POSSIBLE IMPACTS OF UV-B SUPPRESSION OF IMMUNE SYSTEM

* Herpes simplex (demonstrated in humans)
  source: Spruance (1985)

* Leishmaniasis (animal model)
  source: Giannini (1986)

* Skin cancers

* Other infectious diseases (?)

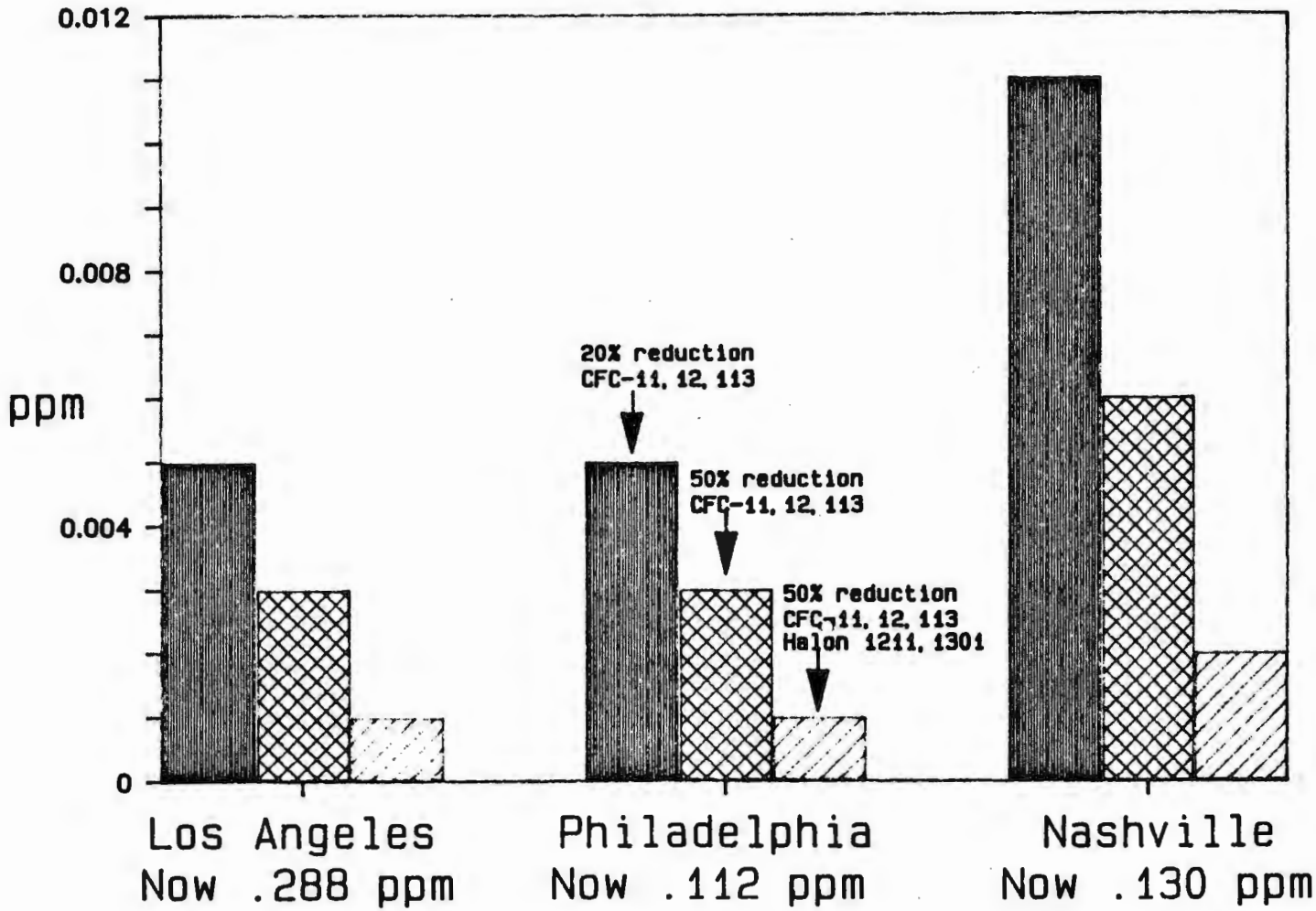
* Other cancers (?)

Surface Ozone is not CFC issue → ① methane ② NOx & hydrocarbons ③ UVB penetration into cities

Increase in Ground-Based Ozone

(research in early stages)

UVB ↑ ⇒ ambient ozone. i.e. Alert in OC where ozone got level went above NAAQS.



Based on analysis of Whitten (1986), in UNEP Vol. 2

CROPS

* Most studies in greenhouse

* 2/3 of tested cultivars vulnerable

* Very few field studies (soybeans)

* Data from greenhouse cannot always reliably be extrapolated

* More data will take a long time

FIELD STUDY OF SOYBEANS:

SUMMARY OF UV-B EFFECTS ON YIELD AND QUALITY OF SENSITIVE CULTIVARS

FOR 20% OZONE REDUCTION

YEAR	Change in yield from control (%)	Change in seed quality from control (%)	
		Proteins	Oils
1981	-25	no data collected	
1982	-23	-5	-2
1983	+6	-4	+1
1984	-7	0	-2
1985	-20	0	0

Drought years: extremely low yields

Source: Teramura, (1986), "Overview of our current state of knowledge of UV effects on Plants", in UNEP, Vol. 1.

