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CHLOROFLUOROCARBONS ON THE ENVIRONMENT

(presented by the Commission to the Council)

COMMUNICATION OF THE COMMISSION
TO THE COUNCIL

CHLOROFLUOROCARBONS ON THE ENVIRONMENT

INTRODUCTION

On the 26th of March 1980, the Council adopted the Decision 80/372/EEC concerning chlorofluorocarbons in the environment[1]. Article 2 of this decision stipulates that "in the course of the first half of 1980, the measures taken will be re-examined in the light of the scientific and economic data available". Moreover, by a statement, the Council invited the Commission "to report on ways and means of reaching agreements with the appropriate Community industries and bodies".[2]

This communication of the Commission constitutes the report required by the Council. It concerns the two aspects of the problem of chlorofluorocarbons in the environment :

I. Re-examination of scientific data
II. Re-examination of economic and technical data

The report on possibilities for a European Convention on the quality of life will be subject to a separate communication.
The examination of these issues should allow guiding and developping Community policy concerning chlorofluorocarbons.

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(1) O.J. L 90 of 3.4.80
(2) Council Doc. 51/75/80, ENV/35 of 27.2.80

I. RE-EXAMINATION OF SCIENTIFIC DATA

A. Effect of chlorofluorocarbons on atmospheric ozone

We retrace here the main conclusions of the critical analysis made for the Commission by Doctor Guy Brasseur on the scientific reports published recently.

As for the detailed discussion, the study itself of Dr. Brasseur must be consulted.

1. Main findings of researches concerning the effect of CFC on ozone

1.1. US findings

The findings obtained by the researchers working on the NASA project may be summarized very briefly by saying that the most probable depletion in the total quantity of ozone, assuming continued emission of CFC 11 and CFC 12 at 1975 level would be between 15 and 18% when the equilibrium state is reached. According to NASA, the depletion will lie in the range 7.5 to 29.8% - with a probability of 95% - given the uncertainties concerning the chemical and photochemical parameters.

The NAS Report concludes that the most likely depletion will be 16.5%. This figure is based on a value of 18.6% given by the mathematical models and takes account of additional effects arising principally from the possible destruction of CFCs in the troposphere and the greenhouse effect of these industrial compounds. The uncertainties affecting the parameters used in the calculations led the NAS to estimate the ozone depletion as lying in the range 5 to 28% with a 95% confidence level.

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There is thus a broad measure of agreement between the NAS and NASA findings : **they both point to an adverse effect of CFCs on the ozone layer and the** average figure assigned to the depletion may be put at 16.5% $\pm$ 10%. The statistical error is thus quite high.

1.2. UK findings

The UK Report challenges the assumption of assigning a global (or average) figure to atmospheric ozone depletion in view of the complex nature of the atmosphere and the existence of many natural variables. The likelihood therefore is a relative reduction of O_3 which varies with latitude and season. But if the simplified calculation but perhaps incorrect of the American researchers is adopted, the following values are obtained : 13% in the Harwell model, 11% in the Meteorological Office model (2-D) and 16% in the Oxford model (2-D).

To appreciate the difficulties inherent in these models, however, it will be observed that by varying the profile of the vertical transport coefficient (at present poorly defined), the result given by the Harwell model may differ by between 6 and 22%. The two-dimensional models also display a high degree of sensitivity to the values assigned to the transport parameters.

Lastly, the UK Report lays emphasis on the likely interaction with other human activities (emission of CO_2 from combustion process or N_2O from chemical fertilizers). It would seem that these effects appreciably reduce the rate of ozone depletion by CFCs.

1.3. Other findings

There has been very intense activity in the atmospheric sciences over the last few years and it is difficult to give even a summary of the most recent work. The reader should therefore refer to the articles published in the scientific press, remembering that many of them have provided the basis for the official reports referred to in this document. The summary record of the meeting of the UNEP Coordinating Committee on the ozone layer (Paris, November 1979) describes the results obtained so far and the research being carried out in Canada, France, the Federal Republic of Germany, Italy,

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Netherlands, Norway, the USSR, the United Kingdom and the United States.*

1.4. Differences between the American and British conclusions

The first point to be made is that the mathematical models used in both the United States and in Europe (particularly in the United Kingdom) provide, for similar assumption, quantitative results which exhibit a high degree of comparability.
The ozone depletion figures obtained by very similar computing techniques are compatible on both sides of the Atlantic.

