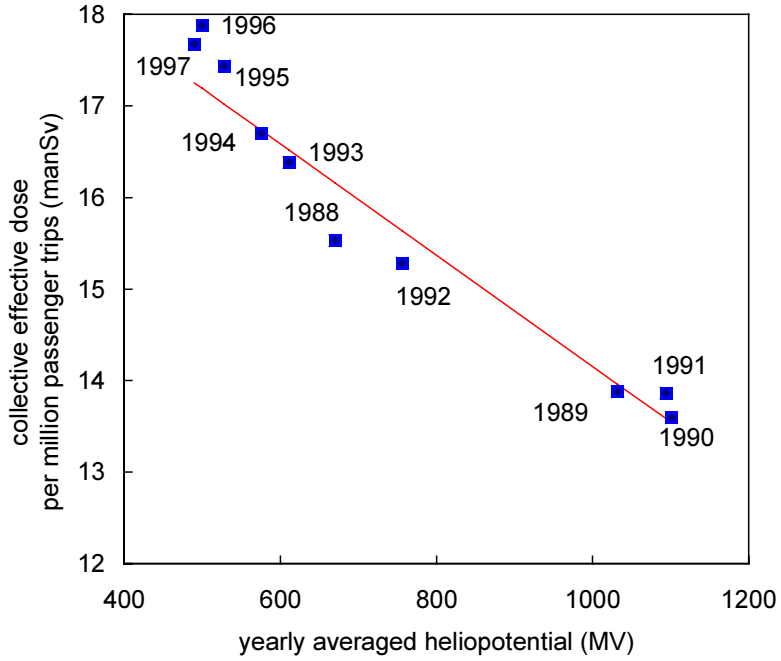

Figure 14 *Collective effective dose per million passenger trips (one way) for the period investigated and a linear fit to these data.*

The linear fit for Schiphol from *Figure 14* is:

collective dose per million passenger trips = 20.2 – 0.006 x heliocentric potential (MV)

From *Figure 15* it can be seen that the distribution – although not constant – over destinations of the last few years in all major regions has not deviated much from that in 1991.

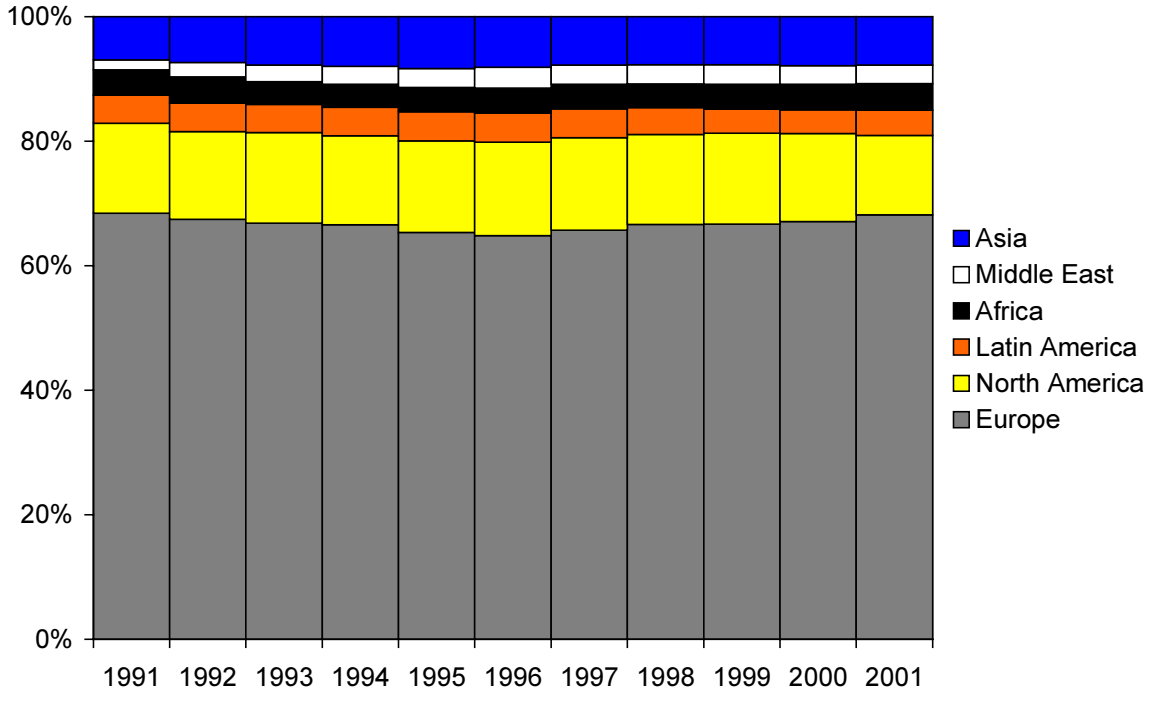

Figure 15 *Cumulative distribution of flights to different parts of the world from Schiphol Airport in 1991-2001[46, 47].*

In 1995-1997 the contribution from flights in Europe is somewhat less than in other years, so that these years are expected to show somewhat higher collective doses per million passenger trips. This is in agreement with the doses found in *Figure 14*.

3.5.2 The growth in passenger numbers

The growth in passenger numbers was high in the years leading up to 2001. Growth rates at Schiphol Airport of 7-11% were usual in the nineties. Even the relapse in global air traffic after the events of September 2001 (attack in the USA of 11 September) only resulted in a zero growth of passenger numbers in 2001. The consequences of even more recent crises, like the Iraq war and the outbreak of SARS, can not yet be assessed fully.

Besides the temporary relapses due to relatively large crises in the world it is still not extraordinary to expect a return to at least a moderate growth in passenger transport of some 4% (see *Figure 16*). In 1998 the project organisers expected this to be a 'low' scenario for the future Dutch Aviation Infrastructure (TNLI in Dutch) [48]. The 4% is also used in scenario descriptions of the Netherlands Bureau for Economic Policy Analysis (CPB) [20, 49], even after September 2001.

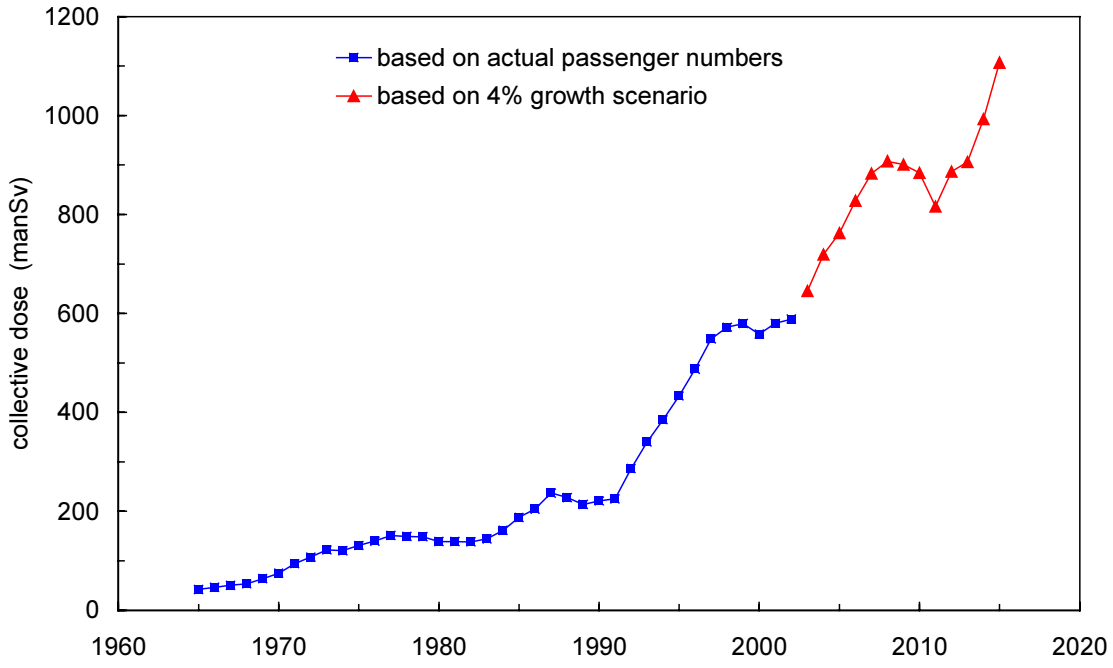

Figure 16 *Collective dose for passengers flying through Schiphol. Doses up to 2002 are based on actual passenger numbers, average annual heliocentric potentials and calculated collective dose according to the linear fit from section 3.5.1. The data for 2003 and further into the future are based on an annual 4% growth in passenger numbers and heliocentric potentials equal to 11 years previous.*

In 2000 the International Civil Aviation Organisation (ICAO) even expected a somewhat higher growth rate for Europe [50].

It can be seen in *Figure 16* that even for an annual growth rate of 4%, the collective dose will double in the period 1997-2015.

3.6 Validation of dose calculation

As mentioned in section 3.1, it is not that simple to make valid measurements of the dose from cosmic radiation. However, more and more measurements are becoming available. In section 3.6.1 these are compared to the calculations made with the CARI model used for this report.
There are also other models and procedures to estimate the dose from cosmic radiation. These are highlighted in section 3.6.2.

3.6.1 Comparison with measurements

Various types of detectors for the measurement of cosmic radiation have been investigated. These can be divided in active and passive detectors [51]:
Active detectors

- GM-counters for detection of photons, protons, electrons and muons
- Scintillation counters for detection of photons, protons, electrons and muons
- Ionisation chambers for detection of photons, protons, electrons and muons
- Tissue-equivalent proportional counters (TEPC) for detection of all radiation types [4, 32]
- Rem counters mainly for detecting neutrons [33]

Passive detectors

- Thermoluminescent detectors (TLD), for instance LiF [34, 52] for low-LET ionising radiation
- Photoluminescent detectors for low-LET ionising radiation
- Bubble detectors for neutrons below 20 MeV [53]
- Polycarbonate detectors for a-particles and heavier particles, neutrons of 1-50 MeV
- PADC/CR39 detectors for neutrons, protons and heavy ions
- Bismuth detectors for high-energy neutrons and protons (> 50 MeV)
- Stacks of thin films of cellulose nitrate detectors LR-115 for heavy ions and high-Z and high-energy particles (HZE)

Sometimes a combination of dosimeters is needed to get a clear picture of the dose received, for instance, TLD and bubble detectors [3].

Although there are not many measurements of radiation dose on specific flights from or to Amsterdam, some of the authors mentioned above compared theirs with doses calculated by the CARI model.
Curzio *et al.* (2001) [6] found their measurements (TLD + rem counter, TEPC + stack detectors) to be in good agreement with the doses calculated by CARI (within 10%) for several long-haul flights. Lewis *et al.* (2002) [54] also found good agreement between their long range TEPC measurements (short- and long-haul flights) and CARI-calculated doses. Hajek *et al.* (2002) [52] found their TLD measurements to be somewhat higher (15% ± 7%) for a number of transatlantic flights from Cologne (Germany) to Winnipeg (Canada), El Paso (Texas) and Washington than calculated doses from CARI.

3.6.2 Other models and methods

Besides CARI there are several other more or less complex computer codes to calculate the dose rate at different altitudes and geomagnetic coordinates. Two often used codes are LUIN and FLUKA. The LUIN code represents a deterministic treatment based on an analytical two-

component solution of the Boltzmann transport equation. The FLUKA code is based on a Monte Carlo simulation using the Badhwar environmental model for the given boundary condition. Both codes yield atmospheric particle spectra, radiance, fluence rates and ionisation intensities. These models are therefore quite versatile but also complex. This was the reason for the development of the CARI and EPCARD (European Package for the Calculation of Aviation Route Doses) [55] models derived from these more complex models. These model results are in good agreement, although the EPCARD values tend to be somewhat higher than the CARI results.

One other model, or actually a procedure, is PCAIRE (Predictive Code for Aircrew Radiation Exposure) [56], a code based on experimental results (a large set of TEPC measurements from all over the globe), making it possible to interpolate dose rates for every specific location. PCAIRE results are also in good agreement with CARI and EPCARD results, especially for locations and dates where information is available. It is of course logical that interpolation will also raise less confidence for locations and times that are less dense in the PCAIRE database.

4. Conclusions and discussion

Because of the growth in aviation worldwide the number of people receiving elevated doses of cosmic radiation have increased considerably. Since the implementation of the new legislation, doses received by aircrews due to enhanced exposures to cosmic radiation have to be collected and retained, similar to other occupationally exposed radiological workers. Because simple measurements using personal dosimeters encountered problems due to the radiation types and qualities that are different from those at sea level, several methods, codes and more complex measurement procedures have been developed in the last 10-20 years to fulfill this obligation. One of these codes, CARI, was used to calculate the dose, not only to aircrew but also to passengers flying through Schiphol Amsterdam Airport.
Some interesting conclusions can be drawn from the detailed research on passenger transport through Schiphol over a period of 10 years, as presented below.

- The total collective dose of all passengers that made use of Amsterdam airport in 1988 amounted to 230 manSv and in 1997 to about 550 manSv. Based on the number of passenger kilometres, this dose is estimated to be 15,000 manSv worldwide for 1997. Even based on an expected moderate annual growth rate of 4%, this dose will double again in the next 12 years (up to 2015).
- Flight doses (single trip) are mostly in the range of 1-60 μSv and are, on average 18 μSv per one-way trip. The high-end dose holds for intercontinental flights to or from North America and East Asia, especially flights that follow a northerly course.
- Most of the Dutch passengers are still once-a-year flyers, but a growing number of especially business people are becoming frequent flyers. An estimated number of 80,000 of them are Dutch and fly on more than 10 trips a year. Some 4000 of them are expected to exceed an annual dose of 1 mSv. This could easily be accomplished by flying to the United States every month.
- An even smaller group of so-called couriers may receive annual doses up to 10 mSv. Not much is known about this group of ‘expensive postmen’.
- Members of an aircrew, the only ones affected by the new regulations, are expected to receive annual doses in the range 1.5 – 5.7 mSv for 1000 block hours. The maximum and minimum may shift somewhat - downwards and upwards - respectively, as a function of the specific point of time during the solar cycle. From data in the first full year of registration in NDRIS (2002), the average working hours are estimated to be half of those given above.
- Although annual doses to passengers normally contribute only a few per cent to the average effective dose from exposure to all sources of radiation of 2.5 mSv a^{-1}, this may be somewhat different for aircrews and frequent flyers, whose annual ‘non-flying’ exposure may be doubled or tripled.

If the collective effective dose is multiplied by 0.05, yielding the fatality risk per Sievert [15], the number of fatalities that will eventually result from this dose can be calculated. The number of fatalities due to accidents with aircraft can be assessed from the Aviation Safety Network [57]. Based on the number of flights passing through Schiphol Airport, the proportion of fatalities occurring on average in the group of passengers flying through Schiphol can then be estimated. As illustrated in *Figure 17*, at the end of the twentieth century both numbers were in balance. The number of fatalities has either stayed constant or decreased during the past decades, a sign that safety is tille improving, considering that the total number of flights and number of passengers per flight have increased.

We can now pose the question: Is flying safe or is it dangerous for the wrong reasons (danger of cosmic radiation replacing danger of accidents)? Or is it all a matter of risk perception?

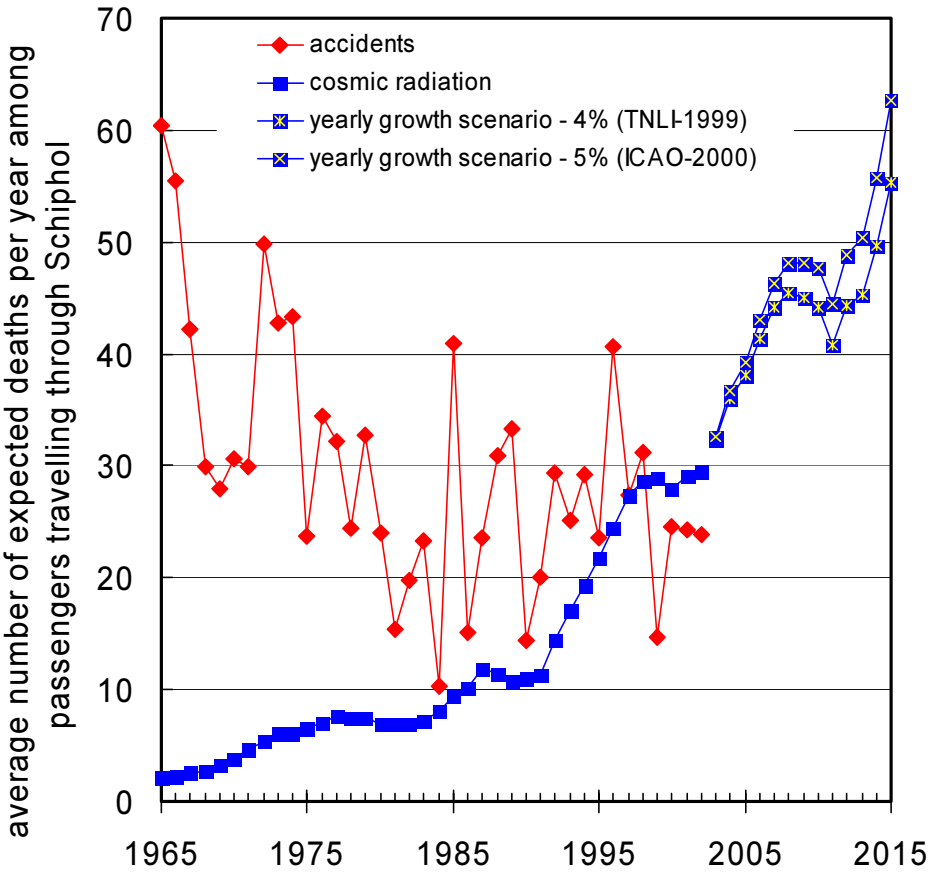

Figure 17 *Average number of expected fatalities per year among passengers travelling through Amsterdam Schiphol Airport. Data on accidents based on Aviation Safety Network [57] and proportion of departures and arrivals at Schiphol compared to the rest of the world. Data on cosmic radiation are taken from the present report. Scenarios from TNLI and ICAO were reported in 1999 and 2000 [48, 50].*

Although future trends in aviation are still partly hanging in the clouds, we can expect a moderate growth of some 4%. Furthermore, new aircraft types like the 737 Next Generation series have higher cruising altitudes than the present aircraft. Due to crowded skies at altitudes between 10 and 12 kilometres, airlines will try to get round the congestion by trying to fly higher (less influence of the weather, more economical). Furthermore, (small) business planes, often flying at altitudes above the commercial air routes, are becoming more and more common.

On the other hand, besides the higher cosmic dose rates, flying at higher altitudes also produces contrails that might negatively affect cloud formation and eventually enhance the greenhouse effect [58]. Only time can tell what effect these arguments will have on the trends already set in by aircraft builders and airlines.

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Appendix 1 Mailing list

1-30 Director of the Directorate for Chemicals, Waste and Radiation Protection, VROM
31 Deputy Director-General of Environmental Protection
32 Director-General RIVM
33 United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), Vienna
34 A.M.T.I. Vermeulen, Ministry of Social Affairs and Employment, Directorate Work Safety and Health, The Hague
35 Warehouse of Dutch Publications and Dutch bibliography
36 Director Environmental Risks and External Safety Division
37 Head of the Laboratory for Radiation Research
38 Author
39 SBC/Communication
40 Report Registry
41 Library RIVM
42 Library LSO
43-47 Internal ‘Bureau Rapportenbeheer’
48-60 Backup copies

Appendix 2 Glossary

Air crew	pilots, flight engineers and cabin crew
Airport code	every airport in the world is known by a code name; usually IATA (3-letter) and ICAO (4-letter) codes are used, for instance AMS or EHAM for Amsterdam Schiphol
Average individual effective dose	individual effective dose averaged over specific flights, time periods or specific groups of exposed persons
Block hours	flight time in block hours, defined here as the time after the blocks in front of the wheels are removed from the aircraft until they are in place again at the destination
CARI	'package' for the calculation of aviation route doses from the Civil Aeromedical Institute, Federal Aviation Administration, USA
CBS	Statistics Netherlands, Heerlen/Voorburg, NL
Collective (effective) dose	individual effective dose summed over the exposed group of persons, expressed in manSv
Contrail	condensation trail of an aircraft
Cosmogenic radionuclides	radionuclides produced in the upper atmosphere as a consequence of reactions between fast cosmic particles and atmospheric constituents; for instance, ^{14}C from ^{14}N
Couriers	express messengers travelling across the world to deliver valuable packages or information
CPB	Netherlands Bureau for Economic Policy Analysis, The Hague, The Netherlands
Cruising altitude	altitude at which the aircraft cruises, depends on aircraft type, flying distance, traffic etc.
EPCARD	European Package for the Calculation of Aviation Route Doses
FAA	Federal Aviation Association, USA
Fatality risk	the risk of mortality; in the case of ionising radiation an effective dose of 1 Sv corresponds to a fatality risk of about 5% [15]
Flight level	altitude of flying, mostly in feet: FL350 means 35,000 feet altitude
Flight profile	the time, location and altitude information on a flight from A to B
FLUKA	a code based on a Monte Carlo simulation for calculation of the radiation field
Frequent flyer	passenger taking more than ten (return) flights a year
Heliocentric potential	an interplanetary magnetic field index that is a measure of the solar activity
IATA	International Air Transport Association
ICAO	Intenational Civil Aviation Organization
Individual effective dose	individual dose averaged over the total body, expressed in Sv (sievert)
KLM	Royal Dutch Airlines

LUIN	a code for the deterministic model for radiation transport calculation in the atmosphere
NDRIS	'Nationaal Dosisregistratie- en Informatiesysteem', the Dutch radiation dose registry for radiation workers
Passenger kilometre	kilometres flown by a passenger (a measure of transport), e.g. 30 people flying a 1000 km stretch 'produce' 30,000 passenger kilometres
PCAIRE	Predictive Code for Aircrew Radiation Exposure, based on experimental data
Radiation exposure	exposure of a person to (ionising) radiation
RIVM	National Institute for Public Health and the Environment, Bilthoven, The Netherlands
Solar cycle	Activity cycle of the sun of about eleven years; during low activity its status is called solar minimum and during highest activity solar maximum
SPE	Solar Particle Event, an eruption of particles from the sun that can even be measured on earth, although most of the energy is absorbed in the upper atmosphere
TEPC	Tissue-Equivalent Proportional Counters, dosimeter for all radiation types
TNLI	'Toekomstige Nederlandse Luchtvaart Infrastructuur', the future Dutch aviation infrastructure
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation, Vienna, Austria

Appendix 3 Distance calculation

For a flight between locations A and B, the shortest distance along the surface of the globe is represented by a so-called great circle path. If the geographic coordinates of both locations are known, this distance may be calculated unambiguously by using the following equations (for a perfectly round globe):

$$\alpha_{AB} = 2 \cdot \arcsin\left[\sqrt{\left(\sin^2\left(\frac{Lat(B) - Lat(A)}{2}\right) + \cos(Lat(A)) \cdot \cos(Lat(B)) \cdot \sin^2\left(\frac{Lon(B) - Lon(A)}{2}\right)\right)}\right]$$

where

α_{AB} is the angle between the lines through A and the centre of the globe and B and the centre of the globe

Lat(A) is latitude of location A

Lat(B) is latitude of location B

Lon(A) is longitude of location A

Lon(B) is longitude of location B

When the angle α_{AB} is given in radians, the distance L (in km) between the locations A and B may be calculated simply by:

$$L = \alpha_{AB} \cdot R$$

where

R is the radius of the earth, set at 6350 km

Appendix 4 Flight level modelling

Table 4 *Travel time or flight duration in hours at various flight levels for four different aircraft types, as a function of total flight duration T (in so-called block hours) according to the method by Oksanen [18]. The time remaining (after subtracting the various times at the different flight levels) is assumed to be spent at ground level (i.e. during taxiing or take off and landing).*

DC10		Flight level FL (feet)						
Travel time T in hours		FL270	FL290	FL310	FL330	FL350	FL370	FL390
from	to	27000	29000	31000	33000	35000	37000	39000
0	3.05					0.5x(T-0.733)	0.5x(T-0.733)	
3.05	5.633				0.5x(T-3.05)	1.16+0.5x(T-3.05)	1.16	
5.633	6.513			0.5x(T-5.633)	1.28+0.5x(T-5.633)	2.44	1.16	
6.513	8.94			0.5x(T-6.513)	1.28+0.5x(T-6.513)	2.57	1.593	0.303
8.94	11.57		0.5x(T-8.94)	1.205+0.5x(T-8.94)	2.485	2.57	1.593	0.303
11.57	---	0.5x(T-11.57)	1.3+0.5x(T-11.57)	2.505	2.485	2.57	1.593	0.303

A300		Flight level FL (feet)						
Travel time T in hours		FL270	FL290	FL310	FL330	FL350	FL370	FL390
from	to	27000	29000	31000	33000	35000	37000	39000
0	1.3				0.5x(T-0.68)	0.5x(T-0.68)		
1.3	3.68			0.5x(T-1.3)	0.307+0.5x(T-1.3)	0.307		
3.68	5.63		0.5x(T-3.68)	1.18+0.5x(T-3.68)	1.487	0.307		
5.63	---	0.5x(T-5.63)	0.975+0.5x(T-5.63)	2.155	1.487	0.307		

MD80		Flight level FL (feet)						
Travel time T in hours		FL270	FL290	FL310	FL330	FL350	FL370	FL390
from	to	27000	29000	31000	33000	35000	37000	39000
0	1.1					0.5x(T-0.8)		
1.1	1.383					0.5x(T-0.8)	0.5x(T-0.8)	
1.383	3.333				0.5x(T-1.383)	0.288+0.5x(T-1.383)	0.288	
3.333	---			0.5x(T-3.333)	0.98+0.5x(T-3.333)	1.268	0.288	

DC9		Flight level FL (feet)						
Travel time T in hours		FL270	FL290	FL310	FL330	FL350	FL370	FL390
from	to	27000	29000	31000	33000	35000	37000	39000
0	1				0.133			
1	1.68				0.5x(T-0.8)	0.5x(T-0.8)		
1.68	---			0.5x(T-1.68)	0.439+0.5x(T-1.68)	0.439		

Example (2 hour flight by DC9)
Travel time noted in the bottom row of the table (1.68 -). Because T=2, the travel time at the different altitudes is: 0.16 hours at FL310, 0.599 hours at FL330 and 0.439 hours at FL350. This leaves about 0.8 hours at ground level (taxiing, starting up to FL310 and landing from FL350) divided into 0.4 hours at the beginning and 0.4 hours at the end of the flight.