1/3 of cultivars are not sensitive to UV-B

AQUATICS (based on laboratory studies)

* Plant community composition change
  Source: Worrest et al., 1981, and EPA Risk Assessment

* Zooplankton

  -- shorter breeding season due to sensitivity
  -- loss of breeding season
  Source: Damkear et al., 1980, and EPA Risk Assessment

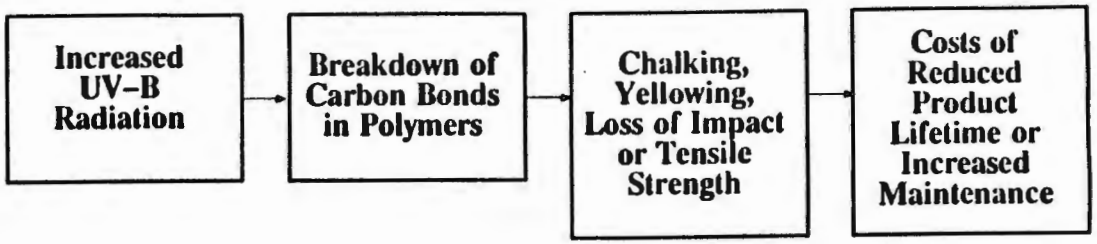
* Higher fish

  -- direct damage to larval stage
  -- indirect damage through food chain
  Sources: see EPA Risk Assessment

* Effects possibly large, but quantitatively uncertain

  -- detailed studies lacking
  -- species in extreme latitudes possibly most sensitive

UV-B AND ACCELERATED WEATHERING OF POLYMERS



Case Study: **PVCs Used Outdoors in Siding and Window Frames**

Assumes: **Use of Stabilizers to Offset losses**
Ozone Depletion Based on Mid-Range Cases

Costs: **Cumulative Costs* of $4.7 Billion in U.S. (1984-2075)**

*Undiscounted

Based on projected ozone depletion for "reference case": 2.5% per year growth in CFC-11 and CFC-12 emissions; 1% per year increase in methane concentrations; historical increases in other trace gases. 26% depletion by 2075.

Source: Andrady and Horst, 1986.

Other polymers that will be influenced

Polymer	Application	Damage
PVC	(a) siding, window frames	[yellowing] + chalking - impact properties - tensile properties + surface distortion
	(b) roofing materials	[+ brittleness] [+ discoloration]
UPE	outdoor surfaces paneling	[+ surface erosion] + discoloration - strength
PE/PP	irrigation pipe, outdoor furniture synthetic turf, stadium seats, packaging	[+ brittleness] - tensile properties - electrical properties
PC	glazing material	[+ yellowing] - transparency

+ = increase
- = decrease
[] = Brackets indicate critical mode of damage (CMD)

GREENHOUSE EFFECT ENHANCED EXECPT AT HIGH LEVELS OF DEPLETION

* Ozone column redistribution

  -- greenhouse effect enhanced
  -- circulation changes possible

* CFCs are a greenhouse gas

* Decreasing CFCs from 20% to 50% averts
  0.15 to 0.45 degrees C (0.27 to 0.81 degrees F)
  of global temperature rise

HOW LONG TO BETTER INFORMATION (*)

Current R&D Low

EPA Budget <1,000,000

Compared to atmospheric research of more than 30,000,000 NASA, NOAA, not including satellites (>60,000,000)

Field Experiments

Expensive

5 years to data each crop

Natural aquatic studies

Health

Critical needs

Infectious diseases

Individual exposure

Epidemiological studies

Air Pollution

Kinetics

Empirical

If Resources Start Expanding Significantly in 1989 (By an order of magnitude)

SIGNIFICANTLY BETTER INFORMATION BY 2000

Improvements by 1996 (primarily on air pollution, estimation, dose-response, a few crops)

(*) OSTP asked for inclusion

ECONOMIC IMPLICATIONS OF POTENTIAL CHLOROFLUOROCARBON RESTRICTIONS

Prepared for
Alliance for Responsible CFC Policy

Prepared by
Putnam, Hayes & Bartlett, Inc.

13 May 1987

ORGANIZATION OF REPORT

I. EXECUTIVE SUMMARY

THIS REPORT ADDRESSES THE ECONOMIC IMPLICATIONS OF POTENTIAL RESTRICTIONS ON U.S. CHLOROFLUOROCARBON (CFC) PRODUCTION.

- PHB was retained on March 30 by the CFC Alliance to evaluate the economic and policy implications of possible CFC restrictions. Estimation of economic consequences requires extensive information, not all of which was available at the time of PHB's assessment. Consequently, the estimates herein should be regarded as preliminary and order-of-magnitude only.

  - Over the last 10 years, EPA has developed a substantial amount of information on CFC use, substitutes, and control technologies. Much of EPA's recent information supporting its "Preliminary Analysis of Costs and Benefits of Stratospheric Ozone Protection" was not available at the time of PHB's assessment.

