



GROUP ON INTERNATIONAL AVIATION AND CLIMATE CHANGE (GIACC)

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Agenda Item 2: Review of aviation emissions-related activities within ICAO and internationally

ICAO ROLE DURING THE 1973-74 OIL CRISIS AND FUEL EFFICIENCY

(Presented by the Secretariat)

1. BACKGROUND

1.1 The early post-World War II era witnessed the erosion of coal's dominance as an energy source, and by the 1950s oil became the dominant power source, contributing to a certain extent to the rapid economic growth of the OECD countries. In the early seventies, oil was powering transportation, supplying one-third of industrial sector power and producing roughly one-quarter of electricity generation. On the supply side, the Organization of Petroleum Exporting Countries (OPEC) commanded a very large spare capacity, and low prices and apparent abundance of oil encouraged its growing use.

1.2 In October 1973, when several OPEC countries took concerted action to reduce oil production from 20.8 to 15.8 million barrels/day, these oil market conditions changed substantially. Around the same time, OPEC decided to increase oil prices by about 400 per cent above previous levels. As a consequence, in a relatively short time, oil became scarce and expensive, and oil-consuming countries had little chance to influence the market. A significant reduction in spare capacity in non-OPEC countries further exacerbated the problems. In that context, improvement of oil consumption efficiency became a major challenge to respond to the changed oil market conditions.

2. ICAO ROLE AND ACTIONS IN PREVIOUS CRISIS TIMES

2.1 In early 1974, the actual prevailing conditions of the oil market had a direct impact on aviation fuel supply. In order to tackle this issue related to the impact of high oil prices on the air transport industry, the ICAO Council approved a recommendation to the Contracting States to take the following actions:

- examine the air navigation and air traffic control procedures over their territories so as to reduce, as much as possible, flying distances and air traffic delays, according to the six identified measures;

- achieve maximum coordination on fuel supply so as to ensure that the operation of air services be maintained at the level required in the public interest;
- where restrictions on aviation fuel supply have to be imposed, give priority to commercial air transport;
- refrain, on a basis of reciprocity, from discrimination against airlines of other countries in the distribution of available fuel at their own airports; and
- consider favourably proposals by airlines of special measures requiring government approval such as amendments to schedules, limitation of frequencies or consolidation of routes, where motivated by the fuel crisis.

2.2 In 1977, the 22nd Session of the ICAO Assembly, gave consideration to the issue of the future availability of aviation fuel, recognizing that this could have important implications for the world transport systems over the next 15 to 25 years. It adopted a resolution (A22-27) calling on the Council to collect and make available to Contracting States relevant information on the subject. In response to that resolution, a study was conducted to assess the outlook for the supply of fuel to meet civil aviation needs up to the year 2000. The results of this study were published in 1979 in Circular 149-AT/52.

2.3 Based on multiple sources available, the study looked into the patterns of global energy consumption and projections for total energy demand and specifically for oil up to the end of the 20th century; the reserves of oil, world oil trade and supply, alternative energy resources and aviation fuel supply, examined trends and prospects in oil prices and tried to evaluate aspects that would impact the civil aviation fuel requirements in the following decade and in a longer term.

2.4 The study assumed that air traffic could double or triple between 1978 and 1990 (i.e. increase on average by 6 to 10% per annum) and further expand towards the end of the century to reach the level between 3 and 6 times higher than that of 1978 (i.e. to grow on average by 5 to 8.5% per annum over the 1978-2000 period). The factors driving the demand for air transport would continue to be general economic growth, declining fares and rates in real terms, route network expansions together with more direct routings, higher service frequencies and reduced travel times.

2.5 Taking into account the projected traffic growth and expected gains in fuel efficiency, the latter, thanks to anticipated changes in airlines' aircraft mix and technological and operational improvements, the study forecast that the fuel consumption up to 1990 might have increased by a factor of 1.6 (4% per annum) if the traffic doubles or by a factor of 2.5 (8% per annum) if the traffic triples. The study anticipated that during the 1990s, with slower prospective traffic growth and further improvements in fuel efficiency, fuel requirements would grow at a slower pace than in the 1980s. Altogether, up to the year 2000, the study forecast that demand for aviation fuel would be 2 and 4 times the level of consumption of the late 1970s.