The basic difference between the American and British approach lies in the confidence placed in the models and the degree of simplification considered to be acceptable. In American case, the effect of pertubations calculated with the aid of one-dimensional models is taken to be representative of the real situation since these models are quite successful in simulating the natural atmosphere. In the British case, the attitude is that atmospheric phenomena are highly complex, that it is therefore impossible to make such over-simplifications and that models having only one dimension - which cannot simulate a number of phenomena in the atmosphere (sudden warmings, variable height of the tropopause, effect of planetary waves, etc.) - are suspect when used to predict ozone depletion.

In other words, it is the methodology which is called into question here and not the calculations themselves. In practice, the quantitative differences between the findings of the simplifed British and American models are small and, in the last resort, of little significance. The key question is to know whether there can be any appreciable difference between the calculated amount of ozone depletion and the actual response by the atmosphere to the effect of CFCs. Thus the problem is that of validating the models and the method of formulating the problem.

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2. Main uncertainties due to atmospheric models

2.1. Mathematical models

Apart from the reservations one might have about the methodology relating to models in general, it must be said that the one-dimensional models - on which the American conclusions are based - lead to over-simplifications. Hence this approach does not necessarily give a satisfactory reflection of the actual situation in the atmosphere. Despite such varied assumptions, it must be stated that, in general terms - and sometimes at the expense of certain adjustments - distributions calculated are not inconsistent with the profiles observed. For certain chemical compounds, however, a comparison between theory and practice does not create certain problems. Uncertainities therefore remain which could substantially affect the estimates of the likely depletion of the ozone layer and the effect of CFCs.

2.2. Atmospheric chemistry

Much more is now known about the chemistry of the atmosphere but unknown mechanisms may still exist or reactions occur whose rate constant is over or under-estimated. A certain degree of measurement error attaches to every reaction rate and the global error in respect of a system containing over 100 reactions is quite considerable.

This error has been estimated in the NASA and NAS reports. Furthermore, the chemistry of the troposphere is still inadequately understood. More extensive research should be conducted, specifically, into the decomposition of CFCs in the troposphere and their possible disappearance into the oceans and soil.

2.3. Atmospheric transport

The problem of how to represent the transport of minority constitutents has not been solved. This will require the building of large three-dimensional models involving advanced computer techniques.

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3. Main findings of observation of the quantity of ozone and future trend

In the temperate latitudes of the northern hemisphere, the quantity of ozone would appear to have fallen until 1962, rising to a peak in 1970.
According to the NAS or NASA figures, the action of CFC 11 and 12 pointed by the models (reduction of 2.1. $\pm$ 1.5% of the quantity of ozone) seems impossible to be detected (minimum threshold : 5 % reduction). According to the British and in particular, French figures (0,7 to 1,3 % reduction of ozone compared to a 2 % detectability threshold), ozone trends should reveal an action of CFC's and validate or not mathematical models.

4. Main conclusions of the critical analysis.

Since the time the hypothesis of the catalytic destruction of ozone by chlorine was first put forward by Stolarski and Cicerone (1974) and Molina and Rowland (1975), the theory underlying this hypothesis had never been called into question. On the contrary, laboratory studies have shown that, in theory, ozone is sensitive to chlorine and the reactions which have been put forward since that time have merely backed up the theory without questioning its underlying principles.

Recent measurements of specific chemical reaction rates have, however, modified the quantitative values of the results obtained by the models and it has been shown that ozone is more sensitive to chlorine and less sensitive to the oxides of nitrogen than was previously thought.

Estimates of this kind are based on mathematical models which, in general, take into account a large number of chemical and photochemical reactions in the atmosphere but which are, at present, unable to simulate correctly the important role played by atmospheric dynamics.

The problem of the validity of the models thus takes on special importance since there is nothing to prove that the chemical mechanisms are at present understood.

