Proposed Control Protocol

Year after EIF	Calendar Year	
0	1988	Entry Into Force (EIF) of Protocol
2	1990	Freeze: o CFC 11, 12, 113, 114, 115 at 1986 levels o Halons 1211, 1301 at 1986 levels Science Review Technological and Economic Assessments Review 20% Reduction of CFC-11,12 for year 4. Decide [A] Reduction for year [10]
4	1992	20% Reduction of CFC 11, 12
6	1994	Science Review Technological and Economic Assessments Decide [B] Reduction for year [16] Review [A] Reduction
10	1998	[A] Reduction Science Review Technological and Economic Assessments Review [B] Reduction
14	2002	Science Review Technological and Economic Assessments Review [B] Reduction
16	2004	[B] Reduction
18	2008	Science Review Technological and Economic Assessments

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20506

June 12, 1987

MEMORANDUM FOR LEE THOMAS

FROM: BEVERLY BERGER BB

SUBJECT: OSTP POSITION ON CFC REDUCTIONS

Attached is the position OSTP recommends on CFC reductions. We'd appreciate your consideration of this option in your inputs to the Presidential decision paper.

Attachment

QUESTION OF U.S. SOVEREIGN POSITION VS. UNITED NATIONS PROCESS ON CFCs REDUCTIONS

Should the U.S. agree, at this time, to an international process which could commit the U.S. to future CFC reductions or reduction schedules that it may conclude from future science reviews are unwarranted and it does not want?

PRO: Shows U.S. willingness to participate in international process.

CON: U.S. should not relinquish its sovereignty lightly. Present scientific predictions for ozone depletions are very uncertain. The data base on ozone and the modelling capabilities will increase significantly in the next 3 years. A major international science review is scheduled for 1990. It is clear that a delay of 5 years in implementing a 20% reduction will have little effect on ozone. Hence it is both unwise and unnecessary to commit to a reduction process at this time.

CHAIRMAN'S TEXT

Distr.
RESTRICTED

UNEP/WG.172/CRP.8/Rev.1
30 April 1987

Original: ENGLISH

Ad Hoc Working Group of Legal and Technical
Experts for the Preparation of a
Protocol on Chlorofluorocarbons to
the Vienna Convention for the
Protection of the Ozone Layer (Vienna Group)

Third Session
Geneva, 27-30 April 1987

TEXT PREPARED BY A SMALL SUB-WORKING GROUP OF
HEAD OF DELEGATIONS

ARTICLE II: CONTROL MEASURES

1. Each party, under the jurisdiction of which CFC 11, CFC 12, CFC 113, (CFC 114, CFC 115) are produced shall ensure that within (2) years after the entry into force of this Protocol the (combined annual production and imports) (combined adjusted annual production) of these substances do not exceed their 1986 level.

2. Each party, under the jurisdiction of which substances referred to in paragraph 1 are not produced at the time of the entry into force of this Protocol, shall ensure that within (2) years from the entry into force of this Protocol (its combined annual production and imports) (its combined adjusted annual production) do not exceed the levels of imports in 1986.

3. Each party shall ensure, that within (4) years after the entry into force of this Protocol levels of substances referred to in paragraph 1 attained in accordance with paragraphs 1 and 2 will be reduced by 20 per cent.

4. Each party shall ensure that within (6) (a), (8) (b) years after the entry into force of this Protocol, the 1986 levels of substances referred to in paragraphs 1 and 2 will be further reduced (by 30 per cent), (a) (if the majority of the parties so decide, (b) (unless parties by a two-third majority otherwise decide), in the light of assessments referred to in Article III, such decision should be taken not later than (2) (4) years after entry into force.

5. Parties shall decide by (two-third majority) (a majority vote)

- whether substances should be added to or removed from the reduction schedule
- whether further reductions of 1986 levels should be undertaken (with the objective of eventual elimination of these substances).

These decisions shall be based on the assessments referred to in Article III.

Note: A second paragraph reading as follows has to be added to Article III. Beginning 1990, and every four years thereafter, the parties shall review the control measures provided for in Article II. At least one year before each of these reviews, the parties shall convene a panel of scientific experts, with composition and terms of reference determined by the parties, to review advances in scientific understanding ~~of~~ modification of the ozone layer, and the potential health, environmental and climatic effects of such modification.

ISSUE I. GENERAL U.S. POSITION ON INTERNATIONAL PROTOCOL

Option 1: Continue negotiations pursuant to the existing State Department Circular 175 (authority to negotiate, approved last November by Under Secretary Allen Wallis following interagency review). The U.S. delegation would be authorized to negotiate for a protocol along the lines of the "Chairman's Text", providing for:

(a) A freeze, at 1986 levels, on production/consumption of CFCs 11, 12, 113, 114 and 115, and Halons 1211 and 1301, to take effect one or two years after the protocol enters into force (EIF).

(b) Periodically scheduled reductions of CFCs 11, 12, 113, 114 and 115, from 1986 levels, beginning with 20 percent two to four years after EIF, followed by an additional 30 percent approximately eight years after EIF, with the possibility of further steps as determined by the parties.

(c) Regularly scheduled assessments of scientific, economic and technological factors, prior to any reductions, to enable the parties to adjust the reduction schedule and add or subtract chemicals.

(d) An ultimate objective, subject to the assessments mentioned above, to eliminate substantially all potential threats to the stratospheric ozone layer from anthropogenic chemicals.

(e) Strong trade, monitoring and reporting provisions to make the protocol as effective as possible.

(f) An attempt to negotiate some system of voting which would give due weight to the currently significant producing and consuming countries.

Pro:

- The U.S. position has been presented through seven months of negotiations and has been publicly advocated by senior Administration officials in Congressional testimony and with foreign governments. This has contributed to an evolution of policy in many countries, and a perceived reversal by the U.S. risks an embarrassing loss of international credibility.

- Change in the U.S. position would also ~~rush~~ risk domestic political backlash on an issue which has until now been a political plus for the Administration, and is likely to lead to unilateral domestic controls -- the worst possible outcome for U.S. industry and consumers.

Con:

- As the negotiations move toward a very important U.S. commitment, the essential elements of a potential protocol from the U.S. perspective should be made more specific.

- The existing Circular 175 has not been reviewed or approved by the highest levels in the inter-agency process.

Rates of Return on Assets

Gross of all taxes	6.2%
Gross of income taxes	5.7%
Net of all taxes	4%

DRAFT

THE WHITE HOUSE

WASHINGTON

June 11, 1987

Close Hold

MEMORANDUM FOR THE PRESIDENT

FROM: THE DOMESTIC POLICY COUNCIL

SUBJECT: Stratospheric Ozone

Issue: What guidance should the U.S. delegation follow during the next stages of international negotiation of a stratospheric ozone protocol?

Background

During the 1970's, concerns were expressed by the science community about potentially harmful effects of depletion of the stratospheric ozone layer. It was felt that emissions of certain chemicals were causing this depletion. This led to a 1978 unilateral ban on aerosols in the United States.

Concern for protection of the ozone layer increased after discovery of the Antarctic "hole" in 1985. Some scientists predict that significant ozone depletion will occur unless international action is taken to control the relevant chemicals. They say that depletion of the ozone layer is likely to cause adverse health and environmental effects including increased skin cancer deaths, cataracts, crop damage and aquatic impacts.

In 1985, the United Nations Environment Program sponsored the Vienna Convention for the Protection of the Ozone Layer. The U.S. has been a leader at the three international meetings held over the past seven months to develop a global agreement on the control of the chemicals thought to cause ozone depletion. The next international meeting is scheduled for June 29, 1987.

There is strong domestic pressure for action to protect the ozone layer. Any such action should be on an international level to best prevent ozone depletion and to prevent disadvantaging American industry in world markets. Yet if an international agreement is not reached, both Congress and the courts are likely to impose unilateral domestic requirements which would fail to protect the ozone layer and would disadvantage U.S. industry.

U.S. industry uses the chemicals thought to deplete the ozone layer in the production of refrigerators, air-conditioners, foam-insulation and electronic products. Industrial groups have publicly recognized the need to control these chemicals through an international agreement.

