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EXECUTIVE SUMMARY
OF THE 1994
TECHNOLOGY AND ECONOMIC ASSESSMENT PANEL
REPORT TO PARTIES

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EXECUTIVE SUMMARY OF THE 1994 TEAP

REPORT TO PARTIES

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ES.1 ESSENTIAL USE NOMINATIONS AND RECOMMENDATIONS

The Technology and Economic Assessment Panel (TEAP) thanks the many members of the Technical Options Committees for their expert assistance in evaluating the 1994 nominations for exemptions to the phaseout of ozone-depleting substances.

The Panel and its Technical Options Committees (TOCs) have learned a great deal from this first assessment of the essential use nominations for CFC, 1,1,1-trichloroethane, and carbon tetrachloride and the second assessment of halon nominations. Whilst a few nominations were complete, many Parties failed to provide necessary and sufficient information to evaluate their nominations according to the requirements of the Essential Use Decision. The TEAP and TOC chairs and members endeavoured to collect additional information from nominating Parties, national experts, and the national organisation making the application. The Panel and its Committees wishes to emphasize that these extraordinary efforts will not be undertaken in the future. The Panel seeks the cooperation of Parties in submitting detailed and complete nominations within designated deadlines.

In most cases the Technology and Economic Assessment Panel and its TOCs are unable to recommend the nominations because they do not satisfy the Essential Use Criteria. Many nominations are for applications where alternatives and substitutes are technically and economically feasible, commercially available, and already implemented elsewhere for similar uses. Furthermore, in most cases, controlled substances are available for the nominated uses, for the period of nomination, in sufficient quantity and quality from existing stocks of banked or recycled material.

However, the Technology and Economic Assessment Panel unanimously endorses the recommendation of its Technical Options Committees and recommends that the Parties authorise production and consumption of controlled substances after 1 January 1996 for:

(1) Aerosol Metered Dose Inhalers (MDIs),

(2) Specific cleaning, bonding and surface activation applications in rocket motor manufacturing for the Space Shuttle, and

(3) Global laboratory/analytical uses.

In the case of the application for use in finger printing for crime investigations, the TEAP and its TOCs are unable to recommend an exemption because technically and economically feasible alternatives and substitutes are commercially available. However, it is not known whether the process will be completed by 1996 to make alternatives and substitutes acceptable to the relevant courts of law. Parties may wish to consider this aspect when deliberating on their decisions.

For those recommended nominations, in cases where Parties submitted complete nominations, it is recommended that the nomination be granted for the years requested subject to:

(1) An annual review of the quantity of controlled substance authorised, and

(2) A biannual review of the essential use criteria, including whether alternatives and substitutes have become technically and economically feasible.

In the case of the nomination by Switzerland for MDIs, an exemption is recommended for 1996 only despite the fact that inadequate information was submitted by the Party. It is recommended that the nomination be granted only for 1996 subject to the requirement that Switzerland submit to the Secretariat supplementary information as requested by the Panel and its Technical Options Committee by January 1995. The supplementary information should include response to the deficiencies identified in a particular nomination as outlined in the Aerosol Products TOC chapter of this report. The nomination for years after 1996 can be resubmitted with complete elaboration.

In the case of MDIs, a major effort is also required to educate physicians and patients in all countries about treatment options including the use of dry powder inhalers which will assist in reducing reliance on CFC-driven MDIs. The TEAP strongly recommends that industry assist appropriate government and medical associations in this area. The information required for the biannual review and the supplementary information to be provided include the estimated volume of MDIs for treatment of pulmonary and non-pulmonary disease and the implementation of actions to reduce reliance on CFCs such as waste minimization actions and physician and patient education. The TEAP recommends that the production/consumption exemption be contingent on good-faith efforts to eliminate or recapture emissions from filling and testing, consistent with national laws and regulations. Such efforts have already been implemented by several manufacturers. Furthermore, the TEAP recommends that MDI manufacturers and Parties investigate recapture and destruction of CFC in MDIs that have exceeded their shelf life or that are ultimately rendered unnecessary by commercialization of alternatives. It is significant that these efforts could reduce emissions by an amount comparable to all other recommended essential uses of controlled substances.