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Nevertheless, the models are very useful since they provide a better understanding of the relative importance of the various chemical and photochemical mechanisms and enable a study to be made of certain interactions taking place within the atmospheric system. However, the atmosphere is complex in this respect and caution must always be exercised when gathering quantitative results.

An investigation of the actual trend in the quantity of ozone in the northern hemisphere (where the majority of CFC emissions occur) since 1963 reveals a positive tendency, the origin of which is not known. At present, therefore, the observed pattern does not tally with the theoretical results but one must not forget the possible combination of several natural (thermal, dynamic, chemical) effects or effects artificially created by man which conceal the direct action of CFCs.

The foregoing analysis shows the need for further research. But if the requisite decision is delayed, the likely effect of CFCs may be greater and the consequences more serious. The British report shows that by extending the date of an assumed total cessation of CFC emissions from 1 January 1979 to 1 January 1983, the maximum amount by which the total quantity of ozone would be depleted would increase from 0.5 to 0.6% since, according to the model, the interval between the cessation of emissions and the maximum O_3 depletion lies in the range 7 to 15 years. Consequently, a delay of 5 years before any decision is taken on CFCs can be reasonably accepted. But the question then is : What is the likelihood of fully resolving the problem within this period ?

Although it can be expected that our knowledge of aeronomic reactions and their rate constants will be improved, the problems relating to the methodology of the mathematical models will not be resolved within five years.

It can be stated very briefly that :

1. There is now much more information available about the photochemical theory of ozone in the stratosphere than there was ten years ago;

2. There are still more uncertainties, however;

3. The models have helped to improve knowledge of the stratosphere;

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4. As they are simplified, they cannot fully describe the behaviour of the atmosphere and its minority constituent parts;

5. In the next few years more sophisticated models must be developed which can take into account simultaneously the chemical, thermal and dynamic aspects of atmospheric processes;

6. This is a task which cannot be completed within five years but steady efforts must be made in this direction;

7. Permanent observation and monitoring of ozone is therefore particularly important;

8. At present there is nothing to indicate that CFCs have had a genuine effect on the ozone layer;

9. Observation facilities should therefore be developed, i.e. both satellite measurements, which supply a large number of observations, and ground measurements, which are easier to calibrate;

10. The examination of the balance sheets of the minority constituent parts should be continued in order to detect natural and artificial sources or sinks of these compounds in the atmosphere;

11. It is vital to study simultaneously all the effects of human activities on atmospheric ozone.

The problem of ozone and its vulnerability to compounds of human origin has now become a permanent problem. The figures now advanced will have to be revised frequently to take into account the development of knowledge, the degree of sophistication of the models and the observations of the minority constituent parts.

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B. EFFECTS OF A POSSIBLE OZONE DEPLETION ON MAN AND THE ENVIRONMENT.

1. Effects of ozone depletion on ultraviolet light

Ozone absorbs strongly in the ultraviolet region of the solar spectrum; the absorption coefficient depends on the wavelength. A depletion of stratospheric ozone will especially affect the region between 280mm and 340mm. As the biological effects are mainly due to wavelengths under 320mm, the critical radiations are those between 280 and 320mm, i.d. UV-B radiations.

Since 1973, in the different studies on stratospheric ozone(1), it is usually estimated that for small modifications of ozone amounts, a 1% decrease of stratospheric ozone corresponds about to a 2 % increase of UV-B radiation. For more important decreases, this proportion can be higher than 2.

A high number of difficult to check variables determine the transmission of solar radiation to the surface of the earth : in addition to the wavelength and to diffusion, the variations of ozone with the season and the latitude play an important role. These difficulties are recognized by all investigators; whereas the recent studies of the NAS and the NASA do not present new evaluations of the ratio "ozone depletion/UV-B radiation increase", the study of the Department of Environment of the United Kingdom discusses them.

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(1)- NAS (National Academy of Science)
Halocarbons : Effects on Stratosphere Ozone, Washington 1976.

- CIAP Report of findings. The effects of Stratosphere pollution by aircrafts. US Department of Transportation, 1974 Washington.