  - The CFC Alliance and PHB intend to conduct further research on the availability and timing of substitutes to improve estimates of the economic consequences of possible CFC restrictions.

A SOUND REGULATORY POLICY SHOULD ENCOURAGE INDUSTRY TO MOVE TOWARD CFC SUBSTITUTES IN AN ORDERLY MANNER.

- CFC restrictions could induce positive change by stimulating the introduction of substitutes, or they could be disruptive by reducing CFC use faster than consumers' and industry's ability to adapt. Whether the balance is tipped in the positive or negative direction depends on the stringency and timing of regulatory intervention.

- Economists have long known that the price sensitivity of demand and supply for any product is greater in the long run than in the short run because there are more opportunities to adapt in the long run.

  - Hence, a sound regulatory strategy should reflect this economic reality by only speeding up regulation to the point where regulatory intervention brings industry quickly to long-run conditions.

A RAPID 95 PERCENT PRODUCTION ROLLBACK, AS REQUIRED BY SENATE LEGISLATION, IS INFEASIBLE AND WOULD CREATE EXTENSIVE DISRUPTION AMONG CONSUMERS AND INDUSTRY.

- A lack of available substitutes hinders consumers' and industry's ability to adapt to a rapid phasedown schedule. Hence, such a schedule is excessively costly to society.

- The phasedown schedule is infeasible because the allowable amount of CFC production falls far short of the service needs of installed equipment, thus rendering billions of dollars of such equipment useless.

  - Currently 37 percent of CFC 11 and 12 production is used to service installed equipment. Almost 80 percent of CFC 11 and 12 refrigerant applications are used to service installed equipment.

  - Service requirements of installed equipment will exceed 10 percent of 1986 CFC 11, 12, and 113 production for a considerable period, possibly extending beyond 2000.

- Additionally, the "essential" aerosol uses, which were exempted from previous CFC restrictions, currently equal 3.3 percent of total CFC production. Hence, it is possible that very few CFCs would be available for other uses under a 95 percent rollback.

A RAPID 95 PERCENT PRODUCTION ROLLBACK, AS REQUIRED BY SENATE LEGISLATION, IS INFEASIBLE AND WOULD CREATE EXTENSIVE DISRUPTION AMONG CONSUMERS AND INDUSTRY (continued).

- If society were forced to comply with a rapid phasedown schedule, then capital stocks would become prematurely obsolete for many consumers and CFC-user firms.

  - For example, approximately 18 million auto air conditioners (one-fifth of the current inventory) valued at $6 billion could be rendered useless in 1993 if CFCs could not be obtained.

- As a consequence of the rapid phasedown schedule, millions of consumers might be unable to use existing products or purchase new products such as refrigerators or freezers.

- As a result of the massive consumer dissatisfaction with the unavailability of everyday products containing CFCs, a repeal of CFC restrictions would probably be demanded. The societal consensus for CFC restrictions would dissipate when confronted with substantial consumer dissatisfaction and economic consequences.

CFC RESTRICTIONS WILL AFFECT INTERNATIONAL TRADE AND U.S. COMPETITIVENESS.

- The trade restrictions in the Senate legislation address the import of CFC-containing or manufactured products. They do not address other, less obvious potential trade consequences.

- Foreign imports may increase as a result of CFC restrictions.

  - In the appliance industry, foreign producers have been unsuccessful in making inroads in the U.S. market. Domestic producers have well developed distribution channels, customers, production capabilities, and so forth (i.e., U.S. producers have a distinct advantage over foreign suppliers). CFC restrictions might cause changes in appliance design and manufacture which might allow foreign producers to capture more of the U.S. market.

- Exports will suffer as product quality declines and prices rise. Unilateral restrictions will accelerate the loss of exports.

  - In the electronics industry, where "critical cleaning" is crucial to some applications, those products cleansed with CFC-113 substitutes may have lower performance levels.
  - If air conditioning equipment, which currently accounts for more than $1 billion in exports, becomes less energy efficient using CFC substitutes, then demand for those products is likely to fall.

CFC RESTRICTIONS WILL ENCOURAGE GREATER USE OF HAZARDOUS AGENTS, THEREBY REVERSING THE TREND TO USE CFCs AS SUBSTITUTES FOR SUCH SUBSTANCES.

- The low toxicity of CFCs is an important reason for its growth in solvent and foam applications.

- Methyl chloroform is a possible major substitute for CFC-113 in electronic solvent uses. The OSHA workplace exposure standard for methyl chloroform is approximately three times as stringent as CFC-113, indicating greater health concern for methyl chloroform.

- Methylene chloride, another possible solvent substitute, is, according to EPA, a possible carcinogen and is being replaced by CFC-113 in some applications because of health and environmental concerns.

- Major foam blowing substitutes include methylene chloride and hydrocarbons, which are highly flammable. Most polystyrene foamers use CFCs 11 and 12 because of flammability concerns.

A PRODUCTION FREEZE AT 1986 LEVELS WILL HAVE SIGNIFICANT CONSEQUENCES FOR CONSUMERS AND INDUSTRY.

- In absence of regulation, U.S. use of CFC 11, 12, and 113 would grow by approximately 55 percent by 2000. Hence, a production freeze would cause shortages that would increase CFC prices.