DRAFT

Discussion

The Domestic Policy Council is recommending that you provide guidance to the U.S. delegation as they enter the final stages of negotiating a protocol. The delegation will meet with the Chairman and a small group in Brussels in late June and early July to discuss country views on the attached Chairman's text. The diplomatic meetings at which the final protocol will be discussed and signed will be in early September, 1987, in Montreal. The protocol must then be ratified by each country. Thus, there will be opportunities for further Administration review.

ISSUE I. GENERAL U.S. POSITION ON INTERNATIONAL PROTOCOL

Ideally, the United States should seek a protocol agreed to by all nations which provides for a true global freeze on covered chemicals. Such an international agreement is not obtainable at this time.

Your decision on the following options will guide the U.S. delegation.

Option 1: Continue negotiations pursuant to State Department Circular 175, with U.S. delegation authorized to use its discretion on all issues, including: chemical coverage; acceptable level of country participation; when and to what extent freeze and further reductions up to 95% should occur; whether reductions should be automatic (subject to reversal by 2/3 vote) or require affirmative vote of majority; whether voting system should give weight to major producing and consuming nations; whether to seek, in addition to freeze, a ban by other nations of non-essential aerosols as the U.S. did in 1978; and whether to seek verification provisions.

Pro:

- The U.S. position, as reflected in the 175 has been presented in formal negotiating sessions, congressional testimony and public position papers. Thus, diplomatic considerations favor continuing with the existing Circular 175.

- The Circular 175 provides a general framework, and allows for the delegation to propose flexible, alternative approaches to the specific provisions of a control protocol.

Con:

- As the negotiations move toward a very important U.S. commitment, the essential elements of a potential protocol from the U.S. perspective should be made more specific.

- The existing Circular 175 has not been reviewed or approved by the highest levels in the inter-agency process.

Those in favor of this option include the Department of State, Environmental Protection Agency, _____ and _____.

DRAFT

Option 2: Continue negotiations, but with the U.S. delegation instructed to make every effort to achieve a protocol containing the following provisions:

(a) Freeze the most ozone-depleting chemicals (CFCs 11, 12, 113, 114 and 115 and Halons 1201 and 1311) at 1986 production level within two years after entry into force.

(b) Twenty percent reduction by participants following a major international scientific, technological, health and economic review which takes into account the effects of the freeze; and when approved by a majority vote of participants not in material breach of freeze.

(c) Further reductions more or less than a cumulative 50%, also following a major scientific, technological, health and economic review which takes into account the effects of the freeze and previous reductions; and when approved by a majority vote of participants not in material breach of the protocol.

(d) Entry into force when sufficient number of countries, determined by formula, sign and ratify.

(e) To encourage participation by current non-producers (such as developing nations), permit a grace period up to the year 2000.

(f) Seek other participants' agreement that, in addition to freeze, they will ban use of non-essential aerosols, as United States did in 1978.

Pro:

- These conditions will help ensure that the U.S. actions are matched by other countries.

- These conditions have been studied and found to be generally acceptable to the U.S. economic and political communities.

Con:

- These could be seen as changes in the U.S. position, thus stimulating major new conditions by other countries.

- Introduction of these could be seen by environmental groups as an attempt to stall the negotiations.

Interior, CEQ and _____ support this option.

DRAFT

Option 3: Advise the Convention that beyond a freeze the negotiations should be delayed, pending a major study of scientific, technological, economic, health an environmental factors related to depletion of the stratospheric ozone layer.

Pro:

- This will provide more certainty to the subsequent protocol agreements.
- This might benefit some industries in that they could continue production of items that would otherwise be banned.

Con:

- Congress and environmental groups will severely criticize this move, and Congress will likely legislate their own "protocol."
- We could lose vital credibility with other countries.

The Office of Science and Technology Policy, Department of Commerce and _____ support this option.

ISSUE II. PROTOCOL TRADE SANCTIONS

Option 1: Generally instruct the delegation to negotiate a trade provision which will protect U.S. industry in world markets.

Pro:

- Gives delegation flexibility to negotiate a trade article.
- Does not risk committing the Administration publicly to trade sanctions in advance of a negotiated agreement.

Con:

- Does not provide specific direction to delegation on desirable aspects of a trade article.
- Does not send strong signal to other countries about the economic value of participating in the negotiations and of complying with a future protocol.

Option 2: Specifically instruct the delegation to attempt to negotiate a protocol which includes a trade provision containing:

(a) Sanctions against non-parties and parties in material breach of protocol requirements;

DRAFT

(b) Such sanctions should include banning or limiting imports by parties of:

(1) controlled chemicals in bulk;

(2) products containing controlled chemicals;

(3) products manufactured by using controlled chemicals.

Pro:

- Encourages participation and compliance in the protocol.
- Prevents the transfer of commercial benefits from parties to non-parties.

Con:

- Establishes precedent for use of trade sanctions to enforce environmental regulations.
- General disfavor of restraints of trade.

Edwin Meese III
Chairman Pro Tempore

Attachment

DECISION:

ISSUE I. GENERAL U.S. POSITION ON INTERNATIONAL PROTOCOL

_____ Option 1. Continue negotiations pursuant to State Department Circular 175.

_____ Option 2. Continue negotiation, with U.S. delegation instructed to achieve protocol under terms described above.

_____ Option 3. Advise Convention that beyond a freeze, further reductions should be delayed.

ISSUE II. PROTOCOL TRADE SANCTIONS

_____ Option 1. U.S. delegation has flexibility to negotiate best possible agreement.

_____ Option 2. Instruct delegation to ensure that the protocol contains specific trade provisions consistent with terms cited above.

TABLE 1: COMPARISON OF BENEFITS AND COSTS OF CFC CONTROL STEPS

Step	BENEFITS* (billions of dollars) Discount Rate 4%	6%	COSTS** (billions of dollars) Discount Rate 4%	6%
(No action) to (Freeze)	$739	$131	$1.6 - $3.3	$1.0 - $1.4
(Freeze) to (Freeze + 20%)	34	6.4	3.5 - 7.0	2.2 - 3.0
(Freeze + 20%) to (Freeze + 50%)	58	11	9.2 - 18.7	5.8 - 8.0

---

*Assumptions for Benefits Calculations:

(1) Deaths averted and scenarios for "Freeze" and cuts corresond to deaths averted and scenarios for health effects estimates. E.g., "Freeze" is a "Protocol Freeze," not a true global freeze, etc.

(2) Benefits and costs as shown in Table are incremental benefits and costs of indicated steps. Present values of marginal benefits are averaged over ranges of parameters reported by Working Group Subcommittee on Benefits and Costs:
- Value of life initially: $2,000,000; $4,000,000
- Increase in value of life over time: growth at 2% per year; value of life constant.
- Four different time profiles for deaths averted

(3) Benefits calculated for premature skin cancer deaths averted only. Benefits for preventing non-fatal skin cancers, cataracts, and other economic damages would be additive.

**Assumptions for Cost Calculations:

(1) Low ends of ranges: marginal costs grow at .625% per year forever.

(2) High ends of ranges: marginal costs grow at 2.5% per year forever.

TABLE 2: SENSITIVITY ANALYSIS--COMPARISON OF BENEFITS AND COSTS UNDER DIFFERENT ASSUMPTIONS

Step	Percent of cases in which benefits exceed costs	Percent of cases in which benefits approximately equal costs	Percent of cases in which benefits are less than costs
(No Action) to (Freeze)	100%	0%	0%
(Freeze) to (Freeze 20%)	78%	3%	19%
(Freeze + 20%) to (Freeze + 50%)	56%	19%	25%

Assumptions: Same as Table 1.

THE WHITE HOUSE

WASHINGTON

June 10, 1987

MEMORANDUM FOR THE DOMESTIC POLICY COUNCIL

FROM: THE ENERGY, NATURAL RESOURCES & ENVIRONMENT WORKING GROUP

SUBJECT: Stratospheric Ozone

On May 20, 1987, the Council met to discuss the international protocol negotiations currently underway to limit emissions of ozone depleting chemicals. Several questions were raised and the Working Group was asked to provide answers. The questions were:

* What are the legislative and legal impacts of an international ozone protocol?