- Department of the Environment Chlorofluorocarbons and their effect on stratospheric Ozone, Pollution Paper no 5, London 1976.

It reveals that the percentage of ozone depletion is lower in the equatorial regions in summer where the intensity of UV radiation is the highest and according to the models leads to a 5 to 10% increase of the integrated dose of UV-B. On the other hand, the ozone depletion is the highest at high latitudes in winter when the intensity of solar radiation is weak.

Another factor of uncertainty is the biological factor. All the wavelengths in the UV-B regio do not induce equal biological responses in targets. Weighing functions have been calculated in order to determine a spectrum of biological effects. An inappropriate knowledge of these functions is one of the major causes of uncertainty with respect to effects of ozone depletion. The Nas report[1] estimates that a 16 % ozone depletion corresponds to a 44 % increase in damaging wheighted UV radiation, and this at mid-latitudes. The last British report indicates that for a 13 % reduction of the ozone layer, the global increase of the weighted UV-B dose would be 12 % for erythema : the conversion factor can be nearer 1 than 2.

2. Effects of UV-B radiations on human health

Ultraviolet radiation is mainly harmful for the skin; it can give rise to different forms of tumors including malignant melanoma, often lethal. The understanding of these effects increases considerably, but does not lead to quantitative correlations and does not untangle definitively the influences of many factors. Moreover, the effects are felt in the long term and epidemiological studies are necessary. Many are in development.

Thus, in the United States, the National Cancer Institute indicates in its very recent report that benign skin cancers are increasing and estimated that the dose-response curves between UV-B radiations and skin cancers present a biological amplification factor of 2, which added to the physical amplification factor of 2 gives a global factor of 4 : i.e. that a 1 % ozone depletion corresponds to a 4 % increase of skin cancers other than melanoma.

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(1) NAS report : Protection against depletion of stratospheric ozone by chlorofluorocarbons, Washington 1979.

In the Community, Italy and the Netherlands are very active in these investigations. One must cite among others an investigation by the Istituto Superiore di Sanità in Rome[1] and a Dutch model of dose-response for skin cancer induced by chronic exposure to ultraviolet radiations (2). The model enables to calculate a dose response relationship for a single population. According to the model, a permanent 16,5 % ozone reduction, as mentioned in the NAS-report, would increase the nonmelanoma skin cancer incidence in the Netherlands by a factor of approximately 2.5.

As far as malignant melanoma are concerned, they are much more unusual and can appear indifferently on exposed or unexposed parts of the body. This is the reason why it is difficult to establish a dose-response relationship between exposure to ultraviolet radiations and this form of cancer, although it has been observed that it is more frequent at low latitudes and in fair-skinned subjects. However there seems to be increasing indications that a relationship between UV-B radiations and melanoma exists (3).

In conclusion, although the limited epidemiological data of which one disposes indicate that ultraviolet radiation influences effectively the incidence of skin cancer (particularly of forms of cancer which appear locally), there exist so many other factors which seem to intervene also - such as race, social habits, environment, the degree of pollution, the cloud layer, the duration of exposure, the exposure regime, etc - that it is difficult to establish a direct quantitative correlation between the decrease of the ozone layer and the incidence of skin cancer.

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(1) Istisan 1980/10, Epidemiologia descrittiva del melanoma maligno della pelle.

(2) F.R. DE GRUIJL and J.C. VAN DER LEUN, A dose-response model for skin cancer. Induction by chronic UV Exposure of a Human Population. J. Theor. biol (in press).

(3) PNUE:Rapport de la 3e session du Comité de Coordination sur la couche d'ozone, novembre 1979.

3. Effects of UV-B on fauna and flora

Given the existing information regarding the effects of ultraviolet radiation on plants and animals, one cannot claim to evaluate precisely and in the near future the possible dangers of this radiation on the bioshere. If it has been possible to establish certain effects on plants, showing a range of different sensitivities, and on plankton, the main uncertainties are the spectrum of biological action, the small number of statistical samples, the degree of penetration of the UV radiation into water as far as aquatic media are concerned, and the environmental conditions under which the experiments are conducted.