Appendix 5 Results

Page

Table 5 Location data of airports used in the calculations in this report. The geographic coordinates are in decimal degrees latitude and longitude (positive is north and east, resp., negative is south and west, resp.). Elevation of runway is in feet above sea level. Flying time is time in so-called block hours. Number of stops and/or transfers is indicated as well as the total distance along the globe via great circle paths. All distances are from Schiphol Amsterdam Airport, The Netherlands (Western Europe), AMS/EHAM at 52.3 N, 4.75 E and at 11 feet below sea level. Data are alphabetically arranged by country. 47

Table 6 Individual effective dose in μSv per flight averaged over outward and return flights (to Amsterdam) for all destination airports used in the calculations in this report. Data are given for 1988 up to and including 1997. Differences throughout the years are due to variations in the solar cycle. Data are alphabetically arranged by country. 57

Table 7 Total numbers of passengers travelling from or arriving at Amsterdam from all airports are used in the calculations in this report. Data are given for 1988 up to and including 1997. Data are taken from CBS [19] and give totals for arriving at and departing from the major, as far as dose is concerned (about 99%), destinations. Data are alphabetically arranged by country. 67

Table 8 Total numbers of passenger kilometres travelled by passengers through Amsterdam Airport as calculated in this report. Data are given for 1988 up to and including 1997. Data are alphabetically arranged by country. 77

Table 9 Collective effective dose in manSv for all passengers flying on outward and return flights (from/to Amsterdam) for all destination airports used in the calculations in this report. Data are given for 1988 up to and including 1997. Data are alphabetically arranged by country. 87

Table 5 *Location data of airports used in the calculations in this report. The geographic coordinates are in decimal degrees latitude and longitude (positive is north and east, resp., negative is south and west, resp.). Elevation of runway is in feet above sea level. Flying time is time in so-called block hours. Number of stops and/or transfers is indicated as well as the total distance along the globe via great circle paths. All distances are from Schiphol Amsterdam Airport, The Netherlands (Western Europe), AMS/EHAM at 52.3 N, 4.75 E and at 11 feet below sea level. Data are alphabetically arranged by country.*

Geographic location Name (City/Airport)	Country	Airport code IATA Code	Airport code ICAO code	Geographic coordinates LAT (decimal degrees)	Geographic coordinates LON (decimal degrees)	Elevation (ft)	Region *)	Flying Time (hh:mm)	Stops	Distance km
Buenos Aires-Ezeiza/Ministro Pistarini International	Argentina	EZE	SAEZ	-34.82	-58.52	66	SAM	14:35	1	11456
Aruba-Reina Beatrix	Aruba	AUA	TNCA	12.50	-70.00	60	CAM	9:30	0	7851
Melbourne	Australia	MEL	YMML	-37.67	144.84	434	AUS	20:30	1	16498
Sydney-Kingsford Smith	Australia	SYD	YSSY	-33.93	151.17	21	AUS	19:45	1	16752
Innsbruck	Austria	INN	LOWI	47.25	11.33	1906	CE	1:45	0	731
Salzburg-WA Mozart	Austria	SZG	LOWS	47.78	13.00	1411	CE	1:45	0	771
Wien-International/Schwechat	Austria	VIE	LOWW	48.10	16.58	600	CE	1:50	0	958
Bahrain	Bahrain	BAH	OBBI	26.27	50.63	6	WAS	6:20	0	4761
Dhaka-Zia International	Bangladesh	DAC	VGZR	23.84	90.40	26	CAS	9:00		7621
Antwerpen/Deurne	Belgium	ANR	EBAW	51.18	4.45	39	WE	0:40	0	126
Brussels	Belgium	BRU	EBBR	50.90	4.48	184	WE	0:50	0	156
Rio de Janeiro International-Galeao Antonio Carlos Jobim	Brazil	GIG	SBGL	-22.80	-43.23	30	SAM	20:59	2	14806
Sao Paulo-Guarulhos International	Brazil	GRU	SBGR	-23.42	-46.47	2459	SAM	11:45	0	9739
Plovdiv	Bulgaria	PDV	LBPD	42.07	24.85	597	EE	3:00		1881
Sofija	Bulgaria	SOF	LBSF	42.68	23.40	1742	EE	2:45		1748
Calgary-International	Canada	YYC	CYYC	51.10	-114.02	3557	NAM	11:41	1	8347
Halifax	Canada	YHZ	CYHZ	44.88	-63.51	477	NAM	6:40	0	4881
Montreal-Dorval	Canada	YUL	CYUL	45.47	-73.73	117	NAM	7:20	0	5484
Ottawa-MacDonald Cartier International	Canada	YOW	CYOW	45.32	-75.67	374	NAM	7:35	0	5612
Toronto-L.B. Pearson	Canada	YYZ	CYYZ	43.67	-79.62	569	NAM	8:00	0	5969
Vancouver-International	Canada	YVR	CYVR	49.18	-123.17	14	NAM	9:50	0	7683
Sal Oceanic/Island-Amilcar Cabral International	Cape Verde Islands	SID	GVAC	16.73	-22.93	177	CA	6:10		4624
Santiago-Arturo Merino Benitez International	Chile	SCL	SCEL	-33.38	-70.78	1554	SAM	16:05	1	12137
Beijing-Capital International	China	PEK	ZBAA	40.07	116.58	116	EAS	9:20	0	7804

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San Jose-Juan Santamaria International	Costa Rica	SJO	MROC	9.98	-84.20	3021	CAM	12:35	1	9217
Dubrovnik-Cilipi	Croatia	DBV	LDDU	42.56	18.27	527	CE	2:40	1	1489
Pula	Croatia	PUY	LDPL	44.89	13.93	276	CE	1:50	0	1060
Split	Croatia	SPU	LDSP	43.54	16.30	60	CE	2:00	0	1293
Zagreb-Pleso	Croatia	ZAG	LDZA	45.73	16.07	353	CE	1:55	0	1096
Holguin-Frank Pais	Cuba	HOG	MUHG	20.78	-76.30	360	CAM	9:55		7570
Varadero-Juan Gualberto Gomez International	Cuba	VRA	MUVR	23.03	-81.43	213	CAM	10:05	0	7724
Larnaca International	Cyprus	LCA	LCLK	34.87	33.62	8	SE	4:10	0	2982
Paphos-International	Cyprus	PFO	LCPH	34.72	32.48	41	SE	4:30	1	3087
Praha-Ruzyne	Czech Rep.	PRG	LKPR	50.10	14.25	1247	CE	1:30	0	703
Billund	Denmark	BLL	EKBI	55.73	9.15	247	WE	1:00	0	476
København-Kastrup	Denmark	CPH	EKCH	55.62	12.65	17	WE	1:25	0	632
Puerto Plata-Gregorio Luperon International	Dominican Republic	POP	MDPP	19.75	-70.57	16	CAM	9:25	0	7269
Punta Cana International	Dominican Republic	PUJ	MDPC	18.57	-68.35	40	CAM	9:20	0	7219
Santo Domingo-Las Americas International	Dominican Republic	SDQ	MDSD	18.42	-69.67	59	CAM	9:25	0	7321
Guayaquil-Simon Bolivar International	Ecuador	GYE	SEGU	-2.15	-79.88	15	SAM	12:25	1	9801
Quito-Mariscal Sucre	Ecuador	UIO	SEQU	-0.13	-78.48	9213	SAM	13:15	2	10074
Cairo-International	Egypt	CAI	HECA	30.12	31.40	382	NA	4:35	0	3277
Hurghada	Egypt	HRG	HEGN	27.18	33.78	52	NA	5:00	0	3676
Helsinki-Vantaa	Finland	HEL	EFHK	60.32	24.95	167	NE	2:30	0	1517
Tampere-Pirkkala	Finland	TMP	EFTP	61.41	23.59	390	NE	3:05	1	1659
Lyon-Satolas/Saint Exupéry	France	LYS	LFLL	45.72	5.08	820	WE	1:40	0	730
Marseille-Provence/Marignane	France	MRS	LFML	43.43	5.20	69	SE	2:10	0	983
Mulhouse-Bale (Basel)	France	MLH	LFSB	47.58	7.52	885	WE	1:20		559
Nice/Côte d'Azur	France	NCE	LFMN	43.65	7.22	13	SE	2:00	0	976
Paris-Charles de Gaulle	France	CDG	LFPG	49.00	2.53	387	WE	1:10	0	398
Paris-Orly	France	ORY	LFPO	48.72	2.35	292	WE	1:10		432

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Strassbourg-Entzheim	France	SXB	LFST	48.53	7.62	505	WE	1:25	0	464
Toulouse-Blagnac	France	TLS	LFBO	43.62	1.35	499	WE	1:55	0	995
Ohrid-Macedonia	FYROM	OHD	LWOH	41.18	20.74	2313	CE	2:45		1723
Skopje	FYROM	SKP	LWSK	41.95	21.62	781	CE	3:10		1705
Banjul-International	Gambia	BJL	GBYD	13.33	-16.65	95	CA	6:15		4718
Berlin-Tegel	Germany	TXL	EDDT	52.57	13.30	121	WE	1:15	0	578
Bremen	Germany	BRE	EDDW	53.03	8.78	14	WE	1:05	0	283
Dortmund-Wickede	Germany	DTM	EDLW	51.52	7.60	419	WE	1:00	0	213
Düsseldorf	Germany	DUS	EDDL	51.28	6.77	138	WE	0:50	0	178
Frankfurt-International	Germany	FRA	EDDF	50.02	8.55	364	WE	1:15	0	366
Hamburg	Germany	HAM	EDDH	53.62	9.98	53	WE	1:05	0	379
Hannover	Germany	HAJ	EDDV	52.45	9.68	183	WE	1:10	0	334
Köln/Bonn	Germany	CGN	EDDK	50.87	7.15	302	WE	1:00	0	229
München-International	Germany	MUC	EDDM	48.35	11.78	1486	CE	1:30	0	662
Nördlingen	Germany	-	EDNO	48.87	10.51	1600	CE	1:25		555
Nürnberg	Germany	NUE	EDDN	49.48	11.07	1045	CE	1:30	0	541
Paderborn-Lippstadt	Germany	PAD	EDLP	51.60	8.60	699	WE	0:55	0	274
Stuttgart	Germany	STR	EDDS	48.67	9.22	1267	CE	1:20	0	511
Accra-Kotoka International	Ghana	ACC	DGAA	5.60	-0.17	205	CA	6:50	0	5195
Athens	Greece	ATH	LGAT	37.88	23.72	68	SE	3:35	0	2168
Heraklion-Nikos Kazantzakis	Greece	HER	LGIR	35.33	25.17	115	SE	3:45	0	2473
Karpathos	Greece	AOK	LGKP	35.42	27.13	66	SE	3:45		2568
Kerkyra-Ioannis Kapodistrias	Greece	CFU	LGKR	39.60	19.90	6	SE	3:10		1821
Khania/Souda	Greece	CHQ	LGSA	35.52	24.13	492	SE	3:40		2404
Kos	Greece	KGS	LGKO	36.78	27.08	409	SE	3:40		2445
Mitilini	Greece	MJT	LGMT	39.06	26.60	57	SE	3:40	0	2224
Rodos-Diagoras	Greece	RHO	LGRP	36.40	28.08	17	SE	3:40	0	2533
Samos	Greece	SMI	LGSM	37.68	26.90	20	SE	3:40		2357
Thessaloniki-International Airport	Greece	SKG	LGTS	40.52	22.97	22	SE	3:00		1899
Zakinthos	Greece	ZTH	LGZA	37.75	20.87	14	SE	3:25		2038

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Guatemala City-La Aurora	Guatemala	GUA	MGGT	14.58	-90.52	4952	SAM	14:24	2	10100
Hong Kong-International Airport	Hong Kong	HKG	VHHH	22.30	113.90	29	EAS	11:15	0	9245
Budapest-Ferihegy	Hungary	BUD	LHBP	47.43	19.25	495	EE	2:05	0	1165
Keflavik Nas	Iceland	KEF	BIKF	63.98	-22.60	171	NE	3:20	0	2031
Calcutta-Netaji Subhash Chandra Bose International	India	CCU	VECC	22.65	88.43	17	CAS	9:00		7590
Delhi-Indira Gandhi International	India	DEL	VIDP	28.55	77.10	776	CAS	8:05	0	6345
Mumbai-Chhatrapati Shivaji International	India	BOM	VABB	19.08	72.87	36	CAS	8:35	0	6838
Denpasar-Bali International	Indonesia	DPS	WRRR	-8.73	115.17	14	EAS	15:30	1	12145
Jakarta-Sukarno Hatta International	Indonesia	CGK	WIII	-6.12	106.65	34	EAS	14:00	1	11358
Medan-Polonia	Indonesia	MES	WIMM	3.55	98.67	90	EAS	11:45		9928
Tehran-Mehrabad	Iran	THR	OIII	35.68	51.30	3962	WAS	5:40	0	4053
Cork	Ireland	ORK	EICK	51.84	-8.49	502	WE	1:45	0	902
Dublin	Ireland	DUB	EIDW	53.42	-6.25	242	WE	1:35	0	746
Ovda	Israel	VDA	LLOV	29.93	34.93	1492	WAS	5:00		3488
Tel Aviv-Ben Gurion	Israel	TLV	LLBG	32.00	34.87	135	WAS	4:35	0	3301
Bologna	Italy	BLQ	LIPE	44.53	11.28	122	SE	1:55	0	985
Firenze-Peretola	Italy	FLR	LIRQ	43.80	11.20	144	SE	2:10	0	1055
Milano-Linate	Italy	LIN	LIML	45.43	9.27	353	SE	1:50	0	829
Milano-Malpensa	Italy	MXP	LIMC	45.62	8.72	768	SE	1:45	0	795
Roma-Fiumicino/Leonardo da Vinci	Italy	FCO	LIRF	41.80	12.25	14	SE	2:20	0	1293
Torino	Italy	TRN	LIMF	45.20	7.65	989	SE	1:45	0	815
Treviso	Italy	TSF	LIPH	45.63	12.18	55	SE	1:45		915
Venezia-Marco Polo/Tessera	Italy	VCE	LIPZ	45.50	12.35	7	SE	1:45	0	934
Montego Bay-Sangster International	Jamaica	MBJ	MKJS	18.50	-77.90	4	CAM	12:10	1	8346
Osaka-Kansai International	Japan	KIX	RJBB	34.42	135.23	26	EAS	11:15	0	9213
Tokyo-Narita/New Tokyo International	Japan	NRT	RJAA	35.75	140.37	139	EAS	11:05	0	9290
Amman-Queen Alia	Jordan	AMM	OJAI	31.72	35.98	2395	WAS	4:50	0	3391
Alma Ata/Almaty	Kazakhstan	ALA	UAAA	43.35	77.03	2234	WAS	6:50	0	5240
Mombasa-Moi International	Kenya	MBA	HKMO	-4.03	39.58	200	CA	9:20	1	7076
Nairobi-Jomo Kenyatta	Kenya	NBO	HKJK	-1.30	36.92	5327	CA	8:20	0	6653

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Kuwait International	Kuwait	KWI	OKBK	29.22	47.97	206	WAS	6:25	0	4342
Bayrut International	Lebanon	BEY	OLBA	33.80	35.48	87	WAS	4:20	0	3183
Monrovia-Roberts International	Liberia	ROB	GLRB	6.22	-10.37	31	CA	7:00		5290
Tripoli International	Libya	TIP	HLLT	32.66	13.16	263	NA	3:35	0	2279
Luxembourg	Luxemburg	LUX	ELLX	49.62	6.20	1234	WE	1:10	0	314
Lilongwe International	Malawi	-	FWLI	-13.79	33.78	4035	SA	10:40	1	8079
Kuala Lumpur-Sultan Abdul Aziz Shah International	Malaysia	KUL	WMKK	2.73	101.70	69	CAS	12:05	0	10204
Valletta – Luqa/Malta International	Malta	MLA	LMML	35.85	14.47	300	SE	3:10	0	1976
Agadir-Al Massira	Marocco	AGA	GMAD	30.33	-9.41	250	NA	4:00		2695
Al Hoceima-Cherif El Idrissi	Marocco	AHU	GMTA	35.17	-3.83	89	NA	3:20		2016
Casablanca-Mohamed V	Marocco	CMN	GMMN	33.37	-7.58	656	NA	3:40	0	2318
Oujda-Angads	Marocco	OUD	GMFO	34.78	-1.92	1535	NA	3:20		2012
Tanger-Boukhalf/Ibn Batouta	Marocco	TNG	GMTT	35.72	-5.91	62	NA	3:20		2019
Cancun International	Mexico	CUN	MMUN	21.03	-86.87	23	CAM	10:20	0	8253
Mexico City	Mexico	MEX	MMMX	19.43	-99.07	7341	CAM	11:30	0	9175
Puerto Vallarta-Licenciado Gustavo Diaz Ordaz	Mexico	PVR	MMPR	20.67	-105.25	20	CAM	12:50	1	9834
Tivat	Montenegro	TIV	LYTV	42.40	18.73	20	CE	3:10	1	1701
Eindhoven	Netherlands	EIN	EHEH	51.45	5.37	74	WE	0:40	0	103
Enschede-Twenthe	Netherlands	ENS	EHTW	52.27	6.87	114	WE	0:45		144
Groningen-Eelde	Netherlands	GRQ	EHGG	53.12	6.57	17	WE	0:50		152
Maastricht	Netherlands	MST	EHBK	50.90	5.77	375	WE	0:40	0	170
Curaçao-Willemstad/Hato	Netherlands Antilles	CUR	TNCC	12.18	-68.95	29	CAM	9:45	0	7807
Kralendijk/Bonaire-Flamingo International	Netherlands Antilles	BON	TNCB	12.12	-68.27	20	CAM	9:30	0	7767
St. Maarten-Princess Juliana International	Netherlands Antilles	SXM	TNCM	18.03	-63.10	13	CAM	8:40	0	6909
Kano-Mallam Aminu International	Nigeria	KAN	DNKN	12.03	8.52	1565	CA	6:00	0	4475
Lagos-Murtala Muhammed	Nigeria	LOS	DNMM	6.57	3.32	135	CA	6:55	0	5070
Bergen-Flesland	Norway	BGO	ENBR	60.29	5.22	165	NE	1:45	0	886

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Oslo-Gardermoen	Norway	OSL	ENGM	60.18	11.10	681	NE	1:50	0	956
Stavanger-Sola	Norway	SVG	ENZV	58.87	5.63	29	NE	1:35	0	730
Masqat-Seeb International	Oman	MCT	OOMS	23.58	58.28	48	WAS	7:35	1	5500
Karachi International/Quaid-e-azam International	Pakistan	KHI	OPKC	24.90	67.15	100	CAS	9:30	1	6948
Rawalpindi/Islamabad-Chaklala	Pakistan	ISB	OPRN	33.61	73.11	1668	CAS	7:50		5681
Panama City-Tocumen International/Gen. Omar Torrijos Herrera	Panama	PTY	MPTO	9.07	-79.38	135	CAM	13:32	1	9391
Lima-Callao/Jorge Chavez International	Peru	LIM	SPIM	-12.02	-77.10	112	SAM	13:35	1	10678
Manila-Ninoy Aquino International Airport	Philippines	MNL	RPLL	14.50	121.02	75	EAS	15:35	1	12687
Warsawa-Okecie	Poland	WAW	EPWA	52.15	20.97	361	EE	2:00	0	1099
Faro	Portugal	FAO	LPFR	37.00	-7.95	24	SE	3:00	0	1963
Funchal	Portugal	FNC	LPFU	32.68	-16.77	192	SE	4:05	0	2774
Lisboa	Portugal	LIS	LPPT	38.77	-9.13	374	SE	2:55	0	1840
Porto	Portugal	OPO	LPPR	41.23	-8.67	228	SE	2:40	0	1589
Doha International	Qatar	DOH	OTBD	25.26	51.57	35	WAS	6:20	0	4906
Bucharest-Otopeni	Romania	OTP	LROP	44.57	26.10	314	EE	2:50	0	1779
Moskwa-Sheremetyevo	Russian Fed.	SVO	UUEE	55.97	37.40	630	WAS	3:20	0	2138
St.-Petersburg-Pulkovo	Russian Fed.	LED	ULLI	59.80	30.25	79	WAS	2:55	0	1768
Dhahran International	Saudi Arabia	DHA	OEDR	26.25	50.15	84	WAS	6:20	0	4731
Jeddah-King Abdulaziz International	Saudi Arabia	JED	OEJN	21.68	39.15	48	WAS	6:00		4481
Freetown-Lungi	Sierra Leone	FNA	GFLL	8.60	-13.18	84	CA	6:55		5108
Singapore-Changi	Singapore	SIN	WSSS	1.35	103.98	22	CAS	12:20	0	10480
Capetown	South Africa	CPT	FACT	-33.95	18.60	151	SA	13:00	1	10252
Johannesburg-International	South Africa	JNB	FAJS	-26.13	28.23	5558	SA	10:40	0	8986
Seoul-Kimpo International	South Korea	SEL	RKSS	37.55	126.78	58	EAS	10:15	0	8533
Alicante	Spain	ALC	LEAL	38.27	-0.55	142	SE	2:35	0	1608
Almeria	Spain	LEI	LEAM	36.83	-2.37	70	SE	2:50		1802
Arrecife (Lanzarote)-Canary Islands	Spain	ACE	GCRR	28.93	-13.60	47	SE	4:40	0	2996
Barcelona	Spain	BCN	LEBL	41.28	2.07	12	SE	2:15	0	1238
Gerona-Costa Brava	Spain	GRO	LEGE	41.90	2.75	468	SE	2:05		1162

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Ibiza	Spain	IBZ	LEIB	38.87	1.37	23	SE	2:20		1511
Santa Cruz (La Palma)-Canary Islands	Spain	SPC	GCLA	28.62	-17.75	104	SE	4:40		3210
Las Palmas (Gran Canaria) – Canary Islands	Spain	LPA	GCLP	27.92	-15.38	77	SE	4:45	0	3172
Madrid-Barajas	Spain	MAD	LEMD	40.47	-3.55	2000	SE	2:35	0	1455
Mahon-Menorca	Spain	MAH	LEMH	39.86	4.22	297	SE	2:20		1379
Malaga	Spain	AGP	LEMG	36.67	-4.48	52	SE	2:50	0	1877
Palma de Mallorca	Spain	PMI	LEPA	39.53	2.73	8	SE	2:20	0	1423
Puerto del Rosario (Fuerteventura)- Canary Islands	Spain	FUE	GCFV	28.45	-12.15	72	SE	4:40		2987
Reus-Tarragona	Spain	REU	LERS	41.13	1.17	234	SE	2:15		1267
Sevilla	Spain	SVQ	LEZL	37.42	-5.88	111	SE	2:55	0	1845
Santa Cruz (Tenerife)-Canary Islands	Spain	TFS	GCTS	28.03	-16.57	209	SE	4:40	0	3213
Valencia	Spain	VLC	LEVC	39.49	-0.48	226	SE	2:30	0	1475
Colombo-Katunayake/Bandaranayake International	Sri Lanka	CMB	VCBI	6.82	79.88	22	CAS	10:10	0	8372
Khartoum	Sudan	KRT	HSSS	15.59	32.55	1261	NA	6:20		4744
Paramaribo-J.A. Pengel	Suriname	PBM	SMJP	5.45	-55.18	59	CAM	9:05	0	7498
Göteborg-Landvetter	Sweden	GOT	ESGG	57.65	12.27	506	NE	1:35	0	761
Malmö/Sturup	Sweden	MMX	ESMS	55.52	13.37	236	NE	1:50	0	665
Stockholm-Arlanda	Sweden	ARN	ESSA	59.65	17.92	124	NE	2:05	0	1150
Basel	Switzerland	BSL	_003	47.58	7.52	271	CE	1:45	0	559
Bern-Belp	Switzerland	BRN	LSZB	46.90	7.48	1673	CE	1:30	0	630
Geneva-Cointrin	Switzerland	GVA	LSGG	46.23	6.10	1411	CE	1:25	0	679
Zürich	Switzerland	ZRH	LSZH	47.45	8.53	1416	CE	1:25	0	601
Damascus International	Syria	DAM	OSDI	33.40	36.52	2020	WAS	4:40	0	3279
Taipei-Chiang Kai Shek	Taiwan	TPE	RCTP	25.07	121.22	107	EAS	14:35	1	11629
Dar es Salaam	Tanzania	DAR	HTDA	-6.87	39.20	182	CA	9:30	1	7326
Kilimanjaro	Tanzania	JRO	HTKJ	-3.42	37.07	2932	CA	8:30	0	6877
Bangkok-International	Thailand	BKK	VTBD	13.90	100.60	9	EAS	11:00	0	9150
Phuket-International	Thailand	HKT	VTSP	8.10	98.30	82	EAS	11:20		9504
Lome-Tokoin	Togo	LFW	DXXX	6.17	1.25	72	CA	6:55		5123
Monastir - Habib Bourguiba International	Tunisia	MIR	DTMB	35.75	10.75	9	NA	3:05	0	1894

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Tunis-Carthage	Tunisia	TUN	DTTA	36.85	10.23	21	NA	2:45	0	1765
Ankara-Esenboga/Etimusgut	Turkey	ANK	LTAC	39.93	32.68	2622	WAS	3:50		2522
Antalya	Turkey	AYT	LTAI	36.90	30.78	177	WAS	3:50	0	2645
Istanbul-Atatürk	Turkey	IST	LTBA	40.97	28.82	158	WAS	3:30	0	2204
Izmir	Turkey	ADB	LTBJ	38.28	27.15	412	WAS	3:40	0	2320
Mugla-Dalaman	Turkey	DLM	LTBS	36.70	28.78	20	WAS	3:45	0	2547
Abu Dhabi International	UAE	AUH	OMAA	24.42	54.65	88	WAS	7:25	1	5268
Dubai-International	UAE	DXB	OMDB	25.25	55.35	34	WAS	6:40	0	5152
Aberdeen-Dyce	UK	ABZ	EGPD	57.20	-2.20	215	WE	1:45	0	701
Belfast-Aldergrove	UK	BFS	EGAA	54.65	-6.22	268	WE	2:40	1	822
Birmingham	UK	BHX	EGBB	52.45	-1.73	325	WE	1:20	0	439
Bristol-Lulsgate	UK	BRS	EGGD	51.37	-2.72	622	WE	1:40	0	522
Cambridge	UK	CBG	EGSC	52.20	0.17	50	WE	0:50	0	311
Cardiff	UK	CWL	EGFF	51.38	-3.33	220	WE	1:45	0	562
East Midlands	UK	EMA	EGNX	52.82	-1.32	305	WE	1:10	0	413
Edinburgh	UK	EDI	EGPH	55.95	-3.35	135	WE	1:35	0	663
Glasgow	UK	GLA	EGPF	55.87	-4.42	26	WE	1:55	0	714
Guernsey-Channel Island	UK	GCI	EGJB	49.44	-2.60	336	WE	2:25	1	798
Humberside/Hull	UK	HUY	EGNJ	53.57	-0.33	122	WE	1:25	0	367
Leeds Bradford	UK	LBA	EGNM	53.87	-1.65	682	WE	1:40	0	460
London-city	UK	LCY	EGLC	51.50	-0.05	17	WE	1:15	0	340
Londonderry-Eglinton	UK	LDY	EGAE	55.03	-7.15	22	WE	1:45		837
London-Gatwick	UK	LGW	EGKK	51.13	-0.18	196	WE	1:15	0	363
London-Heathrow	UK	LHR	EGLL	51.47	-0.45	80	WE	1:20	0	367
London-Luton	UK	LTN	EGGW	51.87	-0.37	526	WE	1:05	0	352
London-Stansted	UK	STN	EGSS	51.88	0.23	348	WE	1:00	0	311
Lydd/Lympne	UK	LYX	EGMD	50.96	0.94	11	WE	1:00	0	301
Manchester	UK	MAN	EGCC	53.35	-2.27	256	WE	1:20	0	484
Manston	UK	MSE	EGMH	51.34	1.33	178	WE	1:00		257
Newcastle	UK	NCL	EGNT	55.03	-1.68	266	WE	1:20	0	520

Geographic location Name (City/Airport)	Country	Airport code IATA Code	ICAO code	Geographic coordinates LAT (decimal degrees)	LON (decimal degrees)	Elevation (ft)	Region *)	Flying Time (hh:mm)	Stops	Distance km
North Weald	UK	-	EGSX	51.72	0.15	321	WE	1:10		320
Norwich	UK	NWI	EGSH	52.67	1.28	117	WE	1:10	0	238
Nottingham	UK	-	EGBN	52.92	-1.07	138	WE	1:10		397
Southampton	UK	SOU	EGHI	50.95	-1.35	44	WE	1:15	0	445
Teesside	UK	MME	EGNV	54.50	-1.42	120	WE	1:40	0	475
Kiev-Borispol	Ukraine	KBP	UKBB	50.33	30.88	427	WAS	2:55	0	1813
Montevideo	Uruguay	MVD	SUMU	-34.83	-56.02	105	SAM	13:35		11297
Atlanta GA-The WB Hartsfield Atlanta International	USA	ATL	KATL	33.63	-84.42	1026	NAM	9:40	0	7042
Baltimore MD-Washington International	USA	BWI	KBWI	39.18	-76.67	146	NAM	9:55	1	6955
Boston MA-General EL Logan International	USA	BOS	KBOS	42.35	-71.00	20	NAM	7:50	0	5529
Chicago IL-O'Hare International	USA	ORD	KORD	41.97	-87.90	668	NAM	8:40	0	6590
Denver CO-International	USA	DEN	KDEN	39.85	-104.67	5431	NAM	10:41	1	7752
Detroit MI-Metropolitan	USA	DTW	KDTW	42.20	-83.33	640	NAM	8:30	0	6302
Fort Lauderdale FL-Executive	USA	FXE	KFXE	26.18	-80.17	14	NAM	11:22	1	8100
Houston TX-George Bush Intercontinent	USA	IAH	KIAH	29.97	-95.33	97	NAM	10:10	0	8023
Los Angeles CA-International	USA	LAX	KLAX	33.93	-118.40	126	NAM	11:15	0	8927
Memphis TN-International	USA	MEM	KMEM	35.03	-89.97	341	NAM	9:35	0	7271
Miami FL-International	USA	MIA	KMIA	25.78	-80.28	8	NAM	9:50	0	7418
Minneapolis/St. Paul MN-International	USA	MSP	KMSP	44.87	-93.22	841	NAM	8:40	0	6664
New York NY-John F. Kennedy International	USA	JFK	KJFK	40.63	-73.77	13	NAM	7:50	0	5827
Newark NJ-Newark International	USA	EWR	KEWR	40.68	-74.17	18	NAM	8:15	0	5849
Oakland CA -Metropolitan International	USA	OAK	KOAK/ K2G4	37.72	-122.22	6	NAM	12:09	1	8893
Orlando International	USA	MCO	KMCO	28.42	-81.30	96	NAM	9:40	0	7267
San Francisco CA-International	USA	SFO	KSFO	37.62	-122.37	11	NAM	11:15	0	8757
Seattle-Tacoma International	USA	SEA	KSEA	47.43	-122.30	429	NAM	10:10	0	7816
Tampa FL-International	USA	TPA	KTPA	27.97	-82.52	26	NAM	11:09	1	7450
Washington DC-Dulles International	USA	IAD	KIAD	38.93	-77.45	313	NAM	8:30	0	6187
Caracas-Maiquetia/Simon Bolivar International	Venezuela	CCS	SVMI	10.60	-66.98	235	SAM	9:50	0	7812
Isla Margarita-Del Caribe International, General Santiago	Venezuela	PMV	SVMG	10.90	-63.97	74	SAM	9:55		7584

Geographic location Name (City/Airport)	Country	Airport code IATA Code	ICAO code	Geographic coordinates LAT (decimal degrees)	LON (decimal degrees)	Elevation (ft)	Region *)	Flying Time (hh:mm)	Stops	Distance km
Mariño										
Paraguana-Josefa Camejo International	Venezuela	QQZ	SVJC	11.44	-70.15	75	SAM	9:30		7952
Hochiminh/Tansonnhat International	Vietnam	SGN	VVTS	10.82	106.65	33	EAS	12:30	1	9888
Belgrade	Yugoslavia	BEG	LYBE	44.82	20.30	335	EE	2:10	0	1406
Harare-International	Zimbabwe	HRE	FVHA	-17.92	31.08	4901	SA	11:20	1	8601

*) AUS-Australia, CA-Central Africa, CAM-Central America, CAS-Central Asia, CE-Central Europe, NA-Northern Africa, NAM-Northern America, NE-Northern Europe, EAS-Eastern Asia, EE-Eastern Europe, WAS-Western Asia, WE-Western Europe, SA-Southern Africa, SAM-Southern America, SE-Southern Europe

Table 6 *Individual effective dose in μSv per flight averaged over outward and return flights (to Amsterdam) for all destination airports used in the calculations in this report. Data are given for 1988 up to and including 1997. Differences throughout the years are due to variations in the solar cycle. Data are alphabetically arranged by country.*

Geographic location		**Individual Effective Dose (μSv) per flight averaged over outward and return flight**									
Name (City/Airport)	**Country**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Buenos Aires-Ezeiza/Ministro Pistarini International	Argentina	35.5	33.9	33.7	33.8	35.1	35.8	36.1	36.3	36.4	36.5
Aruba-Reina Beatrix	Aruba	33.9	31.1	30.6	30.6	33.0	34.2	34.4	34.8	35.1	35.2
Melbourne	Australia	54.7	51.5	50.9	51.0	53.9	55.4	55.8	56.2	56.6	56.7
Sydney-Kingsford Smith	Australia	52.6	49.6	49.1	49.2	51.9	53.2	53.6	54.1	54.4	54.6
Innsbruck	Austria	5.4	4.9	4.8	4.8	5.3	5.6	5.7	5.8	5.8	5.8
Salzburg-WA Mozart	Austria	5.5	5.0	4.9	4.9	5.4	5.7	5.7	5.8	5.9	5.9
Wien-International/Schwechat	Austria	5.9	5.3	5.2	5.3	5.8	6.1	6.2	6.3	6.3	6.4
Bahrain	Bahrain	20.1	18.8	18.6	18.6	19.8	20.5	20.6	20.9	21.0	21.0
Dhaka-Zia International	Bangladesh	30.7	28.3	27.9	27.9	30.1	31.3	31.5	32.0	32.2	32.3
Antwerpen/Deurne	Belgium	1.2	1.0	1.0	1.0	1.1	1.2	1.2	1.2	1.2	1.2
Brussels	Belgium	1.3	1.2	1.2	1.2	1.3	1.4	1.4	1.4	1.4	1.4
Rio de Janeiro International-Galeao Antonio Carlos Jobim	Brazil	78.0	68.9	67.5	67.6	75.4	79.6	80.8	82.6	83.6	84.1
Sao Paulo-Guarulhos International	Brazil	28.5	27.2	27.0	27.1	28.2	28.8	29.0	29.1	29.2	29.3
Plovdiv	Bulgaria	8.9	8.2	8.0	8.1	8.8	9.1	9.2	9.4	9.4	9.5
Sofija	Bulgaria	9.1	8.3	8.2	8.2	9.0	9.3	9.4	9.6	9.7	9.7
Calgary-International	Canada	58.4	49.3	48.0	48.1	55.8	60.2	61.5	63.4	64.6	65.0
Halifax	Canada	34.5	29.4	28.7	28.7	33.0	35.4	36.0	37.0	37.6	37.9
Montreal-Dorval	Canada	38.1	32.2	31.4	31.5	36.4	39.2	40.0	41.2	41.9	42.2
Ottawa-MacDonald Cartier International	Canada	39.3	33.2	32.4	32.5	37.6	40.4	41.3	42.6	43.3	43.6
Toronto-L.B. Pearson	Canada	41.2	34.8	33.9	34.0	39.4	42.3	43.2	44.6	45.4	45.7
Vancouver-International	Canada	49.1	41.3	40.3	40.4	46.9	50.6	51.8	53.5	54.4	54.8
Sal Oceanic/Island-Amilcar Cabral International	Cape Verde Islands	18.4	17.4	17.2	17.2	18.1	18.6	18.7	18.9	19.0	19.0
Santiago-Arturo Merino Benitez International	Chile	36.9	35.3	34.9	35.0	36.5	37.2	37.4	37.6	37.8	37.9
Beijing-Capital International	China	41.9	36.5	35.7	35.8	40.5	43.1	43.8	44.9	45.6	45.8