* What are the most up-to-date scientific data on climatic and health effects of ozone depletion?

* What is the cost/benefit effect of an international protocol restricting ozone depleting chemicals?

The following has been summarized by the Working Group after discussion of detailed presentations by experts in each area.

Climatic and Atmospheric

o Since 1960 the natural variability of the total global column of ozone has been about 3%.

o Observations have shown (1) a decrease in ozone of about 7% during the last decade in the upper part of the stratosphere; and (2) a 40% decrease in total column ozone over Antarctica in the spring season since the mid-1970's. Whether the recent changes in column and upper stratospheric ozone are due to natural phenomena or in part to CFCs remains an open question.

o Continued growth of CFC and Halon emissions at 3% per year is predicted to yield a globally averaged ozone depletion of 6% by the year 2040, and more thereafter, which would be greater than natural variability. In contrast, a true global freeze on emissions of CFCs and Halons (i.e. full international participation, full chemical coverage, and full compliance) is predicted to yield a maximum global average column ozone depletion of less than 1%. Ozone depletions at high latitudes are predicted to be 2-3 times larger than the global average.

o A true global freeze would limit column ozone depletion to less than the natural variability. A protocol freeze would fall short of a true global freeze as it would have less than

full compliance among developed countries and would most likely allow for limited growth in CFC usage in developing countries.

- Ozone depletion in the upper part of the stratosphere greater than 25% is predicted to occur even in the case of a true global freeze. This would lead to a local cooling greater than natural variability. The consequences of this cooling for the earth's climate cannot be predicted at this time.

- There is an uncertainty factor of two to three in the predictive abilities of the theoretical models used to simulate the present atmosphere.

- If there is environmental damage due to CFCs and Halons, their long atmospheric lifetimes would mean that recovery would take many decades even after complete cessation of emissions.

Health and Ecological Effects

- Projected ozone depletion will increase health effects of ultraviolet radiation (UVB)

  -- Without ozone depletion, projections show UVB is a serious problem, and will cause:
  - 2,977,000 skin cancer deaths of Americans born before 2075,
  - 165 million skin cancer cases,
  - 426,516,000 cataracts.

  -- If the predicted 25% depletion of ozone in the upper stratosphere occurs by 2075, UVB related health effects would increase by:

  - 2 million additional skin cancer deaths,
  - 98 million additional skin cancer cases,
  - 43 million additional cataracts.

  -- If upper stratospheric depletion of 7.7% occurs instead (as predicted to result from a protocol freeze with less than full compliance and limited emissions growth in developing countries),

  - 1.6 million additional American deaths would be averted,
  - 79 million additional skin cancer cases would be averted,
  - 32 million additional cataracts would be averted.

  -- If upper stratospheric depletion of 6.1% occurs (as predicted to result from a 20% emissions reduction protocol with less than full compliance and limited emissions growth in developing countries) incrementally,

  - 80,000 additional American deaths would be averted,
  - 4 million additional skin cancer cases would be averted,

- 2 million additional cataracts would be averted.

-- If upper stratospheric depletion of 3.2% occurs (as predicted to result from a 50% emissions reduction protocol with less than full compliance and limited emissions growth in developing countries) incrementally,

- 130 thousand additional American deaths would be averted,
- 7 million additional skin cancer cases would be averted,
- 7 million additional cataracts would be averted.

-- Uncertainties include future ozone depletion, the action spectra and estimates of dose-response coefficients.

- The analysis assumes no behavioral changes.
- Considering quantifiable uncertainties, there is a 50% chance that the actual damages will be between 50% and 125% of the above estimates.
- There is a 90% chance that the actual damages will be between 20% and 260% of the above estimates.

-- Laboratory studies link UVB with suppression of the immune system.

- Evidence suggests a relationship to infectious disease.
- A relationship has been demonstrated in herpes simplex and the tropical disease, leishmanias.

o Evidence supports the conclusion that ozone depletion would exacerbate existing environmental problems.

-- Photochemical air pollution in places like Los Angeles would probably worsen.

-- The lifetime of outdoor plastics and latex paints would be shortened.

o Evidence supports the conclusion that ozone depletion could seriously influence crops and aquatics.

-- Knowledge is limited, but experimental data indicate crop production may be reduced and ecosystems disturbed.

-- Field experiments have not been done, but laboratory data indicate aquatic organisms are sensitive to higher UVB, especially during critical breeding seasons.

o Higher emissions of CFCs and its indirect effects of vertical ozone re-distribution will raise global temperatures and change climate.

Cost/Benefit

- Cost/benefit analysis has been carried out for known health effects (skin cancern deaths, non-fatal skin cancers, cataracts) based on EPA's Risk Assessment.

- Potential effects of ozone depletion on plants, aquatic life, the human immune system, ground-level ozone concentrations, polymer degradation, and sea level rise were not quantified.

- A range of assumptions were used in the analysis to reflect economic uncertainties and lack of inter-agency consensus on the values of key parameters.

- The analysis is based on EPA models which attempt to project health impacts through year 2165 and assume no changes in technology, medicine or human behavior.

- Conclusions:

  -- The economic benefits from a protocol freeze (at 1986 levels with less than full international participation) of CFC emissions are substantially greater than the costs over all plausible assumptions and ranges of uncertainty.

  -- The economic benefits of a protocol freeze plus a 20% reduction in CFC emissions are also in almost all cases substantially in excess of the costs.

  -- The incremental benefits of the additional 20% reduction beyond the freeze are in most cases in excess of the incremental costs of the cut.

  -- The benefits of an additional 30% reduction (beyond the freeze plus 20% reduction) appear in some cases to be greater than the incremental costs, and in other cases to be less. Further scientific, technical, and economic review will be valuable in evaluating benefits and costs before implementing this step.

ISSUES AND DISCUSSION

At the May 20 Council meeting, the status of the international ozone negotiations was provided. It included a review of the November 28, 1986 Circular 175, which was approved by Under Secretary of State Allen Wallis, and which authorized the U.S. delegation to negotiate a protocol. The approval process for the Circular 175 has been criticized by some members of the Working Group, on the basis that numerous departments and agencies had not concurred on the Circular, or that concurrence was by individuals not at policy-making levels. The Circular 175 authorized

the U.S. delegation to negotiate a protocol providing for:

I. A near-term freeze on the combined emissions of the most ozone-depleting substances;

II. A long-term scheduled reduction of emissions of these chemicals down to the point of eliminating emissions from all but limited uses for which no substitutes are commercially available (such reduction could be as much as 95%), subject to III; and

III. Periodic review of the protocol provisions based upon regular assessment of the science. The review could remove or add chemicals, or change the schedule or the emission reduction target.

The international negotiations to date have resulted in a Chairman's Text, a proposed protocol to which negotiating countries have been asked to respond.

The Working Group recommends that the Council support continuation of negotiations pursuant to the current Circular 175. The Working Group also recommends however, that additional guidance be given to the U.S. negotiators, based on reviews by a wider range of agencies such as those represented on the Council.

The following are issues for which the Working Group feels additional guidance to the negotiators may be appropriate.

A. PARTICIPATION AND TRADE PROVISIONS

There are many complex issues pertaining to fair trade provisions and participation of developing countries in the protocol.

1. What should be the U.S. position regarding international participation in the protocol?

The Working Group feels that the U.S. delegation should seek maximum international participation in the protocol. To many, participation is the key issue, because growth of emissions from non-participating countries would offset the emissions reductions of those who are parties to the protocol, thereby hindering overall attainment of protocol objectives.

Developing countries are an important part of the participation issue. While the 48 countries participating in the protocol negotiations account for over 90% of the current production, substantial growth of production and consumption is anticipated in developing countries. The U.S. and the United Nations Environment Program (UNEP) have expended considerable effort to encourage broad participation by developing countries. However, only relatively few have shown the interest or the expertise to participate. Parties to the protocol would not be able to prevent non-joining countries from producing CFCs for their

internal market or from exporting to other non-parties, but, if the protocol provides for trade sanctions, parties could prevent non-parties from profiting through international trade with protocol parties.