- Near-term substitutes for most CFC applications are not available, which increases the pressure for higher prices since consumers cannot switch to alternatives.

- Based on our preliminary analysis of likely industry responses to a freeze, CFC prices will rise immediately, more than doubling in price in 1988.

  - As near-term substitutes are put in place, the pressure for price rises will moderate.

- CFC prices in the mid-1990s will be three to four times higher than current levels, but will moderate in the late 1990s.

  - These price increases assume new CFC substitutes will be available in the mid- to late 1990s. If such substitutes are not available, prices could rise higher.

THE PRODUCTION FREEZE WILL SPUR SUBSTITUTION AND CONSERVATION.

- The production freeze-induced price increase will be a powerful incentive to develop new CFC substitutes.

- As a result of higher prices, new substitutes would be developed and new CFC capture and recycle technologies would be applied by industry.

- If CFC prices rise to the level we predict, then the new CFC substitutes would become much more competitive.

  - Based on our preliminary analysis, market forces, even without phasedown restrictions, would stimulate the development of substitutes.

- Higher prices would also reduce CFCs in low value applications. For example, egg carton foam containers might be replaced by cardboard containers.

A KEY POLICY QUESTION: WILL THE FREEZE MAKE NEW CFCs COMPETITIVE WITH EXISTING CFCs SO MANDATORY RESTRICTIONS, IF NEEDED, COULD BE AVOIDED?

- The answer depends on:
  - The level of the freeze-induced price increase and the price of new CFC substitutes.

- The level of a freeze-induced price increase will be determined by:
  - The timing of specific freeze restrictions.
  - The demand for CFCs, the availability of substitutes, control technology, and conservation measures.
  - The degree to which price increases will induce industry and consumers to conserve CFCs and switch to non-CFC substitutes.

- These issues can be resolved through empirical analysis of CFC markets and the price sensitivity of CFC demand and supply. Further research is needed in this area.

A PRODUCTION FREEZE WILL HAVE SIGNIFICANT CONSEQUENCES FOR CONSUMERS AND INDUSTRY.

- Our analysis of a weighted production freeze* indicates that it would:

  - Cost the economy approximately $1 billion during the period 1988-2000. Annual costs would exceed $180 million in the mid-1990s.

  - Cause substantial wealth transfers away from consumers and user industries, since the freeze-induced shortage would increase prices. Total wealth transfer may be eight times greater than the cost of the freeze -- approximately $8 billion.

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* A weighted production freeze would allow reduction in one CFC to be credited against the need for reduction in other CFCs. The cost of an unweighted freeze would be higher than the cost of a weighted freeze.

II. INTRODUCTION

CFC PRODUCTS ARE PREVALENT IN THE U.S. ECONOMY.

- Chlorofluorocarbons comprise a group of compounds which have a very wide range of uses and can be found in virtually every home and office in the country. A few of the more important uses are:

CFC Type	Major Uses
CFC-11	Home and industrial insulation, auto seat cushions, furniture cushioning, office building air conditioning.
CFC-12	Home and industrial refrigeration, insulation, office building air conditioning, packaging foams, food freezing in transportation.
CFC-113	High performance solvent used in precision instruments and electronic component manufacture.

- CFC producer and user industries employ 1.7 million people and produce products valued at approximately $250 billion.

CFC PRODUCTS ARE PREVALENT IN THE U.S. ECONOMY (continued).

- CFC products are used in:
  - 100 million home refrigerators.
  - 91 million auto air conditioners.*
  - Commercial chillers and freezers found in approximately 500,000 food stores, supermarkets, and restaurants.

- CFCs are also used in home insulation, bedding, extruded polystryene foam cups (i.e., styrofoam cups), carpet cushioning, food packaging, food freezing in transportation, solvents for metal and plastic cleaning, and many other common products.

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* This figure includes only those vehicles with factory installed air conditioning.

THE POSSIBLE EFFECTS OF CFCs ON STRATOSPHERIC OZONE IS A LEGITIMATE CONCERN AND HAS PROMPTED GOVERNMENTAL ACTION.

- For over 10 years, scientists have expressed concern that CFCs, when released into the earth's atmosphere, could lead to a depletion of the ozone layer, which in turn could lead to adverse environmental effects. However, to date there is no reliable evidence that the total amount of ozone has decreased.

- Due to the concern regarding possible future ozone depletion, the U.S. Congress and the U.S. Environmental Protection Agency have sought to restrict CFC use.

  - The first set of restrictions, issued in 1978, eliminated most uses of CFCs as aerosol propellants except in essential applications (like medical uses).

  - The U.S. Congress is now contemplating restrictions on CFCs used in a wide spectrum of other applications.

IN ITS ASSESSMENT OF THE ECONOMIC CONSEQUENCES OF POSSIBLE CFC RESTRICTIONS, PHB HAS CONSIDERED THE FOLLOWING GENERAL PRINCIPLES.

- When the supply of a product is restricted, the price will rise as consumers with high value applications outbid consumers with lower value applications.

- As the price increases, four basic economic results take place.

    1. Increased prices are passed on through various phases of product use to the ultimate consumer.

    2. Substitutes, direct and indirect, become economically more attractive.

    3. Wealth is transferred between businesses and individuals as higher prices cause some businesses to fail and others to become newly viable.