Geographic location Name (City/Airport)	Country	Individual Effective Dose (μSv) per flight averaged over outward and return flight 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
San Jose-Juan Santamaria International	Costa Rica	51.2	45.4	44.5	44.5	49.4	51.9	52.6	53.6	54.3	54.5
Dubrovnik-Cilipi	Croatia	7.0	6.4	6.3	6.3	6.9	7.2	7.3	7.4	7.5	7.5
Pula	Croatia	5.7	5.2	5.1	5.1	5.6	5.9	5.9	6.0	6.1	6.1
Split	Croatia	6.2	5.7	5.6	5.6	6.1	6.4	6.5	6.6	6.6	6.6
Zagreb-Pleso	Croatia	6.0	5.4	5.3	5.4	5.9	6.1	6.2	6.3	6.4	6.4
Holguin-Frank Pais	Cuba	40.6	36.2	35.5	35.6	39.3	41.2	41.6	42.4	42.8	43.0
Varadero-Juan Gualberto Gomez International	Cuba	43.5	38.2	37.5	37.5	41.8	44.1	44.7	45.7	46.2	46.4
Larnaca International	Cyprus	11.4	10.6	10.5	10.5	11.2	11.6	11.7	11.8	11.9	12.0
Paphos-International	Cyprus	11.6	10.7	10.6	10.6	11.4	11.8	11.9	12.0	12.1	12.2
Praha-Ruzyne	Czech Rep.	4.6	4.1	4.0	4.0	4.5	4.7	4.8	4.9	4.9	5.0
Billund	Denmark	2.0	1.7	1.7	1.7	1.9	2.0	2.1	2.1	2.1	2.1
København-Kastrup	Denmark	4.1	3.6	3.5	3.5	3.9	4.2	4.2	4.3	4.4	4.4
Puerto Plata-Gregorio Luperon International	Dominican Republic	36.9	33.3	32.7	32.7	35.8	37.3	37.6	38.3	38.6	38.7
Punta Cana International	Dominican Republic	35.6	32.3	31.8	31.7	34.6	35.9	36.2	36.8	37.1	37.2
Santo Domingo-Las Americas International	Dominican Republic	36.1	32.7	32.2	32.1	35.0	36.5	36.8	37.3	37.7	37.8
Guayaquil-Simon Bolivar International	Ecuador	40.0	36.9	36.4	36.5	39.0	40.2	40.4	40.9	41.2	41.3
Quito-Mariscal Sucre	Ecuador	40.9	37.8	37.3	37.3	39.9	41.1	41.4	41.8	42.1	42.2
Cairo-International	Egypt	11.8	11.0	10.9	10.9	11.6	12.0	12.1	12.2	12.2	12.3
Hurghada	Egypt	12.4	11.6	11.5	11.5	12.2	12.6	12.7	12.8	12.9	12.9
Helsinki-Vantaa	Finland	10.2	8.8	8.5	8.6	9.8	10.5	10.7	10.9	11.1	11.2
Tampere-Pirkkala	Finland	11.5	9.9	9.6	9.7	11.0	11.8	12.0	12.3	12.5	12.6
Lyon-Satolas/Saint Exupéry	France	5.0	4.6	4.5	4.5	4.9	5.2	5.2	5.3	5.4	5.4
Marseille-Provence/Marignane	France	6.9	6.3	6.2	6.2	6.8	7.1	7.2	7.3	7.3	7.4
Mulhouse-Bale (Basel)	France	3.3	2.9	2.9	2.9	3.2	3.3	3.4	3.4	3.5	3.5
Nice/Côte d'Azur	France	6.3	5.7	5.6	5.6	6.1	6.4	6.5	6.6	6.6	6.7
Paris-Charles de Gaulle	France	2.6	2.3	2.3	2.3	2.5	2.7	2.7	2.7	2.8	2.8

Geographic location Name (City/Airport)	Country	Individual Effective Dose (μSv) per flight averaged over outward and return flight 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Paris-Orly	France	2.6	2.3	2.3	2.3	2.5	2.6	2.7	2.7	2.8	2.8
Strassbourg-Entzheim	France	3.7	3.4	3.3	3.3	3.6	3.8	3.9	3.9	4.0	4.0
Toulouse-Blagnac	France	5.9	5.4	5.3	5.3	5.8	6.0	6.1	6.2	6.3	6.3
Ohrid-Macedonia	FYROM	8.9	8.2	8.1	8.1	8.8	9.1	9.2	9.3	9.4	9.4
Skopje	FYROM	9.4	8.6	8.5	8.5	9.2	9.6	9.7	9.9	10.0	10.0
Banjul-International	Gambia	17.9	16.9	16.8	16.8	17.6	18.0	18.1	18.3	18.4	18.4
Berlin-Tegel	Germany	3.2	2.8	2.7	2.8	3.1	3.2	3.3	3.4	3.4	3.4
Bremen	Germany	2.4	2.1	2.1	2.1	2.3	2.5	2.5	2.6	2.6	2.6
Dortmund-Wickede	Germany	1.9	1.7	1.7	1.7	1.9	1.9	2.0	2.0	2.0	2.0
Düsseldorf	Germany	1.4	1.2	1.2	1.2	1.3	1.4	1.4	1.4	1.4	1.5
Frankfurt-International	Germany	3.1	2.8	2.7	2.7	3.0	3.1	3.2	3.3	3.3	3.3
Hamburg	Germany	2.4	2.1	2.1	2.1	2.3	2.5	2.5	2.6	2.6	2.6
Hannover	Germany	2.7	2.4	2.3	2.3	2.6	2.7	2.8	2.8	2.9	2.9
Köln/Bonn	Germany	1.9	1.7	1.7	1.7	1.8	1.9	2.0	2.0	2.0	2.0
München-International	Germany	4.5	4.1	4.0	4.0	4.4	4.6	4.7	4.8	4.8	4.8
Nördlingen	Germany	3.8	3.4	3.3	3.3	3.7	3.9	3.9	4.0	4.0	4.0
Nürnberg	Germany	4.6	4.1	4.0	4.0	4.5	4.7	4.8	4.8	4.9	4.9
Paderborn-Lippstadt	Germany	1.5	1.3	1.3	1.3	1.4	1.5	1.5	1.6	1.6	1.6
Stuttgart	Germany	3.3	3.0	2.9	2.9	3.2	3.4	3.4	3.5	3.5	3.5
Accra-Kotoka International	Ghana	18.9	18.0	17.8	17.9	18.7	19.1	19.2	19.3	19.4	19.4
Athens	Greece	10.4	9.5	9.4	9.4	10.2	10.6	10.7	10.8	10.9	10.9
Heraklion-Nikos Kazantzakis	Greece	10.3	9.6	9.4	9.5	10.1	10.5	10.6	10.8	10.8	10.9
Karpathos	Greece	10.3	9.6	9.5	9.5	10.2	10.5	10.6	10.8	10.8	10.9
Kerkyra-Ioannis Kapodistrias	Greece	9.2	8.4	8.3	8.3	9.0	9.3	9.4	9.6	9.6	9.7
Khania/Souda	Greece	10.2	9.5	9.4	9.4	10.0	10.4	10.5	10.6	10.7	10.8
Kos	Greece	10.4	9.6	9.5	9.5	10.2	10.6	10.7	10.8	10.9	10.9
Mitilini	Greece	10.7	9.9	9.7	9.7	10.5	10.9	11.0	11.2	11.2	11.3
Rodos-Diagoras	Greece	10.3	9.6	9.4	9.5	10.2	10.5	10.6	10.8	10.9	10.9

Geographic location Name (City/Airport)	Country	Individual Effective Dose (μSv) per flight averaged over outward and return flight 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Samos	Greece	10.5	9.7	9.6	9.6	10.4	10.7	10.9	11.0	11.1	11.1
Thessaloniki-International Airport	Greece	8.7	8.0	7.9	7.9	8.6	8.9	9.0	9.1	9.2	9.2
Zakinthos	Greece	9.8	9.0	8.9	8.9	9.6	9.9	10.0	10.2	10.2	10.3
Guatemala City-La Aurora	Guatemala	62.8	54.2	53.0	53.1	60.4	64.4	65.6	67.5	68.5	68.8
Hong Kong-International Airport	Hong Kong	39.6	35.8	35.2	35.3	38.7	40.5	41.0	41.7	42.2	42.3
Budapest-Ferihegy	Hungary	6.9	6.2	6.1	6.1	6.7	7.1	7.2	7.3	7.4	7.4
Keflavik Nas	Iceland	12.9	11.0	10.7	10.8	12.4	13.3	13.5	13.9	14.1	14.2
Calcutta-Netaji Subhash Chandra Bose International	India	30.2	27.8	27.5	27.5	29.6	30.6	31.0	31.3	31.6	31.7
Delhi-Indira Gandhi International	India	28.5	26.3	25.9	26.0	28.0	29.0	29.3	29.7	29.9	30.0
Mumbai-Chhatrapati Shivaji International	India	26.6	24.9	24.6	24.7	26.3	27.1	27.2	27.5	27.7	27.8
Denpasar-Bali International	Indonesia	39.1	36.8	36.4	36.5	38.5	39.5	39.8	40.2	40.5	40.6
Jakarta-Sukarno Hatta International	Indonesia	35.5	33.3	33.0	33.1	35.0	36.0	36.3	36.7	36.9	37.0
Medan-Polonia	Indonesia	31.8	29.7	29.4	29.4	31.3	32.2	32.4	32.8	33.0	33.0
Tehran-Mehrabad	Iran	20.6	19.0	18.7	18.8	20.2	20.9	21.1	21.4	21.6	21.7
Cork	Ireland	5.9	5.2	5.1	5.1	5.7	6.0	6.1	6.2	6.3	6.3
Dublin	Ireland	5.2	4.6	4.5	4.5	5.0	5.3	5.4	5.5	5.6	5.6
Ovda	Israel	12.8	12.0	11.8	11.9	12.6	13.0	13.1	13.3	13.3	13.4
Tel Aviv-Ben Gurion	Israel	12.0	11.2	11.1	11.1	11.8	12.2	12.3	12.5	12.6	12.6
Bologna	Italy	5.9	5.4	5.3	5.3	5.8	6.1	6.1	6.2	6.3	6.3
Firenze-Peretola	Italy	7.0	6.3	6.2	6.3	6.8	7.1	7.2	7.3	7.4	7.4
Milano-Linate	Italy	5.7	5.2	5.1	5.1	5.6	5.9	6.0	6.1	6.1	6.1
Milano-Malpensa	Italy	5.3	4.8	4.7	4.8	5.2	5.5	5.5	5.6	5.7	5.7
Roma-Fiumicino/Leonardo da Vinci	Italy	7.4	6.8	6.7	6.7	7.3	7.6	7.7	7.8	7.8	7.9
Torino	Italy	5.3	4.8	4.7	4.7	5.2	5.4	5.5	5.6	5.6	5.6
Treviso	Italy	5.3	4.8	4.7	4.7	5.2	5.4	5.5	5.6	5.7	5.7
Venezia-Marco Polo/Tessera	Italy	5.3	4.8	4.7	4.7	5.2	5.4	5.5	5.6	5.7	5.7
Montego Bay-Sangster International	Jamaica	49.0	43.5	42.7	42.7	47.4	49.8	50.4	51.4	52.0	52.1
Osaka-Kansai International	Japan	47.8	41.5	40.5	40.6	46.0	49.0	49.9	51.2	52.0	52.2

Geographic location Name (City/Airport)	Country	Individual Effective Dose (μSv) per flight averaged over outward and return flight 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Tokyo-Narita/New Tokyo International	Japan	47.7	41.3	40.3	40.4	45.9	49.0	49.9	51.3	52.0	52.3
Amman-Queen Alia	Jordan	12.6	11.8	11.6	11.7	12.4	12.8	12.9	13.1	13.2	13.2
Alma Ata/Almaty	Kazakhstan	30.1	26.9	26.4	26.4	29.3	30.8	31.2	31.7	32.1	32.2
Mombasa-Moi International	Kenya	22.5	21.5	21.3	21.3	22.2	22.7	22.8	23.0	23.1	23.1
Nairobi-Jomo Kenyatta	Kenya	21.5	20.6	20.4	20.4	21.3	21.7	21.9	22.1	22.1	22.2
Kuwait International	Kuwait	21.0	19.6	19.4	19.4	20.8	21.4	21.6	21.9	22.0	22.0
Bayrut International	Lebanon	11.7	10.8	10.7	10.7	11.5	11.9	12.0	12.1	12.2	12.2
Monrovia-Roberts International	Liberia	19.7	18.7	18.5	18.5	19.4	19.8	19.9	20.1	20.2	20.2
Tripoli International	Libya	9.6	9.0	8.8	8.9	9.5	9.7	9.8	10.0	10.0	10.0
Luxembourg	Luxemburg	2.6	2.3	2.3	2.3	2.6	2.7	2.7	2.8	2.8	2.8
Lilongwe International	Malawi	25.5	24.4	24.2	24.2	25.2	25.7	25.9	26.1	26.2	26.2
Kuala Lumpur-Sultan Abdul Aziz Shah International	Malaysia	32.6	30.5	30.1	30.2	32.1	33.0	33.3	33.6	33.9	34.0
Valletta – Luqa/Malta International	Malta	8.7	8.1	8.0	8.0	8.5	8.8	8.9	9.0	9.1	9.1
Agadir-Al Massira	Marocco	10.5	9.8	9.7	9.7	10.3	10.7	10.8	10.9	11.0	11.0
Al Hoceima-Cherif El Idrissi	Marocco	9.2	8.6	8.5	8.5	9.1	9.4	9.5	9.6	9.7	9.7
Casablanca-Mohamed V	Marocco	10.1	9.4	9.3	9.3	9.9	10.3	10.4	10.5	10.6	10.6
Oujda-Angads	Marocco	9.2	8.5	8.4	8.4	9.0	9.3	9.4	9.5	9.6	9.6
Tanger-Boukhalf/Ibn Batouta	Marocco	9.3	8.6	8.5	8.5	9.2	9.5	9.6	9.7	9.8	9.8
Cancun International	Mexico	44.6	39.1	38.3	38.3	42.9	45.4	46.0	47.0	47.6	47.8
Mexico City	Mexico	49.5	43.0	42.0	42.1	47.6	50.6	51.4	52.7	53.5	53.7
Puerto Vallarta-Licenciado Gustavo Diaz Ordaz	Mexico	51.7	45.1	44.1	44.2	49.8	52.8	53.7	55.0	55.8	56.0
Tivat	Montenegro	8.5	7.8	7.7	7.7	8.3	8.7	8.8	8.9	9.0	9.0
Eindhoven	Netherlands	1.2	1.0	1.0	1.0	1.1	1.2	1.2	1.2	1.2	1.2
Enschede-Twenthe	Netherlands	1.3	1.1	1.1	1.1	1.2	1.3	1.3	1.4	1.4	1.4
Groningen-Eelde	Netherlands	1.4	1.2	1.2	1.2	1.3	1.4	1.4	1.5	1.5	1.5
Maastricht	Netherlands	1.2	1.0	1.0	1.0	1.1	1.2	1.2	1.2	1.2	1.2
Curaçao-Willemstad/Hato	Netherlands Antilles	34.2	31.3	30.9	30.9	33.2	34.4	34.6	35.1	35.4	35.4
Kralendijk/Bonaire-Flamingo International	Netherlands	33.4	30.6	30.1	30.1	32.4	33.5	33.8	34.2	34.4	34.5

Geographic location Name (City/Airport)	Country	Individual Effective Dose (μSv) per flight averaged over outward and return flight 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
St. Maarten-Princess Juliana International	Antilles Netherlands Antilles	32.2	29.4	28.9	28.9	31.2	32.3	32.6	33.0	33.3	33.4
Kano-Mallam Aminu International	Nigeria	16.5	15.7	15.6	15.6	16.3	16.7	16.9	17.0	17.1	17.1
Lagos-Murtala Muhammed	Nigeria	19.2	18.2	18.1	18.1	18.9	19.4	19.5	19.6	19.7	19.7
Bergen-Flesland	Norway	6.3	5.4	5.3	5.3	6.1	6.5	6.6	6.8	6.9	6.9
Oslo-Gardermoen	Norway	6.8	5.9	5.7	5.7	6.5	7.0	7.1	7.3	7.4	7.4
Stavanger-Sola	Norway	5.4	4.7	4.6	4.6	5.2	5.6	5.7	5.8	5.9	5.9
Masqat-Seeb International	Oman	23.2	21.7	21.4	21.4	22.9	23.5	23.7	24.0	24.1	24.2
Karachi International/Quaid-e-azam International	Pakistan	31.4	29.1	28.7	28.7	30.9	32.0	32.3	32.7	32.9	33.0
Rawalpindi/Islamabad-Chaklala	Pakistan	29.3	26.8	26.4	26.5	28.7	29.8	30.1	30.5	30.8	30.9
Panama City-Tocumen International/Gen. Omar Torrijos Herrera	Panama	59.7	52.2	51.0	51.1	57.4	60.9	61.9	63.3	64.1	64.4
Lima-Callao/Jorge Chavez International	Peru	43.1	39.9	39.4	39.4	42.1	43.3	43.6	44.1	44.5	44.6
Manila-Ninoy Aquino International Airport	Philippines	38.9	36.7	36.3	36.4	38.4	39.4	39.7	40.0	40.3	40.4
Warsawa-Okecie	Poland	7.0	6.2	6.1	6.1	6.8	7.2	7.3	7.4	7.5	7.5
Faro	Portugal	8.3	7.7	7.6	7.6	8.2	8.4	8.5	8.6	8.7	8.7
Funchal	Portugal	11.3	10.4	10.3	10.3	11.0	11.4	11.5	11.7	11.7	11.8
Lisboa	Portugal	9.5	8.7	8.6	8.6	9.3	9.7	9.8	9.9	10.0	10.0
Porto	Portugal	8.9	8.1	8.0	8.0	8.7	9.1	9.2	9.3	9.4	9.4
Doha International	Qatar	19.9	18.6	18.4	18.5	19.7	20.2	20.4	20.6	20.8	20.8
Bucharest-Otopeni	Romania	9.8	8.9	8.8	8.8	9.6	10.1	10.2	10.4	10.4	10.5
Moskwa-Sheremetyevo	Russian Fed.	12.1	10.6	10.3	10.4	11.7	12.4	12.6	12.9	13.0	13.1
St.-Petersburg-Pulkovo	Russian Fed.	12.1	10.5	10.2	10.3	11.7	12.4	12.7	13.0	13.2	13.2
Dhahran International	Saudi Arabia	20.1	18.8	18.6	18.6	19.8	20.4	20.6	20.8	21.0	21.0
Jeddah-King Abdulaziz International	Saudi Arabia	18.0	17.0	16.8	16.8	17.8	18.3	18.4	18.6	18.7	18.7
Freetown-Lungi	Sierra Leone	19.8	18.8	18.6	18.6	19.5	20.0	20.1	20.3	20.4	20.4
Singapore-Changi	Singapore	32.9	30.8	30.4	30.5	32.4	33.4	33.7	34.0	34.3	34.4
Capetown	South Africa	32.7	31.3	31.0	31.0	32.4	33.0	33.2	33.4	33.6	33.6

Geographic location Name (City/Airport)	Country	Individual Effective Dose (μSv) per flight averaged over outward and return flight 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Johannesburg-International	South Africa	25.6	24.6	24.4	24.4	25.4	25.9	26.0	26.2	26.3	26.3
Seoul-Kimpo International	South Korea	44.9	39.0	38.1	38.2	43.3	46.1	46.9	48.1	48.9	49.1
Alicante	Spain	8.0	7.4	7.3	7.3	7.8	8.1	8.2	8.3	8.4	8.4
Almeria	Spain	8.9	8.2	8.1	8.1	8.7	9.0	9.1	9.2	9.3	9.3
Arrecife (Lanzarote)-Canary Islands	Spain	12.1	11.3	11.2	11.2	11.9	12.3	12.4	12.5	12.6	12.6
Barcelona	Spain	7.0	6.4	6.3	6.3	6.9	7.1	7.2	7.3	7.4	7.4
Gerona-Costa Brava	Spain	6.4	5.8	5.7	5.8	6.3	6.5	6.6	6.7	6.7	6.8
Ibiza	Spain	7.1	6.6	6.5	6.5	7.0	7.3	7.3	7.4	7.5	7.5
Santa Cruz (La Palma)-Canary Islands	Spain	12.1	11.3	11.2	11.2	11.9	12.3	12.4	12.5	12.6	12.6
Las Palmas (Gran Canaria)- Canary Islands	Spain	12.2	11.4	11.3	11.3	12.0	12.4	12.5	12.6	12.7	12.7
Madrid-Barajas	Spain	8.3	7.6	7.5	7.5	8.1	8.5	8.6	8.7	8.8	8.8
Mahon-Menorca	Spain	7.2	6.6	6.5	6.6	7.1	7.4	7.4	7.5	7.6	7.6
Malaga	Spain	8.9	8.2	8.1	8.1	8.7	9.0	9.1	9.2	9.3	9.3
Palma de Mallorca	Spain	7.2	6.6	6.5	6.5	7.1	7.3	7.4	7.5	7.6	7.6
Puerto del Rosario (Fuerteventura)- Canary Islands	Spain	12.0	11.2	11.1	11.1	11.8	12.2	12.3	12.4	12.5	12.5
Reus-Tarragona	Spain	7.0	6.4	6.3	6.3	6.9	7.1	7.2	7.3	7.4	7.4
Sevilla	Spain	9.2	8.5	8.4	8.4	9.0	9.3	9.4	9.6	9.6	9.7
Santa Cruz (Tenerife)- Canary Islands	Spain	12.0	11.2	11.1	11.1	11.8	12.2	12.3	12.4	12.5	12.5
Valencia	Spain	7.9	7.2	7.1	7.2	7.7	8.0	8.1	8.2	8.3	8.3
Colombo-Katunayake/Bandaranayake International	Sri Lanka	27.8	26.2	25.9	26.0	27.5	28.2	28.4	28.7	28.8	28.9
Khartoum	Sudan	17.8	16.8	16.7	16.7	17.6	18.0	18.1	18.3	18.4	18.4
Paramaribo-J.A. Pengel	Suriname	27.7	25.9	25.6	25.6	27.1	27.8	28.0	28.3	28.4	28.5
Göteborg-Landvetter	Sweden	5.3	4.6	4.5	4.6	5.2	5.5	5.6	5.7	5.8	5.8
Malmö/Sturup	Sweden	6.5	5.7	5.6	5.6	6.3	6.7	6.8	6.9	7.0	7.0
Stockholm-Arlanda	Sweden	7.9	6.8	6.7	6.7	7.6	8.1	8.3	8.5	8.6	8.7
Basel	Switzerland	5.5	4.9	4.8	4.9	5.4	5.6	5.7	5.8	5.8	5.9
Bern-Belp	Switzerland	4.4	4.0	3.9	3.9	4.3	4.5	4.6	4.7	4.7	4.7
Geneva-Cointrin	Switzerland	3.6	3.3	3.2	3.2	3.6	3.7	3.8	3.8	3.9	3.9

Geographic location Name (City/Airport)	Country	Individual Effective Dose (μSv) per flight averaged over outward and return flight 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Zürich	Switzerland	3.7	3.3	3.3	3.3	3.6	3.8	3.8	3.9	4.0	4.0
Damascus International	Syria	12.5	11.7	11.5	11.5	12.3	12.7	12.8	13.0	13.1	13.1
Taipei-Chiang Kai Shek	Taiwan	40.2	37.6	37.2	37.2	39.6	40.8	41.1	41.6	41.9	41.9
Dar es Salaam	Tanzania	22.9	21.9	21.7	21.7	22.7	23.2	23.3	23.4	23.5	23.5
Kilimanjaro	Tanzania	21.7	20.7	20.6	20.6	21.5	22.0	22.1	22.2	22.3	22.3
Bangkok-International	Thailand	33.5	31.0	30.6	30.6	32.9	34.0	34.3	34.8	35.0	35.1
Phuket-International	Thailand	32.2	30.0	29.7	29.7	31.6	32.6	32.9	33.3	33.5	33.6
Lome-Tokoin	Togo	19.2	18.2	18.1	18.1	18.9	19.4	19.5	19.6	19.7	19.7
Monastir - Habib Bourguiba International	Tunisia	8.5	7.9	7.8	7.8	8.3	8.6	8.7	8.8	8.9	8.9
Tunis-Carthage	Tunisia	8.4	7.8	7.7	7.7	8.2	8.5	8.6	8.7	8.8	8.8
Ankara-Esenboga/Etimusgut	Turkey	11.3	10.4	10.2	10.3	11.1	11.5	11.7	11.8	11.9	11.9
Antalya	Turkey	10.8	10.0	9.8	9.9	10.6	11.0	11.0	11.2	11.3	11.3
Istanbul-Atatürk	Turkey	10.5	9.6	9.5	9.5	10.3	10.7	10.8	11.0	11.1	11.1
Izmir	Turkey	10.6	9.8	9.7	9.7	10.5	10.8	10.9	11.1	11.1	11.2
Mugla-Dalaman	Turkey	10.5	9.7	9.6	9.6	10.4	10.7	10.8	10.9	11.0	11.0
Abu Dhabi International	UAE	22.8	21.3	21.1	21.1	22.5	23.1	23.3	23.6	23.7	23.8
Dubai-International	UAE	22.2	20.7	20.5	20.5	21.9	22.5	22.7	23.0	23.1	23.2
Aberdeen-Dyce	UK	6.2	5.4	5.2	5.3	6.0	6.3	6.5	6.6	6.7	6.7
Belfast-Aldergrove	UK	7.1	6.2	6.1	6.1	6.9	7.3	7.4	7.5	7.6	7.7
Birmingham	UK	3.5	3.1	3.0	3.0	3.4	3.5	3.6	3.7	3.7	3.7
Bristol-Lulsgate	UK	5.5	4.9	4.8	4.8	5.4	5.7	5.7	5.9	5.9	6.0
Cambridge	UK	1.4	1.2	1.2	1.2	1.3	1.4	1.4	1.4	1.5	1.5
Cardiff	UK	5.8	5.2	5.1	5.1	5.7	6.0	6.1	6.2	6.3	6.3
East Midlands	UK	2.7	2.4	2.4	2.4	2.7	2.8	2.8	2.9	2.9	3.0
Edinburgh	UK	5.3	4.6	4.5	4.5	5.1	5.5	5.5	5.7	5.8	5.8
Glasgow	UK	7.0	6.1	5.9	5.9	6.7	7.2	7.3	7.5	7.6	7.6
Guernsey-Channel Island	UK	5.9	5.2	5.1	5.1	5.7	6.0	6.1	6.2	6.3	6.3
Humberside/Hull	UK	4.0	3.5	3.5	3.5	3.9	4.1	4.2	4.3	4.3	4.3

Geographic location Name (City/Airport)	Country	Individual Effective Dose (μSv) per flight averaged over outward and return flight 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Leeds Bradford	UK	5.7	5.0	4.9	4.9	5.5	5.8	5.9	6.0	6.1	6.1
London-city	UK	3.2	2.8	2.7	2.7	3.1	3.2	3.3	3.3	3.4	3.4
Londonderry-Eglinton	UK	6.1	5.3	5.2	5.2	5.9	6.3	6.4	6.5	6.6	6.6
London-Gatwick	UK	3.2	2.8	2.7	2.7	3.1	3.2	3.3	3.3	3.4	3.4
London-Heathrow	UK	3.5	3.1	3.0	3.0	3.4	3.5	3.6	3.7	3.7	3.7
London-Luton	UK	2.4	2.1	2.1	2.1	2.3	2.4	2.5	2.5	2.6	2.6
London-Stansted	UK	1.9	1.7	1.7	1.7	1.9	2.0	2.0	2.0	2.0	2.1
Lydd/Lympne	UK	1.9	1.7	1.7	1.7	1.8	1.9	2.0	2.0	2.0	2.0
Manchester	UK	3.5	3.1	3.1	3.1	3.4	3.6	3.7	3.8	3.8	3.8
Manston	UK	1.9	1.7	1.7	1.7	1.9	2.0	2.0	2.0	2.0	2.1
Newcastle	UK	3.6	3.2	3.1	3.1	3.5	3.7	3.8	3.8	3.9	3.9
North Weald	UK	2.7	2.4	2.3	2.3	2.6	2.8	2.8	2.8	2.9	2.9
Norwich	UK	2.7	2.4	2.4	2.4	2.6	2.8	2.8	2.9	2.9	2.9
Nottingham	UK	2.7	2.4	2.4	2.4	2.7	2.8	2.9	2.9	3.0	3.0
Southampton	UK	3.1	2.8	2.7	2.7	3.0	3.2	3.2	3.3	3.3	3.4
Teesside	UK	5.7	5.0	4.9	4.9	5.5	5.9	6.0	6.1	6.2	6.2
Kiev-Borispol	Ukraine	10.9	9.7	9.5	9.6	10.6	11.1	11.3	11.5	11.6	11.7
Montevideo	Uruguay	31.5	30.1	29.9	29.9	31.2	31.8	32.0	32.2	32.3	32.4
Atlanta GA-The WB Hartsfield Atlanta International	USA	46.4	39.7	38.7	38.8	44.4	47.5	48.4	49.7	50.5	50.8
Baltimore MD-Washington International	USA	48.4	41.0	39.9	40.1	46.3	49.8	50.8	52.3	53.2	53.5
Boston MA-General EL Logan International	USA	39.7	33.9	33.0	33.1	38.0	40.8	41.6	42.8	43.5	43.7
Chicago IL-O'Hare International	USA	44.2	37.3	36.4	36.5	42.2	45.5	46.5	47.9	48.8	49.1
Denver CO-International	USA	52.0	44.0	42.9	43.0	49.7	53.5	54.6	56.3	57.3	57.7
Detroit MI-Metropolitan	USA	43.4	36.7	35.7	35.8	41.5	44.7	45.6	47.0	47.8	48.1
Fort Lauderdale FL-Executive	USA	53.6	45.9	44.7	44.9	51.4	55.1	56.1	57.8	58.7	59.0
Houston TX-George Bush Intercontinent	USA	48.0	41.1	40.1	40.2	46.0	49.3	50.2	51.7	52.5	52.8
Los Angeles CA-International	USA	52.6	44.8	43.6	43.8	50.4	54.2	55.3	57.0	58.0	58.3
Memphis TN-International	USA	46.8	39.9	38.9	39.0	44.8	48.1	49.1	50.5	51.4	51.7

