Environmentally Hazardous
Chemicals Act, 1985

Assessment Report

STATE POLLUTION CONTROL COMMISSION

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STATE POLLUTION CONTROL COMMISSION.

Chlorofluorocarbons and halons that deplete the ozone layer.

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Assessment Report

Chlorofluorocarbons and Halons that Deplete the Ozone Layer

Assessment Report 88/2

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ASSESSMENT OF CHLOROFLUOROCARBONS AND HALONS THAT DEPLETE THE OZONE LAYER

1 INTRODUCTION

During the 1930s new compounds were introduced as safe, stable and odourless refrigerants. These compounds, known as chlorofluorocarbons (CFCs), were based on simple hydrocarbon molecules where some or all of the hydrogen atoms had been replaced by chlorine and fluorine atoms.

By the 1940s CFC substances were being used as aerosol spray can propellants and in the 1950s as foam-blowing agents in the production of foam plastics such as polyurethane and polystyrene.

In 1974 it was first recognised that, unlike many other air pollutants, some CFCs released or escaping into the atmosphere are not quickly broken down and removed. They are instead dispersed to the upper atmosphere where they interfere with gas reactions, causing a depletion of ozone. This upper-atmosphere ozone prevents all ultraviolet radiation with wavelengths of less than about 290 nanometres (nm) from reaching the ground; this is fortunate because excessive ultraviolet is most dangerous to living things at wavelengths around 265 nm. It also stops most ultraviolet radiation in the 290-320 nm range; the small amounts that do filter through cause skin cancer and sunburn.

As scientific understanding of this environmental problem has improved, it has been recognised that the widespread nature of the emissions of ozone-depleting gases and the resulting global impact requires an international approach. On 16 September 1987 a global agreement was signed in Montreal, under the auspices of the United Nations Environment Program (UNEP). The agreement establishes a timetable to reduce production and consumption of certain substances that deplete the ozone layer. It was called the Montreal Protocol.

It should be noted that a number of gases have the potential to deplete the ozone layer in the upper atmosphere. The Montreal Protocol addressed the control of selected halogenated hydrocarbons, probably the most persistent of the ozone-depleting gases. In this report the term "ozone-depleting substances" refers specifically to those halogenated gases covered by the Montreal Protocol (as listed in Table 1), but this does not mean that other gases may not also deplete the ozone layer.

The responsibility for Australia's compliance with this agreement rests with the Commonwealth Government. To discharge its responsibility, the Commonwealth is, firstly, coordinating action with the States and, secondly, preparing legislation to control importation and production of the controlled substances and, where appropriate, their end-uses. Because of Canberra's special role in international agreements, Commonwealth legislation is essential. State legislation needs to be complementary, supportive and based on good liaison with the other concerned parties.

The State Pollution Control Commission (SPCC) is currently examining the regulatory options available to ensure that New South Wales legislation will not conflict with the Commonwealth approach.

To determine what changes may be required in the legislation, the SPCC undertook a preliminary study to establish a better inventory of CFC sources which would allow the setting of priorities for action. The study reviewed control technology options to determine practicable controls over several industry processes and uses. Following this study, special working groups were set up nationally to determine what additional controls could be implemented to achieve the maximum practicable reduction in CFCs. Both industry and government were represented on these groups.

The working groups prepared a report on the practicable control options and, on the basis of the report, the SPCC concluded that a Chemical Control Order under the Environmentally Hazardous Chemicals Act 1985 would be essential to regulate the ozone-depleting chemicals. As a result the SPCC on 2 September 1988 gazetted a "Notice of Intention to Make a Chemical Control Order or Determination" on the manufacture, use and disposal of CFCs and halons (Publication No. 140 in the Government Gazette). Consequently this report is aimed at:

- assessing the manufacture, use and disposal of CFCs and halons with particular reference to their ozone-depleting potential

- evaluating the need for any special regulatory controls.

2 THE MONTREAL PROTOCOL

In 1985 an international treaty, the Vienna Convention for the Protection of the Ozone Layer, was concluded. Australia is one of the 16 countries so far to become a party to the treaty.

The Convention provides the framework for a range of actions by different countries. However it does not lay down specific requirements to control substances damaging the ozone layer.

Under the provisions of the Convention, a separate agreement known as the "Montreal Protocol on Substances that Deplete the Ozone Layer" was finalised in September 1987. Australia signed the Protocol in June 1988.

The Montreal Protocol calls for a freeze on the consumption and production of certain chlorofluorocarbons at the 1986 level by 1989; a 20 per cent reduction of 1986 levels by 1993; and a further 30 per cent reduction by 1998-99. In addition the Protocol proposes a freeze in halon usage at 1986 levels, beginning in 1992. The list of controlled substances together with their ozone-depleting potential is shown in Table 1.

The Montreal Protocol seeks to control production and imports and hence the supply of bulk CFCs, as a way to reduce their uses and ultimately their release to the environment. There is no requirement for countries to control the uses to which CFCs are put.

The Protocol was framed in light of the scientific knowledge available in mid-1987. When it was adopted, it was thought that halving CFC production and freezing the production of halons would be enough to protect the ozone layer. The consensus then was that no damage had yet been done.

However in March 1988, after the Montreal controls had been accepted, an international group called the Ozone Trends Panel reported that a 3 per cent decrease in stratospheric ozone had already occurred over heavily populated portions of North America and Europe. A further report released by the United States Environmental Protection Agency (USEPA) (Hoffman et al 1988) in September 1988 said that chlorine will continue its dangerous build-up even if every country agrees to the terms of the Montreal Protocol. If methyl chloroform emissions continue to grow at recent rates, chlorine concentrations will rise from current levels of 2.7 parts per billion (ppb) to 8 ppb by the year 2075 (Figure 1). Twenty-five years ago the stratospheric level of chlorine was only 0.6 ppb.

To stabilise chlorine and bromine levels over the next 100 years, an "immediate 100 per cent reduction" in the use of CFCs and halons and a freeze on methyl chloroform will be required, the USEPA report claims.

Table 1
Controlled Substances

Group	Column 1 Common Name	Column 2 Ozone-Depleting Potential
Group I:		
$CFCl_3$ Trichlorofluoromethane	CFC 11	1.0
CF_2Cl_2 Dichlorodifluoromethane	CFC 12	1.0
CCl_2FCClF_2 1,1,2-trichloro-1,2,2-trifluoroethane	CFC 113	0.8
$CClF_2CClF_2$ 1,2-dichloro-1,2-tetrafluoroethane	CFC 114	1.0
$CClF_2CF_3$ 1-chloro-1,2-pentafluoroethane	CFC 115	0.6
Group II:		
CF_2BrCl Bromochlorodifluoromethane	Halon 1211	3.0
CF_3Br Bromotrifluoromethane	Halon 1301	10.0
$CBrF_2CBrF_2$ 1,2-dibromo-1,2-tetrafluoroethane	Halon 2402	6.0

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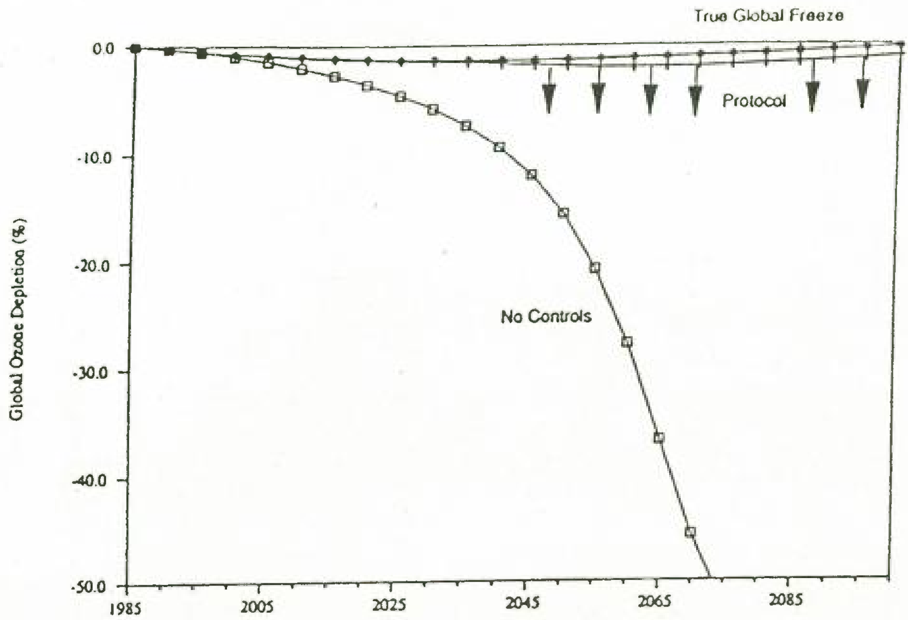

Figure 1: Simulated global average total Column 1 ozone depletion; no controls; Protocol; and true global freeze (Hoffman et all 1988)

Assumptions

"No controls" = Compound use grows at an average annual rate of 2.8 per cent from 1985 to 2050, with no growth thereafter.

"Protocol" = US participation; 94 per cent participation in other developed nations; 65 per cent participation in developing nations. Use of compounds not covered by the Protocol grows at the rates in the "no controls" scenario. Growth rates among non-participants are reduced to 37.5 per cent (developed nations) and 50 per cent (developing nations) of their baseline values.

"True global freeze" = The use of all chlorine-containing compounds is frozen at 1986 levels starting in 1990 and 100 per cent participation is achieved worldwide.