4. Effects on climate

The relationships between a possible modification of the composition of the atmosphere and the subsequent climatic changes constitute a complex problem. The only way of progressing towards its solution will be to study thoroughly all concordant and contradictory effects which risk to affect the composition of the atmosphere.
One of the most preoccupying effects is the possible green-house effect due to factors such as the worldwide increase of atmospheric concentrations of carbondioxyde and CFCs, having a similar action and/or the increase in the quantity of suspenses material in the atmosphere. One can also cite the effects on stratospheric ozone of nitrogen of natural or industrial origin, of chlorinated hydrocarbons and water vapor, as well as of periodic emissions into the stratosphere of natural pollutants due to volcanic activity and other phenomena. The CFCs could have in addition an indirect effect through the changes in the amounts of ozone which also influence the temperature of the atmosphere.

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II. RE-EXAMINATION OF ECONOMIC AND TECHNICAL DATA

The study ordered by the Commission to Metra Consulting Group Limited in London and titled "Aspects of Implementing Reduction in Chlorofluorocarbons Usage in Aerosols" has broadly contributed to elaborate this chapter. Essential data and main findings are presented here. More details are available in the whole study. Member States have also provided the Commission with several data.

1. CFCs 11 AND 12 PRODUCTION AND USE STATISTICS : 1976-1979

1.1. EEC Statistics

The European Fluorocarbon Producers Technical Committee (EFCTC) of CEFIC has provided Metra with statistics on the sales in the Community of CFCs 11 and 12 and sales by end use following the same way than in 1976 (cfr. 1978 Metra Report "Social and Economic Implications of controlling the use of chlorofluorocarbons in the EEC").
The EEC statistics for 1976 and 1979 are presented in Table 1.

Although the production figures include any importation by the CFC producers from outside the EEC, the extent of this is believed to be very small because an excess of production capacity relative to demand has existed for some years and importation is normally only resorted to in the event of operating difficulties.

1.2. World Statistics

World production estimates are provided by the U.S. Chemical Manufacturers Association and are based on data supplied by the companies reporting together with data and estimates in respect of Communist bloc and other countries. Sales analysis by end use are available only for sales by the reporting companies - which include all the EEC producers - but these are believed to account for more than 90 % of world output.

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TABLE 1 : COMPARISON OF CFC 11 and CFC 12 PRODUCTION AND SALES BY EEC PRODUCERS FOR YEARS 1976 AND 1979. (Tons of CFC 11 and CFC 12)

	1976 tons	1979 tons	Change : 1976/1979 tons	%
PRODUCTION				
(including imports by EEC producers)	326,433	304,238	-22,195	- 6.8
SALES				
Sales in EEC by end use :				
Aerosols	176,914	136,552	-40,362	- 22.8
Refrigeration	20,773	20,300	- 473	- 2.3
Foam plastics	42,154	55,788	+13,634	+ 32.3
Other uses	4,178	6,921	+ 2,743	+ 65.7
Total Sales in EEC	244,019	219,561	-24,458	- 10.0
Total Exports to Countries Outside EEC	83,578	81,636	- 1,942	- 2.3
TOTAL EEC AND EXPORT SALES	327,597	301,197	-26,400	- 8.1

Source : EFCTC; further analysis by Metra

1978 is the latest year for which CMA figures are currently available. World and EEC production in the years 1976 - 78 is given in Table 2, and sales by end use in 1978 within the EEC and by all CMA reporting companies are presented in Table 3.

1.3. Production Trends

The decline in world production of CFC-11 and CFC-12 in 1977, continued in 1978 - for which the estimated world total was 709.1 thousand tons, as compared with 799.1 thousand tons in 1976, a fall of 11.3 %. EEC production in the period 1976 to 1978 fell from 326.4 thousand to 307.0 thousand tons, a reduction of 5.9 %.

TABLE 2 : EEC AND WORLD PRODUCTION OF CFC-11 AND CFC-12 : 1976 - 1979

	Production of CFC-11 and CFC-12		
	EEC '000 tons	World '000 tons	EEC as % of World
1976	326.4	799.7	40.8
1977	319.1	755.1	42.3
1978	307.0	709.1	43.3
1979	304.2	n.a.	n.a.