Geographic location Name (City/Airport)	Country	Individual Effective Dose (μSv) per flight averaged over outward and return flight 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Miami FL-International	USA	43.6	38.2	37.3	37.3	41.9	44.3	45.0	45.9	46.5	46.7
Minneapolis/St. Paul MN-International	USA	44.5	37.5	36.5	36.6	42.5	45.8	46.8	48.3	49.2	49.5
New York NY-John F. Kennedy International	USA	39.6	33.8	33.0	33.0	38.0	40.7	41.5	42.6	43.3	43.6
Newark NJ-Newark International	USA	41.5	35.4	34.5	34.6	39.7	42.6	43.4	44.6	45.4	45.6
Oakland CA -Metropolitan International	USA	56.9	48.2	47.0	47.1	54.4	58.6	59.9	61.7	62.8	63.1
Orlando International	USA	44.3	38.5	37.6	37.6	42.6	45.2	45.9	47.0	47.6	47.9
San Francisco CA-International	USA	53.3	45.1	44.0	44.1	51.0	54.9	56.0	57.8	58.8	59.2
Seattle-Tacoma International	USA	50.3	42.4	41.3	41.4	48.0	51.8	53.0	54.7	55.7	56.1
Tampa FL-International	USA	52.0	44.7	43.7	43.8	49.8	53.2	54.1	55.5	56.4	56.7
Washington DC-Dulles International	USA	42.6	36.3	35.4	35.5	40.7	43.7	44.5	45.8	46.5	46.8
Caracas-Maiquetia/Simon Bolivar International	Venezuela	33.3	30.7	30.2	30.2	32.4	33.4	33.7	34.1	34.3	34.4
Isla Margarita-Del Caribe International, General Santiago Mariño	Venezuela	32.9	30.4	30.0	30.0	32.1	33.1	33.3	33.7	33.9	34.0
Paraguana-Josefa Camejo International	Venezuela	33.7	30.9	30.4	30.4	32.7	33.9	34.1	34.6	34.8	34.9
Hochiminh/Tansonnhat International	Vietnam	35.4	32.9	32.5	32.5	34.8	35.9	36.3	36.7	37.0	37.0
Belgrade	Yugoslavia	7.0	6.4	6.3	6.3	6.9	7.2	7.3	7.4	7.5	7.5
Harare-International	Zimbabwe	27.2	26.1	25.8	25.8	26.9	27.4	27.6	27.8	27.9	27.9

Table 7 *Total numbers of passengers travelling from or arriving at Amsterdam from all airports are used in the calculations in this report. Data are given for 1988 up to and including 1997. Data are taken from CBS [19] and give totals for arriving at and departing from the major, as far as dose is concerned (about 99%), destinations. Data are alphabetically arranged by country.*

Geographic location		**Passengers in/out**									
Name (City/Airport)	**Country**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Buenos Aires-Ezeiza/Ministro Pistarini International	Argentina	13514	13775	12353	16408	24279	29443	46002	42124	43166	51882
Aruba-Reina Beatrix	Aruba	2094	5664	2696	12560	81682	79116	75314	73923	87668	87728
Melbourne	Australia	2604	9394	5742		23058	27525				
Sydney-Kingsford Smith	Australia	46878	37900	38698	33189	28528	37842	67496	84635	93032	97868
Innsbruck	Austria			6345	11832	9547	19308	19002	16864	25574	26648
Salzburg-WA Mozart	Austria					6145	10028	23263	38740	40340	45456
Wien-International/Schwechat	Austria	106954	109306	139693	159087	197842	263742	270015	306313	309603	353087
Bahrain	Bahrain	16284	3541	5615	537	19261	31534	43288	43765	55903	61778
Dhaka-Zia International	Bangladesh	14046	10567	9067	11885	6863	5097	10003	33475	32720	
Antwerpen/Deurne	Belgium	35809	31865	27586	31424	37356	43444	53136	51826	58544	62132
Brussels	Belgium	128951	143870	145256	167349	175320	219303	254230	248968	251241	289149
Rio de Janeiro International-Galeao Antonio Carlos Jobim	Brazil	11258	13283	13974	12422	29589	27481	30926	33162	42081	45096
Sao Paulo-Guarulhos International	Brazil					23662	27275	34372	40749	46600	59131
Plovdiv	Bulgaria		3032	5886	9860	10228	13891	12953	11413	9168	7060
Sofija	Bulgaria	10079	11125	12750	13623	16080	16701	15915	20881	22724	19359
Calgary-International	Canada					36678	40278	47376	51788	69445	20711
Halifax	Canada	10194	9913		4502	24324	31716	37645	40016	15626	6856
Montreal-Dorval	Canada	158086	150037	155540	149568	164020	181963	171225	176885	188189	217088
Ottawa-MacDonald Cartier International	Canada		29662	47067	45307	23982	34073	31577	30532	6778	
Toronto-L.B. Pearson	Canada	395974	362841	367240	298941	290085	289044	310196	360718	357103	369746
Vancouver-International	Canada	214678	203642	117669	125475	101660	92162	105904	101760	118424	170349
Sal Oceanic/Island-Amilcar Cabral International	Cape Verde Islands		4162	7404	5208	15182	12403	14354	14718	10275	9734
Santiago-Arturo Merino Benitez International	Chile	66926	65450	63140	64062	18069	21874	26421	26710	36534	37761

Geographic location Name (City/Airport)	Country	Passengers in/out 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Beijing-Capital International	China								88	25506	64731
San Jose-Juan Santamaria International	Costa Rica	43656	45026	44623	42731	18659	21490	25153	33165	44394	53829
Dubrovnik-Cilipi	Croatia	19496	16494	17172							
Pula	Croatia	15026	13953	15009							4245
Split	Croatia	17567	15434	14230				4724		4577	4544
Zagreb-Pleso	Croatia						14456	25633	26125	29582	26688
Holguin-Frank Pais	Cuba					15906	18660	21702	16564	21065	11779
Varadero-Juan Gualberto Gomez International	Cuba						11098	12360	10933	13854	16122
Larnaca International	Cyprus	40662	47492	45019	63624	66509	67568	58652	71340	72859	73924
Paphos-International	Cyprus	11107	23714	22346	10992	30529	23388	35278	41749	39028	32362
Praha-Ruzyne	Czech Rep.	15625	19546	30429	48552	73251	111323	129192	145450	193710	200074
Billund	Denmark				8270	14601	40184	53543	69875	95580	122667
København-Kastrup	Denmark	260225	278283	289842	273686	300447	311254	337116	360119	376614	401768
Puerto Plata-Gregorio Luperon International	Dominican Republic				49251	53782			81215	87491	
Punta Cana International	Dominican Republic		4749	44650			75880	74504			76926
Santo Domingo-Las Americas International	Dominican Republic					13014	22346	23995	22321	21405	14005
Guayaquil-Simon Bolivar International	Ecuador			19421	18849	5975	8148	10236	13066	16468	20880
Quito-Mariscal Sucre	Ecuador	9105	21626			13532	23080	25859	30883	34756	58980
Cairo-International	Egypt	133992	114608	93203	74572	147081	97628	95357	112366	139819	170945
Hurghada	Egypt								6089	38997	53899
Helsinki-Vantaa	Finland	151206	165931	164891	150177	115687	124300	144625	156067	171258	207757
Tampere-Pirkkala	Finland	20429	18696	3995							
Lyon-Satolas/Saint Exupéry	France	18325	30000	38762	46091	51821	69494	68460	76853	90987	126569
Marseille-Provence/Marignane	France	17604		5019	11882	21029	33695	47911	58392	43345	29811
Mulhouse-Bale (Basel)	France			10587	18341	30770	36413	36300	42799	55824	68448
Nice/Côte d'Azur	France	78773	82731	96018	101952	123956	133287	114793	123068	116694	201319

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Paris-Charles de Gaulle	France	547450	603137	622155	592623	666090	707896	772004	738554	731742	816244
Paris-Orly	France								50212	75746	77959
Strassbourg-Entzheim	France	10252	14537	18260	19681	10357	26001	31093	32755	32264	33348
Toulouse-Blagnac	France	3796		4669	8786	16591	27493	40143	51548	64242	86158
Ohrid-Macedonia	FYROM	13611	12400	10894							
Skopje	FYROM						10189	14367	16622	13921	7634
Banjul-International	Gambia								30589	27981	20781
Berlin-Tegel	Germany	72320	76092	69900	74056	117806	157084	178740	190518	204329	243687
Bremen	Germany	49623	57762	56556	62256	74753	85767	102392	109676	105972	113584
Dortmund-Wickede	Germany									40295	39226
Düsseldorf	Germany	85789	90528	87764	106962	105011	129320	135578	154214	122031	159778
Frankfurt-International	Germany	361342	379361	399579	380540	390969	431755	398651	430986	438339	469297
Hamburg	Germany	127784	149432	143148	160153	164977	203229	229609	246633	240609	249484
Hannover	Germany	33560	36140	38439	56419	62418	77520	88235	92264	98648	117932
Köln/Bonn	Germany	2247								17844	69256
München-International	Germany	178225	184222	199879	211966	214691	251820	257166	287445	286436	320921
Nördlingen	Germany								14406		
Nürnberg	Germany	15912	16048	19345	32332	41519	54292	55467	46487	71667	90864
Paderborn-Lippstadt	Germany									10966	40145
Stuttgart	Germany	54852	58960	64671	90142	94811	129501	147666	150789	168192	181288
Accra-Kotoka International	Ghana	64149	64669	57190	67197	40194	50175	52463	52847	59737	64164
Athens	Greece	224879	201193	204049	162845	205971	218134	240192	233017	243094	282966
Heraklion-Nikos Kazantzakis	Greece	169796	198643	256706	234084	299319	279739	302097	252413	223130	254336
Karpathos	Greece				6359	12761	23472	25356	15977	14782	16341
Kerkyra-Ioannis Kapodistrias	Greece	28115	28926	36491	35702	52726	45805	56515	53215	52987	65092
Khania/Souda	Greece	7901	8284	7527	8815	11044	12247	22199	26890	25645	22240
Kos	Greece	47093	69964	73183	79144	104573	93339	94096	76371	70565	84060
Mitilini	Greece	13084	19074	17514	17224	20286	17805	22071	19388	20580	23251

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Rodos-Diagoras	Greece	97897	100609	111103	101837	101632	91723	93807	81296	69891	78034
Samos	Greece	14158	18461	21939	19557	27599	30808	38400	37070	33781	39724
Thessaloniki-International Airport	Greece	5185	12286	8390	6138	19222	15630	19304	15092	18488	14843
Zakinthos	Greece	10582	12840	17845	21235	18302	15777	28447	22124	23516	29819
Guatemala City-La Aurora	Guatemala	20959	22078	22084	32100	27049	25830	28902	32212	29983	32996
Hong Kong-International Airport	Hong Kong	63194	63720	76926	94037	85103	115288	134497	154162	193894	194786
Budapest-Ferihegy	Hungary	71840	77523	93631	83711	102504	164541	162213	147458	194187	221806
Keflavik Nas	Iceland		36305	25769	29179	35251	38083	48661	51267	58001	63718
Calcutta-Netaji Subhash Chandra Bose International	India						15375	16454	14749	15334	14932
Delhi-Indira Gandhi International	India					81765	102669	113317	112312	114182	130138
Mumbai-Chhatrapati Shivaji International	India	21483	14842	3682	32060	13918	69819	73465	81589	86239	105495
Denpasar-Bali International	Indonesia	38632	51453	60294	78229	38374	52358	74702	79690	76798	60926
Jakarta-Sukarno Hatta International	Indonesia	199371	198888	210297	190037	122293	115637	130828	131248	115507	136771
Medan-Polonia	Indonesia					11852	15549	14759		11140	10590
Tehran-Mehrabad	Iran		2		6839	16086	17342	22115	30888	70459	77125
Cork	Ireland	19670				4565	7748	8836	6065	7279	7067
Dublin	Ireland	62981	113848	148328	173804	131934	125140	135729	160809	209453	257652
Ovda	Israel	5900	9195	5254		6889	11497	17741	22171	29126	30869
Tel Aviv-Ben Gurion	Israel	144371	127547	128804	122664	183031	194984	217075	249413	279070	297748
Bologna	Italy									12867	80992
Firenze-Peretola	Italy								15725	25122	28990
Milano-Linate	Italy	277534	301543	349981	298028	350960	402740	447307	448102	494982	523905
Milano-Malpensa	Italy								16915		
Roma-Fiumicino/Leonardo da Vinci	Italy	206626	217550	238551	232897	283221	326656	349542	344436	362698	371784
Torino	Italy				17780	26751	23472	24184	23189	39965	54751
Treviso	Italy		9807	22713	21611	45938	57660	13968			
Venezia-Marco Polo/Tessera	Italy		6431		6193	8092		77112	115723	110873	125991
Montego Bay-Sangster International	Jamaica				16636	22220	24032	25382	24329	23991	26520

Geographic location		Passengers in/out									
Name (City/Airport)	**Country**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Osaka-Kansai International	Japan	17384	16598	11830	11090			20832	114175	162328	181241
Tokyo-Narita/New Tokyo International	Japan	133750	153325	163548	142905	182468	222234	275662	274022	281242	291363
Amman-Queen Alia	Jordan	30166	32313	27534	12160	21275	35328	73859		87209	85624
Alma Ata/Almaty	Kazakhstan								1868	18422	26892
Mombasa-Moi International	Kenya			22747	15114	10878				14848	12047
Nairobi-Jomo Kenyatta	Kenya	27459	27591	25804	29095	47144	43718	45153	51902	54652	95295
Kuwait International	Kuwait	4270	4956	2612		18602	28437	34182	44010	49244	49230
Bayrut International	Lebanon				3725	18798	29065	36472	42854	43715	43474
Monrovia-Roberts International	Liberia	26531	29535	11738							
Tripoli International	Libya	18561	16462	14817	15761	3787					
Luxembourg	Luxemburg	10182	7177	10372	5768	23063	31960	43820	48271	49695	59384
Lilongwe International	Malawi	34932	40271	38360	38356	14061	11841	16391	18618	15946	3165
Kuala Lumpur-Sultan Abdul Aziz Shah International	Malaysia	18557	20910	21976	26530	36218	41243	57697	64576	70299	90200
Valletta – Luqa/Malta International	Malta	44306	41634	48975	49179	65686	70684	100980	90754	97799	109904
Agadir-Al Massira	Marocco	29479	29284	27840	21200	19562	17278	17601	11784	12976	13900
Al Hoceima-Cherif El Idrissi	Marocco	2825	4315		4223	16704	16046	17463	17061	17211	15996
Casablanca-Mohamed V	Marocco	52438	55691	55485	65595	37223	42622	54656	66270	76154	85917
Oujda-Angads	Marocco			6284	2704	19000	20027	22288	21175	19180	21447
Tanger-Boukhalf/Ibn Batouta	Marocco	16885	15513	14728	8448	33110	32993	25819	21891	18180	17105
Cancun International	Mexico				28979	34746	40832	41922	39856	45198	47244
Mexico City	Mexico	176200	188053	190581	188564	81736	85972	87283	81431	76373	75642
Puerto Vallarta-Licenciado Gustavo Diaz Ordaz	Mexico									33772	38337
Tivat	Montenegro	13997	14077	15484							
Eindhoven	Netherlands	41722	41737	44142	40252	43510	38006	43478	49824	72089	80284
Enschede-Twenthe	Netherlands				12657	8590	10933	13790	12529	14437	12496
Groningen-Eelde	Netherlands	3747							17327	19590	22860
Maastricht	Netherlands	38879	42521	53446	47371	53024	63074	68671	67252	68244	72846
Curaçao-Willemstad/Hato	Netherlands Antilles	52525	84055	119331	152500	154573	169168	181116	188648	180629	183991

Geographic location Name (City/Airport)	Country	Passengers in/out 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Kralendijk/Bonaire-Flamingo International	Netherlands Antilles						17125	20633	25293	28169	29224
St. Maarten-Princess Juliana International	Netherlands Antilles					28397	24284	29204	28642	21177	29802
Kano-Mallam Aminu International	Nigeria					15803	14686	16862	18087	15094	19776
Lagos-Murtala Muhammed	Nigeria		204	4833	3934	49608	58503	61298	75186	86737	126408
Bergen-Flesland	Norway	30845									
Oslo-Gardermoen	Norway	107555	118926	132163	134349	170324	223467	252715	272320	283197	320075
Stavanger-Sola	Norway	22847	32504	20613	21906	39769	64049	63486	64125	77199	102386
Masqat-Seeb International	Oman	14133	17855	4370	721	18019	19440	22268	24773	31106	38295
Karachi International/Quaid-e-azam International	Pakistan	9917	10020	9405	6996	27952	32611	47311	45904	52166	54463
Rawalpindi/Islamabad-Chaklala	Pakistan	13383	10001	9436	3673					2757	2564
Panama City-Tocumen International/Gen. Omar Torrijos Herrera	Panama	40174	22583	23069	22356	10058	11273	12529	15137	22275	25455
Lima-Callao/Jorge Chavez International	Peru	39166	40652	40279	37604	19601	24410	34861	51235	50956	70714
Manila-Ninoy Aquino International Airport	Philippines	50698	52480	48656	26136	22750	28027	28482	28850	34625	44198
Warsawa-Okecie	Poland	28751	38838	36463	51690	89331	98584	113665	123664	134912	159523
Faro	Portugal	220107	253650	255335	295919	260373	195308	267991	269347	271128	279877
Funchal	Portugal	13290	14278	14259	15732	13441	12050	16250	27693	31366	31587
Lisboa	Portugal	148940	147045	164236	165022	163373	156350	175675	170817	175480	192041
Porto	Portugal					45063	54894	61229	64850	71681	87433
Doha International	Qatar	21711	21099	15152	5981	6670	6089	5088	1209	1210	1167
Bucharest-Otopeni	Romania	11627	11950	15261	16892	21134	22306	26951	33722	79369	112769
Moskwa-Sheremetyevo	Russian Fed.	21951	31853	49900	62376	74667	106339	133624	144667	145925	165205
St.-Petersburg-Pulkovo	Russian Fed.	13856	18117	22096	33620	28575	40435	39605	41301	41792	56310
Dhahran International	Saudi Arabia	6312	17868	18943		33377	41203	38559	32157	32837	35889
Jeddah-King Abdulaziz International	Saudi Arabia				15347	11099	18244	19573	19619	21757	22128
Freetown-Lungi	Sierra Leone				32401	23197	24823	27621	19669	21832	9892
Singapore-Changi	Singapore	157141	167493	153085	121720	190664	191294	214314	229269	237547	235717

Geographic location Name (City/Airport)	Country	Passengers in/out 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Capetown	South Africa					5035	24890	26813	44693	58264	72945
Johannesburg-International	South Africa	95273	91394	90251	90554	83624	66836	89345	103899	123759	141575
Seoul-Kimpo International	South Korea	15725	23539	41060	47318	57219	68617	78417	118585	131954	136574
Alicante	Spain	269515	224683	189438	115070	120548	114146	149479	170808	188641	222689
Almeria	Spain	7845	8539	5869	7646	5309	5127	7667	15455	14090	14213
Arrecife (Lanzarote)-Canary Islands	Spain	21928	25527	17184	26937	54468	67575	96053	91247	90814	106913
Barcelona	Spain	69146	94166	110012	140445	211092	240983	269499	291721	332821	402839
Gerona-Costa Brava	Spain	45966	36429	23812	19607	17428	12937	15689	16631	17324	16859
Ibiza	Spain	72145	62386	40751	46440	37019	40656	55842	53578	52857	51086
Santa Cruz (La Palma)- Canary Islands	Spain						8983	12953	15659	20336	25194
Las Palmas (Gran Canaria)- Canary Islands	Spain	313169	269592	231793	263612	279579	280395	312840	310406	293619	325237
Madrid-Barajas	Spain	126651	131034	147360	171685	263029	288621	284051	301880	310262	344305
Mahon-Menorca	Spain	23199	18733	9794	10865	9637	8128	11678	14736	17815	21369
Malaga	Spain	334047	290977	244242	209530	161832	156687	219637	242205	255082	289186
Palma de Mallorca	Spain	266706	216501	177114	173406	168062	163940	212329	204572	200658	194687
Puerto del Rosario (Fuerteventura)- Canary Islands	Spain	12945	11468	18237	31874	29137	31269	44025	41031	41344	45516
Reus-Tarragona	Spain	34565	31595	19150	10557	14075	10596	14498	16858	16068	18107
Sevilla	Spain				54595	17878	14186	13350	12749	11116	9382
Santa Cruz (Tenerife)- Canary Islands	Spain	111951	105193	114110	143269	144917	146167	188367	177769	176986	205394
Valencia	Spain	11796	16528	20740	16381	32004	13774				
Colombo-Katunayake/Bandaranayake International	Sri Lanka	77852	92559	85831	97142	75200	80420	87998	93283	73509	51383
Khartoum	Sudan	22812	32513	33168	34513	9367	9650	9535	13455	14393	3760
Paramaribo-J.A. Pengel	Suriname	81221	97506	96727	104818	98091	75386	72720	84260	102469	117234
Göteborg-Landvetter	Sweden	15582	13703	37019	39992	127774	133480	145738	175485	182395	191324
Malmö/Sturup	Sweden		8176	19946	17351	25880	41700	45591	47195	53077	74656
Stockholm-Arlanda	Sweden	155397	171918	191434	184059	203513	256086	283904	303202	326073	374708
Basel	Switzerland	22991	26885	21696	23328	24784	25425	33100	34651	32688	35511
Bern-Belp	Switzerland							4509	19424	28350	30307

Geographic location		Passengers in/out									
Name (City/Airport)	**Country**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Geneva-Cointrin	Switzerland	147351	157876	166372	161156	184938	218978	234784	243160	246266	266413
Zürich	Switzerland	299351	314733	331993	311061	346576	391613	423287	435433	468748	517447
Damascus International	Syria	17355	17728	17521	5762	9281	15962	29280	32396	39857	42397
Taipei-Chiang Kai Shek	Taiwan	160614	182868	206849	191768	93661	92960	79045	79248	91675	142711
Dar es Salaam	Tanzania	4572				22752	21347	23409	31535	31755	26675
Kilimanjaro	Tanzania					11380	18258	21148	23851	25512	28484
Bangkok-International	Thailand	24580	23099	33422	37258	246675	261843	262806	251892	241510	255157
Phuket-International	Thailand				24358	16900	12981	14519	14577	5519	11493
Lome-Tokoin	Togo	42597	42004	42461	43586	8053	6607	9435	12830	9891	10901
Monastir - Habib Bourguiba International	Tunisia	166496	200131	174502	84192	115044	114790	133120	115761	115275	94202
Tunis-Carthage	Tunisia	23143	21104	22436	20725	25199	30326	36306	34110	32830	21390
Ankara-Esenboga/Etimusgut	Turkey	38767	39232	44397	35206	71964	98662	109401	119710	124036	146138
Antalya	Turkey	28895	49479	99601	51965	119437	122946	103930	110742	120789	140778
Istanbul-Atatürk	Turkey	75109	112980	134266	170000	170512	214382	234924	264718	291338	343118
Izmir	Turkey	26855	32463	48053	31660	103909	107717	82260	97764	103306	120013
Mugla-Dalaman	Turkey	21271	36181	55698	57894	91563	87847	71021	83452	93568	112323
Abu Dhabi International	UAE	4781	10	10750	19838	16603	28529	33768	38215	38852	41073
Dubai-International	UAE			2286	51549	42324	53388	60533	86270	103205	110882
Aberdeen-Dyce	UK	100337	119594	130561	143772	66742	71215	81329	93716	122363	162893
Belfast-Aldergrove	UK	58206	78626	84230	85867	35313	42005	37491	31337	31394	63266
Birmingham	UK	73993	68388	66219	67563	138096	170705	202709	233956	272267	320948
Bristol-Lulsgate	UK			8211	16418	40029	49276	55430	63738	65313	76568
Cambridge	UK								18593	16442	14841
Cardiff	UK	28262	39415	42951	44630	34356	45406	56088	61683	72829	88078
East Midlands	UK	41392	50121	51021	45206	53324	58362	64207	76563	90321	102780
Edinburgh	UK			14472		74238	82240	105818	117383	157578	218597
Glasgow	UK	86779	112765	117099	112506	74659	94391	107200	114925	156782	198353
Guernsey-Channel Island	UK	13085	12196	11868	12126	8229	8054	6518	6340	7001	6408

Geographic location Name (City/Airport)	Country	Passengers in/out 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Humberside/Hull	UK	25909	25913	28668	36759	49822	57359	59152	63393	77189	94730
Leeds Bradford	UK	38997	51065	51442	47320	53828	52503	55463	62196	71721	96656
London-city	UK									49799	143011
Londonderry-Eglinton	UK								40258		
London-Gatwick	UK		350322	390059	330780				259448	370771	397552
London-Heathrow	UK	1824876	1441833	1544714	1477048	2075569	2064766	2169533	1841345	1861141	1970405
London-Luton	UK	13815	9778	18878	4845				8873	112494	169966
London-Stansted	UK		66774	75076	100771				143165	234990	323442
Lydd/Lympne	UK	23779	40580								
Manchester	UK	192979	217234	239296	247488	307162	348172	388102	299998	419468	493902
Manston	UK								88288		
Newcastle	UK	45164	25825	18861	34457	76471	96672	111196	89402	149620	184602
North Weald	UK								26290		
Norwich	UK	38566	43109	47404	49128	58066	61226	70749	60459	82992	95968
Nottingham	UK								16729		
Southampton	UK	15217	20498	27414	29935	35807	38934	41774	47253	51256	70076
Teesside	UK		8418	19507	8157	28398	35852	42101	44994	57288	73941
Kiev-Borispol	Ukraine					1706	16898	34921	42736	51224	53024
Montevideo	Uruguay					11602	10524	12262	9001		
Atlanta GA-The WB Hartsfield Atlanta International	USA	103903	106475	156537	176887	200564	187222	178525	166848	178595	232441
Baltimore MD-Washington International	USA	14152	14491	35320	82660	76655	20744				
Boston MA-General EL Logan International	USA	5542			115465	109970	147960	202281	173167	168005	175866
Chicago IL-O'Hare International	USA	188618	194202	179527	151725	162833	172030	168047	156723	189954	193258
Denver CO-International	USA							18242	32269	16996	16331
Detroit MI-Metropolitan	USA	42113	98713	11765	9140	135594	180047	215366	368086	483454	602083
Fort Lauderdale FL-Executive	USA				12959	23929	22278	21355	15125		
Houston TX-George Bush Intercontinent	USA	5580				120261	145534	148762	161261	172910	179314
Los Angeles CA-International	USA	208039	226286	334577	242950	232203	239388	233142	252006	291528	331772

Geographic location Name (City/Airport)	Country	Passengers in/out 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Memphis TN-International	USA								48443	143546	162577
Miami FL-International	USA	40838	77297	85032	98396	110644	134254	93388	99934	129954	135529
Minneapolis/St. Paul MN-International	USA	13251	12797	14346	46331	81158	146632	248221	342803	377636	390609
New York NY-John F. Kennedy International	USA	547959	537764	517824	521819	564530	561684	548344	583520	568224	590468
Newark NJ-Newark International	USA				10843	19326	13367	14017	18904	17052	126851
Oakland CA -Metropolitan International	USA		11140		15316	22664	16024	19070	23841	28012	25043
Orlando International	USA	6958	49409	69138	65458	80968	75646	120706	88037	109562	95498
San Francisco CA-International	USA	18861	11768	25918			93675	119283	102456	135788	188032
Seattle-Tacoma International	USA					16771	17102	16762	24256	21258	19470
Tampa FL-International	USA		4813	26609	36701	35935	47552	47945	43443	35416	38181
Washington DC-Dulles International	USA						130854	177422	185718	286450	312152
Caracas-Maiquetia/Simon Bolivar International	Venezuela	3920	6466	24794	27264	43566	51877	54069	69809	62032	103347
Isla Margarita-Del Caribe International, General Santiago Mariño	Venezuela								56159	66948	
Paraguana-Josefa Camejo International	Venezuela							26953			63826
Hochiminh/Tansonnhat International	Vietnam						7502	21835	29384	25709	28041
Belgrade	Yugoslavia	50744	51106	62757	41465	7811		1645	27849	40602	49183
Harare-International	Zimbabwe						10758	16851	18438	19605	23642

Table 8 Total numbers of passenger kilometres travelled by passengers through Amsterdam Airport as calculated in this report. Data are given for 1988 up to and including 1997. Data are alphabetically arranged by country.