A strong protocol, including the major producing and consuming countries, should lead to earlier development of substitute products, and might discourage non-joiners from investing heavily in CFC technology that would not generate trade with parties to the protocol. Further, some believe that the very existence of a protocol, as an expression of concern by the international community, increases the pressure on non-member countries to join; in essence, if they continue to produce CFCs, they are exposed as behaving irresponsibly on a matter of global import.

The following options are proposed for the Council's consideration:

a. Give the U.S. delegation discretion for seeking maximum participation.

b. Develop criteria for acceptable levels of participation, e.g. minimum participation of countries producing a specified percentage of the total global CFC/Halon production; or a formula requiring minimum participation of countries accounting for a specified portion of the world population.

c. Wait to reassess the U.S. position after we know the extent of participation by other countries.

To encourage the participation of developing countries, some parties favor granting developing countries a limited grace period from compliance with protocol provisions. Such a grace period would be allowed in recognition of the importance of having global participation in the 21st century, and in recognition of the fact that developing countries have not received the benefits of CFC and Halon use. The length of the grace period and the levels of production/consumption that would be permitted are questions that would need to be resolved.

2. Voting among parties to the protocol.

Also at issue is the voting process for making future decisions under the protocol. This could include decisions on future reductions. The Working Group recommends that the U.S. delegation negotiate for a system of voting which would give due weight to the major producing and consuming countries.

3. The control formula and trade provisions

The Working Group recommends that the Council direct the U.S. delegation to continue to seek to include in the protocol an effective formula to control emissions with accountability, the

fewest possible restrictions on the flow of trade and capital among parties, the most favorable formula for U.S. industry, stimulation of substitutes and innovative emission controls, and with no greater restriction on trade involving the U.S. than will be adopted and enforced by other nations.

Trade: The U.S. has pushed for a strong protocol article on trade sanctions to be imposed on parties which have not signed the protocol. This would limit imports not only of the controlled chemicals but also of products containing these chemicals (e.g., air conditioners or foam insulation). The U.S. has pushed for a study of the feasibility of limiting imports of products manufactured using the controlled chemicals (e.g., electronic equipment). The intent of the trade article would be to provide a "stick" for encouraging others to join and to limit the impact on ozone depletion and the transfer of commercial benefits from parties to the protocol to countries which have not joined.

This would represent a major policy decision, as it could be an important precedent for using trade sanctions to enforce environmental regulations. Also to be decided is whether trade sanctions should be applicable to parties who materially violate their protocol obligations.

Control Formula: Since it is not possible to measure emissions directly, the negotiators have explored alternative formulas to control emissions which consider production, consumption, imports and destruction.

4. Should the U.S. seek protocol provisions for reporting, monitoring, verification and enforcement provisions?

There are many complex issues relating to enforcement of a protocol. Because of the enforcement roles of EPA and U.S. environmental groups, our compliance with the protocol is apt to be substantial. Most other nations do not have such enforcement mechanisms. No monitoring or verification system has been identified to date. A system of on-site inspections for the presence of new or expanded CFC-producing facilities would be expensive and probably ineffective because of the large land areas involved.

Some Working Group members believe the U.S. should insist upon strong monitoring and reporting provisions in a protocol. Some favor the U.S. negotiating for strong provisions, and exploring the feasibility and cost effectiveness of establishing ad hoc inspection teams to investigate any alleged violations of protocol requirements. Trade provisions could at least prevent entry of such production into international trade with parties to the protocol.

The following options are presented for the Council's consideration:

a. Give the U.S. delegation discretion for seeking such provisions.

b. Insist that the protocol include such provisions.

5. Should the U.S. attempt to receive "credit" for its 1978 unilateral voluntary ban on CFC-producing non-essential aerosols?

Some believe that in addition to a freeze, other nations should ban non-essential aerosols as the U.S. did in 1978. Otherwise, many nations might be able to meet their obligation to reduce CFC emissions through the simple expedient of banning such aerosols, while the U.S. is required to cut back on other products using CFCs. One form of recognition may be to require other countries to ban non-essential aerosols in addition to meeting other protocol requirements.

The U.S. attempted unsuccessfully to get such credit two years ago during the negotiation of the Vienna Convention on the ozone layer, and some believe that if the U.S. were to insist upon such credit as a condition of a protocol, the negotiations would come to a standstill as in 1985. Some argue that even with the aerosol ban, the U.S. remains responsible for most of the long-lived CFCs in the stratosphere, and the U.S. per capita CFC consumption is still the world's highest.

The Working Group recommends that the Council consider and provide guidance for the U.S. delegation as to whether or not we should attempt to gain credit for our previous actions.

B. AN EMISSIONS CONTROL PROTOCOL

The aforementioned Chairman's Text contains proposals related to (1) a freeze on emissions, and (2) emissions reductions beyond a freeze. The Working Group discussed these at length.

1. A Freeze on Emissions. The following are major questions:

a. What chemicals should the freeze cover?

The Chairman's Text provides for a freeze on emissions at 1986 levels which would cover CFCs 11, 12, 113, 114, and 115. Due to a technicality, Halons are not now included.

The Working Group consensus is that the freeze should include all of these CFCs as well as Halons 1201 and 1311. The U.S. delegation will be seeking to expand the protocol to include the Halons.

From a purely scientific perspective all chemicals containing chlorine and bromine, weighted by the ozone depleting potential, should be considered for the protocol, both for the freeze and for potential future reductions. The Chairman's Text is somewhat less than a purely scientific perspective because only the fully halogenated chemicals (CFCs 11, 12, 113, 114 and 115, and Halons 1201 and 1311) are being considered for inclusion. Chemicals such as CFC 22 and methyl chloroform which are only partially halogenated are not being considered as they are believed to be part of the solution and have relatively low ozone depleting potential.

Concern has been raised with regards to reductions in Halons 1201 and 1311 and CFC 113 because of their strategic value to the U.S., and the apparent lack of suitable substitutes. This is a legitimate concern but one that can be handled if controls are on the sum of the ozone depleting potential of all chemicals, rather than on individual substances. This will allow each individual country the flexibility to live within the internationally agreed protocol with the least interference on how a country wants to implement the protocol.

b. When should a freeze on emissions occur?

The Chairman's Text proposes that the freeze take effect within two years of entry into force. There is uncertainty as to when entry into force will occur, but the best estimate is that it will be in the 1988-90 time period. The Working Group consensus is that a freeze on emissions should go into effect within one to two years after entry into force of the protocol.

2. Reductions Beyond a Freeze

a. What chemicals should the reductions cover?

The Chairman's Text proposes that the additional reductions beyond a freeze include CFCs 11, 12, 113, 114 and 115. The Working Group consensus is that any additional reductions should cover CFCs 11 and 12; however, there are questions about the coverage of CFCs 113, 114, 115, and Halons 1201 and 1311. National security concerns argue against including the Halons in any reductions. There is also a national defense and security concern with including CFC 113 in any reductions beyond a freeze, especially given 113's importance for certain high-technology electrical applications. The questions regarding coverage of CFCs 114 and 115 concern their potential use as substitutes for controlled chemicals and their present low usage.

b. How much and when?

The Chairman's Text provides for a 20% reduction to take effect 4 years after entry into force (1992-94) and an additional 30% reduction to take effect either 6 years (1994-96) or 8 years (1996-98) after entry into force.

With respect to any future reductions, the Working Group recognizes the importance of the future assessments of science, technology, economics and environment.

The Working Group identified distinct issues surrounding each potential reduction. With respect to the 20% reduction, some favor it because it can be accomplished with existing industrial processes and because reductions beyond a freeze may be needed to counterbalance less than full participation in a freeze. Yet others note there are uncertainties as to the need for any additional reductions.