"Other trace gases" = CH_4 grows at 0.017 ppm per year; N_2O grows at 0.2 per cent per year; CO_2 grows at the 50th percentile rate reported by the NAS (about 0.6 per cent per year).

Arrows indicate that ozone depletion estimates may be underestimated.

In addition to the general global depletion of ozone of about 2 per cent since 1979, a localised, more intense depletion over the Antarctic in spring has been recognised (Farman et al 1985). This phenomenon, referred to as the "Antarctic hole" in the ozone layer, is characterised by a 50 per cent reduction in ozone over the last 10 years. There is concern in the scientific community that the ozone hole is increasing in intensity, extent and possibly duration (Lindley 1987).

The October 1988 meeting in the Hague called to review the Montreal Protocol concluded (NASA 1988) that the changes in the scientific understanding of the ozone layer since the adoption of the Protocol were as follows:

a. Anthropogenic chlorine species are primarily responsible for the observed decrease in springtime Antarctic ozone (the Antarctic ozone hole), although the unusual meteorological conditions of the winter Antarctic stratosphere are a necessary prerequisite. Further ozone losses in Antarctica are expected but their magnitude is difficult to predict.

b. No depletion comparable to the one in the Antarctic has been observed over the Arctic polar region.

c. Ground-based ozone monitoring shows measurable ozone decreases from 1969 to 1986, broadly consistent with model calculations, except in winter where observed decreases are larger than predicted. The observed decreases may be wholly or partly due to trace gas changes, primarily CFCs.

d. Inclusion of pre-1965 ground-based ozone data reduces the observed trends, but they remain significant.

e. Even if the current Protocol were ratified by all nations, the Antarctic ozone hole would remain forever because, under today's Protocol, stratospheric chlorine levels will still double from their current levels. The hole will remain until these chlorine levels are reduced to the levels of the early 1970s. This will require a virtual complete phase-out of CFCs and a careful consideration of acceptable emission levels of methyl chloroform. However the hole could disappear if the Antarctic stratosphere were to warm significantly.

Built into the Protocol is the requirement that it is re-assessed at regular intervals. This is particularly important in light of the ozone hole finding. The first review of the Protocol is to be completed by 1990. As such there is a strong possibility that the requirements under the Protocol may be more stringent and include more chemicals.

3 HEALTH AND ENVIRONMENTAL EFFECTS OF OZONE DEPLETION

Life on earth has evolved over the millennia, protected from exposure to harmful wavelengths of ultraviolet (UV) radiation through the atmospheric shield of ozone gas. Thus a decrease in ozone levels would result in an increased amount of this damaging radiation reaching the earth's surface and thereby increasing the exposure of people and other animal and plant species.

There is strong evidence of a causal relationship between exposure to harmful UV radiation and skin cancer in its various forms. Scientific work has indicated that, statistically, a reduction by 1 per cent in the concentration of ozone gas in the atmosphere would result in an increase in the most common forms of skin cancer - the non-melanoma varieties - by between 4 and 6 per cent (CSIRO 1988). Most Australians are familiar with these skin cancers because of their frequent occurrence, in some places the highest incidence in the world.

UV radiation may have other health effects as well such as induction of cataracts of the eye and effects on the body's immune system (Kurzel et al 1977 and Zigman 1977).

Increased exposure to harmful UV radiation would affect the growth of plants (including crops) and organisms living near the surface of water. This radiation is also destructive to some materials such as plastics.

It should be noted that there is a large natural seasonal variation in the amount of UV radiation which reaches the earth. At a latitude of 30°S at noon in summer the intensity of UV radiation is about four times the noon winter value (Cutchis 1974). UV input also varies greatly from place to place, decreasing with distance from the equator. The effects of ozone depletion by CFCs and halons are additional to this seasonal variation.

If the growth in emissions of CFCs and halons were to continue unabated, it would make a significant contribution also to the warming of the atmosphere, which is beginning to occur, and which could result in the earth's average temperature rising by between 2 and 4°C by the year 2030 (Villach 1985). The main cause of this warming is carbon dioxide from the combustion of fossil fuels.

4 EFFECTS ON THE OZONE LAYER

Several different chemical compounds contribute to the depletion of the stratospheric ozone layer.

Fully halogenated CFCs (those with no hydrogen atoms remaining) are very stable compounds. Consequently they do not decompose until a long time after their emission, when they reach the stratosphere and are broken down by the sun's UV radiation. This process liberates chlorine, which in turn catalytically breaks down ozone into ordinary oxygen, while itself remaining intact. It is estimated that one chlorine atom can destroy about a thousand molecules of ozone.

By contrast, partially halogenated CFCs (those retaining at least one hydrogen atom) have much shorter lifetimes because they are broken down in the lower atmosphere. They therefore have a lower ozone-depleting potential.

Fully halogenated CFCs containing fluorine but no chlorine also have less impact on the ozone layer. These fluorine compounds are so stable that they are not even decomposed by UV radiation.

Brominated fluorocarbons (called halons) have the same type of effect on the ozone layer. These compounds (halons 1211 and 1301) are used in relatively small quantities - mainly for firefighting - but they are important because their ozone-depleting potential is as much as 10 times that of CFCs 11 and 12, two commonly used CFCs. Physical properties and numerical codes for some CFCs are shown in Table 2.

CFCs and halons are, of course, not the only pollutants that destroy the ozone layer. Nitrous oxide (N_2O), given off when soil bacteria break down nitrogen fertilisers, is a possible cause for concern. Emissions of this gas as a normal part of the nitrogen cycle in plant life are the main source of ozone-depleting nitrogen oxides in the stratosphere and play a major role in determining the level of stratospheric ozone.

The other most important contributors of ozone-depleting chlorine are carbon tetrachloride and methyl chloroform. Carbon tetrachloride is used primarily to produce CFCs 11 and 12. Methyl chloroform is used largely in solvent and adhesive applications.

Table 2
Numerical Codes and Selected Physical Properties for some Fluorocarbons (Reference)

Code No.	Formula	Molecular Weight	Boiling Point °C	Freezing Point °C	Density (g/cc)/°C
CFC 11	CCl_3F	137.4	23.8	-111	1.487/20
CFC 12	CCl_2F	120.9	-29.8	-158	1.293/30
CFC 22	$CHClF_2$	86.5	-40.8	-160	1.175/30
CFC 113	CCl_2FCClF_2	187.4	47.6	-35	1.533/30
CFC 113a	CF_3CCl_3	187.4	45.7	14	1.579/20
CFC 114	$CClF_2CClF_2$	170.9	3.6	-94	1.440/30
CFC 115	$CClF_2$-CF_3	154.5	-38.7	-106	1.265/30
CFC 123	$CHCl_2CF_3$	153	27.1	-107	1.475/15
CFC 132b	$CClF_2CH_2Cl$	135	46.8	-101.2	1.416/20
CFC 141b	CCl_2FCH_3	116.9	32	-103.5	1.250/10
CFC 134a	CF_3-CH_2F	102	-26.5	-101	-
CFC 142b	$CClF_2$-CH_3	100.5	-9.2	-130.8	1.096/30
CFC 152a	CHF_2-CH_3	66	-24.7	-117	0.966/19
Halon 1211	$CBrClF_2$	165.4	-4	-160.5	1.850/15
Halon 1301	CF_3Br	148.9	-57.8	-168	1.580/21
Halon 2402	$C_2F_4Br_2$	259.76	47	-	-

5 SOURCES OF CFCs IN AUSTRALIA

CFCs 11 and 12 are produced by two companies in Australia both located in Sydney: Chemplex Australia Ltd (previously known as Australian Fluorine Chemicals Pty Ltd) and Pacific Chemical Industries Pty Ltd. Each is a joint venture with companies from the United States and Europe.

Total production of CFCs 11 and 12 in Australia was approximately 14,500 tonnes in 1986, an increase of 20 per cent over 1985's 12,000 tonnes. During the previous decade there had been an overall decrease in the use of CFCs 11 and 12 in Australia since the peak of 1974, when production reached 16,000 tonnes. The combined capacity of the two Australian plants is about 25,500 tonnes per annum.

There has been little export of domestically manufactured CFCs in the past. However in recent years, there has been a large growth in exports of CFCs 11 and 12. Industry has advised that about 17 per cent in 1986 was exported.

CFC 22, used as refrigerant and not included in the Protocol, is almost totally imported by Lovelock Luke, but Pacific Chemicals does manufacture approximately 1500 tonnes annually in batch lots.

CFC 113, used in dry-cleaning and degreasing, is imported by Lovelock Luke and Pacific Chemicals.

CFC 114, used in aerosols, is imported by Monsanto.

CFC 115, used as a refrigerant, is imported largely by Lovelock Luke, but a small quantity is imported by Pacific Chemicals.

Halon 1211, used in firefighting, is imported principally by ICI with small additional quantities imported by Nippon Halon and Great Lakes Chemicals.

Halon 1301, used in firefighting, is imported by Nippon Halon, Diakon and Asahi Glass who collectively represent around 80 per cent of the market.

The only available estimate of the 1986 consumption of CFCs in Australia was made by the Association of Fluorocarbon Consumers and Manufacturers (AFCAM) and Table 3 shows its estimates of CFC consumption in Australia for 1986.