Sources : EEC Statistics - EFCTC
World Statistics - CMA estimates.

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TABLE 3 : CFC-11 /CFC-12 SALES DISTRIBUTION BY END USE IN 1978 : COMPARISON OF EEC AND TOTAL CMA REPORTING COMPANIES'DATA

Sales of CFC-11/CFC-12 in 1978

Application	Sales in EEC		Sales by all CMA reporting companies		EEC sales as % all CMA reporting company sales
	tons	%	tons	%	
Aerosols	150.4	65.0	307.2	47.2	49.0
Refrigeration	20.4	8.8	184.6	28.3	11.1
Foam plastics	54.5	23.6	131.7	20.2	41.4
Other uses	6.1	2.6	27.8	4.3	21.9
TOTAL :	231.4	100.0	561.3	100.0	35.5

Sources : EFCTC and CMA. (1978 is latest year for which CMA data available). The 19 CMA reporting companies include all CFC producers in the EEC, Australia, Japan and the USA, and subsidiaries of those companies in Canada, Spain, Argentina, Brazil, Mexico.

1.4. Sales Trends in the EEC

* Aerosols

Within the EEC there has been a progressive decline in sales for aerosols, from 176,914 tons in 1976 to 136,552 tons in 1979, a total fall of 40,362 tons, or 22.8 %. Nevertheless, this application accounted for 62.2 % of total sales in the EEC in 1979.

To reach the reduction of at least 30 % as required by the Council Decision, sales of CFC-11 and 12 for aerosols must fall by 53,074 tons or more from the 1976 level, entailing a further drop of at

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least 12,712 tons from the 1979 level.

Since individual Member States are each required to reduce F-11/F-12 usage for filling aerosols by at least 30 %, if any country reduces by more than 30 % then the total Community reduction should also exceed 30 %.

* Refrigeration

There has been no significant change in sales for refrigeration and air conditioning, which at 20,300 tons in 1979 accounted for only 9.2 % of sales in the EEC.

* Foam Plastics

Sales for use as blowing agents for foam plactics, mainly flexible and rigid polyurethane foams, have increased by 32.3 % since 1976. Foam plastics are the second largest application, accounting for 25.4 % of EEC sales in 1979.

* Other Uses

Sales for solvent and other uses rose by 65.7 %, but from a relatively low base, and at 6,921 tons in 1979 these made up only 3.2 % of EEC sales.

1.5. Exports Outside the EEC

Exports in 1979 totalled 81,636 tons which was 2.3 % below the 1976 total, and comprises 27 % of all sales by EEC producers. No end use breakdown is available for exports outside the EEC.

1.6. Net Reduction in Total Sales

The decline in sales for aerosols amounting to 40,362 tons in 1979 compared with 1976 has been substantially offset by increases in sales for foam plastics and miscellaneous uses, so that the net reduction in total (EEC and export) sales for the period is 26,400 tons, or 8.1 %.

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1.7. Intra-Community Trading

CFCs are produced in France, F.R. Germany, Italy, The Netherlands and the UK. Other Member States import CFCs 11 and 12 from the producer countries, between which there is also some trading. The volume of intra-Community trading in 1979 (excluding trading between the CFC producers themselves) amounted to about 24 % of all sales in the EEC.

1.8. Member States Statistics

At present CFC sales estimates on national territory are available only for the Federal Republic of Germany. Total CFC sales amount to about 78.000 tons in 1979. CFC sales for usage in aerosols are c.a. 35.000 tons in 1979 (i.d. 45 % of sales) to be compared to 48.200 tons in 1976 showing a reduction of c.a. 27,4 %.

1.9. Contrasts between EEC and World Sales

As may be seen from Table 3, the main differences between the sales pattern in the EEC and that for all CMA reporting companies are in the aerosol and refrigeration sectors. Aerosols accounted for 65 % of EEC sales in 1978 compared with 47.2 % for world sales, and the respective proportions for refrigeration were 8.8. % and 28.3 % respectively.