        - This includes transfers not only between domestic organizations, but also between domestic organizations and foreign competitors.

    4. Capital stocks (i.e., equipment) become uneconomic and must be discarded. Owners of capital stocks include firms and individuals at each stage of CFC production and use.

IN ITS ASSESSMENT OF THE ECONOMIC CONSEQUENCES OF POSSIBLE CFC RESTRICTIONS, PHB HAS CONSIDERED THE FOLLOWING GENERAL PRINCIPLES (continued).

- More severe restrictions would lead to greater price increases and more extreme effects, and vice versa.

  - Effects become greatly exaggerated when acceptable substitutes are not available. Since substitutes take time for development and commercial deployment, CFC restrictions would have the greatest adverse effects in the short term.

THE FOLLOWING CHARACTERISTICS OF CFCs ARE ESPECIALLY RELEVANT TO THE ASSESSMENT OF ECONOMIC IMPACT.

- CFCs are a family of different products which have widespread applications in hundreds of different uses. Consequently, restrictions on CFCs will have widespread economic effects.

- Unlike aerosol propellants, for which substitutes for CFCs were often available, the CFCs now in use have unique properties which are often indispensable for the applications in which they are used. Furthermore, for many applications, near-term substitutes are not available. Consequently, restrictions on CFCs will be, comparatively, much more disruptive and expensive for current end users than were the earlier restrictions for aerosol users.

- While U.S. production has declined by over 13 percent since 1976 in response to aerosol restrictions, efforts to restrict CFC use outside the U.S. have heretofore been unsuccessful. Consequently, the potential impacts on the competitive position of U.S. CFC-user industries (in international markets) is extremely sensitive to the nature and extent of domestic CFC restrictions.

WHILE THIS ASSESSMENT DEALS PRIMARILY WITH ECONOMICS, POLICY MAKERS NEED TO BE CONCERNED ABOUT CHANGES IN CONSUMER BEHAVIOR AS A RESULT OF CFC RESTRICTIONS.

- CFC restrictions will lead to increases in energy consumption.

  - Insulation of homes, buildings, and appliances will become less cost-effective since substitutes are not as efficient, causing energy consumption to rise.

- Rapid implementation of a substantial CFC production phasedown could prevent millions of consumers from servicing existing equipment such as food service refrigerators, chillers, automobile air conditioners, and so forth.

- CFC restrictions will lead to significant increases in hazardous materials use. Such restrictions will reverse the trend to use CFCs as substitutes for hazardous agents.

III. METHODOLOGY

IN GENERAL, THE METHODOLOGY FOR ASSESSING ECONOMIC IMPACT IS CONFIGURED AS FOLLOWS:

- CFC growth to the year 2000 is estimated for the major use categories of CFCs 11, 12, and 113 by relying on published data and industry sources.

- Price elasticities are developed so that prices can be estimated for each level of demand. Elasticities were developed through discussion with industry and taking into account our knowledge of specific control technologies and substitutes in an aggregate manner.

- The cost of new CFC substitutes is assumed to place a "cap" on existing CFC prices, to the extent that such substitutes become available.

- Impacts of higher prices on consuming industries are then estimated, in terms of indirect substitutes and/or decreased consumption.

- The major effects -- higher prices, wealth transfers, capital obsolescence -- are then identified and calculated where possible.

AGGREGATE ESTIMATES WERE DEVELOPED SEPARATELY FOR EACH CFC END USE.

- CFCs are a family of products with different characteristics and different end uses.

- The economics of end-use markets are different.

- PHB was able to examine only the major CFC uses. Further research is needed to better forecast industry response to regulatory intervention.

ESTIMATES WERE DEVELOPED FOR ALTERNATIVE REGULATORY SCENARIOS REQUIRED IN SENATE LEGISLATION.

- PHB considered a freeze at current (1986) production levels to be implemented in 1988, and a 95 percent reduction in CFC production by 1993.

- PHB considered restrictions based on weighted production (according to ozone depletion potential) and on unweighted production (irrespective of ozone depletion potential).

- The available data were sufficient for us to develop quantitative estimates for the production freeze. Further research is needed to develop similar estimates for phasedown scenarios. However, our analysis of the 1993 phasedown level indicates:

  - The infeasibility of meeting the phasedown schedule due to, among other things, the need to service existing equipment.

  - A high degree of consumer dissatisfaction could result due to the millions of consumers unable to purchase various products because of the unavailability of substitutes.

IV A. PRODUCTION FREEZE FINDINGS

A PRODUCTION FREEZE IN 1988 WILL HAVE A SIGNIFICANT EFFECT ON INDUSTRY BEHAVIOR AND THE SEARCH FOR SUBSTITUTES.

- In the absence of regulation, U.S. use of CFC 11, 12, and 113 would grow by approximately 55 percent by 2000, from 660 million pounds in 1987 to 1,020 million pounds in 2000. Hence, prices for CFCs will increase if a production freeze is implemented.

- Near-term responses to a production freeze are likely to be:

  - Containment of CFC use by conservation and recycle through control technologies and better work practice.

  - Limited substitution of alternative blowing agents, solvents, and CFC-22 in some refrigeration applications.