Table 3
Expected CFC Usage in 1992 (tonnes per annum)

	Consumption in 1986	Industry Estimate Consumption in 1992	SPCC Estimate Consumption in 1992
Aerosols	4500	600	600
Flexible Foam: . polyols available	1685	840	840
Rigid Polyurethane: . use of other materials	740	370	370
Extruded EPS Packaging: . use of other blowing agents or materials	925	90	0
Extruded EPS Insulation: . use of other insulating materials (SPCC) . use of other blowing agents (industry)	150	15	0
Commercial Refrigeration and Air Conditioning: . use of CFC 22 in new installations . better design, operation and maintenance . recovery	224	2145	2145
Domestic Refrigeration	160	160	160
Automotive Air Con: . better design to reduce leakages . recovery	1300	1175	1175
Dry Cleaning: . installation of recovery equipment . better maintenance of existing equipment	400	NA (say 200)	200 max.
Degreasing: . recovery . use of other chemicals	350	200	200
TOTAL	12455	5795	5690

6 POTENTIAL FOR EMISSION SOURCE CONTROL

6.1 AEROSOLS

In 1983 the aerosol industry entered into a voluntary agreement with the National Health and Medical Research Council (NHMRC) and the Australian Environment Council (AEC) to voluntarily phase out the use of CFCs in aerosols and to label all products according to the type of propellant they use. Since 1972 the use of CFCs in aerosol packs has declined by almost 70 per cent (from 13,000 to around 4500 tonnes) despite a steady growth in overall sales of aerosol products. The industry has agreed to phase out the use of CFCs in all aerosols, except for essential uses, by 31 December 1989.

Essential use exemption applies to aerosol products for medical, veterinary and defence purposes.

The aerosol industry estimates that after the phase-out approximately 600 tonnes of CFCs will be required for products intended for essential uses.

6.2 PLASTIC FOAM MANUFACTURE

In Australia approximately 30 per cent of the total production of CFCs 11 and 12 is used in plastic foam manufacturing. In 1986 this amounted to 3500 tonnes.

6.2.1 Flexible Polyurethane Foam

Over 20,000 tonnes of polyurethane foam is used in Australia annually. It is extensively used in furniture, car seats etc. as it is non-toxic and non-allergenic and retains its physical characteristics for long periods.

Flexible polyurethane foams are generally created by the reaction of toluene di-isocyanate with a polyol and water. Carbon dioxide is formed during the reaction and used as a primary blowing agent. A significant proportion of moulded flexible foam is made in this way and is known as "water-blown" foam.

To achieve extra softness or low density, an auxilliary blowing agent is employed. Formic acid, methylene chloride and others have been tried, but CFC 11 is most widely used.

6.2.1.1 Current Alternatives

Chemical Substitutes

A number of CFC substitutes hold some promise as blowing agents. Carbon dioxide is already used for blowing some low-density flexible foams and there may be some scope for expanding its use.

Methylene chloride has been used successfully in the United States but threshold limit values for the protection of workers have proven difficult to achieve. Further, there is evidence to suggest that methylene chloride is a carcinogen, which casts further doubt on its suitability as a blowing substitute.

Product Substitutes

Fibrefill materials, cotton batting, latex foams and built-up cushioning using springs may be suitable substitutes in many foam applications. They are not expected to replace a large volume of foam uses, however, because they are more expensive and lack the durability of flexible polyurethane.

Recovery

The most promising route for reducing CFC consumption in the flexible foam industry seems to be recovery of the gases used in blowing. CFC emissions from flexible foam production are quickly released, since virtually all the blowing agent diffuses from the open cells during or soon after foam formation.

Prototype recovery equipment development by Flakt Denmark has involved shrouding the production line with an air extraction system and an activated carbon recovery system. Pilot tests have shown that total capture and recovery efficiency is only about 40 per cent. However Unifoam AG, in cooperation with Draka Interfoam of Belgium, claims it has developed a foam process which can capture up to 85 per cent of CFCs and make them available for re-use. As well as the problem of low efficiency, there are problems of fouling the carbon adsorbent by organic impurities, the effect of water vapour on bed capacity and the purity of reclaimed CFC 11.

6.2.1.2 Future Alternatives

"Soft-Polyols" under development could eliminate the need to use CFC 11 to create a "soft" foam (low-density foam). Their commercial introduction is expected in less than five years.

As mentioned earlier, new alternatives are becoming available and although it is not possible to speculate on the extent to which they can be substituted, mention of time frames for development is appropriate. These alternatives, including recently formulated CFC substances, are not yet commercially produced (e.g. CFCs 123 and 141b). A number of CFC producers have cooperated to develop a program of toxicity testing on such substitute CFCs. Lead time for commercial process development with concurrent toxicity testing is optimistically expected to require five to six years. Several additional years may be necessary for testing and reformulation.

6.2.1.3 The Australian Flexible Foam Industry

In Australia three companies dominate the market of flexible foams. One company in Sydney has just recently installed a new plant which is applying the latest technology. Consequently, it should not be difficult for this plant to employ a recovery technique.

The other company in Sydney has an older plant and retrofit control by recovery would be very expensive. This company has indicated that its research efforts are concentrating on chemical substitutes.

The flexible foam industry has not proposed any specific controls. Should the expected developments fail to materialise, the industry may withdraw those low-density/low-hardness foams which require the highest proportions of CFC 11.

6.2.2 Rigid Polyurethane Foam

The major application of rigid polyurethane foam is in the building industry. It has excellent insulating qualities and strength. Rigid polyurethane containing CFC 11 is also used as the insulation material for domestic refrigerators and freezers.

One common characteristic of all rigid foams is that the foam process creates a high proportion of closed cells which trap the blowing agent. CFC 11 has a very low thermal conductivity and in insulating foams plays a dual role as blowing agent and insulant. In insulation foams there is an incentive to trap as much CFC as possible and for this reason CFC consumption is high. The CFCs in these foams will leak out over several years and reduction of these emissions by control technology does not seem practicable.

It is considered that add-on manufacturing controls will be relatively ineffective as only a small amount of CFC is emitted during the manufacturing.

The most effective controls will not only reduce emissions during manufacture but must also reduce the amount of CFC 11 retained in the products. Both chemical and product substitutes will reduce overall use of CFC 11 in rigid polyurethane foam.

CFCs are an integral part of the insulating product, providing poor thermal conductivity that makes the product more energy-efficient than other insulating materials of the same thickness.

6.2.2.1 Current Alternatives

Many alternative products are currently available as sheathing or roof-insulating materials. Products such as expanded polystyrene foam, beadboard, fibreglass and gypsum could be used instead of polyurethane foam, as they were 30 years ago before its manufacture. In some cases, wall and roofing insulation can be made more thickly to achieve the same insulating capacity, but some use of CFC-blown foam is likely to continue where it provides the only way to meet a building's energy efficiency requirements.

Some product substitutes are available for poured or sprayed foam, depending upon their specific use. In applications such as packaging and flotation, product substitutes are numerous. Combinations of plastic and non-plastic materials can provide equivalent degrees of cushioning, shock resistance and water resistance.

No other insulation materials have the same ability to be poured or sprayed nor can other materials of the same thickness insulate as well as rigid polyurethane foam. For refrigerators, a switch to fibreglass would mean an increase in the energy consumption rating.

6.2.2.2 Future Alternatives

The two most promising new CFC alternatives are CFCs 123 and 141b. Most overseas research seems to be centred on CFC 123. Chemical manufacturers in the United States have indicated that a development period of 5 to 7 years will be required to produce them commercially. Early indications are that the foam blown with CFC 123 will produce a foam with 10 per cent poorer thermal conductivity and hence the insulation would have to be thicker, although to what extent is not known. These substitute chemicals will be two to three times as expensive as CFC 11.

The Australian foam industry has indicated that a blend of CFCs 11 and 22 may be another alternative.

6.2.3 Non-Urethane Foam

The majority of non-urethane foam is polystyrene foam which consists of three main types: extruded polystyrene board, extruded polystyrene sheet and expanded polystyrene. Extruded polystyrene board is used in insulation and is blown with CFC 12 or methylene chloride. Extruded polystyrene sheet, used mainly in packaging such as egg cartons, hamburger shells and meat trays, is blown using CFCs 11 and 12.

Expanded polystyrene does not use CFCs. It accounts for almost 10 per cent of the insulation market. It is blown with steam and its insulating qualities are based on air trapped within the foam rather than on added gases. Expanded polystyrene accounts for almost all foam cups.

6.2.3.1 Extruded Polystyrene Sheet

Current Alternatives

There are a number of chemical substitutes for polystyrene blown with CFCs. The best known is pentane, a flammable liquid hydrocarbon solvent, that would require extensive plant modification to accommodate the storage and handling of the substance. According to a company in Sydney, conversion to pentane as the blowing agent would cost $150,000 per process line.

The most promising alternative short-term substitute for CFC 12 is CFC 22. It costs about 50 per cent more than CFC 12 and has recently been used in foam production in the US. The US Food and Drug Administration has recently approved CFC 22 as a blowing agent for use in polystyrene sheet for fast food applications (e.g. hamburger shells) and for long-term food storage (meat trays, etc.).

Citric acid and baking soda can also be used as blowing agents. A company in Sydney is currently considering building a plant to manufacture CFC-free polystyrene for packaging.

In Australia the market for polystyrene foam production is dominated by three companies. One company is considering a switch to CFC 22, partly due to the demand by the McDonalds hamburger chain for packaging which does not use CFC 12. McDonalds advised all outlets that it wants all plastic trays to be produced with non-CFC 12 by mid-1989.

According to this manufacturer, no major modification to the process line is involved. It should be noted here that CFC 22 is currently being produced in Australia and its production could be increased without capital investment.

There is also the option of substituting traditional packing materials, such as paper and other wood products, for polystyrene.