In the case of the critical cleaning, bonding and surface activation applications used on the NASA/Thiokol Space Shuttle solid rocket motor, the TEAP and the Solvents TOC asks Parties to encourage all organisations manufacturing solid rocket motors to join and support the Industry Cooperative for Ozone Layer Protection (ICOLP) project to identify, verify, and implement alternatives and substitutes.

In the case of laboratory and analytical uses, it is recommended that a "global exemption" be granted only for 1996, 1997, and 1998 with a comprehensive review of alternatives and substitutes by a special subcommittee of the Technology & Economic

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Assessment Panel reporting to the Parties by March 1996 for a decision by 1998. Canada has offered to convene in 1994 a workshop on laboratory and analytical uses to assist such a review. A global exemption is recommended because some Parties may not have appreciated the importance of these applications and may not have submitted nominations. In addition, the uses are small but often specified by national and international standards.

The Technology and Economic Assessment Panel and its Technical Options Committees are unable to recommend that the following 1994 Nominations satisfy the Essential Use Criteria:

aircraft maintenance
various fire fighting applications
cleaning of live electric equipment
fingerprinting
foam standard-of-reference
furniture adhesives
hornet & wasp pesticides; membrane manufacturing
navigational and guidance devices
refrigeration and air conditioning servicing
silicone coating of medical devices

skin refrigerants, vapo-coolants, and topical anaesthetics
uranium enrichment
among others.

Nominations were received for 1,1,1-trichloroethane for production of silicone and carbon tetrachloride (CTC) for the production of chlorinated rubber, chlorine, and terephthaloyldichloride. The TEAP notes that only a few countries nominated these uses even though use of these processes is widespread. Countries may not have nominated such uses because they consider them as 'feedstock' and because controlled substances are recovered, recycled and incinerated, usually resulting in negligible inadvertent emissions. The TEAP recommends that the Parties consider treatment of these uses as 'process agents' similar to the allowed use of controlled substances as feedstocks under the Protocol.

A summary list of nominations and evaluation is attached in Appendix 1.

In several cases the process of preparing and reviewing essential use nominations has been directly responsible for technical breakthroughs and identification of previously undocumented alternatives and substitutes. For example, the Solvent Committee identified the existence of fingerprint technology eliminating CFC-113. In response to the nominations by Belgium, Denmark and Netherlands for solvents necessary for maintenance of the Lockheed F-16 military aircraft, Lockheed and the U.S. Air Force have agreed to work quickly to qualify alternatives for use before 1996.

ES.2 DEVELOPING COUNTRY CONCERNS

As the phase out process accelerates in the industrialized countries, the implementation process in the Article 5 (1) Parties is becoming increasingly important. Hence, the uncertainties inherent in the phase out process have become priority developing countries issues. The Parties have asked the Technology and Economic Assessment Panel (TEAP) and the Technical Options Committees (TOCs) to address the concerns of the developing countries. These include the need for education, adequate supplies of CFCs to service existing equipment, adequate supplies of alternative substances and technologies, and concerns over their respective costs and safety issues. This chapter presents a discussion of the concerns raised by the developing countries and some recommendations by TEAP and its TOCs.

ES.3 HCFCs

Decision IV/30 tasked the TEAP to (i) evaluate alternative substances and technologies to the use of HCFCs as refrigerant and as insulating gas in rigid foam, and (ii) identify other applications for HCFCs, if any, where other more environmentally acceptable alternatives are not available.

The TEAP cautions that HCFCs are important to the phaseout of CFCs and that the selection of alternatives is complex. The selection involves balancing the need to effect an early transition from CFCs and other controlled substances with the need to ensure that use of HCFCs is not encouraged where other more environmentally appropriate technologies exist. Decision-makers must also consider application-, country-, and site-specific economic, regulatory, health and safety, and technological circumstances.

HCFCs are technically and economically necessary for the transition in:

- the majority of refrigeration and air conditioning applications;

- manufacturing of insulating foams;

- selected and limited solvent applications; and

- certain fire protection applications where space constraints exist.