- Near-term substitutes for most CFC applications are not available, which increases the pressure for higher prices since consumers cannot switch to alternatives.

A PRODUCTION FREEZE WILL HAVE A SIGNIFICANT EFFECT ON INDUSTRY BEHAVIOR AND THE SEARCH FOR SUBSTITUTES (continued).

- As a result of higher prices, new substitutes will be developed and new CFC capture and recycle technologies will be applied by industry.

- Also, significant costs and wealth transfers will be incurred by consumers and CFC-user industries.

A PRODUCTION FREEZE WILL SUBSTANTIALLY INCREASE CFC PRICES.

- The increasing demand for CFCs and the lack of near-term substitutes will cause shortages in the supply of CFCs.

- Prices will rise as consumers in high value applications outbid consumers in low value applications.

- Based on our preliminary analysis, we believe prices may rise immediately, by a factor of two or more in 1988, since most near-term substitutes could not be available for full-scale commercial application in six or seven months. Exhibit 1 shows PHB's preliminary analysis of how prices are likely to increase.

- Prices might not rise as much as we expect for two reasons.

  - If more near-term substitutes are available than we expect.

  - If CFC producers choose to limit price increases and allocate the supply of CFCs, thereby causing shortages. (The predicted price increases are sufficient to clear the market and eliminate shortages.)

- Further research is needed to characterize the extent of price increases.

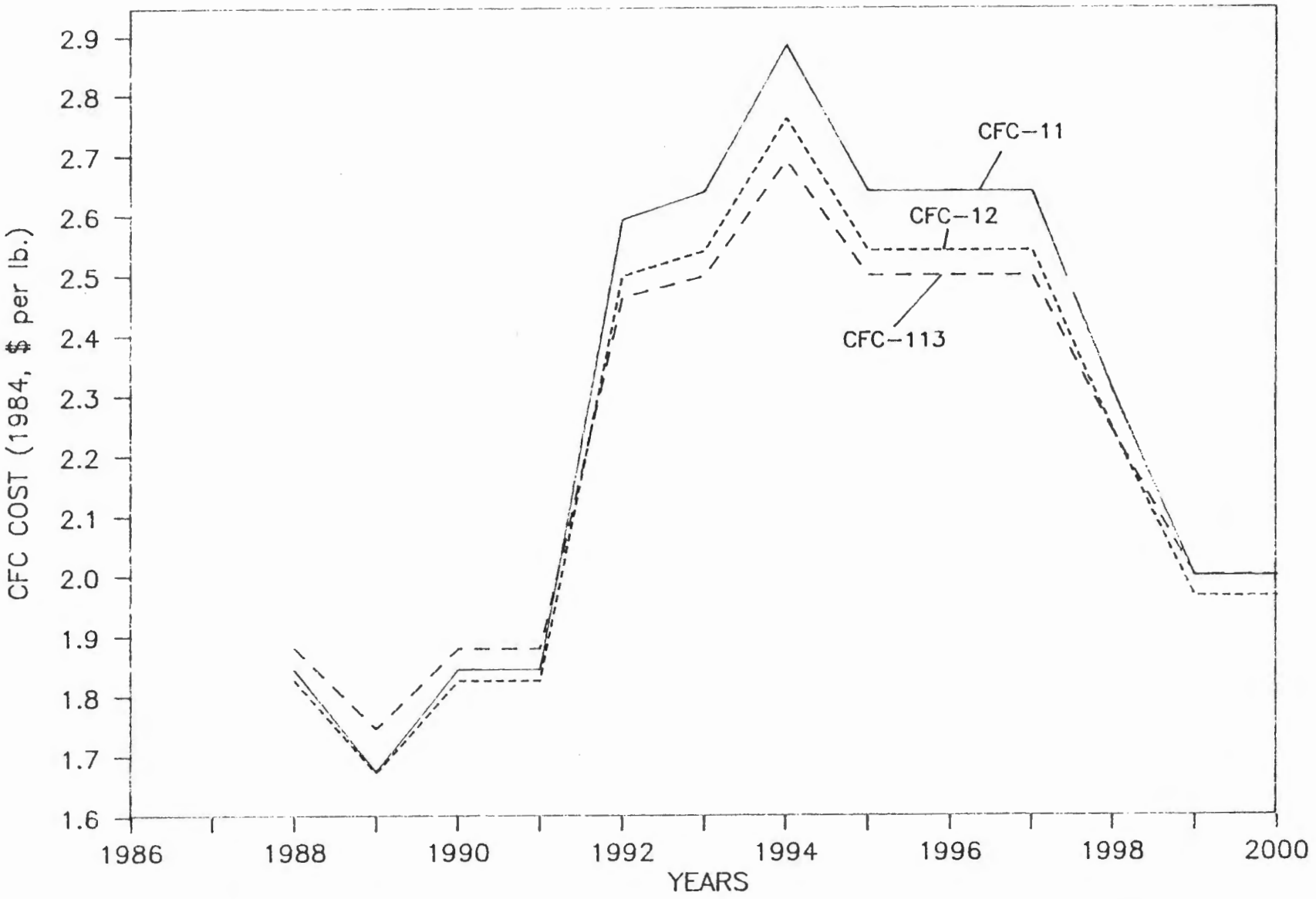
A PRODUCTION FREEZE WILL SUBSTANTIALLY INCREASE CFC PRICES (continued).