Future Alternatives

In the long term, the foam packaging industry expects to find a chemical substitute that has no ozone-depleting potential. Likely alternatives include such chemicals as CFC 134a. Any alternative blowing agent will need to undergo complete toxicity testing before it can be used in food service packaging.

6.2.3.2 Extruded Polystyrene Board

Extruded polystyrene board is used in insulation. Only 150 tonnes of CFC 12 is used in its manufacture. This market, however, does have considerable potential for growth.

Current Alternatives

There are many current alternatives to foam boardstock as insulation, including fibreglass board, perlite, expanded polystyrene, cellular glass, insulating concrete, rock wool, vermiculite, gypsum, plywood, foil-faced laminated board and insulating brick. These alternatives may require greater thickness for equal energy efficiency.

One major American producer of extruded polystyrene boardstock announced that it will substitute partially halogenated CFCs (for example CFC 22) in its manufacturing process beginning in 1989. This will include all plants, domestic and international.

Future Alternatives

In the short term, manufacturers of boardstock might reduce the use of CFCs by switching to chemical blends and partially halogenated CFCs. In the longer term, they are likely to replace CFC 12 in polystyrene boardstock with a chemical substitute such as CFC 134a. Foams blown with CFC 134a may have similar insulating characteristics to those blown with CFC 12. Another chemical undergoing active testing by industry is CFC 142b.

6.2.4 Phenolic Foam

There are two types of phenolic foam: open and closed-cell foam. The closed-cell foam is used only for insulation and the open-cell variety for floral display and some insulation. Improved fire retardancy, low smoke generation, high temperature resistance and good thermal properties have promoted the use of phenolic foam as insulation.

Its good thermal property is obtained by retaining CFC 11, which has low thermal conductivity, inside the closed-cells.

Pentane and hexane are used as blowing agents for open-cell foam. They can, in principle, be used for closed-cell foam. However hydrocarbon blowing agents would reduce its insulating effectiveness.

6.3 REFRIGERATION AND AIR CONDITIONING

6.3.1 Commercial and Industrial Refrigeration and Air Conditioning

It is estimated that in 1986 the commercial and industrial refrigeration industry used 1840 tonnes of CFC 12 while commercial and industrial air conditioning used 400 tonnes of CFCs 11 and 12.

6.3.1.1 Fixed Air-Conditioning Systems

CFCs 11, 12 and 22 are used in existing fixed air-conditioning systems.

Industry advises that almost all new fixed air-conditioning systems use CFC 22, a partially halogenated substance that is not included in the Protocol. However data from the US shows that CFC 11 is still being used for around 16 per cent of fixed systems and there is a potential for further use of CFC 22 in new installations. It is not generally possible to change to another refrigerant in existing systems, as the refrigerant determines the overall design of a system.

There also appears to be a potential for recovery of CFCs which would otherwise be vented to atmosphere during servicing and repair work. It was reported that this recovery is cost-effective as the cost of replacing 300-1000 kilograms of CFCs is substantial. There is a process plant in Sydney used almost exclusively for recycling recovered refrigerant from this source.

In fact, the industry proposed the introduction of a national system of collecting contaminated CFCs 11 and 12 for processing from fixed air-conditioning systems by the end of 1989.

Two chemical substitutes which can replace CFCs 11 and 12 are CFCs 123 and 134a. However it is expected that it will be a long time before these substitutes are available.

6.3.1.2 Commercial Food Processing and Handling

CFCs are used in retail food store refrigeration, cold storage warehouses and refrigerated transport. CFC 12 is used in medium to high-temperature storage, while CFC 502 (a mixture of CFCs 22 and 115) is used in low-temperature storage (freezers).

CFC 12 is also used in refrigerated trucks, trailers and railroad cars.

The largest source of emissions from retail food stores and cold storage warehouses is normal leakages and service venting.

In the short term, fewer service ventings might occur if additional steps were taken to reclaim or purify contaminated refrigerant. For retail food storage refrigeration, new equipment could be designed around CFCs 22 or 502 as a first choice, already widely used in new units in the US. These units have high thermal capacity and need a smaller motor. As such they are more efficient to run. However the initial cost is very high compared with units using CFC 12. In Australia CFC 12 is used almost exclusively in all supermarket chillers.

This may be changed soon as some major users (Coles and Woolworths) recently specified that new and refurbished installations were to use alternative refrigerants.

For cold storage warehouses, ammonia might take an even larger share of the market and CFC 22 (and/or 502) could be used instead of CFC 12.

In the longer term, newer CFC chemical substitutes such as CFC 134a may be more favoured alternatives.

6.3.2 Home Refrigeration Appliances and Small Refrigeration Units

All home refrigeration appliances use CFC 12 and are hermetically sealed. Leakages of refrigerant gases are minimal.

Two companies dominate the industry in Australia. It is estimated that only 150 tonnes of CFC 12 are used as refrigerant in all home refrigeration appliances. Recovery of CFC 12 during service and disposal can only capture a very small portion of CFC emissions. The cost of administration would be very great.

CFC 134a appears to be an attractive substitute refrigerant for CFC 12. This refrigerant is closely, but not completely, compatible with current systems. Its physical properties closely resemble those of CFC 12. It contains no chlorine and has an ozone-depleting potential of zero. However CFC 134a is not commercially available and will require added time for development and toxicity testing.

CFC 22 is another possible substitute but it would involve a complete compressor redesign because of its high vapour pressure. Total retooling costs were estimated at $20 million per manufacturing facility although this figure could be reduced if retooling became necessary world-wide.

6.3.3 Automotive Air Conditioning

At present CFC 12 is used exclusively as the refrigerant in car air conditioners. Australia has some eight million vehicles. Three million have either original equipment or after-market air-conditioning systems. Each system when fully charged contains almost 1 kilogram of CFC 12. Thus the total CFC 12 in use in Australian automotive air-conditioning systems is around 3000 tonnes.

Automotive air conditioning is still a growth industry with over 60 per cent of all new cars fitted with the equipment. The market has been increasing at roughly 3 per cent per annum for the past 10 years. The number of air-conditioned vehicles on the road is expected to increase for at least the next few years.

During the life of an air-conditioning unit, CFC 12 that has leaked from the system must be replaced to maintain its operability. When units are serviced or repaired, the entire charge of CFC 12 is usually replaced with no emission control. At the end of their useful life, vehicles are usually taken to an auto disposal yard. It is estimated that 25-50 per cent of all vehicle air conditioners have some CFC 12 charge remaining at disposal. Current practices do not recover the refrigerant.

The annual usage of CFC 12 in 1986 by the automotive sector is shown in Table 4.

Table 4
CFCs in Automotive Air Conditioning
(From AFCAM Report)

Use	%	Tonnes p.a.
Initial charge	27.2	350
Recharge after service	33.6	430
Recharge after leakage	25.0	325
Accidents	3.9	50
Dump prior to recharge	10.3	145
TOTAL	100.0	1300

Notes

1 The above data are the best estimates based on actual Australian usage with percentages in each category based on American data.

2 "Initial charge" = the amount based on some 350,000 new vehicles being fitted with air conditioners in 1986.

3 "Recharge after service" = recharge after maintenance to the system.

4 "Recharge after leakage" = replacement of charge lost through system leakage.

All CFCs used in automotive air conditioning will eventually be emitted to the atmosphere. CFCs used in the initial charge would not emit immediately. The USEPA has estimated that service venting contributed 35 per cent of the emissions of CFCs from mobile air conditioning, followed by leakage (34.4 per cent), materials handling loss during recharge (12.9 per cent) and accidents (10.6 per cent).

A significant reduction can be achieved by "quality engineering" that would reduce leakage emissions combined with the use of refrigerant recovery at service in the near future. The potential emission reduction achievable through the use of engineering improvements to reduce leakages is approximately 20-30 per cent of CFC losses due to leakages. This alone would reduce emissions of CFCs by about 100 tonnes.

Equipment for recovery of refrigerant is currently available; its reported cost is between $6000 and $7000.

Doubt was expressed by a leading US automobile manufacturer that a refrigerant recycling program would be successful without much greater economic incentives. At present, significant recovery and recycling has only been undertaken for large fleets where a considerable quantity of CFCs can be recovered per fleet.

Small cans of CFC 12 for "home service" of mobile air conditioning are gaining popularity. However sale of these cans could be banned to help reduce emissions in the short term. How much this would reduce CFC emission is not currently known.

CFC 134a is considered by the auto industry to be the leading long-term alternative to the use of CFC 12. One of the major unsolved problems with this chemical is the lack of a suitable lubricant.

CFC 134a is a developmental chemical that will require between 5 and 7 years for commercialisation. CFC 22 is considered the second most promising chemical alternative. In addition to the increase in leakages associated with its high operating pressures, this chemical also has unresolved problems with lubricating oil compatibility.

Du Pont is cooperating with a compressor manufacturer in Melbourne to test the suitability of CFC 134a as a refrigerant.

The industry estimates a total reduction of 420 tonnes per annum through recycling, quality engineering to reduce leakages, and improved recharging techniques.

6.4 DEGREASING

CFCs in degreasing applications represent one of the smaller areas of consumption in Australia. Industry estimates that 350 tonnes of CFC 113 used annually are emitted from degreasing applications. Very low growth rates in the use of CFC 113 are currently being experienced in Australia, mainly, it is thought, because of the relatively large cost of installation and operation of a degreasing tank.

The principal applications include:

. cleaning soldering flux from printed circuit boards after manufacture or repair

- cleaning delicate in-service electronic components, particularly for the defence, aviation and marine industries, often on a routine basis
- cleaning delicate consumer items such as wrist watches or electronic circuits.