The TEAP is of the general view that other more environmentally acceptable alternatives to HCFCs are available in the following applications:

- most fire fighting applications;

- non-insulating foams;

- the majority of solvent applications;

- as an alternative to 1,1,1 trichloroethane (due to comparable ODP);

- aerosols;

- sterilization;

- solar tracking systems.

Discussion of the use of HCFCs in Aerosol Products, Foam, Halon, Miscellaneous Uses, Refrigeration Sterilants, and Solvents Sectors are presented below.

<u>ES.3.1 Aerosol Products</u>

HCFCs have had a minor role as aerosol propellants and their use is being phased out in developed countries because on their ozone depletion potentials. Some use may remain as a partial replacement for CFC-113 used in aerosols where non-flammability is critical.

ES.3.2 Foams

HCFCs are currently necessary as interim substitutes for CFC in the thermal insulating foam markets. Some zero-ODP conversions are being made in appliance and boardstock insulation foam applications. However, until zero-ODP substitutes are available in sufficient quantities and with sufficient testing it will be virtually impossible for manufacturers currently planning and investing in HCFC conversion to change course and adopt any new zero-ODP foam technology before 1996 if energy efficiency levels are to be maintained. The lead time for testing and development of some substitutes prior to commercialization could be several years. Toxicity testing, although done in parallel with foam development, will be a major development activity for many of the currently anticipated HCFC alternatives.

There are, however, many cases where HCFCs are not strictly necessary for timely elimination of CFC-blown foam. These cases include virtually all flexible foam, all packaging foam, and some insulating foam products, particularly in circumstances if the thickness of foam can be increased or replaced by alternative insulation products to achieve equivalent energy efficiency.

ES.3.3 Halons

Alternatives to the use of halons include both chemical replacements and not-in-kind technologies. Examples of alternatives for fixed fire protection systems include: water sprinkler systems, fine water mist systems, carbon dioxide systems, foam systems, dry powder systems, inert gas systems, and other gaseous agent systems.

Of the other gaseous extinguishing agent systems agents, a few are HCFCs or blends of compounds that contain HCFCs. In Europe, regulatory action has been prepared to disallow use of HCFCs as fire extinguishants. In the United States, HCFCs are not allowed to be used as extinguishants in portable fire extinguishers for residential use.

In most countries, fire protection equipment must undergo examination by independent testing agencies. These agencies "approve" equipment that has met their requirements. This "approval" process provides assurance to users and authorities having jurisdiction (insurers, fire departments, etc.) that equipment will function as intended in a fire. Confidence in the ability of fire protection equipment to meet expectations is very important as performance testing by an individual purchaser is impractical. Ironically, the high cost to meet these stringent procedures discourages the use of fire extinguishants such as HCFCs that may have relatively short commercial lifetimes. As there are known limitations on future HCFC availability, the development of fire protection products that employ HCFCs is expected to be very limited. HCFCs could have particular importance as a replacement for halon for limited existing applications where constraints on space available for cylinder storage would make it impractical to employ another alternative.

ES.3.4 Miscellaneous Uses

It is likely that the use of HCFCs may increase as CFCs are eliminated, but their use will remain a very minor fraction of the total global consumption of HCFCs. Some uses reported include a medical application and solar tracking systems.

ES.3.5 Refrigeration

A substantial amount of equipment in the different refrigeration sectors that use CFCs have yet to be converted to other refrigerants. Conversion to HCFCs and HCFC-based blends will be necessary. Furthermore there is a very large amount of existing equipment that was based on HCFC-22, particularly in the A/C sector. After full maturity of HFC based blends has been proven during the period 1994-95, apprehension to using HCFCs will gradually increase. Large investments are required for relatively simple retrofits to HCFC based blends, and even smaller ones for HFC based blend applications. However, retrofits to HFC based blends may not be possible for all refrigeration sub-sectors. Non-fluorocarbon options (ammonia, hydrocarbons) exist for a number of specific cases, but can never be considered a general alternative to HCFCs.

ES.3.6 Solvents

No large scale current use of HCFCs has been reported as solvents, coatings, or adhesives. In the near term HCFCs may be necessary as transition substances in some limited and unique applications. Potentially large use is possible as dry cleaning solvents despite the trend of centralized dry-cleaning plants to convert to traditional hydrocarbon and chlorinated solvents.