Geographic location		Passenger kilometres (km)									
Name (City/Airport)	**Country**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Buenos Aires-Ezeiza/Ministro Pistarini International	Argentina	$1.5x10^{8}$	$1.6x10^{8}$	$1.4x10^{8}$	$1.9x10^{8}$	$2.8x10^{8}$	$3.4x10^{8}$	$5.3x10^{8}$	$4.8x10^{8}$	$4.9x10^{8}$	$5.9x10^{8}$
Aruba-Reina Beatrix	Aruba	$1.6x10^{7}$	$4.4x10^{7}$	$2.1x10^{7}$	$9.9x10^{7}$	$6.4x10^{8}$	$6.2x10^{8}$	$5.9x10^{8}$	$5.8x10^{8}$	$6.9x10^{8}$	$6.9x10^{8}$
Melbourne	Australia	$4.3x10^{7}$	$1.5x10^{8}$	$9.5x10^{7}$	0.0	$3.8x10^{8}$	$4.5x10^{8}$	0.0	0.0	0.0	0.0
Sydney-Kingsford Smith	Australia	$7.9x10^{8}$	$6.3x10^{8}$	$6.5x10^{8}$	$5.6x10^{8}$	$4.8x10^{8}$	$6.3x10^{8}$	$1.1x10^{9}$	$1.4x10^{9}$	$1.6x10^{9}$	$1.6x10^{9}$
Innsbruck	Austria	0.0	0.0	$4.6x10^{6}$	$8.6x10^{6}$	$7.0x10^{6}$	$1.4x10^{7}$	$1.4x10^{7}$	$1.2x10^{7}$	$1.9x10^{7}$	$1.9x10^{7}$
Salzburg-WA Mozart	Austria	0.0	0.0	0.0	0.0	$4.7x10^{6}$	$7.7x10^{6}$	$1.8x10^{7}$	$3.0x10^{7}$	$3.1x10^{7}$	$3.5x10^{7}$
Wien-International/Schwechat	Austria	$1.0x10^{8}$	$1.0x10^{8}$	$1.3x10^{8}$	$1.5x10^{8}$	$1.9x10^{8}$	$2.5x10^{8}$	$2.6x10^{8}$	$2.9x10^{8}$	$3.0x10^{8}$	$3.4x10^{8}$
Bahrain	Bahrain	$7.8x10^{7}$	$1.7x10^{7}$	$2.7x10^{7}$	$2.6x10^{6}$	$9.2x10^{7}$	$1.5x10^{8}$	$2.1x10^{8}$	$2.1x10^{8}$	$2.7x10^{8}$	$2.9x10^{8}$
Dhaka-Zia International	Bangladesh	$1.1x10^{8}$	$8.1x10^{7}$	$6.9x10^{7}$	$9.1x10^{7}$	$5.2x10^{7}$	$3.9x10^{7}$	$7.6x10^{7}$	$2.6x10^{8}$	$2.5x10^{8}$	0.0
Antwerpen/Deurne	Belgium	$4.5x10^{6}$	$4.0x10^{6}$	$3.5x10^{6}$	$3.9x10^{6}$	$4.7x10^{6}$	$5.5x10^{6}$	$6.7x10^{6}$	$6.5x10^{6}$	$7.3x10^{6}$	$7.8x10^{6}$
Brussels	Belgium	$2.0x10^{7}$	$2.2x10^{7}$	$2.3x10^{7}$	$2.6x10^{7}$	$2.7x10^{7}$	$3.4x10^{7}$	$4.0x10^{7}$	$3.9x10^{7}$	$3.9x10^{7}$	$4.5x10^{7}$
Rio de Janeiro International-Galeao Antonio Carlos Jobim	Brazil	$1.7x10^{8}$	$2.0x10^{8}$	$2.1x10^{8}$	$1.8x10^{8}$	$4.4x10^{8}$	$4.1x10^{8}$	$4.6x10^{8}$	$4.9x10^{8}$	$6.2x10^{8}$	$6.7x10^{8}$
Sao Paulo-Guarulhos International	Brazil	0.0	0.0	0.0	0.0	$2.3x10^{8}$	$2.7x10^{8}$	$3.3x10^{8}$	$4.0x10^{8}$	$4.5x10^{8}$	$5.8x10^{8}$
Plovdiv	Bulgaria	0.0	$5.7x10^{6}$	$1.1x10^{7}$	$1.9x10^{7}$	$1.9x10^{7}$	$2.6x10^{7}$	$2.4x10^{7}$	$2.1x10^{7}$	$1.7x10^{7}$	$1.3x10^{7}$
Sofija	Bulgaria	$1.8x10^{7}$	$1.9x10^{7}$	$2.2x10^{7}$	$2.4x10^{7}$	$2.8x10^{7}$	$2.9x10^{7}$	$2.8x10^{7}$	$3.7x10^{7}$	$4.0x10^{7}$	$3.4x10^{7}$
Calgary-International	Canada	0.0	0.0	0.0	0.0	$3.1x10^{8}$	$3.4x10^{8}$	$4.0x10^{8}$	$4.3x10^{8}$	$5.8x10^{8}$	$1.7x10^{8}$
Halifax	Canada	$5.0x10^{7}$	$4.8x10^{7}$	0.0	$2.2x10^{7}$	$1.2x10^{8}$	$1.5x10^{8}$	$1.8x10^{8}$	$2.0x10^{8}$	$7.6x10^{7}$	$3.3x10^{7}$
Montreal-Dorval	Canada	$8.7x10^{8}$	$8.2x10^{8}$	$8.5x10^{8}$	$8.2x10^{8}$	$9.0x10^{8}$	$1.0x10^{9}$	$9.4x10^{8}$	$9.7x10^{8}$	$1.0x10^{9}$	$1.2x10^{9}$
Ottawa-MacDonald Cartier International	Canada	0.0	$1.7x10^{8}$	$2.6x10^{8}$	$2.5x10^{8}$	$1.3x10^{8}$	$1.9x10^{8}$	$1.8x10^{8}$	$1.7x10^{8}$	$3.8x10^{7}$	0.0
Toronto-L.B. Pearson	Canada	$2.4x10^{9}$	$2.2x10^{9}$	$2.2x10^{9}$	$1.8x10^{9}$	$1.7x10^{9}$	$1.7x10^{9}$	$1.9x10^{9}$	$2.2x10^{9}$	$2.1x10^{9}$	$2.2x10^{9}$
Vancouver-International	Canada	$1.6x10^{9}$	$1.6x10^{9}$	$9.0x10^{8}$	$9.6x10^{8}$	$7.8x10^{8}$	$7.1x10^{8}$	$8.1x10^{8}$	$7.8x10^{8}$	$9.1x10^{8}$	$1.3x10^{9}$
Sal Oceanic/Island-Amilcar Cabral International	Cape Verde Islands	0.0	$1.9x10^{7}$	$3.4x10^{7}$	$2.4x10^{7}$	$7.0x10^{7}$	$5.7x10^{7}$	$6.6x10^{7}$	$6.8x10^{7}$	$4.8x10^{7}$	$4.5x10^{7}$
Santiago-Arturo Merino Benitez International	Chile	$8.1x10^{8}$	$7.9x10^{8}$	$7.7x10^{8}$	$7.8x10^{8}$	$2.2x10^{8}$	$2.7x10^{8}$	$3.2x10^{8}$	$3.2x10^{8}$	$4.4x10^{8}$	$4.6x10^{8}$
Beijing-Capital International	China	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$6.9x10^{5}$	$2.0x10^{8}$	$5.1x10^{8}$
San Jose-Juan Santamaria International	Costa Rica	$4.0x10^{8}$	$4.1x10^{8}$	$4.1x10^{8}$	$3.9x10^{8}$	$1.7x10^{8}$	$2.0x10^{8}$	$2.3x10^{8}$	$3.1x10^{8}$	$4.1x10^{8}$	$5.0x10^{8}$

Geographic location Name (City/Airport)	Country	Passenger kilometres (km) 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Dubrovnik-Cilipi	Croatia	$2.9x10^7$	$2.5x10^7$	$2.6x10^7$	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pula	Croatia	$1.6x10^7$	$1.5x10^7$	$1.6x10^7$	0.0	0.0	0.0	0.0	0.0	0.0	$4.5x10^6$
Split	Croatia	$2.3x10^7$	$2.0x10^7$	$1.8x10^7$	0.0	0.0	0.0	$6.1x10^6$	0.0	$5.9x10^6$	$5.9x10^6$
Zagreb-Pleso	Croatia	0.0	0.0	0.0	0.0	0.0	$1.6x10^7$	$2.8x10^7$	$2.9x10^7$	$3.2x10^7$	$2.9x10^7$
Holguin-Frank Pais	Cuba	0.0	0.0	0.0	0.0	$1.2x10^8$	$1.4x10^8$	$1.6x10^8$	$1.3x10^8$	$1.6x10^8$	$8.9x10^7$
Varadero-Juan Gualberto Gomez International	Cuba	0.0	0.0	0.0	0.0	0.0	$8.6x10^7$	$9.5x10^7$	$8.4x10^7$	$1.1x10^8$	$1.2x10^8$
Larnaca International	Cyprus	$1.2x10^8$	$1.4x10^8$	$1.3x10^8$	$1.9x10^8$	$2.0x10^8$	$2.0x10^8$	$1.7x10^8$	$2.1x10^8$	$2.2x10^8$	$2.2x10^8$
Paphos-International	Cyprus	$3.4x10^7$	$7.3x10^7$	$6.9x10^7$	$3.4x10^7$	$9.4x10^7$	$7.2x10^7$	$1.1x10^8$	$1.3x10^8$	$1.2x10^8$	$1.0x10^8$
Praha-Ruzyne	Czech Rep.	$1.1x10^7$	$1.4x10^7$	$2.1x10^7$	$3.4x10^7$	$5.1x10^7$	$7.8x10^7$	$9.1x10^7$	$1.0x10^8$	$1.4x10^8$	$1.4x10^8$
Billund	Denmark	0.0	0.0	0.0	$3.9x10^6$	$7.0x10^6$	$1.9x10^7$	$2.5x10^7$	$3.3x10^7$	$4.6x10^7$	$5.8x10^7$
København-Kastrup	Denmark	$1.6x10^8$	$1.8x10^8$	$1.8x10^8$	$1.7x10^8$	$1.9x10^8$	$2.0x10^8$	$2.1x10^8$	$2.3x10^8$	$2.4x10^8$	$2.5x10^8$
Puerto Plata-Gregorio Luperon International	Dominican Republic	0.0	0.0	0.0	$3.6x10^8$	$3.9x10^8$	0.0	0.0	$5.9x10^8$	$6.4x10^8$	0.0
Punta Cana International	Dominican Republic	0.0	$3.4x10^7$	$3.2x10^8$	0.0	0.0	$5.5x10^8$	$5.4x10^8$	0.0	0.0	$5.6x10^8$
Santo Domingo-Las Americas International	Dominican Republic	0.0	0.0	0.0	0.0	$9.5x10^7$	$1.6x10^8$	$1.8x10^8$	$1.6x10^8$	$1.6x10^8$	$1.0x10^8$
Guayaquil-Simon Bolivar International	Ecuador	0.0	0.0	$1.9x10^8$	$1.8x10^8$	$5.9x10^7$	$8.0x10^7$	$1.0x10^8$	$1.3x10^8$	$1.6x10^8$	$2.0x10^8$
Quito-Mariscal Sucre	Ecuador	$9.2x10^7$	$2.2x10^8$	0.0	0.0	$1.4x10^8$	$2.3x10^8$	$2.6x10^8$	$3.1x10^8$	$3.5x10^8$	$5.9x10^8$
Cairo-International	Egypt	$4.4x10^8$	$3.8x10^8$	$3.1x10^8$	$2.4x10^8$	$4.8x10^8$	$3.2x10^8$	$3.1x10^8$	$3.7x10^8$	$4.6x10^8$	$5.6x10^8$
Hurghada	Egypt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$2.2x10^7$	$1.4x10^8$	$2.0x10^8$
Helsinki-Vantaa	Finland	$2.3x10^8$	$2.5x10^8$	$2.5x10^8$	$2.3x10^8$	$1.8x10^8$	$1.9x10^8$	$2.2x10^8$	$2.4x10^8$	$2.6x10^8$	$3.2x10^8$
Tampere-Pirkkala	Finland	$3.4x10^7$	$3.1x10^7$	$6.6x10^6$	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lyon-Satolas/Saint Exupéry	France	$1.3x10^7$	$2.2x10^7$	$2.8x10^7$	$3.4x10^7$	$3.8x10^7$	$5.1x10^7$	$5.0x10^7$	$5.6x10^7$	$6.6x10^7$	$9.2x10^7$
Marseille-Provence/Marignane	France	$1.7x10^7$	0.0	$4.9x10^6$	$1.2x10^7$	$2.1x10^7$	$3.3x10^7$	$4.7x10^7$	$5.7x10^7$	$4.3x10^7$	$2.9x10^7$
Mulhouse-Bale (Basel)	France	0.0	0.0	$5.9x10^6$	$1.0x10^7$	$1.7x10^7$	$2.0x10^7$	$2.0x10^7$	$2.4x10^7$	$3.1x10^7$	$3.8x10^7$
Nice/Côte d'Azur	France	$7.7x10^7$	$8.1x10^7$	$9.4x10^7$	$9.9x10^7$	$1.2x10^8$	$1.3x10^8$	$1.1x10^8$	$1.2x10^8$	$1.1x10^8$	$2.0x10^8$
Paris-Charles de Gaulle	France	$2.2x10^8$	$2.4x10^8$	$2.5x10^8$	$2.4x10^8$	$2.6x10^8$	$2.8x10^8$	$3.1x10^8$	$2.9x10^8$	$2.9x10^8$	$3.2x10^8$
Paris-Orly	France	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$2.2x10^7$	$3.3x10^7$	$3.4x10^7$

Geographic location Name (City/Airport)	Country	Passenger kilometres (km) 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Strassbourg-Entzheim	France	4.8×10^{6}	6.7×10^{6}	8.5×10^{6}	9.1×10^{6}	4.8×10^{6}	1.2×10^{7}	1.4×10^{7}	1.5×10^{7}	1.5×10^{7}	1.5×10^{7}
Toulouse-Blagnac	France	3.8×10^{6}	0.0	4.6×10^{6}	8.7×10^{6}	1.7×10^{7}	2.7×10^{7}	4.0×10^{7}	5.1×10^{7}	6.4×10^{7}	8.6×10^{7}
Ohrid-Macedonia	FYROM	2.3×10^{7}	2.1×10^{7}	1.9×10^{7}	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Skopje	FYROM	0.0	0.0	0.0	0.0	0.0	1.7×10^{7}	2.4×10^{7}	2.8×10^{7}	2.4×10^{7}	1.3×10^{7}
Banjul-International	Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4×10^{8}	1.3×10^{8}	9.8×10^{7}
Berlin-Tegel	Germany	4.2×10^{7}	4.4×10^{7}	4.0×10^{7}	4.3×10^{7}	6.8×10^{7}	9.1×10^{7}	1.0×10^{8}	1.1×10^{8}	1.2×10^{8}	1.4×10^{8}
Bremen	Germany	1.4×10^{7}	1.6×10^{7}	1.6×10^{7}	1.8×10^{7}	2.1×10^{7}	2.4×10^{7}	2.9×10^{7}	3.1×10^{7}	3.0×10^{7}	3.2×10^{7}
Dortmund-Wickede	Germany	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.6×10^{6}	8.4×10^{6}
Düsseldorf	Germany	1.5×10^{7}	1.6×10^{7}	1.6×10^{7}	1.9×10^{7}	1.9×10^{7}	2.3×10^{7}	2.4×10^{7}	2.7×10^{7}	2.2×10^{7}	2.8×10^{7}
Frankfurt-International	Germany	1.3×10^{8}	1.4×10^{8}	1.5×10^{8}	1.4×10^{8}	1.4×10^{8}	1.6×10^{8}	1.5×10^{8}	1.6×10^{8}	1.6×10^{8}	1.7×10^{8}
Hamburg	Germany	4.8×10^{7}	5.7×10^{7}	5.4×10^{7}	6.1×10^{7}	6.2×10^{7}	7.7×10^{7}	8.7×10^{7}	9.3×10^{7}	9.1×10^{7}	9.4×10^{7}
Hannover	Germany	1.1×10^{7}	1.2×10^{7}	1.3×10^{7}	1.9×10^{7}	2.1×10^{7}	2.6×10^{7}	2.9×10^{7}	3.1×10^{7}	3.3×10^{7}	3.9×10^{7}
Köln/Bonn	Germany	5.2×10^{5}	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1×10^{6}	1.6×10^{7}
München-International	Germany	1.2×10^{8}	1.2×10^{8}	1.3×10^{8}	1.4×10^{8}	1.4×10^{8}	1.7×10^{8}	1.7×10^{8}	1.9×10^{8}	1.9×10^{8}	2.1×10^{8}
Nördlingen	Germany	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0×10^{6}	0.0	0.0
Nürnberg	Germany	8.6×10^{6}	8.7×10^{6}	1.0×10^{7}	1.7×10^{7}	2.2×10^{7}	2.9×10^{7}	3.0×10^{7}	2.5×10^{7}	3.9×10^{7}	4.9×10^{7}
Paderborn-Lippstadt	Germany	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0×10^{6}	1.1×10^{7}
Stuttgart	Germany	2.8×10^{7}	3.0×10^{7}	3.3×10^{7}	4.6×10^{7}	4.8×10^{7}	6.6×10^{7}	7.5×10^{7}	7.7×10^{7}	8.6×10^{7}	9.3×10^{7}
Accra-Kotoka International	Ghana	3.3×10^{8}	3.4×10^{8}	3.0×10^{8}	3.5×10^{8}	2.1×10^{8}	2.6×10^{8}	2.7×10^{8}	2.7×10^{8}	3.1×10^{8}	3.3×10^{8}
Athens	Greece	4.9×10^{8}	4.4×10^{8}	4.4×10^{8}	3.5×10^{8}	4.5×10^{8}	4.7×10^{8}	5.2×10^{8}	5.1×10^{8}	5.3×10^{8}	6.1×10^{8}
Heraklion-Nikos Kazantzakis	Greece	4.2×10^{8}	4.9×10^{8}	6.3×10^{8}	5.8×10^{8}	7.4×10^{8}	6.9×10^{8}	7.5×10^{8}	6.2×10^{8}	5.5×10^{8}	6.3×10^{8}
Karpathos	Greece	0.0	0.0	0.0	1.6×10^{7}	3.3×10^{7}	6.0×10^{7}	6.5×10^{7}	4.1×10^{7}	3.8×10^{7}	4.2×10^{7}
Kerkyra-Ioannis Kapodistrias	Greece	5.1×10^{7}	5.3×10^{7}	6.6×10^{7}	6.5×10^{7}	9.6×10^{7}	8.3×10^{7}	1.0×10^{8}	9.7×10^{7}	9.6×10^{7}	1.2×10^{8}
Khania/Souda	Greece	1.9×10^{7}	2.0×10^{7}	1.8×10^{7}	2.1×10^{7}	2.7×10^{7}	2.9×10^{7}	5.3×10^{7}	6.5×10^{7}	6.2×10^{7}	5.3×10^{7}
Kos	Greece	1.2×10^{8}	1.7×10^{8}	1.8×10^{8}	1.9×10^{8}	2.6×10^{8}	2.3×10^{8}	2.3×10^{8}	1.9×10^{8}	1.7×10^{8}	2.1×10^{8}
Mitilini	Greece	2.9×10^{7}	4.2×10^{7}	3.9×10^{7}	3.8×10^{7}	4.5×10^{7}	4.0×10^{7}	4.9×10^{7}	4.3×10^{7}	4.6×10^{7}	5.2×10^{7}
Rodos-Diagoras	Greece	2.5×10^{8}	2.5×10^{8}	2.8×10^{8}	2.6×10^{8}	2.6×10^{8}	2.3×10^{8}	2.4×10^{8}	2.1×10^{8}	1.8×10^{8}	2.0×10^{8}
Samos	Greece	3.3×10^{7}	4.4×10^{7}	5.2×10^{7}	4.6×10^{7}	6.5×10^{7}	7.3×10^{7}	9.0×10^{7}	8.7×10^{7}	8.0×10^{7}	9.4×10^{7}

Geographic location Name (City/Airport)	Country	Passenger kilometres (km) 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Thessaloniki-International Airport	Greece	$9.8x10^6$	$2.3x10^7$	$1.6x10^7$	$1.2x10^7$	$3.6x10^7$	$3.0x10^7$	$3.7x10^7$	$2.9x10^7$	$3.5x10^7$	$2.8x10^7$
Zakinthos	Greece	$2.2x10^7$	$2.6x10^7$	$3.6x10^7$	$4.3x10^7$	$3.7x10^7$	$3.2x10^7$	$5.8x10^7$	$4.5x10^7$	$4.8x10^7$	$6.1x10^7$
Guatemala City-La Aurora	Guatemala	$2.1x10^8$	$2.2x10^8$	$2.2x10^8$	$3.2x10^8$	$2.7x10^8$	$2.6x10^8$	$2.9x10^8$	$3.3x10^8$	$3.0x10^8$	$3.3x10^8$
Hong Kong-International Airport	Hong Kong	$5.8x10^8$	$5.9x10^8$	$7.1x10^8$	$8.7x10^8$	$7.9x10^8$	$1.1x10^9$	$1.2x10^9$	$1.4x10^9$	$1.8x10^9$	$1.8x10^9$
Budapest-Ferihegy	Hungary	$8.4x10^7$	$9.0x10^7$	$1.1x10^8$	$9.8x10^7$	$1.2x10^8$	$1.9x10^8$	$1.9x10^8$	$1.7x10^8$	$2.3x10^8$	$2.6x10^8$
Keflavik Nas	Iceland	0.0	$7.4x10^7$	$5.2x10^7$	$5.9x10^7$	$7.2x10^7$	$7.7x10^7$	$9.9x10^7$	$1.0x10^8$	$1.2x10^8$	$1.3x10^8$
Calcutta-Netaji Subhash Chandra Bose International	India	0.0	0.0	0.0	0.0	0.0	$1.2x10^8$	$1.2x10^8$	$1.1x10^8$	$1.2x10^8$	$1.1x10^8$
Delhi-Indira Gandhi International	India	0.0	0.0	0.0	0.0	$5.2x10^8$	$6.5x10^8$	$7.2x10^8$	$7.1x10^8$	$7.2x10^8$	$8.3x10^8$
Mumbai-Chhatrapati Shivaji International	India	$1.5x10^8$	$1.0x10^8$	$2.5x10^7$	$2.2x10^8$	$9.5x10^7$	$4.8x10^8$	$5.0x10^8$	$5.6x10^8$	$5.9x10^8$	$7.2x10^8$
Denpasar-Bali International	Indonesia	$4.7x10^8$	$6.2x10^8$	$7.3x10^8$	$9.5x10^8$	$4.7x10^8$	$6.4x10^8$	$9.1x10^8$	$9.7x10^8$	$9.3x10^8$	$7.4x10^8$
Jakarta-Sukarno Hatta International	Indonesia	$2.3x10^9$	$2.3x10^9$	$2.4x10^9$	$2.2x10^9$	$1.4x10^9$	$1.3x10^9$	$1.5x10^9$	$1.5x10^9$	$1.3x10^9$	$1.6x10^9$
Medan-Polonia	Indonesia	0.0	0.0	0.0	0.0	$1.2x10^8$	$1.5x10^8$	$1.5x10^8$	0.0	$1.1x10^8$	$1.1x10^8$
Tehran-Mehrabad	Iran	0.0	$8.1x10^3$	0.0	$2.8x10^7$	$6.5x10^7$	$7.0x10^7$	$9.0x10^7$	$1.3x10^8$	$2.9x10^8$	$3.1x10^8$
Cork	Ireland	$1.8x10^7$	0.0	0.0	0.0	$4.1x10^6$	$7.0x10^6$	$8.0x10^6$	$5.5x10^6$	$6.6x10^6$	$6.4x10^6$
Dublin	Ireland	$4.7x10^7$	$8.5x10^7$	$1.1x10^8$	$1.3x10^8$	$9.8x10^7$	$9.3x10^7$	$1.0x10^8$	$1.2x10^8$	$1.6x10^8$	$1.9x10^8$
Ovda	Israel	$2.1x10^7$	$3.2x10^7$	$1.8x10^7$	0.0	$2.4x10^7$	$4.0x10^7$	$6.2x10^7$	$7.7x10^7$	$1.0x10^8$	$1.1x10^8$
Tel Aviv-Ben Gurion	Israel	$4.8x10^8$	$4.2x10^8$	$4.3x10^8$	$4.0x10^8$	$6.0x10^8$	$6.4x10^8$	$7.2x10^8$	$8.2x10^8$	$9.2x10^8$	$9.8x10^8$
Bologna	Italy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$1.3x10^7$	$8.0x10^7$
Firenze-Peretola	Italy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$1.7x10^7$	$2.7x10^7$	$3.1x10^7$
Milano-Linate	Italy	$2.3x10^8$	$2.5x10^8$	$2.9x10^8$	$2.5x10^8$	$2.9x10^8$	$3.3x10^8$	$3.7x10^8$	$3.7x10^8$	$4.1x10^8$	$4.3x10^8$
Milano-Malpensa	Italy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$1.3x10^7$	0.0	0.0
Roma-Fiumicino/Leonardo da Vinci	Italy	$2.7x10^8$	$2.8x10^8$	$3.1x10^8$	$3.0x10^8$	$3.7x10^8$	$4.2x10^8$	$4.5x10^8$	$4.5x10^8$	$4.7x10^8$	$4.8x10^8$
Torino	Italy	0.0	0.0	0.0	$1.4x10^7$	$2.2x10^7$	$1.9x10^7$	$2.0x10^7$	$1.9x10^7$	$3.3x10^7$	$4.5x10^7$
Treviso	Italy	0.0	$9.0x10^6$	$2.1x10^7$	$2.0x10^7$	$4.2x10^7$	$5.3x10^7$	$1.3x10^7$	0.0	0.0	0.0
Venezia-Marco Polo/Tessera	Italy	0.0	$6.0x10^6$	0.0	$5.8x10^6$	$7.6x10^6$	0.0	$7.2x10^7$	$1.1x10^8$	$1.0x10^8$	$1.2x10^8$
Montego Bay-Sangster International	Jamaica	0.0	0.0	0.0	$1.4x10^8$	$1.9x10^8$	$2.0x10^8$	$2.1x10^8$	$2.0x10^8$	$2.0x10^8$	$2.2x10^8$
Osaka-Kansai International	Japan	$1.6x10^8$	$1.5x10^8$	$1.1x10^8$	$1.0x10^8$	0.0	0.0	$1.9x10^8$	$1.1x10^9$	$1.5x10^9$	$1.7x10^9$
Tokyo-Narita/New Tokyo International	Japan	$1.2x10^9$	$1.4x10^9$	$1.5x10^9$	$1.3x10^9$	$1.7x10^9$	$2.1x10^9$	$2.6x10^9$	$2.5x10^9$	$2.6x10^9$	$2.7x10^9$

Geographic location Name (City/Airport)	Country	Passenger kilometres (km) 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Amman-Queen Alia	Jordan	$1.0x10^8$	$1.1x10^8$	$9.3x10^7$	$4.1x10^7$	$7.2x10^7$	$1.2x10^8$	$2.5x10^8$	0.0	$3.0x10^8$	$2.9x10^8$
Alma Ata/Almaty	Kazakhstan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$9.8x10^6$	$9.7x10^7$	$1.4x10^8$
Mombasa-Moi International	Kenya	0.0	0.0	$1.6x10^8$	$1.1x10^8$	$7.7x10^7$	0.0	0.0	0.0	$1.1x10^8$	$8.5x10^7$
Nairobi-Jomo Kenyatta	Kenya	$1.8x10^8$	$1.8x10^8$	$1.7x10^8$	$1.9x10^8$	$3.1x10^8$	$2.9x10^8$	$3.0x10^8$	$3.5x10^8$	$3.6x10^8$	$6.3x10^8$
Kuwait International	Kuwait	$1.9x10^7$	$2.2x10^7$	$1.1x10^7$	0.0	$8.1x10^7$	$1.2x10^8$	$1.5x10^8$	$1.9x10^8$	$2.1x10^8$	$2.1x10^8$
Bayrut International	Lebanon	0.0	0.0	0.0	$1.2x10^7$	$6.0x10^7$	$9.3x10^7$	$1.2x10^8$	$1.4x10^8$	$1.4x10^8$	$1.4x10^8$
Monrovia-Roberts International	Liberia	$1.4x10^8$	$1.6x10^8$	$6.2x10^7$	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tripoli International	Libya	$4.2x10^7$	$3.8x10^7$	$3.4x10^7$	$3.6x10^7$	$8.6x10^6$	0.0	0.0	0.0	0.0	0.0
Luxembourg	Luxemburg	$3.2x10^6$	$2.3x10^6$	$3.3x10^6$	$1.8x10^6$	$7.2x10^6$	$1.0x10^7$	$1.4x10^7$	$1.5x10^7$	$1.6x10^7$	$1.9x10^7$
Lilongwe International	Malawi	$2.8x10^8$	$3.3x10^8$	$3.1x10^8$	$3.1x10^8$	$1.1x10^8$	$9.6x10^7$	$1.3x10^8$	$1.5x10^8$	$1.3x10^8$	$2.6x10^7$
Kuala Lumpur-Sultan Abdul Aziz Shah International	Malaysia	$1.9x10^8$	$2.1x10^8$	$2.2x10^8$	$2.7x10^8$	$3.7x10^8$	$4.2x10^8$	$5.9x10^8$	$6.6x10^8$	$7.2x10^8$	$9.2x10^8$
Valletta – Luqa/Malta International	Malta	$8.8x10^7$	$8.2x10^7$	$9.7x10^7$	$9.7x10^7$	$1.3x10^8$	$1.4x10^8$	$2.0x10^8$	$1.8x10^8$	$1.9x10^8$	$2.2x10^8$
Agadir-Al Massira	Marocco	$7.9x10^7$	$7.9x10^7$	$7.5x10^7$	$5.7x10^7$	$5.3x10^7$	$4.7x10^7$	$4.7x10^7$	$3.2x10^7$	$3.5x10^7$	$3.7x10^7$
Al Hoceima-Cherif El Idrissi	Marocco	$5.7x10^6$	$8.7x10^6$	0.0	$8.5x10^6$	$3.4x10^7$	$3.2x10^7$	$3.5x10^7$	$3.4x10^7$	$3.5x10^7$	$3.2x10^7$
Casablanca-Mohamed V	Marocco	$1.2x10^8$	$1.3x10^8$	$1.3x10^8$	$1.5x10^8$	$8.6x10^7$	$9.9x10^7$	$1.3x10^8$	$1.5x10^8$	$1.8x10^8$	$2.0x10^8$
Oujda-Angads	Marocco	0.0	0.0	$1.3x10^7$	$5.4x10^6$	$3.8x10^7$	$4.0x10^7$	$4.5x10^7$	$4.3x10^7$	$3.9x10^7$	$4.3x10^7$
Tanger-Boukhalf/Ibn Batouta	Marocco	$3.4x10^7$	$3.1x10^7$	$3.0x10^7$	$1.7x10^7$	$6.7x10^7$	$6.7x10^7$	$5.2x10^7$	$4.4x10^7$	$3.7x10^7$	$3.5x10^7$
Cancun International	Mexico	0.0	0.0	0.0	$2.4x10^8$	$2.9x10^8$	$3.4x10^8$	$3.5x10^8$	$3.3x10^8$	$3.7x10^8$	$3.9x10^8$
Mexico City	Mexico	$1.6x10^9$	$1.7x10^9$	$1.7x10^9$	$1.7x10^9$	$7.5x10^8$	$7.9x10^8$	$8.0x10^8$	$7.5x10^8$	$7.0x10^8$	$6.9x10^8$
Puerto Vallarta-Licenciado Gustavo Diaz Ordaz	Mexico	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$3.3x10^8$	$3.8x10^8$
Tivat	Montenegro	$2.4x10^7$	$2.4x10^7$	$2.6x10^7$	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eindhoven	Netherlands	$4.3x10^6$	$4.3x10^6$	$4.6x10^6$	$4.2x10^6$	$4.5x10^6$	$3.9x10^6$	$4.5x10^6$	$5.1x10^6$	$7.4x10^6$	$8.3x10^6$
Enschede-Twenthe	Netherlands	0.0	0.0	0.0	$1.8x10^6$	$1.2x10^6$	$1.6x10^6$	$2.0x10^6$	$1.8x10^6$	$2.1x10^6$	$1.8x10^6$
Groningen-Eelde	Netherlands	$5.7x10^5$	0.0	0.0	0.0	0.0	0.0	0.0	$2.6x10^6$	$3.0x10^6$	$3.5x10^6$
Maastricht	Netherlands	$6.6x10^6$	$7.2x10^6$	$9.1x10^6$	$8.1x10^6$	$9.0x10^6$	$1.1x10^7$	$1.2x10^7$	$1.1x10^7$	$1.2x10^7$	$1.2x10^7$
Curaçao-Willemstad/Hato	Netherlands Antilles	$4.1x10^8$	$6.6x10^8$	$9.3x10^8$	$1.2x10^9$	$1.2x10^9$	$1.3x10^9$	$1.4x10^9$	$1.5x10^9$	$1.4x10^9$	$1.4x10^9$
Kralendijk/Bonaire-Flamingo International	Netherlands Antilles	0.0	0.0	0.0	0.0	0.0	$1.3x10^8$	$1.6x10^8$	$2.0x10^8$	$2.2x10^8$	$2.3x10^8$