The "reservoir" of CFC 113 in use is much greater than the amount lost to the atmosphere.

Almost all installations have vapour recovery devices of one type or another. Most are a tank with either a fume hood or enclosed recovery system. A refrigerated condensing system recovers vapours and returns them to the tank.

Contaminated CFC 123 remaining in cleaning baths contains dust, grit and solder and cannot be re-used without purification. Disposal of contaminated solvent is a problem and a recycling system would reduce the emission. There are already small commercial operators who recycle CFC 113 but the industry seems to be generally unaware of their facilities.

6.5 DRY-CLEANING

Originally dry-cleaning plants used carbon tetrachloride as a solvent, but toxicity concerns led the industry to seek safer alternatives. The industry progressively moved to trichlorethylene and then perchlorethylene which is now the most widely used solvent. Recent doubts concerning the long-term safety of perchlorethylene have arisen and some dry-cleaners now use CFC 113 as a solvent.

This is approximately 10 times more expensive than perchlorethylene and hence CFC 113 use is proceeding slowly. However perchlorethylene is a powerful solvent and is not suitable for many of the more delicate cleaning operations for which CFC 113 is eminently suitable. With CFC 113, dry-cleaners are able to take on highly specialised tasks such as cleaning fur coats. It is estimated that in 1986 approximately 400 tonnes of CFC 113 were used in dry-cleaning.

6.5.1 Substitutes

Research is being carried out in the US to find an alternative solvent. Such research is currently centred on CFCs 123, 132b and blends of CFC 113.

CFC 132b is non-flammable and has a boiling point similar to CFC 113 (46.8^{0}C compared with 47.6^{0}C for CFC 113). Its toxicological testing is incomplete and it is not commercially manufactured. CFC 132b has an extremely low ozone-depleting potential and greenhouse effect potential. Its physical properties would enable it to be used in existing equipment, with virtually no modification.

Existing plants might also be converted to substitute solvents at very little cost. The ultimate price of CFC 132b, once available in commercial quantities, would be the principal factor in determining the impact on industry.

There are no other known CFCs which have a potential for use in the specialised solvent applications where CFC 113 is currently used.

6.5.2 Emission Control

CFC 113 can leak out, although the latest dry-cleaning machines have been designed to minimise fugitive emissions. Improving dry-cleaning machines helps reduce unnecessary loss of solvent.

6.6 FIRE PROTECTION

In the last decade or so, specialised fire protection systems have been developed for highly effective and rapid quenching of fires in high-capital value installations such as aircraft (both maintenance facilities and the aircraft themselves), ships and computer centres. Halons play a unique role in fire protection and are used in both fixed systems and in portable equipment.

The inertness of the chemicals allows the system to operate without damaging the expensive equipment itself. No residue is left behind by the extinguishant and delicate electronic circuits or metals are unaffected. Speedy response is assured as the chemical can be released before occupants have evacuated the area.

6.6.1 Portable Extinguishers

Hand-held fire extinguishers for these specialised applications use halon 1211.

The annual market is estimated to be 894 tonnes, although only a small fraction of that quantity would be released in the year of importation. The industry estimates that 170 tonnes of halon 1211 is emitted per year.

Primary substitutes for halon 1211 are dry chemicals and carbon dioxide. Halons in portable extinguishers are replaced every six years. There is a need to ensure halons are recovered and recycled.

6.6.2 Fixed Systems

Halon 1301 is preferred for the larger fixed installations where a reservoir of the chemical is held in a central tank and the extinguishant is distributed to the fire zone by electro-mechanical controls. Distribution can be through diffusing nozzles directly to the space to be protected from fire or in some instances released into specialised air handling systems which quickly diffuse extinguishant into a general area. The Australian market is estimated at 378 tonnes per annum of which 125 tonnes is emitted.

6.6.2.1 Substitutes

No alternatives for halons are on the horizon, although work is under way in a number of areas.

In some circumstances carbon dioxide could be used, but it has a number of drawbacks that prevent it achieving the fire ratings of halon extinguishers.

Sprinkler systems have not been favoured in the past because of water damage to electronic equipment and possible loss of data in computer systems.

6.6.2.2 Conservation

Without feasible substitutes for the halons, action in the medium term will need to concentrate on conservation.

One of the major sources of emissions comes from full discharge tests of fixed systems which are required to ensure the halon system is functioning correctly so that it does not fail in an actual fire. Therefore a major area where halons can be reduced is in testing of system integrity to reduce test and accidental discharges.

Alternative methods of testing fixed flooding systems and improved design of systems and detectors are available or being developed.

Specific approaches to reducing unwanted discharges are:

. to use improved fire detection and system control equipment

. to raise the extinguisher activation threshold

. to increase activation time delay

. to provide better training

. to use manual activation in manned areas.

7 SUMMARY OF EMISSION REDUCTIONS

The use of CFCs 11 and 12 in foam-blowing and the refrigeration and air-conditioning industries will continue to rise without any regulatory action, while the use of CFCs as aerosol propellant will continue to decline. Control measures should therefore concentrate on industries other than aerosol.

Scientific research in the US over the last few years has made significant advances in the search for chemical substitutes. However further research is needed before any of these substitutes can be marketed commercially.

7.1 EMISSION REDUCTIONS BY INDUSTRY

Estimates of possible reductions in each industry sector are discussed below.

7.1.1 Flexible Foam

There is currently no recovery of CFCs during production of flexible foam in Australia. Recovery systems in existing plants are not cost-effective. The industry (AFCAM) predicted that a reduction of 50 per cent by 1992 can be achieved, assuming progressive introduction of alternative blowing agents. It appears that this estimate is very optimistic considering the problem in using alternative blowing agents. At a meeting in the Hague in October 1988 to review the Montreal Protocol, it was recognised that there were still significant technical breakthroughs and product performance issues to be resolved before alternative blowing agents could be used in any significant quantity. The Commission had some doubts about the industry's estimates. However the industry (AFCAM) has assured the Commission that their estimates will be met. Accordingly, for this report (Table 4), the industry estimates have been accepted as obtainable.

7.1.2 Rigid Polyurethane Foam

The CFCs used in the manufacture of rigid polyurethane foam are gradually released throughout the life of foam. There is no clear prospect of controlling these emissions at their production points nor is there a chemical substitute in the short term. Foams produced without CFCs have poorer insulating properties. The only possible reduction is by alternative insulating materials. AFCAM estimated a reduction of 50 per cent could be achieved in 1990 from alternative blowing agents, while overseas estimates indicate a maximum of 10 per cent through alternative insulating materials. However the industry has assured the Commission that its estimate will be met.

7.1.3 Extruded Polystyrene (EPS) Packaging

The US Food and Drug Administration has given approval for CFC 22 to be used as a blowing agent for EPS packaging. This would allow a reduction in the ozone-depleting potential of substances used in this area by up to 90 per cent. Australian industry expects up to 90 per cent reduction in 1989.

7.1.4 Extruded Polystyrene Insulation

The industry predicted that 90 per cent of emissions can be reduced by converting to CFC 22. As part of its control, the Commonwealth is planning to ban the manufacture and import of extruded polystyrene in insulation. This would totally eliminate the emission from this source.

7.1.5 Commercial Refrigeration and Air Conditioning

AFCAM estimates that the commercial and industrial refrigeration and air-conditioning sector can reduce its annual usage of CFCs 11 and 12 from 2240 tonnes in 1986 to 2147 tonnes in 1992. These savings will be brought about by the use of CFCs 22 and 502 in new installations, recovering refrigerants for recycling when equipment is serviced or repaired and more stringent design, operating and maintenance standards.

7.1.6 Automotive Air Conditioning

CFCs can be reduced by changes in design to reduce leakages and by requiring recovery during servicing. The industry estimates that a total saving of 420 tonnes per year can be achieved by 1992. However the actual reduction in usage would be less because of a potential increase in growth.

7.1.7 Solvents/Degreasing

Considerable reduction in CFC use in the engineering degreasing industry should be possible by installing recovery equipment, improving maintenance and, in certain cases, changing to other cleaning methods. Industry estimates that a saving of 43 per cent (i.e. 150 tonnes) can be obtained in 1992.

7.1.8 Dry-Cleaning

It should also be possible to achieve considerable reductions in emissions from dry-cleaning plants by introducing recovery equipment, installing more leak-proof machinery and improving maintenance. The USEPA has estimated that CFC in dry-cleaning can be reduced by up to 50 per cent by improving maintenance and recovery.

The industry has not estimated the reduction from improved operational procedures. However it indicates that as no new machines are being imported and the average economic life of a CFC machine is about 10 years, there will be no CFCs used in dry-cleaning in 1998.

7.1.9 Firefighting

The industry estimates that, by improving the operation and design equipment to more stringent standards, the emissions of halons 1211 and 1301 could be reduced by 60 and 80 tonnes per annum respectively.

7.2 CONCLUSION

Although it should be possible to reduce annual use by around 50 per cent, the same reduction that is required to achieve the long-term strategy of the Montreal Protocol, most of this reduction is from eliminating CFCs as propellants for aerosols. This elimination occurred in the US in the late 1970s and aerosol use is therefore not included in the 1986 use level which forms the base line for the Montreal Protocol in that country. For industries other than the aerosol industry, the reduction falls far short of the Montreal requirements. It should be emphasised here that these estimates are very conservative, taking into account all possible reductions including maximum use of alternative materials. If the Montreal Protocol is made more stringent, then the industry in Australia would need to revise its plan accordingly.