Regarding the additional 30% reduction, some favor its inclusion on the basis of judgements about the science and potential adverse health effects. Others emphasize, however, the uncertainties about the need to commit at this time to this additional measure. One or more scientific reviews would be available prior to this reduction going into effect.

The Working Group recommends that the Council discuss and provide guidance on whether the U.S. position is to support:

1. A 20% reduction beyond a freeze.

2. An additional 30% reduction.

3. Additional reductions beyond 50%.

c. Should the reductions be automatic (subject to reversal by a 2/3 vote) or contingent upon a positive vote of a majority of the parties?

The Chairman's Text proposes an initial 20% reduction to take effect automatically (implicitly reversible by a 2/3 vote).

The Text provides two alternative implementing mechanisms for the next 30% reduction -- 6 years after entry into force if the majority of the parties so decide, or 8 years after entry into force unless reversed by a two-third majority of the parties.

There are strong views in the Working Group on the implementing mechanism for the additional 30% percent reduction. Many do not wish to commit to the reduction at this time unless it is contingent upon a positive vote of a majority of the parties. Others, however, believe the evidence warrants committing to this reduction at this time.

Most believe the future assessments of the science, technology, economics and environment are important to these reduction decisions. There are differing views, however, on how such future assessments ought to factor into reduction decisions. Some believe final reduction decisions ought to follow future

assessments, whereas others believe reductions should be scheduled now with an opportunity for reversal based upon future assessments.

The Working Group recommends that the Council provide guidance on whether the U.S. should support automatic reductions of:

a. 20% beyond the freeze.

b. an additional 30%.

C. ISSUES FOR LATER CONSIDERATION

The Working Group identified several related issues that will require further consideration. They include:

1. The relationship between international protocol and domestic regulations. Since the overall objective of the protocol is to avoid or reduce health and environmental risks, compliance with the international protocol will necessarily result in domestic regulation. There is legal precedent for such a linkage between international agreements and subsequent domestic regulations.

2. Non-Regulatory Approaches. There is no reason why the Nation's efforts to achieve the objectives sought in the protocol should be limited to a regulatory approach. The suggestion has been made that if the government imposes such regulatory burdens upon the people and the economy of the U.S., consideration should also be given to policies which may ease the regulatory burdens, including, but not limited to, possibly rendering unnecessary imposition of regulations beyond those necessary to assure U.S. compliance with the international protocol.

Such a domestic, non-regulatory supplement to the international protocol might, for example, contain elements intended to eliminate government barriers to, or facilitate, the development of: substitutes for covered chemicals, technology to mitigate or eliminate the adverse effects of chemical emissions upon stratospheric ozone, or medical advancements in the understanding and treatment of the problems caused by ozone depletion.

[NOTE: This paper attempts to protray the general flavor of the Working Group discussions on this very complex issue. It was not possible to include all of the important comments contributed by representatives of the participating agencies.]

6/9/87

Action	Skin Cancer Deaths	Incremental Skin Cancer Deaths
No Controls	4,946,400	
Protocol Freeze	3,324,100	1,622,300
Freeze + 20%	3,246,400	77,700
Freeze + 50%	3,114,500	131,900

Fractions of 300 current deaths associated with control actions.

Action	Fraction	Number
Protocol Freeze	.886	266 → 265 (rounding)
Freeze +20%	.0424	13
Freeze +50%	.0720	22

Example 1

Value of life = $2,000,000
Value of life grows @ 2%

Profile 1.

$$D = \int_0^{88} e^{gt}\,dt = \frac{1}{g}\left[e^{88g} - 1\right] = 1,622,300$$

g	$\frac{1}{g}\left[e^{88g} - 1\right]$
.15	3,602,426
.13	715,123
.14	1,600,951
.141	1,735,821
.1405	1,667,012
.1402	1,627,053
.1401	1,613,949

g	
.14015	1,620,488
.14016	1,621,798 ⊛
.14017	1,623,110

use this one

$D = 77,700$

g	
.1	66,332
.101	145,395
.105	98,096
.1020	77,548
.10201	78,157
.10202	77,608
.10203	77,670 ⊛
	77,730

use this one

$D = 131,900$

g	
.11	145,395
.108	124,188
.109	134,368
.1085	129,176
.1087	131,228
.1088	132,269
.10875	131,746
.10876	131,850 ⊛
.10877	131,954

use this

Profile 1 $L_0 = 2{,}000{,}000$

$L = L_0 e^{-.02t}$

$$mB = \frac{L}{g + .02 - r}\left[e^{(g+.02-r)\,88} - 1\right]$$

	4%	6%
Freeze	651	134
20%	33	7.5
50%	56	12
F+20	684	142

Profile 2.

$$1{,}622{,}300 = 265 \int_0^{89} e^{gt}\,dt = \frac{1}{g}\left[e^{889} - 1\right]$$

$$\frac{1{,}622{,}300}{265} = 6122$$

g	
.07	6749
.06	3256
.068	5824
.069	6269
.0685	6042
.0687	6132
.0686	6087
.06869	6127
.06864	6123
.06867	6118

Cell 3 the same

Profile 2 $\quad V_0 = 2{,}000{,}000$

$V = V_0 e^{.02t}$

	4%	6%
Freeze	778	212
20%	38	10
50%	65	18
Freeze +20%	816	222

$$MB = \int_0^{88} L N_0 e^{(g+.02-r)t}\, dt = \frac{L N_0}{g+.02-r}\left[e^{(g+.02-r)88} - 1\right]$$

Profile 3 $L_0 = 2{,}070{,}000$

$L_t = L_0 e^{.02t}$

$$MB = \int_{50}^{138} L N_0 e^{g(t-50)} e^{(.02-r)t} dt$$

$$+ \int_{138}^{\infty} L N_0 e^{88g} e^{.02\times 138} e^{-rt} dt$$

$$= \frac{L N_0}{g+.02-r} e^{-50g} \left[e^{138(g+.02-r)} - e^{50(g+.02-r)} \right]$$

$$+ L N_0 e^{88g} e^{.02\times 138} e^{-138r} \cdot \frac{1}{r}$$

	4%	6%
Freeze	639	44
20%	31	2.1
50%	53	3.6
Freeze +10%	670	46

Profile 4

1,622,350/2 = 811,150

g	
.13	715,123
.132	839,821
.131	774,946
.1315	806,726
.1316	813,238
.13155	809,975
.13156	810,627
.13157	811,279

77,700 ÷ 2 = 38850

g	
.09	30,564
.093	38,518
.0931	38,817
.09311	38,847
.09312	38,877

131,900 ÷ 2 = 65,950

g	
.1	66,332
.099	61,357
.0999	65,817
.09991	65,828
.09992	65,930
.09993	65,971

Profile 4 $\quad V_0 = 2{,}000{,}000$

$V = V_0 e^{.02t}$

$$MB = \int_0^{88} L e^{(g+.02-r)t}\,dt + \int_{88}^{\infty} L e^{88g}\, e^{.02\times 88}\, e^{-rt}\,dt$$

$$= \frac{L}{g+.02-r}\left[e^{88(g+.02-r)} - 1\right]$$

$$+ L e^{88g}\, e^{.02\times 88}\, e^{-88r} \cdot \frac{1}{r}$$

	4%	6%
Freeze	1246	174
20%	48	7.6
50%	85	13
Ft20	1294	182

Example 2 :

Profile 1 $L = 2,000,000$, no growth

$$MB = \frac{L}{g - r}\left[e^{(g-r)88} - 1\right]$$

	4%	6%
Freeze	134	29
20%	7.5	1.9
50%	12	3.0
F+20	142	31

Profile 2 $L = 2,000,000$

$$MB = \frac{2N_0}{g-r}\left[e^{(g-r)88} - 1\right]$$

	4%	6%
F	212	70
20	10	3.4
50	18	5.8
Ftw	222	73

Profile 3 : $L = 2{,}000{,}000$, no growth

$$MB = \frac{L N_0 e^{-50g}}{g-r}\left[e^{138(g-r)} - e^{50(g-r)}\right]$$

$$+ L N_0 e^{88g} e^{-138r} \cdot \frac{1}{r}$$

	4%	6%
Freeze	51	4.4
70	2.5	.22
50	4.2	.37
Ftlo	54	4.6

Profile 4: $L = 2{,}000{,}000$, no growth.