Geographic location Name (City/Airport)	Country	Passenger kilometres (km) 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
St. Maarten-Princess Juliana International	Netherlands Antilles	0.0	0.0	0.0	0.0	$2.0x10^8$	$1.7x10^8$	$2.0x10^8$	$2.0x10^8$	$1.5x10^8$	$2.1x10^8$
Kano-Mallam Aminu International	Nigeria	0.0	0.0	0.0	0.0	$7.1x10^7$	$6.6x10^7$	$7.5x10^7$	$8.1x10^7$	$6.8x10^7$	$8.9x10^7$
Lagos-Murtala Muhammed	Nigeria	0.0	$1.0x10^6$	$2.5x10^7$	$2.0x10^7$	$2.5x10^8$	$3.0x10^8$	$3.1x10^8$	$3.8x10^8$	$4.4x10^8$	$6.4x10^8$
Bergen-Flesland	Norway	$2.7x10^7$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oslo-Gardermoen	Norway	$1.0x10^8$	$1.1x10^8$	$1.3x10^8$	$1.3x10^8$	$1.6x10^8$	$2.1x10^8$	$2.4x10^8$	$2.6x10^8$	$2.7x10^8$	$3.1x10^8$
Stavanger-Sola	Norway	$1.7x10^7$	$2.4x10^7$	$1.5x10^7$	$1.6x10^7$	$2.9x10^7$	$4.7x10^7$	$4.6x10^7$	$4.7x10^7$	$5.6x10^7$	$7.5x10^7$
Masqat-Seeb International	Oman	$7.8x10^7$	$9.8x10^7$	$2.4x10^7$	$4.0x10^6$	$9.9x10^7$	$1.1x10^8$	$1.2x10^8$	$1.4x10^8$	$1.7x10^8$	$2.1x10^8$
Karachi International/Quaid-e-azam International	Pakistan	$6.9x10^7$	$7.0x10^7$	$6.5x10^7$	$4.9x10^7$	$1.9x10^8$	$2.3x10^8$	$3.3x10^8$	$3.2x10^8$	$3.6x10^8$	$3.8x10^8$
Rawalpindi/Islamabad-Chaklala	Pakistan	$7.6x10^7$	$5.7x10^7$	$5.4x10^7$	$2.1x10^7$	0.0	0.0	0.0	0.0	$1.6x10^7$	$1.5x10^7$
Panama City-Tocumen International/Gen. Omar Torrijos Herrera	Panama	$3.8x10^8$	$2.1x10^8$	$2.2x10^8$	$2.1x10^8$	$9.4x10^7$	$1.1x10^8$	$1.2x10^8$	$1.4x10^8$	$2.1x10^8$	$2.4x10^8$
Lima-Callao/Jorge Chavez International	Peru	$4.2x10^8$	$4.3x10^8$	$4.3x10^8$	$4.0x10^8$	$2.1x10^8$	$2.6x10^8$	$3.7x10^8$	$5.5x10^8$	$5.4x10^8$	$7.6x10^8$
Manila-Ninoy Aquino International Airport	Philippines	$6.4x10^8$	$6.7x10^8$	$6.2x10^8$	$3.3x10^8$	$2.9x10^8$	$3.6x10^8$	$3.6x10^8$	$3.7x10^8$	$4.4x10^8$	$5.6x10^8$
Warsawa-Okecie	Poland	$3.2x10^7$	$4.3x10^7$	$4.0x10^7$	$5.7x10^7$	$9.8x10^7$	$1.1x10^8$	$1.2x10^8$	$1.4x10^8$	$1.5x10^8$	$1.8x10^8$
Faro	Portugal	$4.3x10^8$	$5.0x10^8$	$5.0x10^8$	$5.8x10^8$	$5.1x10^8$	$3.8x10^8$	$5.3x10^8$	$5.3x10^8$	$5.3x10^8$	$5.5x10^8$
Funchal	Portugal	$3.7x10^7$	$4.0x10^7$	$4.0x10^7$	$4.4x10^7$	$3.7x10^7$	$3.3x10^7$	$4.5x10^7$	$7.7x10^7$	$8.7x10^7$	$8.8x10^7$
Lisboa	Portugal	$2.7x10^8$	$2.7x10^8$	$3.0x10^8$	$3.0x10^8$	$3.0x10^8$	$2.9x10^8$	$3.2x10^8$	$3.1x10^8$	$3.2x10^8$	$3.5x10^8$
Porto	Portugal	0.0	0.0	0.0	0.0	$7.2x10^7$	$8.7x10^7$	$9.7x10^7$	$1.0x10^8$	$1.1x10^8$	$1.4x10^8$
Doha International	Qatar	$1.1x10^8$	$1.0x10^8$	$7.4x10^7$	$2.9x10^7$	$3.3x10^7$	$3.0x10^7$	$2.5x10^7$	$5.9x10^6$	$5.9x10^6$	$5.7x10^6$
Bucharest-Otopeni	Romania	$2.1x10^7$	$2.1x10^7$	$2.7x10^7$	$3.0x10^7$	$3.8x10^7$	$4.0x10^7$	$4.8x10^7$	$6.0x10^7$	$1.4x10^8$	$2.0x10^8$
Moskwa-Sheremetyevo	Russian Fed.	$4.7x10^7$	$6.8x10^7$	$1.1x10^8$	$1.3x10^8$	$1.6x10^8$	$2.3x10^8$	$2.9x10^8$	$3.1x10^8$	$3.1x10^8$	$3.5x10^8$
St.-Petersburg-Pulkovo	Russian Fed.	$2.5x10^7$	$3.2x10^7$	$3.9x10^7$	$5.9x10^7$	$5.1x10^7$	$7.1x10^7$	$7.0x10^7$	$7.3x10^7$	$7.4x10^7$	$1.0x10^8$
Dhahran International	Saudi Arabia	$3.0x10^7$	$8.5x10^7$	$9.0x10^7$	0.0	$1.6x10^8$	$1.9x10^8$	$1.8x10^8$	$1.5x10^8$	$1.6x10^8$	$1.7x10^8$
Jeddah-King Abdulaziz International	Saudi Arabia	0.0	0.0	0.0	$6.9x10^7$	$5.0x10^7$	$8.2x10^7$	$8.8x10^7$	$8.8x10^7$	$9.7x10^7$	$9.9x10^7$
Freetown-Lungi	Sierra Leone	0.0	0.0	0.0	$1.7x10^8$	$1.2x10^8$	$1.3x10^8$	$1.4x10^8$	$1.0x10^8$	$1.1x10^8$	$5.1x10^7$
Singapore-Changi	Singapore	$1.6x10^9$	$1.8x10^9$	$1.6x10^9$	$1.3x10^9$	$2.0x10^9$	$2.0x10^9$	$2.2x10^9$	$2.4x10^9$	$2.5x10^9$	$2.5x10^9$
Capetown	South Africa	0.0	0.0	0.0	0.0	$5.2x10^7$	$2.6x10^8$	$2.7x10^8$	$4.6x10^8$	$6.0x10^8$	$7.5x10^8$
Johannesburg-International	South Africa	$8.6x10^8$	$8.2x10^8$	$8.1x10^8$	$8.1x10^8$	$7.5x10^8$	$6.0x10^8$	$8.0x10^8$	$9.3x10^8$	$1.1x10^9$	$1.3x10^9$

Geographic location Name (City/Airport)	Country	Passenger kilometres (km) 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Seoul-Kimpo International	South Korea	$1.3x10^8$	$2.0x10^8$	$3.5x10^8$	$4.0x10^8$	$4.9x10^8$	$5.9x10^8$	$6.7x10^8$	$1.0x10^9$	$1.1x10^9$	$1.2x10^9$
Alicante	Spain	$4.3x10^8$	$3.6x10^8$	$3.0x10^8$	$1.9x10^8$	$1.9x10^8$	$1.8x10^8$	$2.4x10^8$	$2.7x10^8$	$3.0x10^8$	$3.6x10^8$
Almeria	Spain	$1.4x10^7$	$1.5x10^7$	$1.1x10^7$	$1.4x10^7$	$9.6x10^6$	$9.2x10^6$	$1.4x10^7$	$2.8x10^7$	$2.5x10^7$	$2.6x10^7$
Arrecife (Lanzarote)-Canary Islands	Spain	$6.6x10^7$	$7.6x10^7$	$5.1x10^7$	$8.1x10^7$	$1.6x10^8$	$2.0x10^8$	$2.9x10^8$	$2.7x10^8$	$2.7x10^8$	$3.2x10^8$
Barcelona	Spain	$8.6x10^7$	$1.2x10^8$	$1.4x10^8$	$1.7x10^8$	$2.6x10^8$	$3.0x10^8$	$3.3x10^8$	$3.6x10^8$	$4.1x10^8$	$5.0x10^8$
Gerona-Costa Brava	Spain	$5.3x10^7$	$4.2x10^7$	$2.8x10^7$	$2.3x10^7$	$2.0x10^7$	$1.5x10^7$	$1.8x10^7$	$1.9x10^7$	$2.0x10^7$	$2.0x10^7$
Ibiza	Spain	$1.1x10^8$	$9.4x10^7$	$6.2x10^7$	$7.0x10^7$	$5.6x10^7$	$6.1x10^7$	$8.4x10^7$	$8.1x10^7$	$8.0x10^7$	$7.7x10^7$
Santa Cruz (La Palma)- Canary Islands	Spain	0.0	0.0	0.0	0.0	0.0	$2.9x10^7$	$4.2x10^7$	$5.0x10^7$	$6.5x10^7$	$8.1x10^7$
Las Palmas (Gran Canaria)- Canary Islands	Spain	$9.9x10^8$	$8.6x10^8$	$7.4x10^8$	$8.4x10^8$	$8.9x10^8$	$8.9x10^8$	$9.9x10^8$	$9.8x10^8$	$9.3x10^8$	$1.0x10^9$
Madrid-Barajas	Spain	$1.8x10^8$	$1.9x10^8$	$2.1x10^8$	$2.5x10^8$	$3.8x10^8$	$4.2x10^8$	$4.1x10^8$	$4.4x10^8$	$4.5x10^8$	$5.0x10^8$
Mahon-Menorca	Spain	$3.2x10^7$	$2.6x10^7$	$1.4x10^7$	$1.5x10^7$	$1.3x10^7$	$1.1x10^7$	$1.6x10^7$	$2.0x10^7$	$2.5x10^7$	$2.9x10^7$
Malaga	Spain	$6.3x10^8$	$5.5x10^8$	$4.6x10^8$	$3.9x10^8$	$3.0x10^8$	$2.9x10^8$	$4.1x10^8$	$4.5x10^8$	$4.8x10^8$	$5.4x10^8$
Palma de Mallorca	Spain	$3.8x10^8$	$3.1x10^8$	$2.5x10^8$	$2.5x10^8$	$2.4x10^8$	$2.3x10^8$	$3.0x10^8$	$2.9x10^8$	$2.9x10^8$	$2.8x10^8$
Puerto del Rosario (Fuerteventura)- Canary Islands	Spain	$3.9x10^7$	$3.4x10^7$	$5.4x10^7$	$9.5x10^7$	$8.7x10^7$	$9.3x10^7$	$1.3x10^8$	$1.2x10^8$	$1.2x10^8$	$1.4x10^8$
Reus-Tarragona	Spain	$4.4x10^7$	$4.0x10^7$	$2.4x10^7$	$1.3x10^7$	$1.8x10^7$	$1.3x10^7$	$1.8x10^7$	$2.1x10^7$	$2.0x10^7$	$2.3x10^7$
Sevilla	Spain	0.0	0.0	0.0	$1.0x10^8$	$3.3x10^7$	$2.6x10^7$	$2.5x10^7$	$2.4x10^7$	$2.1x10^7$	$1.7x10^7$
Santa Cruz (Tenerife)- Canary Islands	Spain	$3.6x10^8$	$3.4x10^8$	$3.7x10^8$	$4.6x10^8$	$4.7x10^8$	$4.7x10^8$	$6.1x10^8$	$5.7x10^8$	$5.7x10^8$	$6.6x10^8$
Valencia	Spain	$1.7x10^7$	$2.4x10^7$	$3.1x10^7$	$2.4x10^7$	$4.7x10^7$	$2.0x10^7$	0.0	0.0	0.0	0.0
Colombo-Katunayake/Bandaranayake International	Sri Lanka	$6.5x10^8$	$7.7x10^8$	$7.2x10^8$	$8.1x10^8$	$6.3x10^8$	$6.7x10^8$	$7.4x10^8$	$7.8x10^8$	$6.2x10^8$	$4.3x10^8$
Khartoum	Sudan	$1.1x10^8$	$1.5x10^8$	$1.6x10^8$	$1.6x10^8$	$4.4x10^7$	$4.6x10^7$	$4.5x10^7$	$6.4x10^7$	$6.8x10^7$	$1.8x10^7$
Paramaribo-J.A. Pengel	Suriname	$6.1x10^8$	$7.3x10^8$	$7.3x10^8$	$7.9x10^8$	$7.4x10^8$	$5.7x10^8$	$5.5x10^8$	$6.3x10^8$	$7.7x10^8$	$8.8x10^8$
Göteborg-Landvetter	Sweden	$1.2x10^7$	$1.0x10^7$	$2.8x10^7$	$3.0x10^7$	$9.7x10^7$	$1.0x10^8$	$1.1x10^8$	$1.3x10^8$	$1.4x10^8$	$1.5x10^8$
Malmö/Sturup	Sweden	0.0	$5.4x10^6$	$1.3x10^7$	$1.2x10^7$	$1.7x10^7$	$2.8x10^7$	$3.0x10^7$	$3.1x10^7$	$3.5x10^7$	$5.0x10^7$
Stockholm-Arlanda	Sweden	$1.8x10^8$	$2.0x10^8$	$2.2x10^8$	$2.1x10^8$	$2.3x10^8$	$2.9x10^8$	$3.3x10^8$	$3.5x10^8$	$3.7x10^8$	$4.3x10^8$
Basel	Switzerland	$1.3x10^7$	$1.5x10^7$	$1.2x10^7$	$1.3x10^7$	$1.4x10^7$	$1.4x10^7$	$1.8x10^7$	$1.9x10^7$	$1.8x10^7$	$2.0x10^7$
Bern-Belp	Switzerland	0.0	0.0	0.0	0.0	0.0	0.0	$2.8x10^6$	$1.2x10^7$	$1.8x10^7$	$1.9x10^7$
Geneva-Cointrin	Switzerland	$1.0x10^8$	$1.1x10^8$	$1.1x10^8$	$1.1x10^8$	$1.3x10^8$	$1.5x10^8$	$1.6x10^8$	$1.7x10^8$	$1.7x10^8$	$1.8x10^8$
Zürich	Switzerland	$1.8x10^8$	$1.9x10^8$	$2.0x10^8$	$1.9x10^8$	$2.1x10^8$	$2.4x10^8$	$2.5x10^8$	$2.6x10^8$	$2.8x10^8$	$3.1x10^8$

Geographic location Name (City/Airport)	Country	Passenger kilometres (km) 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Damascus International	Syria	$5.7x10^7$	$5.8x10^7$	$5.7x10^7$	$1.9x10^7$	$3.0x10^7$	$5.2x10^7$	$9.6x10^7$	$1.1x10^8$	$1.3x10^8$	$1.4x10^8$
Taipei-Chiang Kai Shek	Taiwan	$1.9x10^9$	$2.1x10^9$	$2.4x10^9$	$2.2x10^9$	$1.1x10^9$	$1.1x10^9$	$9.2x10^8$	$9.2x10^8$	$1.1x10^9$	$1.7x10^9$
Dar es Salaam	Tanzania	$3.3x10^7$	0.0	0.0	0.0	$1.7x10^8$	$1.6x10^8$	$1.7x10^8$	$2.3x10^8$	$2.3x10^8$	$2.0x10^8$
Kilimanjaro	Tanzania	0.0	0.0	0.0	0.0	$7.8x10^7$	$1.3x10^8$	$1.5x10^8$	$1.6x10^8$	$1.8x10^8$	$2.0x10^8$
Bangkok-International	Thailand	$2.2x10^8$	$2.1x10^8$	$3.1x10^8$	$3.4x10^8$	$2.3x10^9$	$2.4x10^9$	$2.4x10^9$	$2.3x10^9$	$2.2x10^9$	$2.3x10^9$
Phuket-International	Thailand	0.0	0.0	0.0	$2.3x10^8$	$1.6x10^8$	$1.2x10^8$	$1.4x10^8$	$1.4x10^8$	$5.2x10^7$	$1.1x10^8$
Lome-Tokoin	Togo	$2.2x10^8$	$2.2x10^8$	$2.2x10^8$	$2.2x10^8$	$4.1x10^7$	$3.4x10^7$	$4.8x10^7$	$6.6x10^7$	$5.1x10^7$	$5.6x10^7$
Monastir - Habib Bourguiba International	Tunisia	$3.2x10^8$	$3.8x10^8$	$3.3x10^8$	$1.6x10^8$	$2.2x10^8$	$2.2x10^8$	$2.5x10^8$	$2.2x10^8$	$2.2x10^8$	$1.8x10^8$
Tunis-Carthage	Tunisia	$4.1x10^7$	$3.7x10^7$	$4.0x10^7$	$3.7x10^7$	$4.4x10^7$	$5.4x10^7$	$6.4x10^7$	$6.0x10^7$	$5.8x10^7$	$3.8x10^7$
Ankara-Esenboga/Etimusgut	Turkey	$9.8x10^7$	$9.9x10^7$	$1.1x10^8$	$8.9x10^7$	$1.8x10^8$	$2.5x10^8$	$2.8x10^8$	$3.0x10^8$	$3.1x10^8$	$3.7x10^8$
Antalya	Turkey	$7.6x10^7$	$1.3x10^8$	$2.6x10^8$	$1.4x10^8$	$3.2x10^8$	$3.3x10^8$	$2.7x10^8$	$2.9x10^8$	$3.2x10^8$	$3.7x10^8$
Istanbul-Atatürk	Turkey	$1.7x10^8$	$2.5x10^8$	$3.0x10^8$	$3.7x10^8$	$3.8x10^8$	$4.7x10^8$	$5.2x10^8$	$5.8x10^8$	$6.4x10^8$	$7.6x10^8$
Izmir	Turkey	$6.2x10^7$	$7.5x10^7$	$1.1x10^8$	$7.3x10^7$	$2.4x10^8$	$2.5x10^8$	$1.9x10^8$	$2.3x10^8$	$2.4x10^8$	$2.8x10^8$
Mugla-Dalaman	Turkey	$5.4x10^7$	$9.2x10^7$	$1.4x10^8$	$1.5x10^8$	$2.3x10^8$	$2.2x10^8$	$1.8x10^8$	$2.1x10^8$	$2.4x10^8$	$2.9x10^8$
Abu Dhabi International	UAE	$2.5x10^7$	$5.3x10^4$	$5.7x10^7$	$1.0x10^8$	$8.7x10^7$	$1.5x10^8$	$1.8x10^8$	$2.0x10^8$	$2.0x10^8$	$2.2x10^8$
Dubai-International	UAE	0.0	0.0	$1.2x10^7$	$2.7x10^8$	$2.2x10^8$	$2.8x10^8$	$3.1x10^8$	$4.4x10^8$	$5.3x10^8$	$5.7x10^8$
Aberdeen-Dyce	UK	$7.0x10^7$	$8.4x10^7$	$9.2x10^7$	$1.0x10^8$	$4.7x10^7$	$5.0x10^7$	$5.7x10^7$	$6.6x10^7$	$8.6x10^7$	$1.1x10^8$
Belfast-Aldergrove	UK	$4.8x10^7$	$6.5x10^7$	$6.9x10^7$	$7.1x10^7$	$2.9x10^7$	$3.5x10^7$	$3.1x10^7$	$2.6x10^7$	$2.6x10^7$	$5.2x10^7$
Birmingham	UK	$3.2x10^7$	$3.0x10^7$	$2.9x10^7$	$3.0x10^7$	$6.1x10^7$	$7.5x10^7$	$8.9x10^7$	$1.0x10^8$	$1.2x10^8$	$1.4x10^8$
Bristol-Lulsgate	UK	0.0	0.0	$4.3x10^6$	$8.6x10^6$	$2.1x10^7$	$2.6x10^7$	$2.9x10^7$	$3.3x10^7$	$3.4x10^7$	$4.0x10^7$
Cambridge	UK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$5.8x10^6$	$5.1x10^6$	$4.6x10^6$
Cardiff	UK	$1.6x10^7$	$2.2x10^7$	$2.4x10^7$	$2.5x10^7$	$1.9x10^7$	$2.6x10^7$	$3.2x10^7$	$3.5x10^7$	$4.1x10^7$	$5.0x10^7$
East Midlands	UK	$1.7x10^7$	$2.1x10^7$	$2.1x10^7$	$1.9x10^7$	$2.2x10^7$	$2.4x10^7$	$2.6x10^7$	$3.2x10^7$	$3.7x10^7$	$4.2x10^7$
Edinburgh	UK	0.0	0.0	$9.6x10^6$	0.0	$4.9x10^7$	$5.5x10^7$	$7.0x10^7$	$7.8x10^7$	$1.0x10^8$	$1.4x10^8$
Glasgow	UK	$6.2x10^7$	$8.1x10^7$	$8.4x10^7$	$8.0x10^7$	$5.3x10^7$	$6.7x10^7$	$7.7x10^7$	$8.2x10^7$	$1.1x10^8$	$1.4x10^8$
Guernsey-Channel Island	UK	$1.0x10^7$	$9.7x10^6$	$9.5x10^6$	$9.7x10^6$	$6.6x10^6$	$6.4x10^6$	$5.2x10^6$	$5.1x10^6$	$5.6x10^6$	$5.1x10^6$
Humberside/Hull	UK	$9.5x10^6$	$9.5x10^6$	$1.1x10^7$	$1.4x10^7$	$1.8x10^7$	$2.1x10^7$	$2.2x10^7$	$2.3x10^7$	$2.8x10^7$	$3.5x10^7$
Leeds Bradford	UK	$1.8x10^7$	$2.3x10^7$	$2.4x10^7$	$2.2x10^7$	$2.5x10^7$	$2.4x10^7$	$2.6x10^7$	$2.9x10^7$	$3.3x10^7$	$4.4x10^7$

Geographic location Name (City/Airport)	Country	Passenger kilometres (km) 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
London-city	UK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$1.7x10^7$	$4.9x10^7$
Londonderry-Eglinton	UK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$3.4x10^7$	0.0	0.0
London-Gatwick	UK	0.0	$1.3x10^8$	$1.4x10^8$	$1.2x10^8$	0.0	0.0	0.0	$9.4x10^7$	$1.3x10^8$	$1.4x10^8$
London-Heathrow	UK	$6.7x10^8$	$5.3x10^8$	$5.7x10^8$	$5.4x10^8$	$7.6x10^8$	$7.6x10^8$	$8.0x10^8$	$6.8x10^8$	$6.8x10^8$	$7.2x10^8$
London-Luton	UK	$4.9x10^6$	$3.4x10^6$	$6.6x10^6$	$1.7x10^6$	0.0	0.0	0.0	$3.1x10^6$	$4.0x10^7$	$6.0x10^7$
London-Stansted	UK	0.0	$2.1x10^7$	$2.3x10^7$	$3.1x10^7$	0.0	0.0	0.0	$4.5x10^7$	$7.3x10^7$	$1.0x10^8$
Lydd/Lympne	UK	$7.2x10^6$	$1.2x10^7$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Manchester	UK	$9.3x10^7$	$1.1x10^8$	$1.2x10^8$	$1.2x10^8$	$1.5x10^8$	$1.7x10^8$	$1.9x10^8$	$1.5x10^8$	$2.0x10^8$	$2.4x10^8$
Manston	UK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$2.3x10^7$	0.0	0.0
Newcastle	UK	$2.3x10^7$	$1.3x10^7$	$9.8x10^6$	$1.8x10^7$	$4.0x10^7$	$5.0x10^7$	$5.8x10^7$	$4.6x10^7$	$7.8x10^7$	$9.6x10^7$
North Weald	UK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$8.4x10^6$	0.0	0.0
Norwich	UK	$9.2x10^6$	$1.0x10^7$	$1.1x10^7$	$1.2x10^7$	$1.4x10^7$	$1.5x10^7$	$1.7x10^7$	$1.4x10^7$	$2.0x10^7$	$2.3x10^7$
Nottingham	UK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$6.6x10^6$	0.0	0.0
Southampton	UK	$6.8x10^6$	$9.1x10^6$	$1.2x10^7$	$1.3x10^7$	$1.6x10^7$	$1.7x10^7$	$1.9x10^7$	$2.1x10^7$	$2.3x10^7$	$3.1x10^7$
Teesside	UK	0.0	$4.0x10^6$	$9.3x10^6$	$3.9x10^6$	$1.3x10^7$	$1.7x10^7$	$2.0x10^7$	$2.1x10^7$	$2.7x10^7$	$3.5x10^7$
Kiev-Borispol	Ukraine	0.0	0.0	0.0	0.0	$3.1x10^6$	$3.1x10^7$	$6.3x10^7$	$7.7x10^7$	$9.3x10^7$	$9.6x10^7$
Montevideo	Uruguay	0.0	0.0	0.0	0.0	$1.3x10^8$	$1.2x10^8$	$1.4x10^8$	$1.0x10^8$	0.0	0.0
Atlanta GA-The WB Hartsfield Atlanta International	USA	$7.3x10^8$	$7.5x10^8$	$1.1x10^9$	$1.2x10^9$	$1.4x10^9$	$1.3x10^9$	$1.3x10^9$	$1.2x10^9$	$1.3x10^9$	$1.6x10^9$
Baltimore MD-Washington International	USA	$9.8x10^7$	$1.0x10^8$	$2.5x10^8$	$5.7x10^8$	$5.3x10^8$	$1.4x10^8$	0.0	0.0	0.0	0.0
Boston MA-General EL Logan International	USA	$3.1x10^7$	0.0	0.0	$6.4x10^8$	$6.1x10^8$	$8.2x10^8$	$1.1x10^9$	$9.6x10^8$	$9.3x10^8$	$9.7x10^8$
Chicago IL-O'Hare International	USA	$1.2x10^9$	$1.3x10^9$	$1.2x10^9$	$1.0x10^9$	$1.1x10^9$	$1.1x10^9$	$1.1x10^9$	$1.0x10^9$	$1.3x10^9$	$1.3x10^9$
Denver CO-International	USA	0.0	0.0	0.0	0.0	0.0	0.0	$1.4x10^8$	$2.5x10^8$	$1.3x10^8$	$1.3x10^8$
Detroit MI-Metropolitan	USA	$2.7x10^8$	$6.2x10^8$	$7.4x10^7$	$5.8x10^7$	$8.5x10^8$	$1.1x10^9$	$1.4x10^9$	$2.3x10^9$	$3.0x10^9$	$3.8x10^9$
Fort Lauderdale FL-Executive	USA	0.0	0.0	0.0	$1.0x10^8$	$1.9x10^8$	$1.8x10^8$	$1.7x10^8$	$1.2x10^8$	0.0	0.0
Houston TX-George Bush Intercontinent	USA	$4.5x10^7$	0.0	0.0	0.0	$9.6x10^8$	$1.2x10^9$	$1.2x10^9$	$1.3x10^9$	$1.4x10^9$	$1.4x10^9$
Los Angeles CA-International	USA	$1.9x10^9$	$2.0x10^9$	$3.0x10^9$	$2.2x10^9$	$2.1x10^9$	$2.1x10^9$	$2.1x10^9$	$2.2x10^9$	$2.6x10^9$	$3.0x10^9$
Memphis TN-International	USA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$3.5x10^8$	$1.0x10^9$	$1.2x10^9$
Miami FL-International	USA	$3.0x10^8$	$5.7x10^8$	$6.3x10^8$	$7.3x10^8$	$8.2x10^8$	$1.0x10^9$	$6.9x10^8$	$7.4x10^8$	$9.6x10^8$	$1.0x10^9$