2.6 The study concluded that the future availability of oil for civil aviation and the adequacy of supplies will depend primarily upon:

- the development of the demand for energy overall;
- the extent of energy reserves, the rate of extraction from reserves and the availability of alternatives to oil;
- developments in process for oil and alternative fuels and shifts in the use of the various sources of energy; and
- the rate of development of air transport activity and the achievement of greater efficiency in the use of fuel in aircraft.

2.7 More specifically, the major findings were:

- by the end of the 20th century, the consumption of aviation fuel (2 to 4 times the level of the late 1970s, or on average between 3 and 6.5% per annum) would represent 5 to 10 per cent of projected total oil consumption. Fuel efficiency was forecast to improve over the period to the end of the 20th century by some 2 per cent;
- as fuel needs of civil aviation are relatively small, the possibility of satisfying these needs in the future might depend less on the magnitude of total crude oil production but rather on the proportion of the production which can be refined to meet civil aviation specifications;
- as 10 to 15 per cent of total crude oil production can be converted to kerosene and based on the projections of world consumption, that amount should meet the needs of civil aviation. However, as long-term projections were not certain, the demand for aviation fuel towards the end of the 20th century might be higher than 10 to 15 per cent of total oil supply; and
- if the prospective availability of aviation fuel had not been adequate, there would have been a need for remedial measures such as broader technical specifications to aviation fuel (however, there were limits here determined by safety and other considerations) or the use of synthetic fuels or possibly by the development of engine installations that could use heavier types of fuel.

2.8 With respect to price developments, the study indicated that there might be substantial fluctuations in the price of oil during the horizon covered. However, there would be a long-term price trend reflecting the gradual adjustment of demand resulting from conservation measures and the development of other energy sources. With future price trends for aviation fuel being as uncertain as with those for crude oil, another element of uncertainty would be competing needs for fuel from other transport modes. That could widen the price differential between these fuels and other oil products and change the price relationships between aviation fuel, gasoline and distillate fuel dependant upon demand developments.

3. HISTORICAL TRENDS IN AIR TRAFFIC AND AVIATION FUEL CONSUMPTION SINCE THE LATE 1970s

3.1 Since the late 1970s, scheduled air traffic (expressed in revenue tonne-kilometres) has been growing steadily (with the exception of the years 1991 and 2001) at an average annual growth rate of some 5.8 per cent and consequently increased by a factor of 5.4. These growth rates are lower than those for the earlier decades due to the maturity of certain markets. International traffic grew at faster rates, on average by about 7 per cent per annum and increased almost eight-fold, while domestic traffic increased at lower rates, on average by 4.1 per cent (and increased by factor of 3.3).

3.2 Over that time period, fuel consumption on international scheduled services, according to ICAO's modelled data, has increased by a factor of 3.9 and has grown at an average annual rate of 4.6 per cent. For total (international and domestic) scheduled services, fuel consumption data are available only for the period starting from 1991; since then fuel consumption has increased 1.7 times, while traffic has grown about 2.4 times. The improvement of fuel efficiency during that period was estimated at some 2.2 per cent per annum.

3.3 Lower growth rates in fuel consumption are due to the improved fuel efficiencies resulted mainly from the introduction of more fuel efficient aircraft, more efficient operational procedures and

improved flight management techniques. More recently, environmental protection issues (such as phase-out of noisy, and usually older and less fuel efficient, aircraft as well as measures to mitigate the climate change) have been contributing to lowering fuel consumption growth rates.

3.4 The quest for the improved fuel efficiency has been triggered mainly by the economic aspects of the air transport operations, by the looming possibility of shortages in aviation fuel supply at certain times (e.g. the 1973-1974 oil crisis, as discussed above) and the environmental protection concerns.