8 SUBMISSIONS TO THE ASSESSMENT

Anyone who wanted to lodge submissions with the State Pollution Control Commission in relation to the assessment of CFCs and halons were invited to do so by notice in the Government Gazette (No. 140, 2 September 1988, page 4644).

Submissions were received from AFCAM, Glaxo Australia, ACI Operations, Lilypak Limited, Aerosol Association of Australia, Pacific Industries, Pacific-Dunlop, Kent-Moore Australia, Total Environment Centre, Austech Environmental and Process Services and the Australian Consumers' Association. The Australian Conservation Foundation also put in a late submission on 23 December 1988.

All submissions were considered by the Commission. The main points of each are set out below. It must be stressed that the Commission does not necessarily agree with all points made in each submission.

AFCAM

The submission from AFCAM was basically the same report which the industry submitted to Senator Graham Richardson, the Federal Minister for the Environment.

The main points were:

. Industry action plans will take Australia beyond the minimum requirements for controls laid down by the Montreal Protocol.

. Industry action plans will allow industry to focus its efforts on areas that show potential for the most substantial decrease in emissions that is achievable without incurring punitive costs and creating severe dislocation to employment and investment.

. Recovered and recycled products need to meet the same standards as new products or else they will not be accepted by the industry.

. The plans need to be updated from time to time.

The actual plans for each sector have been discussed before in this report. They are substantial and detailed and available for reference.

GLAXO AUSTRALIA

The company sought exemptions for some aerosol products from the anticipated prohibitions for the following reasons:

. CFCs as propellants can safely deliver controlled amounts of active drug to the target respiratory system.

- No efficient alternative delivery system is available.
- Uses of CFCs in inhalation aerosols are minor compared with other uses.
- There is a lengthy and costly approval process for using alternative propellant in medical products.

ACI OPERATIONS

ACI supported the Montreal Protocol saying it would be able to use a mixture of 70 per cent CFC 22 and 30 per cent CFC 11 as an alternative foam-blowing agent.

LILYPAK

The company's intention is to use CFC 22 as a replacement for CFCs 11 and 12. Ultimately Lilypak may revert to pentane which has no effect on the ozone layer.

AEROSOL ASSOCIATION OF AUSTRALIA

The Association expressed its support for the industry plan made as part of AFCAM's submission, that is the ban of CFCs used in aerosols, except for essential uses.

PACIFIC DUNLOP

The company considered that the Federal Government's proposed adoption of the Montreal Protocol was a reasonable approach and pointed out a number of actions it had taken to reduce CFC emissions.

KENT-MOORE AUSTRALIA

The company markets refrigerated recovery/recycling stations and made the following recommendations:

- All CFC 12 used in refrigeration and air-conditioning systems should be recovered and recycled for use.
- All premises or persons handling or servicing such equipment should be licensed.
- All cylinders and equipment containing CFCs should be labelled.
- Electronic leak detectors and high vacuum pumps should be installed on all CFC systems.

In addition the company recommended that:

- a State tax on controlled CFCs be imposed and that the tax be increased monthly

. there be a financial incentive for the first company that makes alternative refrigerant (non-CFC 12)

. a code of practice be established and that it should become an Australian Standard.

AUSTECH ENVIRONMENTAL AND PROCESS SERVICES

The company claimed that it can recover CFCs and halons by direct refrigeration.

AUSTRALIAN CONSUMERS' ASSOCIATION

The following is a summary of the Association's submission:

. ACA urges the Commission to advocate to the New South Wales Government the need for prompt regulatory action to control CFCs within the State. Such controls should aim for an 85 per cent or more reduction at the earliest possible target date. Such controls should be enshrined in a separate Act in order to allow for proper public debate and scrutiny of the measures to be taken.

. ACA urges the Commission to arrange public consultation involving the New South Wales Government, industry and community organisations in order to examine implementation of the industry plan at State level and coordination with relevant New South Wales legislation.

. ACA urges the Commission to give priority to the careful planning of an education campaign through industry training channels, educational institutions and community education outlets.

. ACA urges the Commission to consult with the New South Wales Health Department on the planning of a public health campaign aimed at reducing exposure of the community to dangerous levels of UV radiation.

TOTAL ENVIRONMENT CENTRE

The Centre pointed out that the reference level for control in Australia is higher than in the US because the use of CFCs in aerosol cans was banned in America in 1986.

The Centre stated that at a recent conference with the industry "it became apparent that the industry is not, at present, willing to put much effort into developing new products and processes which conserve or do without CFCs".

The Centre made a number of further points:

. Only the substitution of compounds which contain no chlorine atoms in their molecules will definitely reduce the ozone destruction. All others which reduce the chlorine content are only temporary "band-aid" measures.

. The list of controlled compounds is likely to be extended and the Government should recognise this in formulating control.

. It is essential that the excess production capacity in Australia not be used to export to other countries.

AUSTRALIAN CONSERVATION FOUNDATION

The Australian Conservation Foundation (ACF) expressed the view that:

> "the issue of ozone depletion is one of the major environmental challenges facing the planet. Only strong and effective action, which goes beyond the Montreal Protocol's limitations, as we have outlined in this submission, will ameliorate this problem".

ACF's submission is very detailed and has the following recommendations.

. The New South Wales Government should legislate to achieve an effective phase-out of ozone-depleting substances by 31 December 1995.

. The New South Wales Government should identify all the uses for CFCs and the extent of each use. The Commonwealth Government's assessment would provide a useful database to begin the process.

. The New South Wales Government should ensure that all products containing CFCs or which use CFCs in their manufacture are clearly labelled and can be so identified by the consumer. Such a measure would assist in the development of alternatives, e.g. evaporative air conditioning. Alternatives may be outside the CFC industry.

. The New South Wales Government should use the existing legislation, which should be strengthened by specific regulations where the it proves inadequate to achieve all the recommendations.

. An assessment of the progress of eliminating the production of ozone-depleting substances should be carried out by an independent body of experts, including representatives of environmental and consumer groups. This body would also assess the effectiveness of recovery and recycling programs inside two years from commencement of the phase-out program.

In addition to the above recommendations, ACF made recommendations for end-use controls as summarised below:

Aerosols

- Immediate elimination of CFCs in aerosols except for essential purposes.

- A detailed assessment of all aerosol products which require CFCs be carried out.

- Mandatory labelling.

- Before any exemption for an "essential purpose" is allowed, evidence that viable research into an alternative propellant is under way should be submitted.

Flexible Foam

- The use of CFCs in flexible foam is phased out by 1992 and that alternative blowing agents be used. In the phase-out period, emission control practice at the point of manufacture be carefully monitored to achieve full recovery of CFCs emitted during manufacture.

Extruded Polystyrene

- The use of CFCs in extruded polystyrene be phased out by 31 December 1989.

Polyurethane Foam

- The use of CFCs in polyurethane foam be phased out by 1992 with strict emission control in the interim.

Refrigeration and Air Conditioning

- CFCs used in new refrigeration, heating and air conditioning to cease by end of 1994.

Halons

- The use of halons be phased out by 31 December 1995.

ACF also recommends that the New South Wales Government establish an independent committee with the specific responsibility of monitoring the phase-out of ozone-depleting substances. The committee should comprise independent experts, community organisations and appropriate industry.

9 CONTROLS IN AUSTRALIA

9.1 THE COMMONWEALTH

As stated earlier, the responsibility for Australia's compliance with the strategies of the Montreal Protocol rests with the Commonwealth Government. The Commonwealth has significant powers to legislate on such controls since the Protocol is an international treaty. These powers, however, would not be sufficiently comprehensive to cover all conceivable circumstances. For example, Commonwealth powers do not extend to controlling intrastate activities of non-corporate entities. It is therefore envisaged that States legislate on areas of activity outside Commonwealth control. States may not have the power to enact parallel legislation unless it is especially provided for in any Commonwealth legislation enacted for this purpose. However section 4 of the Commonwealth's Ozone Protection Bill 1988, states that:

> "It is the intention of the Parliament that this Act is not to affect the operation of a law of a State or of a Territory that makes provision with respect to the protection of ozone in the atmosphere and is capable of operating concurrently with this Act."

The Montreal Protocol seeks to control production and imports and hence the supply of bulk CFCs to reduce their use. While this strategy has the advantage of being simple to implement, it does not take into consideration the desirability or otherwise of maintaining specific end-uses (essential uses such as in pharmaceuticals) while reducing other uses. Consequently the Commonwealth's Ozone Protection Bill also seeks to control the manufacture of products containing CFCs together with controls on the manufacture, import and export of CFCs and halons.

The controls on products containing CFCs will allow the Government to target more precisely the products or uses where reductions or phase-out will occur and to ensure that adequate attention is given to reducing the chemicals with the highest ozone-depleting potential. This would also ensure that low-cost reductions will be undertaken as soon as they become cost-effective.

The Prime Minister and Senator Richardson in a joint statement on 5 June 1988 said:

> "Australia should not necessarily confine action to meeting the particular requirements of the Montreal Protocol. These should be regarded as the minimum. All practical steps should be taken to reduce emissions of the ozone-depleting substances".

Senator Richardson also told an ALP Conference:

> "In refrigeration and air conditioning, we will get agreements to go further than the 50 per cent".

In NSW the Minister for the Environment has also said that some products containing CFCs and used purely for cosmetic purposes may need to have some form of end-use regulation imposed upon them.