Parties may wish to strongly discourage the use of HCFC-141b to replace 1,1,1-trichloroethane as a solvent by promoting the fact that HCFC-141b has an ozone depletion potential comparable to 1,1,1-trichloroethane.

It is estimated that HCFC-141b and HCFC-225 together will not replace more than 1% of global CFC-113 uses unless HCFC-225 becomes a substitute for CFC-113 in dry cleaning, which could increase use to up to 5%. In some countries with aggressive HCFC sales efforts, at least 5% of CFC-113 solvent use (excluding dry-cleaning which may increase use) may be replaced with HCFC-141b. It is the consensus estimate of the Solvents Committee Members that HCFCs may replace 1-5 percent of 1986 CFC-113 and 1,1,1-trichloroethane use as transitional substances and where no alternatives or substitutes are currently available.

ES.3.7 Sterilants

HCFC 124 is being commercialized,but is not technically required, as a short-term option to substitute CFC 12. It acts as a diluent for ethylene oxide in sterilisation of heat and moisture sensitive devices. The volumes of HCFC used in this application are not expected to exceed 6000 tonnes per year over the next few years when it will be replaced by non-ODS alternatives for sterilisation in the hospital environment. Some of these alternatives are already available and have been adopted as the preferred substitute of CFC 12 in many parts of the world.

HCFCs are technically and economically necessary for the transition in:

- the majority of refrigeration and air conditioning applications;

- manufacturing of insulating foams;

- selected and limited solvent applications; and

- certain fire protection applications where space constraints exist.

The TEAP is of the general view that other more environmentally acceptable alternatives to HCFCs are available in the following applications:

- most fire fighting applications;

- non-insulating foams;

- the majority of solvent applications;

- as an alternative to 1,1,1 trichloroethane (due to comparable ODP);

- aerosols where flammability is not a concern;

- sterilization;

- solar tracking systems.

ES.4 RECOVERY AND RECYCLE

Decision IV/24 urges Parties to take all practicable measures to prevent releases of controlled substances into the atmosphere, including recovery for purposes of recycling, reclamation and re-use, leakage control and destruction. This decision also requested the TEAP to review and report on a range of issues related to recovery and recycling.

The TEAP believes that recovery, recycling, containment and leakage-control programmes are necessary to:

- Minimize ODS emissions to the atmosphere;

- Ensure that controlled substances are available to service existing equipment beyond phase-out, in particular for critical applications and essential uses, and

- Off-set the demand for ODS in developing countries.

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Commercially demonstrated and effective technologies are available for the recovery, recycling, containment and leakage-control of halons, methyl bromide, refrigerants and solvents. These technologies are detailed in the relevant TOC chapters.

In principle, it is possible to meet a portion of the demand for ODS in Article 5 (1) countries from supplies recovered and recycled in developed countries. However, with the possible exception of halons, recovery and recycling in Article 5 (1) countries is challenging due to the lack of existing equipment base, training, and equipment and refrigerant standards.

<u>ES.4.1 Refrigeration</u>

Refrigeration systems are designed as sealed units to provide long-term operation. The quality of the containment is affected by the design, installation and the service of the system. It varies when going from domestic appliances to commercial equipment, and from small cold storage to industrial refrigeration and chilling. Recovery and recycling is important to be able to service domestic appliances in case of malfunction, to keep high investment, large equipment in operation, as well as for mobile air-conditioning. Apart from environmental concerns, the economic incentive plays an important role, both in developed and in Article 5(1) countries.

Refrigerant recovery equipment is available with a wide range of features and prices, with requirements that provide for recovering 92 to 97% of the refrigerant. Recycling equipment is rated for contaminant removal capability by standardized best methods. A variety of equipment is also available over a wide price range.

The extent that refrigerants can be recovered and recycled to supply equipment for continued operation is very difficult to estimate. In how far this can satisfy the need for refrigerants worldwide in servicing practices is also difficult to estimate. It would assume no trade restrictions and a global banking system being in place where the latter cannot be the case for the refrigeration sector with its infrastructure.