$$mB = \frac{L}{g-r}\left[e^{88(g-r)} - 1\right]$$

$$+ L e^{88g} e^{-88r} \cdot \frac{1}{F}$$

	4%	6%
F	227	33
20	9.3	1.7
50	16	2.7
F+20	236	35

Example 1: $L_0 = 2,000,000$

$L = L_0 e^{.02t}$

Profile 1

	4%	6%
F	651	134
20	33	7.5
50	56	12
F+20	684	142

Profile 2

	4%	6%
F	778	212
20	38	10
50	65	18
F+20	816	222

Profile 3

	4%	6%
F	639	44
20	31	2.1
50	53	3.6
F+20	670	46

Profile 4

	4%	6%
F	1246	174
20	48	7.6
50	85	13
F+20	1294	[illegible]

Example 2

$L_o = 2{,}000{,}000$; $L = L_o$

Profile 1	4%	6%
F	134	29
20	7.5	1.9
50	12	3.0
F+20	142	31

Profile 2	4%	6%
F	212	70
20	10	3.4
50	18	5.8
F+20	222	73

Profile 3	4%	6%
F	51	4.4
20	2.5	.22
50	4.2	.37
F+20	54	4.6

Profile 4	4%	6%
F	227	33
20	9.3	1.07
50	16	2.7
F+20	236	35

Example 3: $L_0 = 4{,}000{,}000$
$L = L_0 e^{-.02t}$

Profile 1	4%	6%
F	1302	268
20	66	15
50	112	24
F+20	1368	283

Profile 2	4%	6%
F	1556	424
20	76	20
50	130	36
F+20	1632	444

Profile 3	4%	6%
F	1278	88
20	62	4.2
50	106	7.2
F+20	1340	92

Profile 4	4%	6%
F	2494	348
20	96	15
50	170	26
F+20	2588	3643

Example 4: $L_o = 4{,}000{,}000$; $L = L_o$

Profile 1	4%	6%
F	268	58
20	15	3.8
50	24	6.0
F+20	283	62

Profile 2	4%	6%
F	424	140
20	20	6.8
50	36	12
F+20	444	147

Profile 3	4%	6%
F	102	8.8
20	5.0	.44
50	8.4	.74
F+20	107	9.2

Profile 4	4%	6%
F	454	66
20	19	3.4
50	32	5.4
F+20	473	69

Total Benefit

	4%	6%
F	738.5	131.3
F+20	33.6	6.4
F+50	58.0	11
F+20	772.1	138

	4%	6%
F	739	131
20	34	6.4
50	58	11
F+20	773	137

$L_0 = 4{,}000{,}000$
$L = \int L_0 e^{.02t}$

$L_0 = 4{,}000{,}000$
$L = L_0$

		4%	6%	4%	6%
	Freeze	1302	268	268	58
	20%	66	15	15	3.8
Profile 1	50%	112	12	12	3.0
	F+20	1368	284	284	62
	Freeze	1556	424	424	140
	20%	76	20	20.8	6.8
Profile 2	50%	130	36	36	11.6
	F+20	1632	444	445	147
	Freeze	1278	88	102	8.8
	20%	62	4.2	6	0.44
Profile 3	50%	106	7.2	4.4	0.8
	F+20	1340	92	108	9
	Freeze	2492	348	454	66.6
	20%	96	15.2	18.6	3.4
	50%	170	26	32	5.4
	F+20	2588	363	473	70

$L_0 = 2{,}000{,}000$
$L = L_0 e^{.02t}$

$L_0 = 2{,}000{,}000$
$L = L_0$

		4%	6%	4%	6%
Profile 1	Freeze	651	134	134	29
	20%	33	7.5	7.5	1.9
	50%	56	12	12	3.0
	F+20	684	142	142	31
Profile 2	Freeze	778	212	212	70
	20%	38	10	10.4	3.4
	50%	65	18	18	5.8
	F+20	816	222	222	73.
Profile 3	Freeze	639	44	51	4.4
	20%	31	2.1	3	0.22
	50%	53	3.6	4.2	0.4
	F+20	670	46	54	5
Profile 4	Freeze	1246	174	227	33.3
	20%	48	7.6	9.3	1.7
	50%	85	13	16	2.7
	F+20	1294	182	236	35

	Total Benefits	4%	6%
Freeze	435 (± 568)	738 (± 674)	131 (± 125)
20%	20 (± 24)	34 (± 28)	6.5 (± 6)
50%	34 (± 43)	57 (± 51)	10 (± 9.8)
F+20	455 (± 592)	772 (± 702)	138 (± 131)

Total Discounted Present Value
of Marginal Costs
(billions of dollars)

Step	Discount Rate 4%	6%
(No action) to (Freeze)	$1.6 - $3.3	$1.0 - $1.4
(Freeze) to (Freeze + 20%)	$3.5 - $7.0	$2.2 - $3.0
(Freeze + 20%) to (Freeze + 50%)	$9.2 - $18.7	$5.8 - $8.0
(No action) to (Freeze + 20%)	$5.1 - $10.3	$3.2 - $4.4

	B > C	B ≈ C	B < C
F	32	0	0
20	25	1	6
50%	18	6	8
F+20	32	0	0

In %

	B > C	B ≈ C	B < C
F	100%	0%	0%
20	78%	3%	19%
50	56%	19%	25%
F+20	100%	0%	0%
20%		1	
50		1	

Capital [redacted] discarded are included

Energy costs

[redacted]

1-time costs of R+D + cost of changeover.

Current Research < $1,000,000/yr.

Between 6-10 million/yr. to make a difference. To get improved info.
Delay in start = delay in answer.

Atmospherics

30-40 million for scientists

~ 100 million for satellites.

	Benefits Exceed Costs	Benefits in Range of Costs	Benefits Advocacy.
~~22~~			
Freeze	100%	0	0
20%	60	30	10
30%	30	50	50

Intro on differences.

Research in terms of millions.

Monday 2:00 - Trade Group.

~~* (3)~~

~~Assumptions~~

* Assumptions for Benefits Calculation:
  (1) ~~"Freeze" cases~~ Deaths averted and "Freeze" 5 scenarios for ~~3~~ cuts correspond to 5 deaths averted and ~~cuts~~ for health effects estimates.
  E.g., "Freeze" is "Protocol Freeze," not true global freeze, etc.
  (2) ~~3~~ Present values of Marginal Benefits are ~~averaged~~ averaged over ranges of parameters reported by Working Group Subcommittee on Benefits + Costs, ~~over~~
  — Value of life: initially $2,000,000, $4,000,000
  — Value of life grows at 2% per year; Value of life constant
  — Four different time profiles for deaths averted
  (3) Benefits calculated for premature deaths averted only. Benefits from ~~cuts~~ preventing non-fatal skin cancers, cataracts, and other economic damages would be additive.

~~3~~

** Assumptions for cost calculations:
  (1) Low end of range: marginal costs grow at .625% per year forever.
  (2) High end of range: marginal costs grow at 2.5% per year forever.

SENSITIVITY ANALYSIS: Comparisons of Benefits and Costs under Different Assumptions.

Step	Percent of cases in which Benefits Exceed Costs	Percent of Cases in which Benefits Approximately Equal Costs	Percent of Cases in which Benefits are Less than Costs
	100%	0%	0%
vo action) to (Freeze)			
reeze) to (Freeze + 20%)	78%	3%	19%
Freeze + 20%) to (Freeze + 50%)	56%	19%	25%
(No Action) to (Freeze + 20%)	100%	0%	0%

Assumptions; same as previous table.