Therefore to achieve such extra reduction, control on products containing or using CFCs is a justifiable strategy. However it should be noted that the products which are currently proposed to be controlled by the Ozone Protection Bill are those where alternative products are readily available or are judged to be less essential.

Controls on other applications will be introduced progressively when control technology and alternatives are available. In addition controls on the manufacture, import and export of CFCs and halons are by licensing and tradeable quotas based on 1986 production levels.

9.2 **STATES OTHER THAN NEW SOUTH WALES**

Victoria has already moved to amend existing legislation to enable regulations to be made for end-use controls. The State is prepared to cooperate in the development of the Commonwealth control measures with a view to implementing parallel measures.

Queensland's existing legislation will probably require amendment to enable end-use controls to be implemented and that course is likely to be delayed by a major review of all environmental legislation.

South Australia is likely to use existing enabling legislation to enact controls complementary to those under the Commonwealth. Any regulatory action by South Australia is likely to be in parallel with the Commonwealth legislation.

Legislation in **Tasmania** to control CFCs and other ozone-depleting substances came into effect from from January 1989. It prohibits the manufacture, distribution and sale of "controlled substances" prescribed by regulation, including those controlled substances by the Montreal Protocol. The Director of Environmental Control can exempt substances and the Act requires a licence to be issued for manufacture or distribution (but not sale) of "exempt substances". The Act does not provide for any control on the importation of controlled substances. A number of other aspects still need to be developed.

Western Australia has introduced regulations controlling the use of CFC propellants in aerosol sprays. Further control action is likely to be under existing legislation and probably complementary to the Commonwealth legislation. Existing regulations might be withdrawn ultimately when Commonwealth controls are implemented.

9.3 EXISTING LEGISLATION IN NEW SOUTH WALES

Two different pieces of legislation in New South Wales provide a practicable framework for controlling the manufacture and use of CFCs: the Environmentally Hazardous Chemicals Act 1985 and the Clean Air Act 1961.

9.3.1 Environmentally Hazardous Chemicals Act 1985

The Act was introduced to minimise the risk and threat to the environment and human health from environmentally hazardous chemicals. It is administered by the State Pollution Control Commission.

Under the Act, the Commission has powers to control prescribed activities associated with chemicals and chemical wastes. These activities are the manufacturing, processing, keeping, distributing, conveying, using, selling and disposing of chemicals or chemical wastes.

The Commission may prohibit a prescribed activity or permit a prescribed activity subject to certain conditions, where it has reasonable grounds to believe that a potentially harmful situation may arise. It is therefore possible under the Act to use a Chemical Control Order to control the use, disposal and manufacture of CFCs in New South Wales.

9.3.2 Clean Air Act 1961

This Act is also administered by the State Pollution Control Commission and is designed to control pollution in the atmosphere.

The relevant control provisions under the Act are:

- to require the occupier of scheduled premises to hold a licence to maintain and operate control equipment and not to carry out certain works without prior approval from the Commission
- to make regulations under section 34(1) of the Act.

Controlling CFC emissions is possible with minor amendments to section 34(1) of the Act; the legislation currently does not allow for any regulation to control CFCs being made.

9.4 EFFECTIVENESS OF NEW SOUTH WALES LEGISLATION

The existing legislation seems to provide a powerful tool for controlling the supply and uses of CFCs. The Environmentally

Hazardous Chemicals Act provides wide powers that could be successfully applied to control the manufacture, use and disposal of CFCs by making a Chemical Control Order.

Following gazettal of a Chemical Control Order, certain activities may be permitted. Detailed conditions can be set out in a licence for a specific site and occupier.

It is more desirable to control CFC emissions by regulation under the Clean Air Act as the regulations are more accessible to the public, while a Chemical Control Order is published in the Gazette and is not as readily available.

With regard to controlling the manufacture, use, storage, sale and disposal of CFCs and halons, it appears that the Clean Air Act does not allow for any such control, while it is specifically provided for in the Environmentally Hazardous Chemicals Act.

However before a Chemical Control Order for chemicals can be made, an environmental assessment of these chemicals has to be carried out. This process includes the gazettal of a notice of intention, receipt of submissions and preparation of the assessment report. Amendments to a Chemical Control Order may require further assessments. This could limit the flexibility of implementing any control measures in response to the progressive development of substitute chemicals, new technologies, etc.

Alternatively, controls might be effected by introducing new specific legislation on ozone-depleting substances.

10 REVIEW OF MANAGEMENT ALTERNATIVES

The Commission, as a longer term goal, prefers CFC emissions to be reduced to the lowest possible levels. A certain level of use in equipment already installed will continue for some time. Emissions from such sources should be minimised wherever possible. In the longer term, however, new products must be manufactured without fully halogenated CFCs, even where this is currently difficult or very expensive.

At the same time, it is reasonable to begin, in the short term, by restricting CFC use in areas in which reductions will involve the lowest cost to society. In addition, the mechanisms or regulations used to promote reductions should be chosen in order to ensure they are easily administered.

There are several regulatory options for controlling CFC emissions and they are discussed below.

10.1 CONTROLS ON MANUFACTURING/SUPPLY OF CFCs

The Commonwealth Government has drafted an Act to control ozone-depleting substances based on a licence/quota scheme. In brief the Act provides for:

- the granting of licences to produce, import and export controlled substances to persons already engaged in these activities

- the assignment of quotas for one or other class of controlled substances to licence holders with reference to

  production for domestic purposes
  production for export
  importation

- adjustment of their activities by quota holders in response to market changes provided these adjustments are within the scope of the allocated quota.

There has been a suggestion that the States should have the responsibility for assigning production quotas, while the Commonwealth should administer import and export quotas. It is desirable that control on manufacturing be effected in New South Wales. This might be achieved through the Environmentally Hazardous Chemicals Act, as the two manufacturers are in New South Wales, and they are already licensed under the Clean Air Act. If New South Wales is to control manufacturing, Commonwealth legislation needs to provide the State with some input to any decision made for changing the manufacturing quotas. In addition, good communications with the Commonwealth will be necessary to keep a total picture of production and consumption.

10.2 CONTROLS ON APPLICATIONS OF CFCs

Although not specifically required by the Montreal Protocol, it is desirable to legislate to control CFCs, so that some necessary end-uses can be maintained while others are reduced.

At this time, it is not possible to specify precisely what measures for reduction in emissions will be proposed for each industry sector. However it is expected that a combination of the following measures will be required:

. prohibitions or restrictions on particular applications

. requirements for recovery, recycling and disposal of controlled substances

. specification of codes of practice for use in the handling of controlled substances and specification of design standards, size and labelling of equipment and containers of controlled substances for the purpose of recovery and preventing emissions

. the labelling of products to identify the use of controlled substances

. licensing of some end-uses of controlled substances.

It is envisaged that prohibitions or restrictions on particular applications could be done by gazetting a Chemical Control Order under the Environmentally Hazardous Chemicals Act. Other control measures could be effected by regulation under the Clean Air Act or under new specific legislation on ozone-depleting substances.

In drafting the regulations, several policy issues would require resolution. Some of these are discussed below.

10.2.1 Aerosols

The use of CFCs as aerosol propellants should be prohibited, except for essential uses as from 31 December 1989. A mechanism for determining essential uses needs to be finalised. The mechanism must provide for:

. publication of exempted products

. provision for periodic review of exemptions.

10.2.2 Commercial and Industrial Refrigeration and Air Conditioning

The industry has developed a code of practice which will minimise emissions of controlled substances. It should be possible to introduce such code-of-practice provisions as regulations under the Clean Air Act.

There should be a mechanism to allow updating of this code of practice. A need for licensing installation and maintenance personnel should be addressed when formulating the regulation.

The industry also proposed a national collection and reprocessing facility for recovery of refrigerants from refrigeration equipment. It may be necessary to make it compulsory for refrigerant suppliers to accept used refrigerants, provided the recovered refrigerants meet the same standards as new products. To ensure that refrigerants are not released into the atmosphere when equipment is serviced or repaired, an economic incentive should be investigated.

10.2.3 Automotive Air Conditioning

The regulation should implement, where possible, the code of practice developed by the industry to reduce emissions from leakages, and from maintenance and servicing of equipment.

The need to license air conditioning service agents with adequate on-site recovery recycling equipment should be addressed, as well as the need for any exemption. If all service agents were licensed, administration costs would be very significant. Consideration should also be given to incentives and an education program to encourage vehicle owners to maintain auto air conditioning systems properly.

10.2.4 Domestic Refrigeration

Appropriate handling, maintenance and recycling of refrigerant are important to reduce unnecessary emission of CFCs to the atmosphere.

10.2.5 Flexible Polyurethane Foams

It appears that, at least in the short term, the recovery of CFCs from existing manufacturing plants of flexible foams is not cost-effective. The majority of manufacturing plants are licensed under the Clean Air Act. It would be possible to reduce emissions by improving operating procedures through attaching conditions on licences. In addition product substitution and interim substitution of alternative blowing agents should be encouraged to obtain further reduction.

10.2.6 Rigid Foams

The difference in performance characteristics between CFC and non-CFC foams and the effects on the practicability of application should be further investigated. Results of the investigation need to be taken into consideration in drafting legislation.

10.2.7 Extruded Polystyrene Packaging

The manufacture and sale of CFC-12 blown extruded polystyrene can be banned from a certain date by which time it would be possible for all plants to convert to alternative chemicals.

10.2.8 Firefighting

The industry is currently involved in development of Australian standards relating to approval mechanisms. Some potential exists for tightening the requirements for certification of halon systems.

Further consideration should be given to the assessment and specification of the need for halon fire-protection systems for various applications.