- As Exhibit 1 indicates, after the near-term substitutes are put in place, the pressure for price rises will moderate. If substitutes or control technologies can be introduced rapidly, then price increases would be less severe. However, prices would continue to rise if CFC demand grows faster than industry's ability to introduce commercial substitutes for CFCs. In the longer term, prices begin to moderate again as new substitutes are introduced. Finally, prices level off at the price of new CFC substitutes.

  - Based on our preliminary analysis, real prices for CFCs might be three to four times greater than current prices by 1995, and by 2000, real prices would moderate to two to three and one-half times greater.

EXHIBIT 1

CFC PRICE INCREASES UNDER FREEZE
1986 to 1997



SOURCE: Putnam, Hayes & Bartlett, Inc., 17 April 1987.

CFC PRICE RISE IS CONSISTENT WITH ENERGY PRICE RISES DURING SHORTAGES.

- The CFC price rises that we forecast have historical precedents in similar situations.

- During the period from first quarter 1979 to fourth quarter 1980, world crude oil production declined 6.25 percent, while prices more than doubled -- spot price of Arab light crude oil rose from $18.35/BBL to $38.63/BBL. This infers that, in the short run, world demand for oil is relatively insensitive to changes in price.

- A CFC production freeze would reduce CFC supplies and increase CFC prices in a manner approximately duplicating the oil crisis of 1979/1980. This is because U.S. CFC user industries and consumers are relatively insensitive to changes in price.

  - A production freeze at 1986 levels would reduce 1988 production by about seven percent from the levels that would have been expected in the absence of a freeze. We anticipate that 1988 CFC prices would rise to more than two times current prices

THE PRODUCTION FREEZE WILL SPUR SUBSTITUTION.

- The production freeze-induced price increase will be a powerful incentive to develop new CFC substitutes.

  - In the late 1970s, CFC users were unwilling to pay costs projected to be two to five times the current CFC price to purchase substitute CFCs. Hence, research into CFC substitutes was halted because of these discouraging economic signals.

  - In contrast, a production freeze may increase prices up to four times current levels, thus dramatically changing the long-term business prospects for CFC substitutes.

- Exhibit 2 compares the possible price rise of CFCs 11, 12, and 113 to the estimated prices for CFC substitutes. This comparison shows that if CFC prices rise to levels we predict, then the new CFC substitutes will become much more competitive. However, each currently identified CFC presents potential application problems which must be overcome.

  - Hence, market forces, even without phasedown restrictions, could be sufficient to stimulate the development of substitutes. Further research is needed to determine the likely price rise and the extent to which new CFCs could compete with current CFCs in all markets.

EXHIBIT 2

LIKELY PRICE AND POSSIBLE USE OF CFC SUBSTITUTES

CFC Substitute	Long-Term Bulk Price (1987 $/LB.)	Uses
123	$1.25 - $2.50	Solvent, flexible foam, rigid insulating foam
124	2.00 - 4.00	Rigid foam
132b	1.00 - 2.00	Solvent
134a	2.00 - 4.00	Mobile AC, refrigerant, rigid foam
141b	1.00 - 2.00	Flexible and rigid foams

* *

Current CFCs	Price (1990-2000)	Current Price (Oct. 1986)
11	$1.85 - $2.90	$0.61
12	1.80 - 2.80	0.71
113	1.90 - 2.70	0.91

Sources: 1) Draft Report: Chlorofluorocarbon Chemical Substitutes; EPA Contract No. 68-02-3994, Work Assignment 80, December 4, 1986. 2) Industry data.

THE PRODUCTION FREEZE WILL REDUCE CFC USAGE.

- Use of CFC control technology to recover and reuse CFCs will be encouraged as prices rise. These technologies often are not economic at current CFC prices, but will pay for themselves at higher prices.

  - Similarly, higher prices will encourage better work practices and conservation efforts that will reduce CFC use.

  - Improved conservation efforts may involve little cost and, at low CFC prices, return little benefit. Higher prices will motivate the service industry to improve its work habits.

- Higher prices would also induce end-use substitution for lower value applications. For example, egg carton foam containers might be replaced by cardboard containers, or fiber board might be used in building insulation instead of CFC insulating rigid foam (in spite of reduced insulation efficiency).