By subtracting the EEC tonnages from the CMA totals the pattern of non-EEC usage can be established and the contrast becomes stronger with aerosols accounting for 37.3 % and refrigeration for 39.1 %.

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2. AEROSOL PRODUCTION TRENDS

EEC total fillings peaked in 1976 at 1,873 million units, falling to 1,857 m. in 1977 and to 1,837 m. in 1978. The world total of 6,027 m. in 1978 is the highest since the previous peak of 6,009 m. in 1974, and the USA production in 1978 was higher than in the previous year - reversing for the first time the decline which set in after the peak of 1973. EEC fillings in 1978 represented over 30 % of the world total.

Within the EEC the United Kingdom continued to be the largest producer in unit terms, having increased production each year since 1975 to the highest total yet of 563 m. units in 1978. Production in West Germany, the Netherlands and Belgium was marginally lower in 1978 compared with 1977; Italy increased production from 192 m. to 207 m., but in France output dropped sharply from 466 m. to 412 m.

Personal products are still the largest sector, accounting for 54.2 % of EEC fillings in 1978, compared with 58.7 % in 1976, but there have been significant falls in the fillings for hairsprays, antiperspirants and deoderants, (personal products with high CFC concentrations) which have been partly offset by increases in the household and other categories (frequently formulated without CFCs).

Another problem in drawing comparisons either between Member States or between sectors is that unit statistics are not a reliable guide to relative product volumes.

Table 4.3. shows estimates from an industrial source of the distribution of propellant usage in EEC countries.

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TABLE 4.3. : PROPELLANT USAGE IN THE EEC : 1979

	Propellant Usage Distribution % No. of Aerosol Units			
	Fluoro-carbon	Hydro-carbon	Dimethyl-ether ('DME')	Carbon dioxide
Belgium	50	28	18	4
Denmark	55	40	-	5
France	70	25	-	5
West Germany	67	23	-	10
Italy	60	30	-	10
Netherlands	10	70	15	5
U.K.	68	30	-	2

Source : confidential

3. CFCs 11 and 12 SUBSTITUTION IN AEROSOLS : TECHNICAL ASPECTS

3.1. The reduction in CFCs 11 and 12 propellant usage between 1976 and 1979 is due to an unquantifiable combination of substitution by non-CFC propellants and changes in the aerosol demand pattern.

3.2. Hydrocarbon (propane/butane) propellants are proving to be the principal substitutes for CFCs 11 and 12, with many fillers preferring to make gradual changes by using CFC/hydrocarbon blends.

3.3. Dimethylether (DME) has potential as an alternative to hydrocarbons because of better solvent properties and miscibility with water. DME is mainly being used in Belgium and the Netherlands. Other countries are waiting before adopting DME pending a fuller examination of its toxicological properties and research on these aspects is being supported by the Netherlands Government.

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3.4. No fluorocarbon alternatives for CFCs 11 and 12 acceptable for large scale general use have yet emerged.

4. SOCIO-ECONOMIC ASPECTS OF CFCs 11 AND 12 SUBSTITUTION

4.1. There are no significant new data since 1978.

4.2. There is substantial capital investment entailed in converting to the principal CFC substitute - hydrocarbons - because of the extensive safety precautions required. In urban areas it may be impracticable to comply with local regulations, so that a filler may have the options of moving that part of his operations to another site, ceasing to produce aerosols, or employ a contract filler.

4.3. The cost and other problems attaching to conversion bear more heavily on the smaller fillers, and it is expected that some large fillers will expand their businesses and some small fillers will cease operation. There could be a greater net effect in countries such as Denmark and Ireland where all the fillers are comparatively small.

4.4. Any reduction in overall CFC production adversely affects the fluorspar mining industry and this is of special concern in Italy.

A reduction of CFC-11/CFC-12 usage in aerosols going much beyond 30 % is also likely to cause socio-economic problems in the CFC producing and allied industry sectors, because there is already an over-capacity situation and sales of CFCs for aerosols in the EEC in 1979 accounted for 45 % of production.

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