Consideration should be given to limiting the use of portable halon extinguishers for certain applications. The current high levels of discharge testing of halon flood systems could be eliminated by prohibition of discharge testing using halon.

11 DISCUSSION

11.1 CONTROLS IN NEW SOUTH WALES

As discussed before, the responsibility for Australia's compliance with the Montreal Protocol rests with the Commonwealth Government. At a meeting of Commonwealth and State officers in August 1988, there was general agreement that both levels of government should have legislation as comprehensive as possible, although it was recognised this could lead to considerable overlap.

In reality it would be difficult for the Commonwealth to enforce the appropriate legislation using its own resources, and it would be necessary for State authorities to carry the major enforcement function. This could be done either by authorising State officers under Commonwealth legislation or by using State legislation directly.

This latter type of procedure has been followed before to deal with international environmental conventions such as the Environmental Protection (Sea Dumping) Act 1981. In this Commonwealth Act, section 9 provides for State involvement where there is appropriate State legislation. Without this section, State action could be legally challenged and rendered invalid, and the enactment of the legislation itself might even be unconstitutional.

From discussions between officers, it appears the Commonwealth will include a section to avoid this difficulty in its enabling legislation. It is believed bans on the import or manufacture of the following products will be regulation when the Act is introduced:

- do-it-yourself air-conditioning kits (effective from 31 January 1989)
- disposable containers of refrigerants containing up to and including a net weight of five kilograms of ozone-depleting substances (effective from 1 July 1989)
- extruded polystyrene packaging produced with or containing ozone-depleting substances (effective from 31 December 1989)
- extruded polystyrene insulation produced with or containing ozone-depleting substances (effective from 1 January 1990)
- dry-cleaning machines (effective from the date of gazettal)
- aerosols, except for essential uses (effective from 31 December 1989).

No provision for controlling of stockpiling of these products is included in the regulations.

New South Wales may either introduce new legislation which is compatible and complementary the Commonwealth's or use existing legislation to control these substances.

Under existing legislation the Commission could:

1 control the manufacture, use, keeping, sale and disposal of CFCs by gazetting a Chemical Control Order under the Environmentally Hazardous Chemicals Act

2 control the manufacture, use, storage, sale and disposal of other products as currently proposed by the Commonwealth, by gazetting a Chemical Control Order under the Environmentally Hazardous Chemicals Act

3 control emissions such as those from flexible foam plants by regulation using an amended section 34(1) of the Clean Air Act.

Alternatively, controls might be effected by introduction of new specific legislation on ozone-depleting substances.

New South Wales proposes to control the use and sale of certain products containing CFCs, while the Commonwealth only proposes to control the manufacture and import of the products.

The controls by New South Wales would be consistent with the Commonwealth controls.

11.2 IMPACT OF CONTROLS

The impacts of these controls, if New South Wales should decide to follow Commonwealth controls, are discussed below.

11.2.1 Manufacture of CFCs and Halons

The two manufacturers in Sydney are well aware of the Montreal Protocol requirements. Changes were foreseen and planned well in advance. The manufacture of CFCs will be prohibited except in accordance with a licence issued by the Commission.

The licence was granted to each manufacturer engaged in production of CFCs and halons in 1986. A licence may have conditions relating to the manufacturing level allowed on any premises. The manufacturing level may be defined in terms of both the quantity of ozone-depleting substances and its corresponding ozone-depleting potential as specified in the schedule. The manufacture may be adjusted in accordance with the program of reduction as specified in Article 2 of the Montreal Protocol or in accordance with any levels of reductions as specified by the Minister.

Scientific evidence has recently shown that the timetable set out in the Montreal Protocol is not adequate and the phase-out of ozone-depleting substances should be advanced whenever possible. If this is the case, the cost of CFCs will increase significantly and only those uses where it is essential or it represents a small proportion of the value of the final product will remain.

Control of CFC manufacture could become effective immediately after gazettal of a Chemical Control Order.

11.2.2 Aerosols

The Aerosol Association of Australia announced it will stop manufacturing all aerosol products containing CFCs (except in essential uses) from the end of 1989. This practice has been enforced in the US for a number of years. Major producers already have processing plants for producing non-CFC aerosol products.

The manufacture and sale of aerosols containing CFCs, except in essential services, is banned from 31 December 1989, unless exemption is granted. Exemption can be granted if the Commission is satisfied that:

a the article is essential for medical, veterinary, defence, industrial safety or public safety purposes

b no practical alternative exists to the use of ozone-depleting substances in the operation or manufacture, as the case requires, of the products if it is to continue to be cffective for such a purpose

c because of the legal requirements concerning the manufacture or use of the article, there is no practical alternative to the use of ozone-depleting substances in the operation or manufacture, as the case requires, of the products

d the product is to be used in the calibration of scientific measuring or safety equipment.

11.2.3 Extruded Polystyrene

11.2.3.1 Packaging

Following the approval of the US Food and Drug Administration (FDA) to use CFC 22 as a blowing agent in food servicing and packaging, packaging industries in the US have adopted a voluntary phase-out of CFCs 11 and 12 in extruded polystyrene as from 31 December 1988.

Industries in Australia can follow the American practice, as the cost of converting to CFC 22 is not significant. In addition the industry is also under commercial pressure from users for non-CFCs 11 and 12 products. McDonalds announced that it will require non-CFCs 11 and 12 packaging as from mid-1989.

11.2.3.2 Extruded Polystyrene Insulation

Dow Chemicals, a major producer of extruded polystyrene insulation in Australia and in the world, announced that it will stop worldwide production of insulation using CFCs from early 1989.

11.2.4 Automotive Air Conditioning and Maintenance Kits

All of these kits are imported into Australia. One major importer has already stopped importing these products because of the pending ban by the Commonwealth Government. The saving in CFCs from this ban is estimated at about five to ten tonnes per annum.

11.2.5 Dry-Cleaning Machinery

Senator Richardson set up a working group to report on the use of CFCs in dry-cleaning. That group has agreed with the Commonwealth that the use of CFCs in these machines be restricted to the machines currently in use and that such use be allowed to decline by the machines' eventual withdrawal from service (natural attrition).

It is noted that all of these machines are imported into Australia and, because they are designed to use a specific solvent, they cannot use alternative solvents.

Some garments and fabrics allegedly need to be cleaned using CFC solvents.

This strategy of "natural attrition" applies equally to the machines and to the garments dependent on them.

Following the industry's voluntary ban on installation of new machines from the beginning of 1988, the Commonwealth will legislate to prohibit importation and manufacture of further machines. It will also advise the fabric industry that it should no longer use fabrics requiring dry cleaning with CFCs.

It is believed that there are between 40 and 60 of these CFC-dedicated machines being used in New South Wales (200 in Australia), about 20 per cent of the dry-cleaning market. They are valued at between $40,000 and $60,000 each. Thus with a ban on their import and manufacture they will virtually all be retired after an average economic life of ten years.

Replacement by machines using alternative solvents should not result in any significant disruption to the industry.

12 RECOMMENDATIONS

It is recommended that:

1 **EITHER** new legislation is prepared to control ozone-depleting substances **OR** existing legislation (Environmentally Hazardous Chemicals Act and Clean Air Act with minor amendments to section 34(1) to allow control of CFC emissions by regulation) be used

2 liaison with industry continue so workable legislation can be established

3 the cost effectiveness of control measures be established

4 an education program be prepared and implemented.

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ADDENDUM

This assessment was completed on 16 November 1988 and hence only represents the information that was available to the Commission at that time. However there have been rapid developments since then and they are summarised below.

"Saving the Ozone Layer" Conference was held in London from 5 to 7 March 1989. At this conference, a strong consensus emerged on an early phase-out of all ozone-depleting substances. Science Minister Barry Jones referred to Australia going beyond the minimum requirements of the Protocol with a total phase-out of CFCs and halons by 1998.

The Commonwealth's **Ozone Protection Act**, proclaimed on 16 March 1989, provides for controls on manufacturing, import and export by licence and quota systems which directly give effect to the Montreal requirements. It also has some end-use controls specifying the phase-out dates for some current readily substituted uses. Further end-use controls can be implemented by the progressive introduction of regulations. The Act is being administered as planned with quota allocation finalised by 1 July 1989.

The **United Nations Environment Program meeting** in Helsinki on 2-5 May 1989 boosted prospects for a strengthened Montreal Protocol. Declarations of the meeting are summarised below:

- a call to all States to join the Convention and Protocol
- agreement to phase out CFCs controlled by the Protocol as soon as possible (but not later than 2000), which is a tightening of the original timetables in the Protocol
- agreement to phase out halons and to control and reduce other ozone-depleting substances as soon as possible
- agreement, as resources permit, for individual States to accelerate the development of acceptable substitutes
- agreement on facilitation of technological access for developing countries and the need to develop appropriate funding mechanisms.

The Standing Committee of the **Australian Environment Council** (AEC) at its meeting of 8 and 9 March 1989 asked for the convening of an ad hoc AEC Working Party to allow the quick development of a national strategy on the control of ozone-depleting substances. New South Wales is a member of that Working Party. The Working Party has met on numerous occasions and has also had discussions with industries. A draft strategy was circulated to industry and environmental groups for comment with a final National Strategy submitted for Ministerial consideration and agreement as appropriate to the AEC Meeting in New Zealand on 3 July 1989.

It is estimated that a total phase-out of CFCs and halons, with the exception of essential uses, can be achieved by 1995, if all recommendations proposed by the AEC Working Party are implemented.