The amounts recovered and recycled will reduce the amounts needed in the developed countries. Recovery and recycle of CFCs in the developed countries can only partly satisfy the needs of Article 5(1) countries. Logistics will be different for small versus large equipment, where, for the latter, global refrigerant distribution can be easier.

<u>ES.4.2 Halons</u>

It is clear that each country's existing and proposed recycled halon bank management programme is different, and reflects the unique conditions in each country. A country's political structure, economic structure and industry pattern will shape the solution and mean that each 'bank' will be tailor made. There are, however, some similarities between approaches. Switzerland, the UK and the USA have chosen a simple clearing house approach where the free market can be used to drive the process. The Netherlands and Malaysia selected a much more regulated structure.

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Basic requirements for a recycled halon banking strategy

The objective of a bank management strategy is to match those enterprises with available halon with those who have a need for halon. The key element of the banking process is the reversal of the original supply/distribution process which varied from country to country. The solution is not to copy a ready made strategy, but to have one tailored for the situation in any given country. It is, however, possible to pare the elements of the schemes proposed to date down to a certain number of minimum requirements to which other elements can be added depending on the regulatory aims of the country concerned and/or goals of the participants.

Key players

It is interesting to note that in some countries the fire equipment suppliers play a major role (Denmark, Switzerland, UK), but in the USA they have a very minor role. In Switzerland, for example, the users play an almost passive role whereas they are they prime movers in most of the other schemes. These differences reflect the historic shape of the halon supply market of the countries.

Governments too, have a widely differing function in these schemes. In some cases (Malaysia), the government imposes a regulatory framework because they wish to control the management of the halon stocks within their country. On the other hand (UK and USA) governments have left it to the participants to define the operating framework and permit market forces to prevail. However, it is Governments who are uniquely placed to act as facilitators of the process and provide, as a minimum, a forum for discussion among stakeholders so that a strategy can be prepared. It is also important that action by Governments do not hinder the collection, transport and wise management of recovered and recycled halons.

Inventory and brokerage

Some banking strategies are based on a detailed inventory of the halon held in a country and others on an inventory of the halons held by the members of the bank. As a minimum, any banking strategy must have a list of the halon users who no longer require material and one of users who still require halons but who do not have a sufficient stock. There must then be a method of matching the two.

Recycling and standards of material

Halon for transfer may need to be processed and/or recycled, so that any strategy must provide access to such facilities. At the most basic, this would be a list of companies who have or have access to recycling facilities.

Those users who need halon have to be assured that it is fit for use in fire protection applications and therefore there has to be some level of confidence in the material. This can be provided either by requiring material to be recycled to a certain agreed standard (ISO 7201, ASTM ES 24-93) or by knowing its provenance - a history of where it has been used, stored etc.

ES.4.3 Methyl Bromide

There are well developed technologies for decreasing the rate of leakage of methyl bromide to the atmosphere, but these are only in limited use worldwide. Good containment is a prerequisite for efficient recovery.

The overall scope of recovery of methyl bromide from fumigation is low and likely to be impractical in most situations. As an exception, recovery and recycling of methyl bromide used in fumigation in chambers, usually of perishables, appears likely to be feasible with recoveries of methyl bromide at about 90% per cycle. It is expected that equipment suitable for this application will be generally available soon. Some installations are already operating or soon to be commissioned.

The potential for banking reclaimed methyl bromide is insignificant due to low rates of recovery from most applications. As a result, banked and recycled methyl bromide would not be a viable source to supply the needs of Article 5 (1) Parties.

If recovery of methyl bromide is to be recognised as an acceptable means of reducing methyl bromide emissions, there will need to be specifications set to define efficiencies of capture and tolerable residual emissions.

ES.4.4 Solvents

Solvent losses are often excessive in conventional poorly maintained plants and facilities. In a poorly maintained plant, often less than 20 percent of the purchased solvent quantity is generally recovered or sent to waste management. The latest low-emission plants can reduce emissions by 70 percent to 90 percent.

Newly developed, commercially installed technologies include membrane separation technique that recover solvents from ventilation above vapour degreasers with a reported efficiency in excess of 95 percent. However, the investment costs for such systems is a function of design and concentration of solvent in the exhaust.