COMPARISON OF [redacted] BENEFITS and COSTS

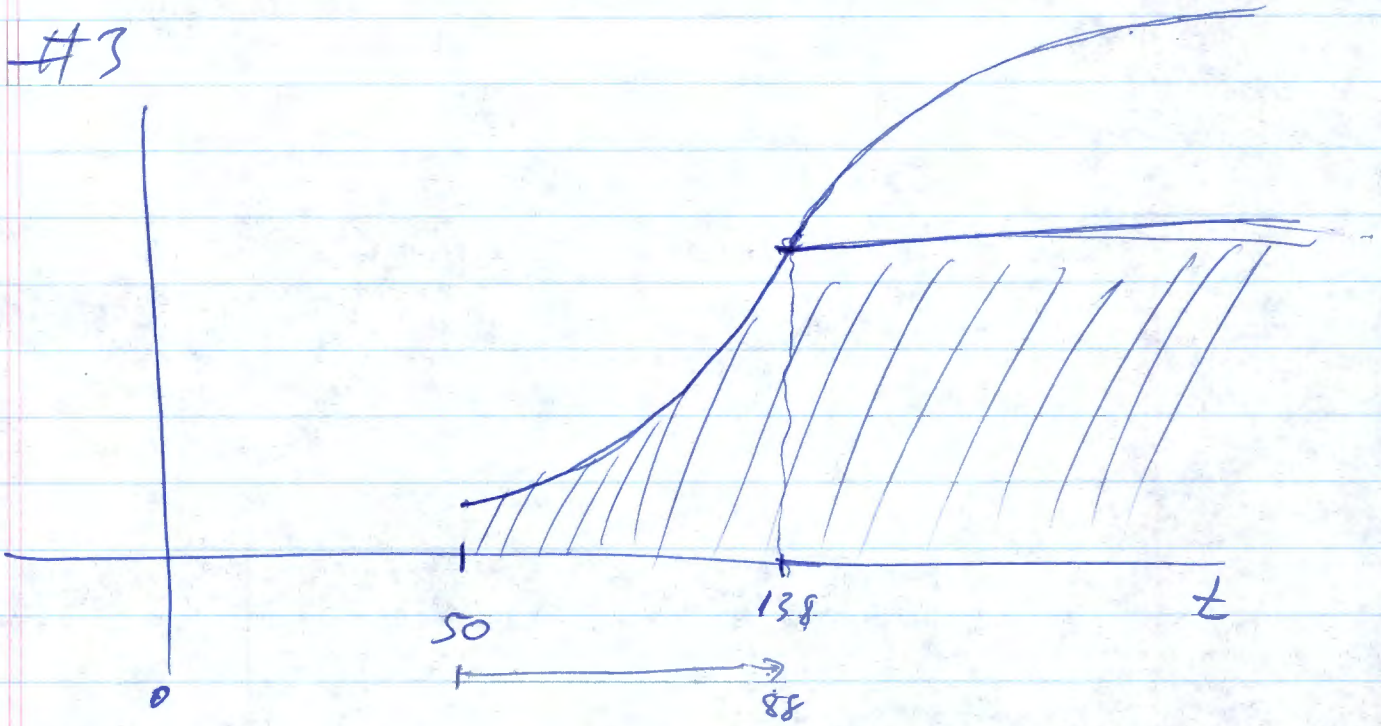
MARGINAL BENEFITS* (billions of dollars)

Step	Discount Rate 4%	6%
(No actin) to (Freeze)	$739	$131
(Freeze) to (Freeze +20%)	34	6.4
(Freeze +20%) to (Freeze + 50%)	58	11
(No actin) to (Freeze +20%)	773	137

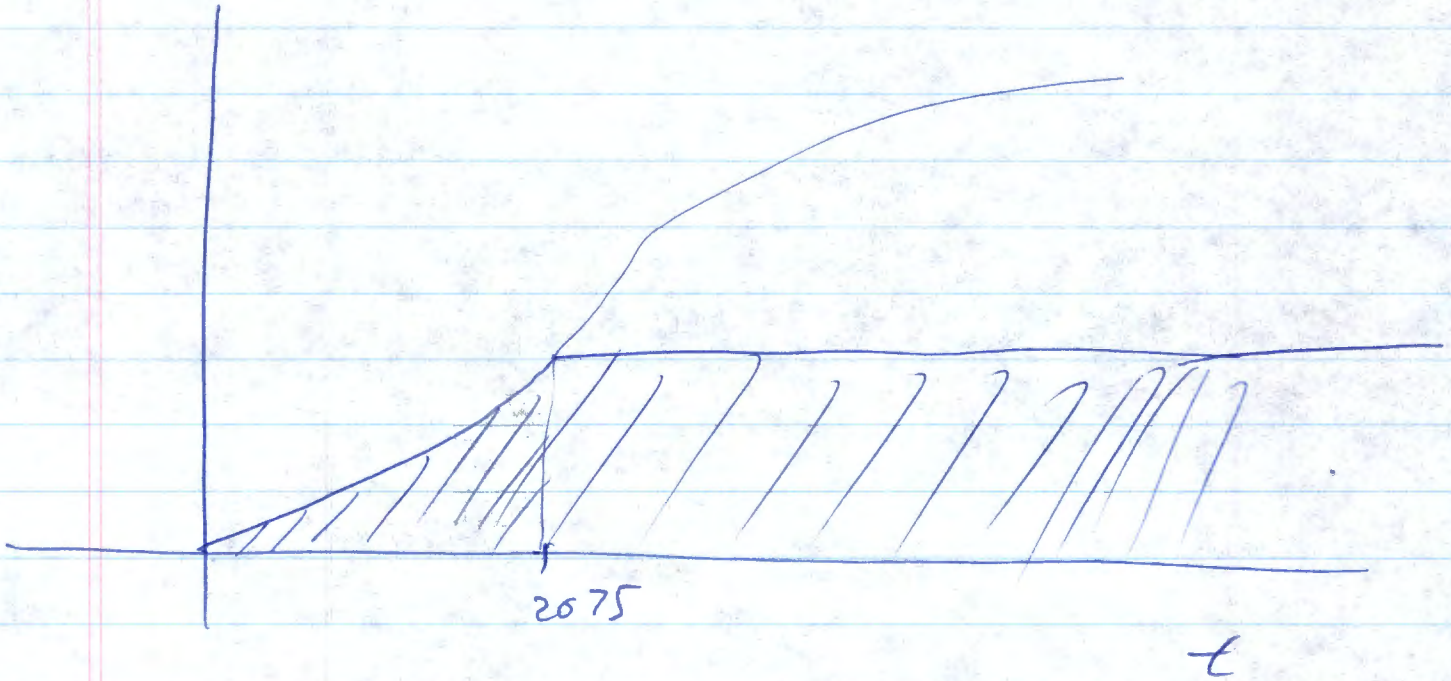
MARGINAL COSTS** (billions of dollars)