4. AVIATION FUEL PRICES AND EVOLUTION OF AIRLINES' OPERATING COSTS

4.1 Based on information available from the US DOE's Energy Information Administration, over the period 1978-2008, aviation fuel prices, expressed in nominal (actual) terms, increased by a factor of almost 8. Expressed in constant 1978 dollars (using US CPI), they rose by a factor of 2.4. During that period, there were significant fluctuations both in aviation fuel and crude oil prices, as shown in **Table 1**.

4.2 Generally speaking, changes in fuel prices are correlated with the economic growth, but changes in aviation fuel prices are not until now inversely correlated with the fuel consumption, although they are one of the major drives for the improvements in that consumption.

4.3 Changes in aviation fuel prices impacted the airlines operating costs, as aircraft fuel costs constitute the major part of airline costs among cost categories that ICAO collects data on, through a reporting Form EF – Financial Data – Commercial Air Carriers. As can be seen in Table 1, the shifts in the shares of fuel costs in total airline operating costs are closely correlated with the changes in aviation fuel prices. The shares increased from 18.4 per cent in 1978 to 25.4 per cent in 2007 (precise data for 2008 are not available yet), with the highest share of over 29 per cent in 1981, following huge price increases in the preceding few years, and the lowest of less than 11 per cent in 1998, when the estimated decrease of aviation fuel prices from the previous year was about 26 per cent.

Table 1 – Crude oil and aviation fuel prices and share of fuel costs in total airline operating costs 1978-2008

Year	Crude Oil Prices, US\$/barrel	% change	Refiner Price of Kerosene-Type Jet Fuel to End Users (Nominal Cents per Gallon Excluding Taxes)	% change	Share of fuel costs in total airline operating costs
1978	15.0		38.7		18.4
1979	25.1	67.9	54.7	41.3	22.8
1980	37.4	49.1	86.8	58.7	28.2
1981	35.8	-4.5	102.4	18.0	29.2
1982	31.8	-11.0	96.3	-6.0	27.2
1983	29.1	-8.6	87.8	-8.8	24.5
1984	28.8	-1.1	84.2	-4.1	23.3
1985	26.9	-6.4	79.6	-5.5	22.0
1986	14.4	-46.4	52.9	-33.5	15.9
1987	17.8	22.9	54.3	2.6	14.8
1988	14.9	-16.2	51.3	-5.5	13.3
1989	18.3	23.3	59.2	15.4	13.7
1990	23.2	26.5	76.6	29.4	15.2
1991	20.2	-12.9	65.2	-14.9	13.2
1992	19.3	-4.7	61.0	-6.4	12.2
1993	16.8	-13.0	58.0	-4.9	12.0
1994	15.7	-6.5	53.4	-7.9	11.4
1995	16.8	7.0	54.0	1.1	11.4
1996	20.5	22.1	65.1	20.6	12.8
1997	18.6	-8.9	61.3	-5.8	12.6
1998	11.9	-36.1	45.2	-26.3	10.4
1999	16.6	39.0	54.3	20.1	11.0
2000	27.4	65.4	89.9	65.6	14.4
2001	23.0	-16.0	77.5	-13.8	13.5
2002	22.8	-0.8	72.1	-7.0	13.0
2003	27.7	21.4	87.2	20.9	13.6
2004	37.7	36.0	120.7	38.4	17.3
2005	50.0	32.9	173.5	43.7	22.2
2006	58.3	16.5	199.8	15.2	23.8
2007	64.2	10.1	216.5	8.4	25.4
2008	99.7	55.2	305.3	41.0	

Source: EIA Energy Information Administration, ICAO Form EF - Financial Data - Commercial Air Carriers, for share of fuel costs in total airline operating costs.