Totally enclosed solvent machines incorporate very high containment and new vapour recovery technology. There is a choice of spending money to contain solvent vapours in the cleaning equipment or recovering solvent vapours from around the equipment or from the ventilation air or a combination of the above. Recovery systems can be designed to reuse solvent or for destruction, as appropriate. Recovery techniques apply to high concentration single-solvent waste streams, (e.g. in lip extractor on a degreaser). Recovery technology has lower efficiency in situations such as clean room area ventilation air streams where the vapour concentration is low and consists of mixed solvents. Recovered mixed solvent may need to be destroyed if it cannot be reused due to quality requirements. In some cases, expensive investments are required that may be difficult to finance, especially for a small user.

ES.5 DESTRUCTION TECHNOLOGIES

The Parties asked the Technology and Economic Assessment Panel (TEAP) to evaluate issues related to the destruction of ozone-depleting substances, primarily as a follow-up to the work of the 1992 Technical Advisory Committee on ODS Destruction Technologies.

The TEAP anticipates that there will be significant quantities of unwanted, contaminated or surplus ODS and products containing ODS requiring destruction or transformation to avoid atmospheric releases that would otherwise contribute to depletion of the ozone layer. The Parties may wish to implement ODS destruction and transformation activities for these materials.

The TEAP estimates that the current capacity of approved ODS destruction technologies may not be sufficient to destroy the expected stockpiles of ODS within an acceptable time frame. There is a need to maintain and possibly expand the options available for destruction/transformation technologies to ensure that the disposal of stockpiled ODS is performed in an environmentally acceptable manner. The report in Chapter 10 makes specific recommendations on research and development, treatment of inadvertent emissions from ODS destruction facilities, approved destruction technologies, and otherwise provides a technology update on existing and emerging technologies.

ES.6 INADVERTENT PRODUCTION

As a consequence of any chemical manufacturing process there will be process emissions or losses. In the majority of cases these losses result from fugitive emissions, for example from valves, or from handling and packing the products prior to shipment for sale. Such losses of product will be minimised by the manufacturer for the simple reason that they represent a loss of marketable material and hence a loss of income. Also in many circumstances national or local regulations limit the quantities of emissions permitted from individual manufacturing sites, from individual manufacturing plants and from packaging plants.

This report makes a worst case estimate for the amount of controlled substances that are currently emitted as a consequence of inadvertent production and process emissions.

A worst case estimate for the current emissions from the inadvertent production and process emissions of chlorofluorocarbons (CFCs), carbon tetrachloride (CTC), methyl chloroform, hydrochlorofluorocarbons (HCFCs) and methyl bromide is approximately 7,200 ODP-tonnes. It is estimated that this will reduce to a worst case emission of 5,800 ODP-tonnes in the year 2000. These levels equate to about 0.5 percent of the amount of controlled substances produced in their baseline years.

It is highly desirable that the Parties to the Montreal Protocol work with their respective governments and industries to take steps to minimise emissions of such substances, including such steps as avoidance of the creation of such emissions, reduction of emissions using practicable technologies or process changes, containment or destruction. It is particularly important that such technologies are transferred to developing countries where CFC production, and hence process emissions and inadvertent production, may continue for a number of years under the Montreal Protocol.

ES.7 PROBLEMS PROTOCOL DEFINITIONS AND METHYL BROMIDE CONTROL

The Protocol definitions of `bulk substances` under Decision I/12A, and the lack of definitions of `preshipment` and `quarantine` treatments referred to in Article 2H need to be solved. Since the controls on methyl bromide under Article 2H come into effect on 1 January 1995, clarification of the problems raised should be decided by the Parties at their 1994 meeting. Failure to agree on the definitions may result in inconsistent interpretation among the Parties.

TEAP recommends that Parties consider the advantages of not exempting any uses except feedstock and instead rely on the essential use process to consider each nomination on a case-by-case basis. This course of action will not jeopardise current quarantine and pre-shipment uses, even as broadly defined, as in many cases alternatives already exist. Where they do not, supplies can be provided from within the consumption level of the particular Party.