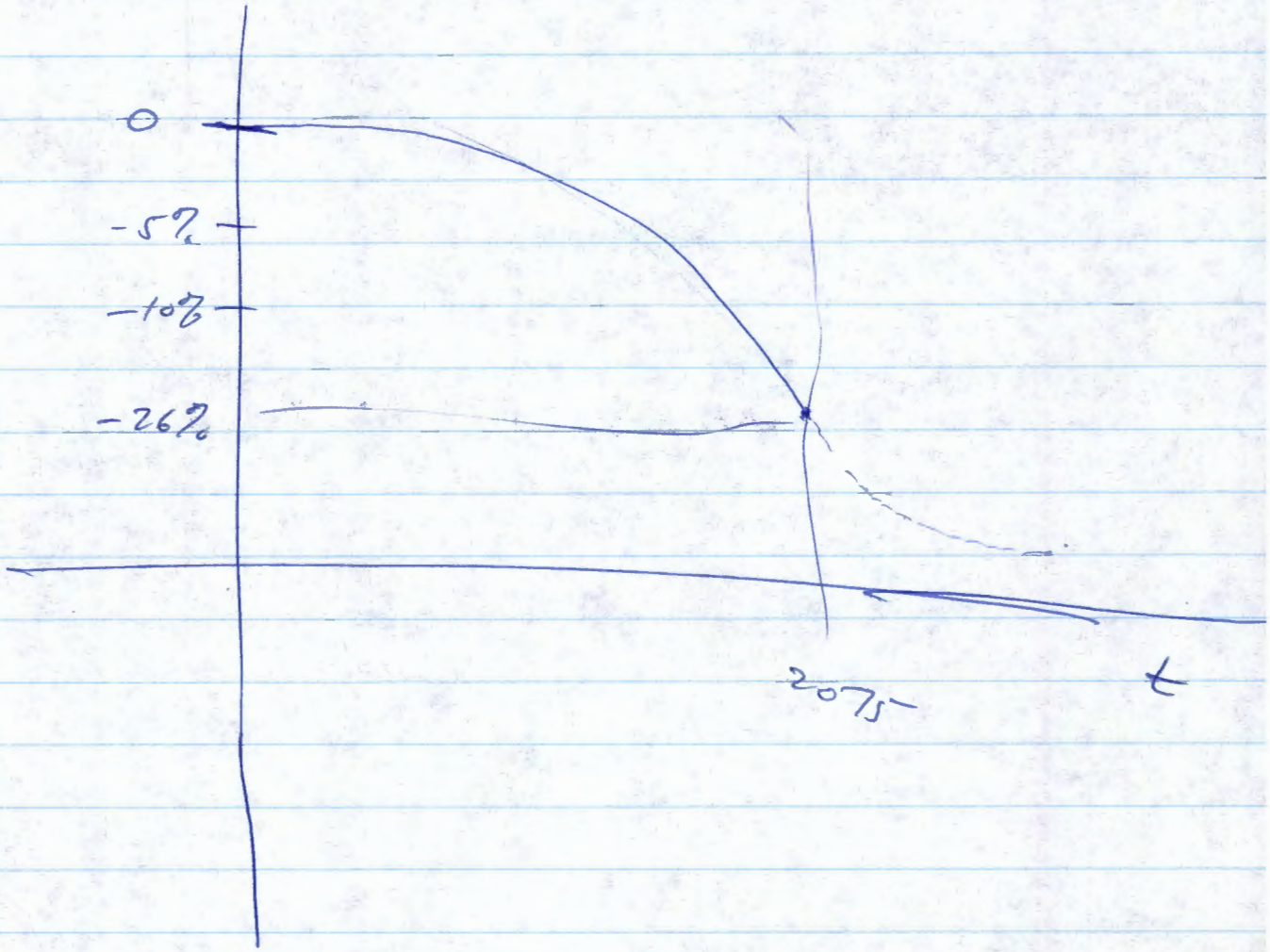
Step	Discount Rate 4%	6%
(No actin) to (Freeze)	$1.6 - $3.3	$1.0 - $1.4
(Freeze) to (Freeze +20%)	3.5 - 7.0	2.2 - 3.0
(Freeze +20%) to (Freeze +50%)	9.2 - 18.7	5.8 - 8.0
(No actin) to (Freeze +20%)	5.1 - 10.3	3.2 - 4.4

#3



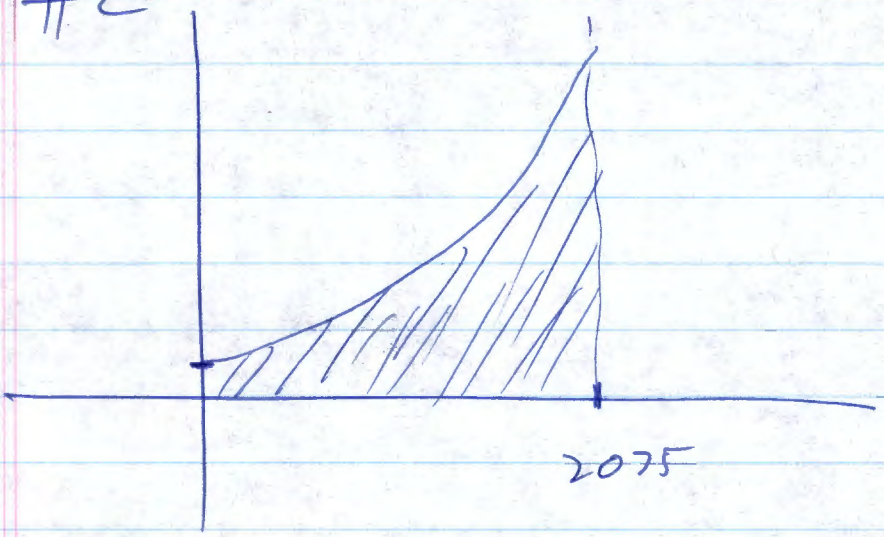
#4




0
-5%
-10%
-26%
2075
t

#1

#2



Estimates of Skin Cancer Incidence and Mortality Under Five Scenarios

	Incidence		Mortality	
	Non-Melanoma	Melanoma	Non-Melanoma	Melanoma
No Ozone Depletion:	160,748,100	4,252,000	1,770,500	1,207,000 = 2,977,000
No Controls:				
Total	255,617,000	4,787,300	3,515,300	1,337,400 = 4,852,000
Additional	94,868,900	535,300	1,744,800	130,400
				Δ1,536,000
Freeze:				
Total	179,297,600	4,399,200	2,073,500	1,242,500 = 3,326,000
Additional	18,549,500	147,200	303,000	35,500
				Δ 84,000
20% Reduction:				
Total	175,345,200	4,370,300	2,007,000	1,235,600 = 3,242,000
Additional	14,597,100	118,300	236,500	28,600
				Δ 126,000
50% Reduction:				
Total	168,517,300	4,317,900	1,894,300	1,222,800 = 3,116,000
Additiona	17,769,200	65,900	123,800	15,800

Assumptions:

- People alive today and born through 2075.
- DNA-damage action spectrum.
- U.S. population projection from: U.S. Census Population Projections 1985-2080.
- Baseline incidence and mortality rates held constant at current rates (i.e., no change in exposure-related activities, medical advances, or other factors).
- Based on parameterization of 1-D model that reports least ozone depletion of UNEP-analyzed models.
- Depletion held constant after 2100 even though the model indicates that declines may continue after 2100.

Note: The majority of additional skin cancer incidence and mortality occurs in future generations.

For all scenarios:

- Baseline CFC growth averages 2.5% through 2050. Production is held constant after 2050.

- Other trace gases:

  - methane grows 0.017 ppb annually;

  - nitrous oxide grows at 0.2% annually;

  - carbon dioxide grows at amounts specified in the NAS 50th percentile.

- Depletion held constant after 2100 even though the model indicates that declines may continue after 2100.

Specific Scenario Assumptions:

- No Controls - No variation from baseline assumptions.

- Freeze

  -- Coverage: CFC-11, -12, -113

  -- Developed World: freeze at 1986 levels starting in 1990.

  Compliance: 100% in the U.S., 80% in the rest of the developed nations. Growth of non-compliers is 1/4 of their baseline growth.

  -- Developing World: freeze at 2000 levels starting in 2000.

  Compliance: 10%; growth in non-compliers is 7/8 of their baseline growth.

- 20% reduction

  -- Coverage: CFC-11, -12, -113

  -- Developed World: freeze at 2000 levels starting in 1990; 20% reduction from 1986 levels by 1992.

  Compliance: 100% in the U.S., 80% in the rest of the developed nations. Growth of non-compliers is 1/4 of their baseline growth.

  -- Developing World: freeze at 2000 levels starting in 2000; 20% reduction from 2000 levels by 2002.

  Compliance: 20%; growth in non-compliers is 3/4 of their baseline growth.

- 50% reduction

  -- Coverage: CFC-11, -12, -113

  -- Developed World: freeze at 1986 levels starting in 1990; 20% reduction from 1986 levels by 1992; 50% reduction from 1986 levels by 1998.

     Compliance: 100% in the U.S., 80% in the rest of the developed nations. Growth of non-compliers is 1/4 of their baseline growth.

  -- Developing World: freeze at 2000 levels starting in 2000; 20% reduction from 2000 levels by 2002; 50% reduction from 2000 levels by 2008.

     Compliance: 50%; growth in non-compliers is 1/4 of their baseline growth.