5. ENERGY AND OIL OUTLOOK, 2006-2030 AND THE IMPACT ON AVIATION FUEL AVAILABILITY

5.1 According to the IEA World Energy Outlook 2007, under a reference scenario (with assumptions about economic growth, population, energy prices and technology but with no change in energy and environmental policies throughout the period), total primary energy supply is expected to

increase 1.5 times or at an average annual growth rate of 1.7 per cent over the period 2006-2030. At the same time, oil demand and production are anticipated to increase 1.4 times or at an average annual growth rate of 1.3 per cent, indicating a very tight balance between demand and production. **Tables 2 and 3** show historical and projected trends in oil demand and production.

5.2 World oil reserves are sufficient to meet the projected growth in demand to 2030. Non-conventional supplies such as gas-to-liquids and oil sands are expected to make a growing contribution to output. OPEC countries collectively are projected to take a growing share in the world oil market, as they hold the bulk of remaining proven oil reserves, and ultimately recoverable resources, and their development and production costs are generally lower than elsewhere.

Table 2 – World Primary Oil Demand in the Reference Scenario
(million barrels/day)

	1980	2000	2006	2010	2015	2030	Average annual growth rate (%)	
							1980-2006	2006-2030
World	64.8	77.0	84.7	91.1	98.5	116.3	1.0	1.3
OECD	41.8	46.0	47.3	49.0	50.8	52.9	0.5	0.5
Transition economies	9.4	4.2	4.5	4.7	5.1	5.6	-2.8	0.9
Developing countries	11.3	23.1	28.8	33.7	38.7	53.3	3.7	2.6

Table 3 – World Oil Production in the Reference Scenario
(million barrels/day)

	1980	2000	2006	2010	2015	2030	Average annual growth rate (%)	
							1980-2006	2006-2030
World	65.2	76.8	84.6	91.1	98.5	116.3	1.0	1.3
Non-OPEC	35.5	43.5	47.0	48.6	50.3	53.2	1.1	0.5
OPEC	28.1	31.7	35.8	40.6	46.0	60.6	0.9	2.2
OPEC market share (%)	43.1	41.3	42.3	44.6	46.7	52.1		

5.3 Oil prices are expected to remain the main driver of energy prices, generally, through inter-fuel competition and price indexation clauses in some long-term gas contracts. The IEA crude oil import price – a proxy for international oil prices – is assumed to fall to around US \$57 in real 2006 dollars by 2015. This is based on an assumption that crude oil production and refining capacity will rise marginally faster than demand, as the recent wave of investments in new facilities bears fruit. Prices are then assumed to recover slowly, reaching US \$62 by 2030 (real 2006 dollars); in nominal terms, this equates to a price of almost US \$110.

5.4 According to ICAO fuel consumption modelling, in 1980, air travel fuel consumption was representing 3 per cent of the world oil production before reaching a market share of 6.4 per cent in 2005. According to the average scenario of fuel burn calculated by the Forecasting and Economic Analysis Support Group (FESG) (Task Group of the Committee on Aviation Environmental Protection (CAEP)), until 2050, the estimated fuel burn for 2030 is between 400 and 420 million tonnes, which represent about 10 per cent of the total projected oil supply in 2030. This percentage is in line with the existing refining capacity for aviation fuel, assuming that the current conditions will continue to prevail in 2030.

6. CONCLUSION

6.1 Since the end of 2007, the expansion of the world economy has been decelerating and civil aviation has come under extreme pressure from fuel price trends and a lingering credit crunch that has persisted despite massive public cash infusions since September 2008.

6.2 According to a consensus among economic forecasting, world economies are currently in the midst of one of the worst recessions in the post war period and the 2009 outlook for traffic is significantly affected. The elapsed time between two crisis impacting civil aviation growth is shortening and as such the need for a close monitoring of the crisis effects on fuel efficiency trends is becoming critical. Therefore, in parallel with the data collection on fuel consumption implementation, it is necessary to develop more sophisticated forecasting methodologies enabling sensitivity analysis to several kinds of economic drivers. Moreover, the scenarios developed in the seventies showed that it is unrealistic to continue providing a long-term fuel consumption forecast on an unconstrained basis, either from the fuel availability side or from the airport and airspace future capacity side.

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