Geographic location Name (City/Airport)	Country	Passenger kilometres (km) 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Minneapolis/St. Paul MN-International	USA	$8.8x10^7$	$8.5x10^7$	$9.6x10^7$	$3.1x10^8$	$5.4x10^8$	$9.8x10^8$	$1.7x10^9$	$2.3x10^9$	$2.5x10^9$	$2.6x10^9$
New York NY-John F. Kennedy International	USA	$3.2x10^9$	$3.1x10^9$	$3.0x10^9$	$3.0x10^9$	$3.3x10^9$	$3.3x10^9$	$3.2x10^9$	$3.4x10^9$	$3.3x10^9$	$3.4x10^9$
Newark NJ-Newark International	USA	0.0	0.0	0.0	$6.3x10^7$	$1.1x10^8$	$7.8x10^7$	$8.2x10^7$	$1.1x10^8$	$1.0x10^8$	$7.4x10^8$
Oakland CA -Metropolitan International	USA	0.0	$9.9x10^7$	0.0	$1.4x10^8$	$2.0x10^8$	$1.4x10^8$	$1.7x10^8$	$2.1x10^8$	$2.5x10^8$	$2.2x10^8$
Orlando International	USA	$5.1x10^7$	$3.6x10^8$	$5.0x10^8$	$4.8x10^8$	$5.9x10^8$	$5.5x10^8$	$8.8x10^8$	$6.4x10^8$	$8.0x10^8$	$6.9x10^8$
San Francisco CA-International	USA	$1.7x10^8$	$1.0x10^8$	$2.3x10^8$	0.0	0.0	$8.2x10^8$	$1.0x10^9$	$9.0x10^8$	$1.2x10^9$	$1.6x10^9$
Seattle-Tacoma International	USA	0.0	0.0	0.0	0.0	$1.3x10^8$	$1.3x10^8$	$1.3x10^8$	$1.9x10^8$	$1.7x10^8$	$1.5x10^8$
Tampa FL-International	USA	0.0	$3.6x10^7$	$2.0x10^8$	$2.7x10^8$	$2.7x10^8$	$3.5x10^8$	$3.6x10^8$	$3.2x10^8$	$2.6x10^8$	$2.8x10^8$
Washington DC-Dulles International	USA	0.0	0.0	0.0	0.0	0.0	$8.1x10^8$	$1.1x10^9$	$1.1x10^9$	$1.8x10^9$	$1.9x10^9$
Caracas-Maiquetia/Simon Bolivar International	Venezuela	$3.1x10^7$	$5.1x10^7$	$1.9x10^8$	$2.1x10^8$	$3.4x10^8$	$4.1x10^8$	$4.2x10^8$	$5.5x10^8$	$4.8x10^8$	$8.1x10^8$
Isla Margarita-Del Caribe International, General Santiago Mariño	Venezuela	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$4.3x10^8$	$5.1x10^8$	0.0
Paraguana-Josefa Camejo International	Venezuela	0.0	0.0	0.0	0.0	0.0	0.0	$2.1x10^8$	0.0	0.0	$5.1x10^8$
Hochiminh/Tansonnhat International	Vietnam	0.0	0.0	0.0	0.0	0.0	$7.4x10^7$	$2.2x10^8$	$2.9x10^8$	$2.5x10^8$	$2.8x10^8$
Belgrade	Yugoslavia	$7.1x10^7$	$7.2x10^7$	$8.8x10^7$	$5.8x10^7$	$1.1x10^7$	0.0	$2.3x10^6$	$3.9x10^7$	$5.7x10^7$	$6.9x10^7$
Harare-International	Zimbabwe	0.0	0.0	0.0	0.0	0.0	$9.3x10^7$	$1.4x10^8$	$1.6x10^8$	$1.7x10^8$	$2.0x10^8$

Table 9 *Collective effective dose (manSv) for all passengers flying on outward and return flights (from/to Amsterdam) for all destination airports used in the calculations in this report. Data are given for 1988 up to and including 1997. Data are alphabetically arranged by country.*

Location name		Collective effective dose (manSv)									
Name (City/Airport)	**Country**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Buenos Aires-Ezeiza/Ministro Pistarini International	Argentina	4.8×10^{-1}	4.7×10^{-1}	4.2×10^{-1}	5.5×10^{-1}	8.5×10^{-1}	1.1	1.7	1.5	1.6	1.9
Aruba-Reina Beatrix	Aruba	7.1×10^{-2}	1.8×10^{-1}	8.2×10^{-2}	3.8×10^{-1}	2.7	2.7	2.6	2.6	3.1	3.1
Melbourne	Australia	1.4×10^{-1}	4.8×10^{-1}	2.9×10^{-1}	0.0	1.2	1.5	0.0	0.0	0.0	0.0
Sydney-Kingsford Smith	Australia	2.5	1.9	1.9	1.6	1.5	2.0	3.6	4.6	5.1	5.3
Innsbruck	Austria	0.0	0.0	3.1×10^{-2}	5.7×10^{-2}	5.1×10^{-2}	1.1×10^{-1}	1.1×10^{-1}	9.7×10^{-2}	1.5×10^{-1}	1.6×10^{-1}
Salzburg-WA Mozart	Austria	0.0	0.0	0.0	0.0	3.3×10^{-2}	5.7×10^{-2}	1.3×10^{-1}	2.3×10^{-1}	2.4×10^{-1}	2.7×10^{-1}
Wien-International/Schwechat	Austria	6.3×10^{-1}	5.8×10^{-1}	7.3×10^{-1}	8.4×10^{-1}	1.1	1.6	1.7	1.9	2.0	2.2
Bahrain	Bahrain	3.3×10^{-1}	6.7×10^{-2}	1.0×10^{-1}	1.0×10^{-2}	3.8×10^{-1}	6.4×10^{-1}	8.9×10^{-1}	9.1×10^{-1}	1.2	1.3
Dhaka-Zia International	Bangladesh	4.3×10^{-1}	3.0×10^{-1}	2.5×10^{-1}	3.3×10^{-1}	2.1×10^{-1}	1.6×10^{-1}	3.2×10^{-1}	1.1	1.1	0.0
Antwerpen/Deurne	Belgium	4.1×10^{-2}	3.3×10^{-2}	2.8×10^{-2}	3.2×10^{-2}	4.2×10^{-2}	5.1×10^{-2}	6.3×10^{-2}	6.3×10^{-2}	7.2×10^{-2}	7.6×10^{-2}
Brussels	Belgium	1.7×10^{-1}	1.7×10^{-1}	1.7×10^{-1}	2.0×10^{-1}	2.3×10^{-1}	3.0×10^{-1}	3.5×10^{-1}	3.5×10^{-1}	3.6×10^{-1}	4.1×10^{-1}
Rio de Janeiro International-Galeao Antonio Carlos Jobim	Brazil	8.8×10^{-1}	9.2×10^{-1}	9.4×10^{-1}	8.4×10^{-1}	2.2	2.2	2.5	2.7	3.5	3.8
Sao Paulo-Guarulhos International	Brazil	0.0	0.0	0.0	0.0	6.7×10^{-1}	7.8×10^{-1}	1.0	1.2	1.4	1.7
Plovdiv	Bulgaria	0.0	2.5×10^{-2}	4.7×10^{-2}	8.0×10^{-2}	9.0×10^{-2}	1.3×10^{-1}	1.2×10^{-1}	1.1×10^{-1}	8.7×10^{-2}	6.7×10^{-2}
Sofija	Bulgaria	9.2×10^{-2}	9.3×10^{-2}	1.0×10^{-1}	1.1×10^{-1}	1.4×10^{-1}	1.6×10^{-1}	1.5×10^{-1}	2.0×10^{-1}	2.2×10^{-1}	1.9×10^{-1}
Calgary-International	Canada	0.0	0.0	0.0	0.0	2.0	2.4	2.9	3.3	4.5	1.3
Halifax	Canada	3.5×10^{-1}	2.9×10^{-1}	0.0	1.3×10^{-1}	8.0×10^{-1}	1.1	1.4	1.5	5.9×10^{-1}	2.6×10^{-1}
Montreal-Dorval	Canada	6.0	4.8	4.9	4.7	6.0	7.1	6.8	7.3	7.9	9.2
Ottawa-MacDonald Cartier International	Canada	0.0	9.8×10^{-1}	1.5	1.5	9.0×10^{-1}	1.4	1.3	1.3	2.9×10^{-1}	0.0
Toronto-L.B. Pearson	Canada	1.6×10^{1}	1.3×10^{1}	1.2×10^{1}	1.0×10^{1}	1.1×10^{1}	1.2×10^{1}	1.3×10^{1}	1.6×10^{1}	1.6×10^{1}	1.7×10^{1}
Vancouver-International	Canada	1.1×10^{1}	8.4	4.7	5.1	4.8	4.7	5.5	5.4	6.4	9.3
Sal Oceanic/Island-Amilcar Cabral International	Cape Verde Islands	0.0	7.2×10^{-2}	1.3×10^{-1}	8.9×10^{-2}	2.7×10^{-1}	2.3×10^{-1}	2.7×10^{-1}	2.8×10^{-1}	2.0×10^{-1}	1.8×10^{-1}
Santiago-Arturo Merino Benitez International	Chile	2.5	2.3	2.2	2.2	6.6×10^{-1}	8.1×10^{-1}	9.9×10^{-1}	1.0	1.4	1.4
Beijing-Capital International	China	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0×10^{-3}	1.2	3.0
San Jose-Juan Santamaria International	Costa Rica	2.2	2.0	2.0	1.9	9.2×10^{-1}	1.1	1.3	1.8	2.4	2.9

Location name Name (City/Airport)	Country	Collective effective dose (manSv) 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Dubrovnik-Cilipi	Croatia	$1.4x10^{-1}$	$1.1x10^{-1}$	$1.1x10^{-1}$	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pula	Croatia	$8.6x10^{-2}$	$7.2x10^{-2}$	$7.6x10^{-2}$	0.0	0.0	0.0	0.0	0.0	0.0	$2.6x10^{-2}$
Split	Croatia	$1.1x10^{-1}$	$8.8x10^{-2}$	$8.0x10^{-2}$	0.0	0.0	0.0	$3.1x10^{-2}$	0.0	$3.0x10^{-2}$	$3.0x10^{-2}$
Zagreb-Pleso	Croatia	0.0	0.0	0.0	0.0	0.0	$8.9x10^{-2}$	$1.6x10^{-1}$	$1.7x10^{-1}$	$1.9x10^{-1}$	$1.7x10^{-1}$
Holguin-Frank Pais	Cuba	0.0	0.0	0.0	0.0	$6.2x10^{-1}$	$7.7x10^{-1}$	$9.0x10^{-1}$	$7.0x10^{-1}$	$9.0x10^{-1}$	$5.1x10^{-1}$
Varadero-Juan Gualberto Gomez International	Cuba	0.0	0.0	0.0	0.0	0.0	$4.9x10^{-1}$	$5.5x10^{-1}$	$5.0x10^{-1}$	$6.4x10^{-1}$	$7.5x10^{-1}$
Larnaca International	Cyprus	$4.6x10^{-1}$	$5.0x10^{-1}$	$4.7x10^{-1}$	$6.6x10^{-1}$	$7.4x10^{-1}$	$7.8x10^{-1}$	$6.8x10^{-1}$	$8.4x10^{-1}$	$8.7x10^{-1}$	$8.8x10^{-1}$
Paphos-International	Cyprus	$1.3x10^{-1}$	$2.5x10^{-1}$	$2.4x10^{-1}$	$1.2x10^{-1}$	$3.5x10^{-1}$	$2.7x10^{-1}$	$4.2x10^{-1}$	$5.0x10^{-1}$	$4.7x10^{-1}$	$3.9x10^{-1}$
Praha-Ruzyne	Czech Rep.	$7.2x10^{-2}$	$8.0x10^{-2}$	$1.2x10^{-1}$	$2.0x10^{-1}$	$3.3x10^{-1}$	$5.3x10^{-1}$	$6.2x10^{-1}$	$7.1x10^{-1}$	$9.5x10^{-1}$	$9.9x10^{-1}$
Billund	Denmark	0.0	0.0	0.0	$1.4x10^{-2}$	$2.8x10^{-2}$	$8.2x10^{-2}$	$1.1x10^{-1}$	$1.5x10^{-1}$	$2.0x10^{-1}$	$2.6x10^{-1}$
København-Kastrup	Denmark	1.1	$9.9x10^{-1}$	1.0	$9.6x10^{-1}$	1.2	1.3	1.4	1.6	1.7	1.8
Puerto Plata-Gregorio Luperon International	Dominican Republic	0.0	0.0	0.0	1.6	1.9	0.0	0.0	3.1	3.4	0.0
Punta Cana International	Dominican Republic	0.0	$1.5x10^{-1}$	1.4	0.0	0.0	2.7	2.7	0.0	0.0	2.9
Santo Domingo-Las Americas International	Dominican Republic	0.0	0.0	0.0	0.0	$4.6x10^{-1}$	$8.1x10^{-1}$	$8.8x10^{-1}$	$8.3x10^{-1}$	$8.1x10^{-1}$	$5.3x10^{-1}$
Guayaquil-Simon Bolivar International	Ecuador	0.0	0.0	$7.1x10^{-1}$	$6.9x10^{-1}$	$2.3x10^{-1}$	$3.3x10^{-1}$	$4.1x10^{-1}$	$5.3x10^{-1}$	$6.8x10^{-1}$	$8.6x10^{-1}$
Quito-Mariscal Sucre	Ecuador	$3.7x10^{-1}$	$8.2x10^{-1}$	0.0	0.0	$5.4x10^{-1}$	$9.5x10^{-1}$	1.1	1.3	1.5	2.5
Cairo-International	Egypt	1.6	1.3	1.0	$8.1x10^{-1}$	1.7	1.2	1.1	1.4	1.7	2.1
Hurghada	Egypt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$7.8x10^{-2}$	$5.0x10^{-1}$	$7.0x10^{-1}$
Helsinki-Vantaa	Finland	1.5	1.5	1.4	1.3	1.1	1.3	1.5	1.7	1.9	2.3
Tampere-Pirkkala	Finland	$2.3x10^{-1}$	$1.8x10^{-1}$	$3.8x10^{-2}$	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lyon-Satolas/Saint Exupéry	France	$9.2x10^{-2}$	$1.4x10^{-1}$	$1.7x10^{-1}$	$2.1x10^{-1}$	$2.6x10^{-1}$	$3.6x10^{-1}$	$3.6x10^{-1}$	$4.1x10^{-1}$	$4.9x10^{-1}$	$6.8x10^{-1}$
Marseille-Provence/Marignane	France	$1.2x10^{-1}$	0.0	$3.1x10^{-2}$	$7.4x10^{-2}$	$1.4x10^{-1}$	$2.4x10^{-1}$	$3.4x10^{-1}$	$4.2x10^{-1}$	$3.2x10^{-1}$	$2.2x10^{-1}$
Mulhouse-Bale (Basel)	France	0.0	0.0	$3.1x10^{-2}$	$5.3x10^{-2}$	$9.8x10^{-2}$	$1.2x10^{-1}$	$1.2x10^{-1}$	$1.5x10^{-1}$	$1.9x10^{-1}$	$2.4x10^{-1}$
Nice/Côte d'Azur	France	$4.9x10^{-1}$	$4.7x10^{-1}$	$5.4x10^{-1}$	$5.7x10^{-1}$	$7.6x10^{-1}$	$8.5x10^{-1}$	$7.4x10^{-1}$	$8.1x10^{-1}$	$7.8x10^{-1}$	1.3
Paris-Charles de Gaulle	France	1.4	1.4	1.4	1.4	1.7	1.9	2.1	2.0	2.0	2.3

Location name Name (City/Airport)	Country	Collective effective dose (manSv) 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Paris-Orly	France	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4×10^{-1}	2.1×10^{-1}	2.2×10^{-1}
Strassbourg-Entzheim	France	3.8×10^{-2}	4.9×10^{-2}	6.0×10^{-2}	6.5×10^{-2}	3.8×10^{-2}	9.9×10^{-2}	1.2×10^{-1}	1.3×10^{-1}	1.3×10^{-1}	1.3×10^{-1}
Toulouse-Blagnac	France	2.2×10^{-2}	0.0	2.5×10^{-2}	4.7×10^{-2}	9.6×10^{-2}	1.7×10^{-1}	2.4×10^{-1}	3.2×10^{-1}	4.0×10^{-1}	5.4×10^{-1}
Ohrid-Macedonia	FYROM	1.2×10^{-1}	1.0×10^{-1}	8.8×10^{-2}	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Skopje	FYROM	0.0	0.0	0.0	0.0	0.0	9.8×10^{-2}	1.4×10^{-1}	1.6×10^{-1}	1.4×10^{-1}	7.6×10^{-2}
Banjul-International	Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6×10^{-1}	5.1×10^{-1}	3.8×10^{-1}
Berlin-Tegel	Germany	2.3×10^{-1}	2.1×10^{-1}	1.9×10^{-1}	2.0×10^{-1}	3.6×10^{-1}	5.1×10^{-1}	5.9×10^{-1}	6.4×10^{-1}	6.9×10^{-1}	8.3×10^{-1}
Bremen	Germany	1.2×10^{-1}	1.2×10^{-1}	1.2×10^{-1}	1.3×10^{-1}	1.7×10^{-1}	2.1×10^{-1}	2.6×10^{-1}	2.8×10^{-1}	2.7×10^{-1}	3.0×10^{-1}
Dortmund-Wickede	Germany	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.2×10^{-2}	8.0×10^{-2}
Düsseldorf	Germany	1.2×10^{-1}	1.1×10^{-1}	1.0×10^{-1}	1.3×10^{-1}	1.4×10^{-1}	1.8×10^{-1}	1.9×10^{-1}	2.2×10^{-1}	1.8×10^{-1}	2.3×10^{-1}
Frankfurt-International	Germany	1.1	1.0	1.1	1.0	1.2	1.4	1.3	1.4	1.4	1.5
Hamburg	Germany	3.1×10^{-1}	3.2×10^{-1}	3.0×10^{-1}	3.3×10^{-1}	3.9×10^{-1}	5.0×10^{-1}	5.7×10^{-1}	6.3×10^{-1}	6.2×10^{-1}	6.5×10^{-1}
Hannover	Germany	8.9×10^{-2}	8.6×10^{-2}	8.9×10^{-2}	1.3×10^{-1}	1.6×10^{-1}	2.1×10^{-1}	2.4×10^{-1}	2.6×10^{-1}	2.8×10^{-1}	3.4×10^{-1}
Köln/Bonn	Germany	4.3×10^{-3}	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6×10^{-2}	1.4×10^{-1}
München-International	Germany	8.1×10^{-1}	7.5×10^{-1}	7.9×10^{-1}	8.5×10^{-1}	9.5×10^{-1}	1.2	1.2	1.4	1.4	1.6
Nördlingen	Germany	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7×10^{-2}	0.0	0.0
Nürnberg	Germany	7.3×10^{-2}	6.6×10^{-2}	7.8×10^{-2}	1.3×10^{-1}	1.9×10^{-1}	2.5×10^{-1}	2.6×10^{-1}	2.2×10^{-1}	3.5×10^{-1}	4.5×10^{-1}
Paderborn-Lippstadt	Germany	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7×10^{-2}	6.3×10^{-2}
Stuttgart	Germany	1.8×10^{-1}	1.8×10^{-1}	1.9×10^{-1}	2.6×10^{-1}	3.1×10^{-1}	4.4×10^{-1}	5.1×10^{-1}	5.3×10^{-1}	5.9×10^{-1}	6.4×10^{-1}
Accra-Kotoka International	Ghana	1.2	1.2	1.0	1.2	7.5×10^{-1}	9.6×10^{-1}	1.0	1.0	1.2	1.2
Athens	Greece	2.3	1.9	1.9	1.5	2.1	2.3	2.6	2.5	2.6	3.1
Heraklion-Nikos Kazantzakis	Greece	1.7	1.9	2.4	2.2	3.0	2.9	3.2	2.7	2.4	2.8
Karpathos	Greece	0.0	0.0	0.0	6.0×10^{-2}	1.3×10^{-1}	2.5×10^{-1}	2.7×10^{-1}	1.7×10^{-1}	1.6×10^{-1}	1.8×10^{-1}
Kerkyra-Ioannis Kapodistrias	Greece	2.6×10^{-1}	2.4×10^{-1}	3.0×10^{-1}	3.0×10^{-1}	4.7×10^{-1}	4.3×10^{-1}	5.3×10^{-1}	5.1×10^{-1}	5.1×10^{-1}	6.3×10^{-1}
Khania/Souda	Greece	8.1×10^{-2}	7.9×10^{-2}	7.0×10^{-2}	8.3×10^{-2}	1.1×10^{-1}	1.3×10^{-1}	2.3×10^{-1}	2.9×10^{-1}	2.7×10^{-1}	2.4×10^{-1}
Kos	Greece	4.9×10^{-1}	6.7×10^{-1}	6.9×10^{-1}	7.5×10^{-1}	1.1	9.9×10^{-1}	1.0	8.2×10^{-1}	7.7×10^{-1}	9.2×10^{-1}
Mitilini	Greece	1.4×10^{-1}	1.9×10^{-1}	1.7×10^{-1}	1.7×10^{-1}	2.1×10^{-1}	1.9×10^{-1}	2.4×10^{-1}	2.2×10^{-1}	2.3×10^{-1}	2.6×10^{-1}
Rodos-Diagoras	Greece	1.0	9.6×10^{-1}	1.0	9.6×10^{-1}	1.0	9.6×10^{-1}	9.9×10^{-1}	8.7×10^{-1}	7.6×10^{-1}	8.5×10^{-1}

Location name Name (City/Airport)	Country	Collective effective dose (manSv) 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Samos	Greece	$1.5x10^{-1}$	$1.8x10^{-1}$	$2.1x10^{-1}$	$1.9x10^{-1}$	$2.9x10^{-1}$	$3.3x10^{-1}$	$4.2x10^{-1}$	$4.1x10^{-1}$	$3.7x10^{-1}$	$4.4x10^{-1}$
Thessaloniki-International Airport	Greece	$4.5x10^{-2}$	$9.8x10^{-2}$	$6.6x10^{-2}$	$4.9x10^{-2}$	$1.6x10^{-1}$	$1.4x10^{-1}$	$1.7x10^{-1}$	$1.4x10^{-1}$	$1.7x10^{-1}$	$1.4x10^{-1}$
Zakinthos	Greece	$1.0x10^{-1}$	$1.2x10^{-1}$	$1.6x10^{-1}$	$1.9x10^{-1}$	$1.8x10^{-1}$	$1.6x10^{-1}$	$2.9x10^{-1}$	$2.3x10^{-1}$	$2.4x10^{-1}$	$3.1x10^{-1}$
Guatemala City-La Aurora	Guatemala	1.3	1.2	1.2	1.7	1.6	1.7	1.9	2.2	2.1	2.3
Hong Kong-International Airport	Hong Kong	2.5	2.3	2.7	3.3	3.3	4.7	5.5	6.4	8.2	8.2
Budapest-Ferihegy	Hungary	$5.0x10^{-1}$	$4.8x10^{-1}$	$5.7x10^{-1}$	$5.1x10^{-1}$	$6.9x10^{-1}$	1.2	1.2	1.1	1.4	1.6
Keflavik Nas	Iceland	0.0	$4.0x10^{-1}$	$2.8x10^{-1}$	$3.1x10^{-1}$	$4.4x10^{-1}$	$5.0x10^{-1}$	$6.6x10^{-1}$	$7.1x10^{-1}$	$8.2x10^{-1}$	$9.0x10^{-1}$
Calcutta-Netaji Subhash Chandra Bose International	India	0.0	0.0	0.0	0.0	0.0	$4.7x10^{-1}$	$5.1x10^{-1}$	$4.6x10^{-1}$	$4.8x10^{-1}$	$4.7x10^{-1}$
Delhi-Indira Gandhi International	India	0.0	0.0	0.0	0.0	2.3	3.0	3.3	3.3	3.4	3.9
Mumbai-Chhatrapati Shivaji International	India	$5.7x10^{-1}$	$3.7x10^{-1}$	$9.1x10^{-2}$	$7.9x10^{-1}$	$3.7x10^{-1}$	1.9	2.0	2.2	2.4	2.9
Denpasar-Bali International	Indonesia	1.5	1.9	2.2	2.9	1.5	2.1	3.0	3.2	3.1	2.5
Jakarta-Sukarno Hatta International	Indonesia	7.1	6.6	6.9	6.3	4.3	4.2	4.7	4.8	4.3	5.1
Medan-Polonia	Indonesia	0.0	0.0	0.0	0.0	$3.7x10^{-1}$	$5.0x10^{-1}$	$4.8x10^{-1}$	0.0	$3.7x10^{-1}$	$3.5x10^{-1}$
Tehran-Mehrabad	Iran	0.0	$3.8x10^{-5}$	0.0	$1.3x10^{-1}$	$3.2x10^{-1}$	$3.6x10^{-1}$	$4.7x10^{-1}$	$6.6x10^{-1}$	1.5	1.7
Cork	Ireland	$1.2x10^{-1}$	0.0	0.0	0.0	$2.6x10^{-2}$	$4.7x10^{-2}$	$5.4x10^{-2}$	$3.8x10^{-2}$	$4.6x10^{-2}$	$4.5x10^{-2}$
Dublin	Ireland	$3.3x10^{-1}$	$5.2x10^{-1}$	$6.6x10^{-1}$	$7.8x10^{-1}$	$6.6x10^{-1}$	$6.7x10^{-1}$	$7.3x10^{-1}$	$8.9x10^{-1}$	1.2	1.5
Ovda	Israel	$7.5x10^{-2}$	$1.1x10^{-1}$	$6.2x10^{-2}$	0.0	$8.7x10^{-2}$	$1.5x10^{-1}$	$2.3x10^{-1}$	$2.9x10^{-1}$	$3.9x10^{-1}$	$4.1x10^{-1}$
Tel Aviv-Ben Gurion	Israel	1.7	1.4	1.4	1.4	2.2	2.4	2.7	3.1	3.5	3.7
Bologna	Italy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$8.1x10^{-2}$	$5.1x10^{-1}$
Firenze-Peretola	Italy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$1.2x10^{-1}$	$1.9x10^{-1}$	$2.1x10^{-1}$
Milano-Linate	Italy	1.6	1.6	1.8	1.5	2.0	2.4	2.7	2.7	3.0	3.2
Milano-Malpensa	Italy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$9.5x10^{-2}$	0.0	0.0
Roma-Fiumicino/Leonardo da Vinci	Italy	1.5	1.5	1.6	1.6	2.1	2.5	2.7	2.7	2.8	2.9
Torino	Italy	0.0	0.0	0.0	$8.4x10^{-2}$	$1.4x10^{-1}$	$1.3x10^{-1}$	$1.3x10^{-1}$	$1.3x10^{-1}$	$2.2x10^{-1}$	$3.1x10^{-1}$
Treviso	Italy	0.0	$4.7x10^{-2}$	$1.1x10^{-1}$	$1.0x10^{-1}$	$2.4x10^{-1}$	$3.1x10^{-1}$	$7.7x10^{-2}$	0.0	0.0	0.0
Venezia-Marco Polo/Tessera	Italy	0.0	$3.1x10^{-2}$	0.0	$2.9x10^{-2}$	$4.2x10^{-2}$	0.0	$4.2x10^{-1}$	$6.5x10^{-1}$	$6.3x10^{-1}$	$7.1x10^{-1}$
Montego Bay-Sangster International	Jamaica	0.0	0.0	0.0	$7.1x10^{-1}$	1.1	1.2	1.3	1.2	1.2	1.4
Osaka-Kansai International	Japan	$8.3x10^{-1}$	$6.9x10^{-1}$	$4.8x10^{-1}$	$4.5x10^{-1}$	0.0	0.0	1.0	5.8	8.4	9.5

Location name Name (City/Airport)	Country	Collective effective dose (manSv) 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Tokyo-Narita/New Tokyo International	Japan	6.4	6.3	6.6	5.8	8.4	1.1×10^{1}	1.4×10^{1}	1.4×10^{1}	1.5×10^{1}	1.5×10^{1}
Amman-Queen Alia	Jordan	3.8×10^{-1}	3.8×10^{-1}	3.2×10^{-1}	1.4×10^{-1}	2.6×10^{-1}	4.5×10^{-1}	9.5×10^{-1}	0.0	1.1	1.1
Alma Ata/Almaty	Kazakhstan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.9×10^{-2}	5.9×10^{-1}	8.7×10^{-1}
Mombasa-Moi International	Kenya	0.0	0.0	4.8×10^{-1}	3.2×10^{-1}	2.4×10^{-1}	0.0	0.0	0.0	3.4×10^{-1}	2.8×10^{-1}
Nairobi-Jomo Kenyatta	Kenya	5.9×10^{-1}	5.7×10^{-1}	5.3×10^{-1}	5.9×10^{-1}	1.0	9.5×10^{-1}	9.9×10^{-1}	1.1	1.2	2.1
Kuwait International	Kuwait	9.0×10^{-2}	9.7×10^{-2}	5.1×10^{-2}	0.0	3.9×10^{-1}	6.1×10^{-1}	7.4×10^{-1}	9.6×10^{-1}	1.1	1.1
Bayrut International	Lebanon	0.0	0.0	0.0	4.0×10^{-2}	2.2×10^{-1}	3.4×10^{-1}	4.4×10^{-1}	5.2×10^{-1}	5.3×10^{-1}	5.3×10^{-1}
Monrovia-Roberts International	Liberia	5.2×10^{-1}	5.5×10^{-1}	2.2×10^{-1}	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tripoli International	Libya	1.8×10^{-1}	1.5×10^{-1}	1.3×10^{-1}	1.4×10^{-1}	3.6×10^{-2}	0.0	0.0	0.0	0.0	0.0
Luxembourg	Luxemburg	2.7×10^{-2}	1.7×10^{-2}	2.4×10^{-2}	1.3×10^{-2}	5.9×10^{-2}	8.6×10^{-2}	1.2×10^{-1}	1.3×10^{-1}	1.4×10^{-1}	1.7×10^{-1}
Lilongwe International	Malawi	8.9×10^{-1}	9.8×10^{-1}	9.3×10^{-1}	9.3×10^{-1}	3.5×10^{-1}	3.0×10^{-1}	4.2×10^{-1}	4.9×10^{-1}	4.2×10^{-1}	8.3×10^{-2}
Kuala Lumpur-Sultan Abdul Aziz Shah International	Malaysia	6.0×10^{-1}	6.4×10^{-1}	6.6×10^{-1}	8.0×10^{-1}	1.2	1.4	1.9	2.2	2.4	3.1
Valletta – Luqa/Malta International	Malta	3.9×10^{-1}	3.4×10^{-1}	3.9×10^{-1}	3.9×10^{-1}	5.6×10^{-1}	6.2×10^{-1}	9.0×10^{-1}	8.2×10^{-1}	8.9×10^{-1}	1.0
Agadir-Al Massira	Marocco	3.1×10^{-1}	2.9×10^{-1}	2.7×10^{-1}	2.1×10^{-1}	2.0×10^{-1}	1.8×10^{-1}	1.9×10^{-1}	1.3×10^{-1}	1.4×10^{-1}	1.5×10^{-1}
Al Hoceima-Cherif El Idrissi	Marocco	2.6×10^{-2}	3.7×10^{-2}	0.0	3.6×10^{-2}	1.5×10^{-1}	1.5×10^{-1}	1.7×10^{-1}	1.6×10^{-1}	1.7×10^{-1}	1.5×10^{-1}
Casablanca-Mohamed V	Marocco	5.3×10^{-1}	5.2×10^{-1}	5.1×10^{-1}	6.1×10^{-1}	3.7×10^{-1}	4.4×10^{-1}	5.7×10^{-1}	6.9×10^{-1}	8.0×10^{-1}	9.1×10^{-1}
Oujda-Angads	Marocco	0.0	0.0	5.3×10^{-2}	2.3×10^{-2}	1.7×10^{-1}	1.9×10^{-1}	2.1×10^{-1}	2.0×10^{-1}	1.8×10^{-1}	2.1×10^{-1}
Tanger-Boukhalf/Ibn Batouta	Marocco	1.6×10^{-1}	1.3×10^{-1}	1.3×10^{-1}	7.2×10^{-2}	3.0×10^{-1}	3.1×10^{-1}	2.5×10^{-1}	2.1×10^{-1}	1.8×10^{-1}	1.7×10^{-1}
Cancun International	Mexico	0.0	0.0	0.0	1.1	1.5	1.9	1.9	1.9	2.1	2.3
Mexico City	Mexico	8.7	8.1	8.0	7.9	3.9	4.3	4.5	4.3	4.1	4.1
Puerto Vallarta-Licenciado Gustavo Diaz Ordaz	Mexico	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	2.1
Tivat	Montenegro	1.2×10^{-1}	1.1×10^{-1}	1.2×10^{-1}	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eindhoven	Netherlands	4.8×10^{-2}	4.3×10^{-2}	4.5×10^{-2}	4.1×10^{-2}	4.9×10^{-2}	4.5×10^{-2}	5.2×10^{-2}	6.1×10^{-2}	8.9×10^{-2}	1.0×10^{-1}
Enschede-Twenthe	Netherlands	0.0	0.0	0.0	1.4×10^{-2}	1.1×10^{-2}	1.4×10^{-2}	1.8×10^{-2}	1.7×10^{-2}	2.0×10^{-2}	1.7×10^{-2}
Groningen-Eelde	Netherlands	5.1×10^{-3}	0.0	0.0	0.0	0.0	0.0	0.0	2.5×10^{-2}	2.9×10^{-2}	3.4×10^{-2}
Maastricht	Netherlands	4.5×10^{-2}	4.4×10^{-2}	5.4×10^{-2}	4.8×10^{-2}	6.0×10^{-2}	7.4×10^{-2}	8.2×10^{-2}	8.2×10^{-2}	8.4×10^{-2}	9.0×10^{-2}
Curaçao-Willemstad/Hato	Netherlands Antilles	1.8	2.6	3.7	4.7	5.1	5.8	6.3	6.6	6.4	6.5
Kralendijk/Bonaire-Flamingo International	Netherlands	0.0	0.0	0.0	0.0	0.0	5.7×10^{-1}	7.0×10^{-1}	8.6×10^{-1}	9.7×10^{-1}	1.0

Location name Name (City/Airport)	Country	Collective effective dose (manSv) 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
St. Maarten-Princess Juliana International	Antilles Netherlands Antilles	0.0	0.0	0.0	0.0	8.9×10^{-1}	7.8×10^{-1}	9.5×10^{-1}	9.5×10^{-1}	7.1×10^{-1}	9.9×10^{-1}
Kano-Mallam Aminu International	Nigeria	0.0	0.0	0.0	0.0	2.6×10^{-1}	2.5×10^{-1}	2.8×10^{-1}	3.1×10^{-1}	2.6×10^{-1}	3.4×10^{-1}
Lagos-Murtala Muhammed	Nigeria	0.0	3.7×10^{-3}	8.7×10^{-2}	7.1×10^{-2}	9.4×10^{-1}	1.1	1.2	1.5	1.7	2.5
Bergen-Flesland	Norway	1.9×10^{-1}	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oslo-Gardermoen	Norway	7.3×10^{-1}	7.0×10^{-1}	7.6×10^{-1}	7.7×10^{-1}	1.1	1.6	1.8	2.0	2.1	2.4
Stavanger-Sola	Norway	1.2×10^{-1}	1.5×10^{-1}	9.4×10^{-2}	1.0×10^{-1}	2.1×10^{-1}	3.6×10^{-1}	3.6×10^{-1}	3.7×10^{-1}	4.5×10^{-1}	6.1×10^{-1}
Masqat-Seeb International	Oman	3.3×10^{-1}	3.9×10^{-1}	9.4×10^{-2}	1.5×10^{-2}	4.1×10^{-1}	4.6×10^{-1}	5.3×10^{-1}	5.9×10^{-1}	7.5×10^{-1}	9.3×10^{-1}
Karachi International/Quaid-e-azam International	Pakistan	3.1×10^{-1}	2.9×10^{-1}	2.7×10^{-1}	2.0×10^{-1}	8.6×10^{-1}	1.0	1.5	1.5	1.7	1.8
Rawalpindi/Islamabad-Chaklala	Pakistan	3.9×10^{-1}	2.7×10^{-1}	2.5×10^{-1}	9.7×10^{-2}	0.0	0.0	0.0	0.0	8.5×10^{-2}	7.9×10^{-2}
Panama City-Tocumen International/Gen. Omar Torrijos Herrera	Panama	2.4	1.2	1.2	1.1	5.8×10^{-1}	6.9×10^{-1}	7.7×10^{-1}	9.6×10^{-1}	1.4	1.6
Lima-Callao/Jorge Chavez International	Peru	1.7	1.6	1.6	1.5	8.2×10^{-1}	1.1	1.5	2.3	2.3	3.2
Manila-Ninoy Aquino International Airport	Philippines	2.0	1.9	1.8	9.5×10^{-1}	8.7×10^{-1}	1.1	1.1	1.2	1.4	1.8
Warsawa-Okecie	Poland	2.0×10^{-1}	2.4×10^{-1}	2.2×10^{-1}	3.2×10^{-1}	6.1×10^{-1}	7.0×10^{-1}	8.2×10^{-1}	9.2×10^{-1}	1.0	1.2
Faro	Portugal	1.8	1.9	1.9	2.2	2.1	1.6	2.3	2.3	2.4	2.4
Funchal	Portugal	1.5×10^{-1}	1.5×10^{-1}	1.5×10^{-1}	1.6×10^{-1}	1.5×10^{-1}	1.4×10^{-1}	1.9×10^{-1}	3.2×10^{-1}	3.7×10^{-1}	3.7×10^{-1}
Lisboa	Portugal	1.4	1.3	1.4	1.4	1.5	1.5	1.7	1.7	1.7	1.9
Porto	Portugal	0.0	0.0	0.0	0.0	3.9×10^{-1}	5.0×10^{-1}	5.6×10^{-1}	6.0×10^{-1}	6.7×10^{-1}	8.2×10^{-1}
Doha International	Qatar	4.3×10^{-1}	3.9×10^{-1}	2.8×10^{-1}	1.1×10^{-1}	1.3×10^{-1}	1.2×10^{-1}	1.0×10^{-1}	2.5×10^{-2}	2.5×10^{-2}	2.4×10^{-2}
Bucharest-Otopeni	Romania	1.1×10^{-1}	1.1×10^{-1}	1.3×10^{-1}	1.5×10^{-1}	2.0×10^{-1}	2.2×10^{-1}	2.7×10^{-1}	3.5×10^{-1}	8.3×10^{-1}	1.2
Moskwa-Sheremetyevo	Russian Fed.	2.7×10^{-1}	3.4×10^{-1}	5.1×10^{-1}	6.5×10^{-1}	8.7×10^{-1}	1.3	1.7	1.9	1.9	2.2
St.-Petersburg-Pulkovo	Russian Fed.	1.7×10^{-1}	1.9×10^{-1}	2.3×10^{-1}	3.4×10^{-1}	3.3×10^{-1}	5.0×10^{-1}	5.0×10^{-1}	5.3×10^{-1}	5.5×10^{-1}	7.4×10^{-1}
Dhahran International	Saudi Arabia	1.3×10^{-1}	3.4×10^{-1}	3.5×10^{-1}	0.0	6.6×10^{-1}	8.4×10^{-1}	7.9×10^{-1}	6.7×10^{-1}	6.9×10^{-1}	7.5×10^{-1}
Jeddah-King Abdulaziz International	Saudi Arabia	0.0	0.0	0.0	2.6×10^{-1}	2.0×10^{-1}	3.3×10^{-1}	3.6×10^{-1}	3.6×10^{-1}	4.1×10^{-1}	4.1×10^{-1}
Freetown-Lungi	Sierra Leone	0.0	0.0	0.0	6.0×10^{-1}	4.5×10^{-1}	5.0×10^{-1}	5.5×10^{-1}	4.0×10^{-1}	4.4×10^{-1}	2.0×10^{-1}
Singapore-Changi	Singapore	5.2	5.2	4.7	3.7	6.2	6.4	7.2	7.8	8.1	8.1
Capetown	South Africa	0.0	0.0	0.0	0.0	1.6×10^{-1}	8.2×10^{-1}	8.9×10^{-1}	1.5	2.0	2.5

Location name Name (City/Airport)	Country	Collective effective dose (manSv) 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Johannesburg-International	South Africa	2.4	2.2	2.2	2.2	2.1	1.7	2.3	2.7	3.3	3.7
Seoul-Kimpo International	South Korea	$7.1x10^{-1}$	$9.2x10^{-1}$	1.6	1.8	2.5	3.2	3.7	5.7	6.4	6.7
Alicante	Spain	2.2	1.7	1.4	$8.4x10^{-1}$	$9.5x10^{-1}$	$9.3x10^{-1}$	1.2	1.4	1.6	1.9
Almeria	Spain	$6.9x10^{-2}$	$7.0x10^{-2}$	$4.7x10^{-2}$	$6.2x10^{-2}$	$4.6x10^{-2}$	$4.6x10^{-2}$	$7.0x10^{-2}$	$1.4x10^{-1}$	$1.3x10^{-1}$	$1.3x10^{-1}$
Arrecife (Lanzarote)- Canary Islands	Spain	$2.7x10^{-1}$	$2.9x10^{-1}$	$1.9x10^{-1}$	$3.0x10^{-1}$	$6.5x10^{-1}$	$8.3x10^{-1}$	1.2	1.1	1.1	1.3
Barcelona	Spain	$4.8x10^{-1}$	$6.0x10^{-1}$	$6.9x10^{-1}$	$8.9x10^{-1}$	1.4	1.7	1.9	2.1	2.5	3.0
Gerona-Costa Brava	Spain	$2.9x10^{-1}$	$2.1x10^{-1}$	$1.4x10^{-1}$	$1.1x10^{-1}$	$1.1x10^{-1}$	$8.4x10^{-2}$	$1.0x10^{-1}$	$1.1x10^{-1}$	$1.2x10^{-1}$	$1.1x10^{-1}$
Ibiza	Spain	$5.2x10^{-1}$	$4.1x10^{-1}$	$2.6x10^{-1}$	$3.0x10^{-1}$	$2.6x10^{-1}$	$3.0x10^{-1}$	$4.1x10^{-1}$	$4.0x10^{-1}$	$4.0x10^{-1}$	$3.8x10^{-1}$
Santa Cruz (La Palma)- Canary Islands	Spain	0.0	0.0	0.0	0.0	0.0	$1.1x10^{-1}$	$1.6x10^{-1}$	$1.9x10^{-1}$	$2.6x10^{-1}$	$3.2x10^{-1}$
Las Palmas (Gran Canaria)- Canary Islands	Spain	3.8	3.1	2.6	3.0	3.4	3.5	3.9	3.9	3.7	4.1
Madrid-Barajas	Spain	1.1	1.0	1.1	1.3	2.1	2.4	2.4	2.6	2.7	3.0
Mahon-Menorca	Spain	$1.7x10^{-1}$	$1.2x10^{-1}$	$6.4x10^{-2}$	$7.1x10^{-2}$	$6.8x10^{-2}$	$6.0x10^{-2}$	$8.7x10^{-2}$	$1.1x10^{-1}$	$1.4x10^{-1}$	$1.6x10^{-1}$
Malaga	Spain	3.0	2.4	2.0	1.7	1.4	1.4	2.0	2.2	2.4	2.7
Palma de Mallorca	Spain	1.9	1.4	1.2	1.1	1.2	1.2	1.6	1.5	1.5	1.5
Puerto del Rosario (Fuerteventura)- Canary Islands	Spain	$1.6x10^{-1}$	$1.3x10^{-1}$	$2.0x10^{-1}$	$3.5x10^{-1}$	$3.4x10^{-1}$	$3.8x10^{-1}$	$5.4x10^{-1}$	$5.1x10^{-1}$	$5.1x10^{-1}$	$5.7x10^{-1}$
Reus-Tarragona	Spain	$2.4x10^{-1}$	$2.0x10^{-1}$	$1.2x10^{-1}$	$6.7x10^{-2}$	$9.7x10^{-2}$	$7.6x10^{-2}$	$1.0x10^{-1}$	$1.2x10^{-1}$	$1.2x10^{-1}$	$1.3x10^{-1}$
Sevilla	Spain	0.0	0.0	0.0	$4.6x10^{-1}$	$1.6x10^{-1}$	$1.3x10^{-1}$	$1.3x10^{-1}$	$1.2x10^{-1}$	$1.1x10^{-1}$	$9.1x10^{-2}$
Santa Cruz (Tenerife)- Canary Islands	Spain	1.3	1.2	1.3	1.6	1.7	1.8	2.3	2.2	2.2	2.6
Valencia	Spain	$9.3x10^{-2}$	$1.2x10^{-1}$	$1.5x10^{-1}$	$1.2x10^{-1}$	$2.5x10^{-1}$	$1.1x10^{-1}$	0.0	0.0	0.0	0.0
Colombo-Katunayake/Bandaranayake International	Sri Lanka	2.2	2.4	2.2	2.5	2.1	2.3	2.5	2.7	2.1	1.5
Khartoum	Sudan	$4.1x10^{-1}$	$5.5x10^{-1}$	$5.5x10^{-1}$	$5.8x10^{-1}$	$1.6x10^{-1}$	$1.7x10^{-1}$	$1.7x10^{-1}$	$2.5x10^{-1}$	$2.6x10^{-1}$	$6.9x10^{-2}$
Paramaribo-J.A. Pengel	Suriname	2.2	2.5	2.5	2.7	2.7	2.1	2.0	2.4	2.9	3.3
Göteborg-Landvetter	Sweden	$8.3x10^{-2}$	$6.4x10^{-2}$	$1.7x10^{-1}$	$1.8x10^{-1}$	$6.6x10^{-1}$	$7.3x10^{-1}$	$8.1x10^{-1}$	1.0	1.1	1.1
Malmö/Sturup	Sweden	0.0	$4.7x10^{-2}$	$1.1x10^{-1}$	$9.7x10^{-2}$	$1.6x10^{-1}$	$2.8x10^{-1}$	$3.1x10^{-1}$	$3.3x10^{-1}$	$3.7x10^{-1}$	$5.3x10^{-1}$
Stockholm-Arlanda	Sweden	1.2	1.2	1.3	1.2	1.6	2.1	2.3	2.6	2.8	3.2
Basel	Switzerland	$1.3x10^{-1}$	$1.3x10^{-1}$	$1.1x10^{-1}$	$1.1x10^{-1}$	$1.3x10^{-1}$	$1.4x10^{-1}$	$1.9x10^{-1}$	$2.0x10^{-1}$	$1.9x10^{-1}$	$2.1x10^{-1}$
Bern-Belp	Switzerland	0.0	0.0	0.0	0.0	0.0	0.0	$2.1x10^{-2}$	$9.1x10^{-2}$	$1.3x10^{-1}$	$1.4x10^{-1}$
Geneva-Cointrin	Switzerland	$5.3x10^{-1}$	$5.2x10^{-1}$	$5.4x10^{-1}$	$5.2x10^{-1}$	$6.6x10^{-1}$	$8.1x10^{-1}$	$8.9x10^{-1}$	$9.3x10^{-1}$	$9.5x10^{-1}$	1.0

Location name Name (City/Airport)	Country	Collective effective dose (manSv) 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Zürich	Switzerland	1.1	1.1	1.1	1.0	1.3	1.5	1.6	1.7	1.9	2.0
Damascus International	Syria	2.2×10^{-1}	2.1×10^{-1}	2.0×10^{-1}	6.6×10^{-2}	1.1×10^{-1}	2.0×10^{-1}	3.7×10^{-1}	4.2×10^{-1}	5.2×10^{-1}	5.6×10^{-1}
Taipei-Chiang Kai Shek	Taiwan	6.5	6.9	7.7	7.1	3.7	3.8	3.3	3.3	3.8	6.0
Dar es Salaam	Tanzania	1.0×10^{-1}	0.0	0.0	0.0	5.2×10^{-1}	4.9×10^{-1}	5.4×10^{-1}	7.4×10^{-1}	7.5×10^{-1}	6.3×10^{-1}
Kilimanjaro	Tanzania	0.0	0.0	0.0	0.0	2.4×10^{-1}	4.0×10^{-1}	4.7×10^{-1}	5.3×10^{-1}	5.7×10^{-1}	6.4×10^{-1}
Bangkok-International	Thailand	8.2×10^{-1}	7.1×10^{-1}	1.0	1.1	8.1	8.9	9.0	8.8	8.5	8.9
Phuket-International	Thailand	0.0	0.0	0.0	7.2×10^{-1}	5.3×10^{-1}	4.2×10^{-1}	4.8×10^{-1}	4.9×10^{-1}	1.8×10^{-1}	3.9×10^{-1}
Lome-Tokoin	Togo	8.2×10^{-1}	7.6×10^{-1}	7.7×10^{-1}	7.9×10^{-1}	1.5×10^{-1}	1.3×10^{-1}	1.8×10^{-1}	2.5×10^{-1}	1.9×10^{-1}	2.1×10^{-1}
Monastir - Habib Bourguiba International	Tunisia	1.4	1.6	1.4	6.6×10^{-1}	9.6×10^{-1}	9.9×10^{-1}	1.2	1.0	1.0	8.4×10^{-1}
Tunis-Carthage	Tunisia	1.9×10^{-1}	1.6×10^{-1}	1.7×10^{-1}	1.6×10^{-1}	2.1×10^{-1}	2.6×10^{-1}	3.1×10^{-1}	3.0×10^{-1}	2.9×10^{-1}	1.9×10^{-1}
Ankara-Esenboga/Etimusgut	Turkey	4.4×10^{-1}	4.1×10^{-1}	4.5×10^{-1}	3.6×10^{-1}	8.0×10^{-1}	1.1	1.3	1.4	1.5	1.7
Antalya	Turkey	3.1×10^{-1}	4.9×10^{-1}	9.8×10^{-1}	5.1×10^{-1}	1.3	1.3	1.1	1.2	1.4	1.6
Istanbul-Atatürk	Turkey	7.8×10^{-1}	1.1	1.3	1.6	1.7	2.3	2.5	2.9	3.2	3.8
Izmir	Turkey	2.8×10^{-1}	3.2×10^{-1}	4.6×10^{-1}	3.1×10^{-1}	1.1	1.2	9.0×10^{-1}	1.1	1.1	1.3
Mugla-Dalaman	Turkey	2.2×10^{-1}	3.5×10^{-1}	5.3×10^{-1}	5.6×10^{-1}	9.5×10^{-1}	9.4×10^{-1}	7.7×10^{-1}	9.1×10^{-1}	1.0	1.2
Abu Dhabi International	UAE	1.1×10^{-1}	2.1×10^{-4}	2.3×10^{-1}	4.2×10^{-1}	3.7×10^{-1}	6.6×10^{-1}	7.9×10^{-1}	9.0×10^{-1}	9.2×10^{-1}	9.8×10^{-1}
Dubai-International	UAE	0.0	0.0	4.7×10^{-2}	1.1	9.2×10^{-1}	1.2	1.4	2.0	2.4	2.6
Aberdeen-Dyce	UK	6.2×10^{-1}	6.4×10^{-1}	6.8×10^{-1}	7.6×10^{-1}	4.0×10^{-1}	4.5×10^{-1}	5.2×10^{-1}	6.2×10^{-1}	8.2×10^{-1}	1.1
Belfast-Aldergrove	UK	4.1×10^{-1}	4.9×10^{-1}	5.2×10^{-1}	5.3×10^{-1}	2.4×10^{-1}	3.1×10^{-1}	2.8×10^{-1}	2.4×10^{-1}	2.4×10^{-1}	4.9×10^{-1}
Birmingham	UK	2.6×10^{-1}	2.1×10^{-1}	2.0×10^{-1}	2.0×10^{-1}	4.6×10^{-1}	6.1×10^{-1}	7.3×10^{-1}	8.6×10^{-1}	1.0	1.2
Bristol-Lulsgate	UK	0.0	0.0	3.9×10^{-2}	7.9×10^{-2}	2.1×10^{-1}	2.8×10^{-1}	3.2×10^{-1}	3.7×10^{-1}	3.9×10^{-1}	4.6×10^{-1}
Cambridge	UK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7×10^{-2}	2.4×10^{-2}	2.2×10^{-2}
Cardiff	UK	1.7×10^{-1}	2.0×10^{-1}	2.2×10^{-1}	2.3×10^{-1}	1.9×10^{-1}	2.7×10^{-1}	3.4×10^{-1}	3.8×10^{-1}	4.6×10^{-1}	5.5×10^{-1}
East Midlands	UK	1.1×10^{-1}	1.2×10^{-1}	1.2×10^{-1}	1.1×10^{-1}	1.4×10^{-1}	1.6×10^{-1}	1.8×10^{-1}	2.2×10^{-1}	2.7×10^{-1}	3.0×10^{-1}
Edinburgh	UK	0.0	0.0	6.5×10^{-2}	0.0	3.8×10^{-1}	4.5×10^{-1}	5.9×10^{-1}	6.7×10^{-1}	9.1×10^{-1}	1.3
Glasgow	UK	6.0×10^{-1}	6.8×10^{-1}	6.9×10^{-1}	6.7×10^{-1}	5.0×10^{-1}	6.7×10^{-1}	7.8×10^{-1}	8.6×10^{-1}	1.2	1.5
Guernsey-Channel Island	UK	7.7×10^{-2}	6.3×10^{-2}	6.0×10^{-2}	6.2×10^{-2}	4.7×10^{-2}	4.8×10^{-2}	4.0×10^{-2}	3.9×10^{-2}	4.4×10^{-2}	4.0×10^{-2}
Humberside/Hull	UK	1.0×10^{-1}	9.2×10^{-2}	9.9×10^{-2}	1.3×10^{-1}	1.9×10^{-1}	2.4×10^{-1}	2.5×10^{-1}	2.7×10^{-1}	3.3×10^{-1}	4.1×10^{-1}

Location name		Collective effective dose (manSv)									
Name (City/Airport)	**Country**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Leeds Bradford	UK	2.2×10^{-1}	2.5×10^{-1}	2.5×10^{-1}	2.3×10^{-1}	2.9×10^{-1}	3.0×10^{-1}	3.3×10^{-1}	3.8×10^{-1}	4.4×10^{-1}	5.9×10^{-1}
London-city	UK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7×10^{-1}	4.8×10^{-1}
Londonderry-Eglinton	UK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6×10^{-1}	0.0	0.0
London-Gatwick	UK	0.0	9.8×10^{-1}	1.1	9.1×10^{-1}	0.0	0.0	0.0	8.6×10^{-1}	1.2	1.3
London-Heathrow	UK	6.3	4.4	4.6	4.4	7.0	7.3	7.8	6.7	6.9	7.3
London-Luton	UK	3.3×10^{-2}	2.1×10^{-2}	3.9×10^{-2}	1.0×10^{-2}	0.0	0.0	0.0	2.2×10^{-2}	2.9×10^{-1}	4.4×10^{-1}
London-Stansted	UK	0.0	1.1×10^{-1}	1.3×10^{-1}	1.7×10^{-1}	0.0	0.0	0.0	2.9×10^{-1}	4.8×10^{-1}	6.6×10^{-1}
Lydd/Lympne	UK	4.5×10^{-2}	6.9×10^{-2}	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Manchester	UK	6.8×10^{-1}	6.8×10^{-1}	7.3×10^{-1}	7.6×10^{-1}	1.1	1.3	1.4	1.1	1.6	1.9
Manston	UK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8×10^{-1}	0.0	0.0
Newcastle	UK	1.6×10^{-1}	8.1×10^{-2}	5.8×10^{-2}	1.1×10^{-1}	2.7×10^{-1}	3.6×10^{-1}	4.2×10^{-1}	3.4×10^{-1}	5.8×10^{-1}	7.2×10^{-1}
North Weald	UK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5×10^{-2}	0.0	0.0
Norwich	UK	1.0×10^{-1}	1.0×10^{-1}	1.1×10^{-1}	1.2×10^{-1}	1.5×10^{-1}	1.7×10^{-1}	2.0×10^{-1}	1.7×10^{-1}	2.4×10^{-1}	2.8×10^{-1}
Nottingham	UK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.9×10^{-2}	0.0	0.0
Southampton	UK	4.8×10^{-2}	5.7×10^{-2}	7.5×10^{-2}	8.2×10^{-2}	1.1×10^{-1}	1.2×10^{-1}	1.4×10^{-1}	1.6×10^{-1}	1.7×10^{-1}	2.4×10^{-1}
Teesside	UK	0.0	4.2×10^{-2}	9.5×10^{-2}	4.0×10^{-2}	1.6×10^{-1}	2.1×10^{-1}	2.5×10^{-1}	2.7×10^{-1}	3.5×10^{-1}	4.6×10^{-1}
Kiev-Borispol	Ukraine	0.0	0.0	0.0	0.0	1.8×10^{-2}	1.9×10^{-1}	3.9×10^{-1}	4.9×10^{-1}	5.9×10^{-1}	6.2×10^{-1}
Montevideo	Uruguay	0.0	0.0	0.0	0.0	3.6×10^{-1}	3.3×10^{-1}	3.9×10^{-1}	2.9×10^{-1}	0.0	0.0
Atlanta GA-The WB Hartsfield Atlanta International	USA	4.8	4.2	6.1	6.9	8.9	8.9	8.6	8.3	9.0	1.2×10^{1}
Baltimore MD-Washington International	USA	6.8×10^{-1}	5.9×10^{-1}	1.4	3.3	3.5	1.0	0.0	0.0	0.0	0.0
Boston MA-General EL Logan International	USA	2.2×10^{-1}	0.0	0.0	3.8	4.2	6.0	8.4	7.4	7.3	7.7
Chicago IL-O'Hare International	USA	8.3	7.2	6.5	5.5	6.9	7.8	7.8	7.5	9.3	9.5
Denver CO-International	USA	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.8	9.7×10^{-1}	9.4×10^{-1}
Detroit MI-Metropolitan	USA	1.8	3.6	4.2×10^{-1}	3.3×10^{-1}	5.6	8.0	9.8	1.7×10^{1}	2.3×10^{1}	2.9×10^{1}
Fort Lauderdale FL-Executive	USA	0.0	0.0	0.0	5.8×10^{-1}	1.2	1.2	1.2	8.7×10^{-1}	0.0	0.0
Houston TX-George Bush Intercontinent	USA	2.7×10^{-1}	0.0	0.0	0.0	5.5	7.2	7.5	8.3	9.1	9.5
Los Angeles CA-International	USA	1.1×10^{1}	1.0×10^{1}	1.5×10^{1}	1.1×10^{1}	1.2×10^{1}	1.3×10^{1}	1.3×10^{1}	1.4×10^{1}	1.7×10^{1}	1.9×10^{1}
Memphis TN-International	USA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	7.4	8.4

Location name Name (City/Airport)	Country	Collective effective dose (manSv) 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Miami FL-International	USA	1.8	2.9	3.2	3.7	4.6	5.9	4.2	4.6	6.0	6.3
Minneapolis/St. Paul MN-International	USA	5.9×10^{-1}	4.8×10^{-1}	5.2×10^{-1}	1.7	3.4	6.7	1.2×10^{1}	1.7×10^{1}	1.9×10^{1}	1.9×10^{1}
New York NY-John F. Kennedy International	USA	2.2×10^{1}	1.8×10^{1}	1.7×10^{1}	1.7×10^{1}	2.1×10^{1}	2.3×10^{1}	2.3×10^{1}	2.5×10^{1}	2.5×10^{1}	2.6×10^{1}
Newark NJ-Newark International	USA	0.0	0.0	0.0	3.7×10^{-1}	7.7×10^{-1}	5.7×10^{-1}	6.1×10^{-1}	8.4×10^{-1}	7.7×10^{-1}	5.8
Oakland CA -Metropolitan International	USA	0.0	5.4×10^{-1}	0.0	7.2×10^{-1}	1.2	9.4×10^{-1}	1.1	1.5	1.8	1.6
Orlando International	USA	3.1×10^{-1}	1.9	2.6	2.5	3.4	3.4	5.5	4.1	5.2	4.6
San Francisco CA-International	USA	1.0	5.3×10^{-1}	1.1	0.0	0.0	5.1	6.7	5.9	8.0	1.1×10^{1}
Seattle-Tacoma International	USA	0.0	0.0	0.0	0.0	8.1×10^{-1}	8.9×10^{-1}	8.9×10^{-1}	1.3	1.2	1.1
Tampa FL-International	USA	0.0	2.2×10^{-1}	1.2	1.6	1.8	2.5	2.6	2.4	2.0	2.2
Washington DC-Dulles International	USA	0.0	0.0	0.0	0.0	0.0	5.7	7.9	8.5	1.3×10^{1}	1.5×10^{1}
Caracas-Maiquetia/Simon Bolivar International	Venezuela	1.3×10^{-1}	2.0×10^{-1}	7.5×10^{-1}	8.2×10^{-1}	1.4	1.7	1.8	2.4	2.1	3.5
Isla Margarita-Del Caribe International, General Santiago Mariño	Venezuela	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	2.3	0.0
Paraguana-Josefa Camejo International	Venezuela	0.0	0.0	0.0	0.0	0.0	0.0	9.2×10^{-1}	0.0	0.0	2.2
Hochiminh/Tansonnhat International	Vietnam	0.0	0.0	0.0	0.0	0.0	2.7×10^{-1}	7.9×10^{-1}	1.1	9.5×10^{-1}	1.0
Belgrade	Yugoslavia	3.6×10^{-1}	3.3×10^{-1}	3.9×10^{-1}	2.6×10^{-1}	5.4×10^{-2}	0.0	1.2×10^{-2}	2.1×10^{-1}	3.0×10^{-1}	3.7×10^{-1}
Harare-International	Zimbabwe	0.0	0.0	0.0	0.0	0.0	2.9×10^{-1}	4.6×10^{-1}	5.1×10^{-1}	5.5×10^{-1}	6.6×10^{-1}