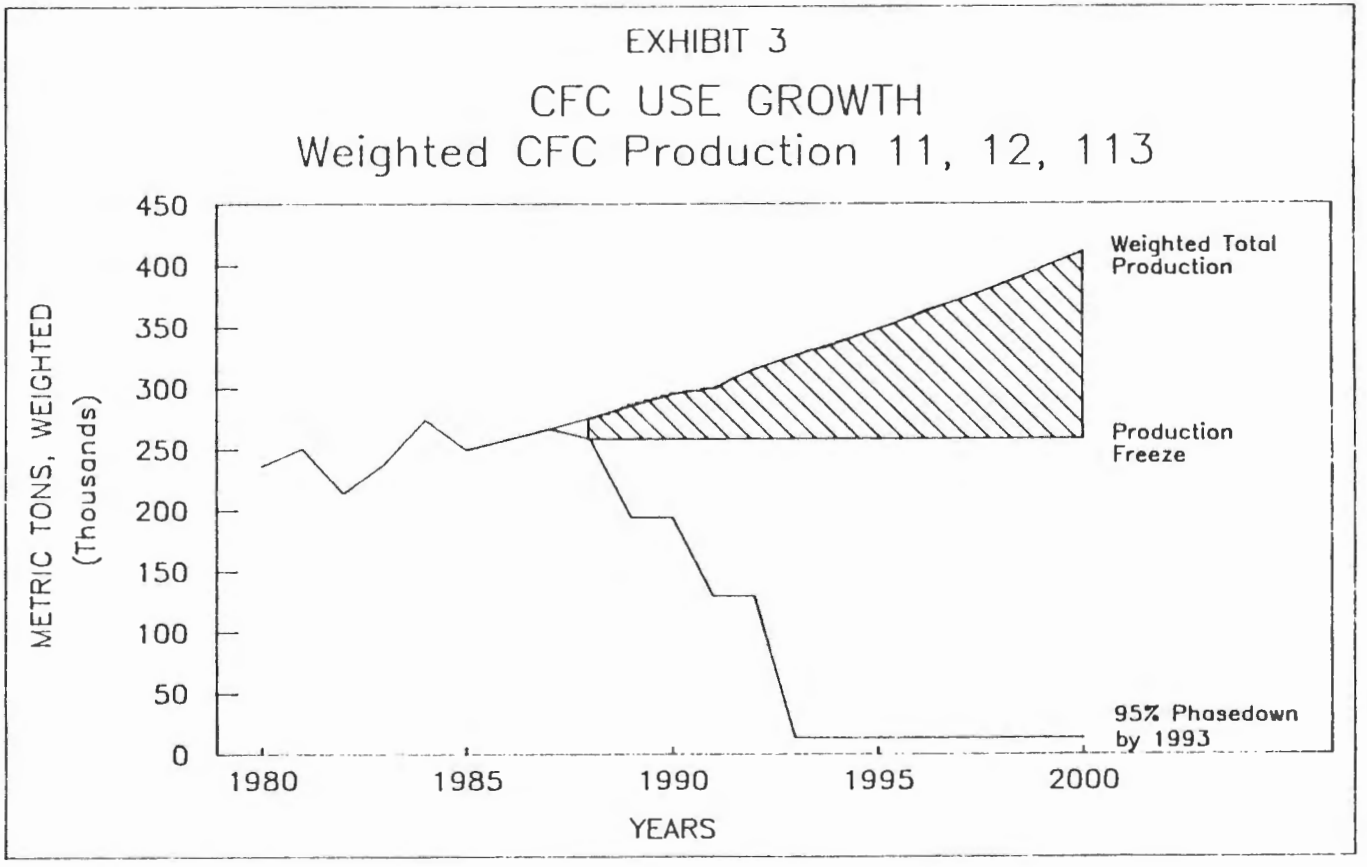
A PRODUCTION FREEZE WILL SUBSTANTIALLY REDUCE EMISSIONS.

- Exhibit 3 below shows the impact of a freeze on the growth in (weighted) total production of CFCs 11, 12, and 113. The freeze reduces cumulative production by approximately 1.1 million metric tons relative to the no regulation case. This amount is equivalent to about four years at current production levels.

EXHIBIT 3

CFC USE GROWTH

Weighted CFC Production 11, 12, 113



CFC RESTRICTIONS MIGHT ENCOURAGE GREATER USE OF HAZARDOUS AGENTS.

- Before new substitutes can be developed, industry's response to CFC restrictions might be to use the substances they have used in the past.

  - In solvents and in foam blowing applications, CFC use has grown because it has replaced flammable or more toxic compounds.

- Methyl chloroform is a possible major substitute for CFC-113 in electronic solvent uses. It is approximately one-third the cost of CFC-113, has a workplace exposure standard which is three times as stringent as CFC-113, and is less energy efficient due to its high boiling point.

- Methylene chloride is a substitute for CFCs in electronic solvent uses and flexible foam applications. Even though it is less expensive than CFCs, its use is limited because of high toxicity, potential carcinogenicity, and technical barriers in certain foam grades.

- Hydrocarbons are substitutes for CFC-12 in polystyrene foam production. However, a majority of foamers use CFC-12 because hydrocarbons are highly flammable.

  - Use of hydrocarbons would also contribute to the formation of photochemical smog.

A WEIGHTED PRODUCTION FREEZE IS BETTER PUBLIC POLICY THAN AN UNWEIGHTED PRODUCTION FREEZE.

- A weighted production freeze that allows reductions in one CFC to be credited against the need for reductions in other CFCs -- such credits would depend on the relative ozone depletion potential of each CFC -- would reduce disruption to the economy.

  - This approach would allow continued use of CFCs which are "hard to substitute" provided that other CFCs, where substitutes are available, could offset the increases in the "hard to substitute" CFC category.

- An unweighted production freeze, that is, a freeze on <u>each</u> CFC, could have significant near-term implications and provide no long-term environmental benefits.

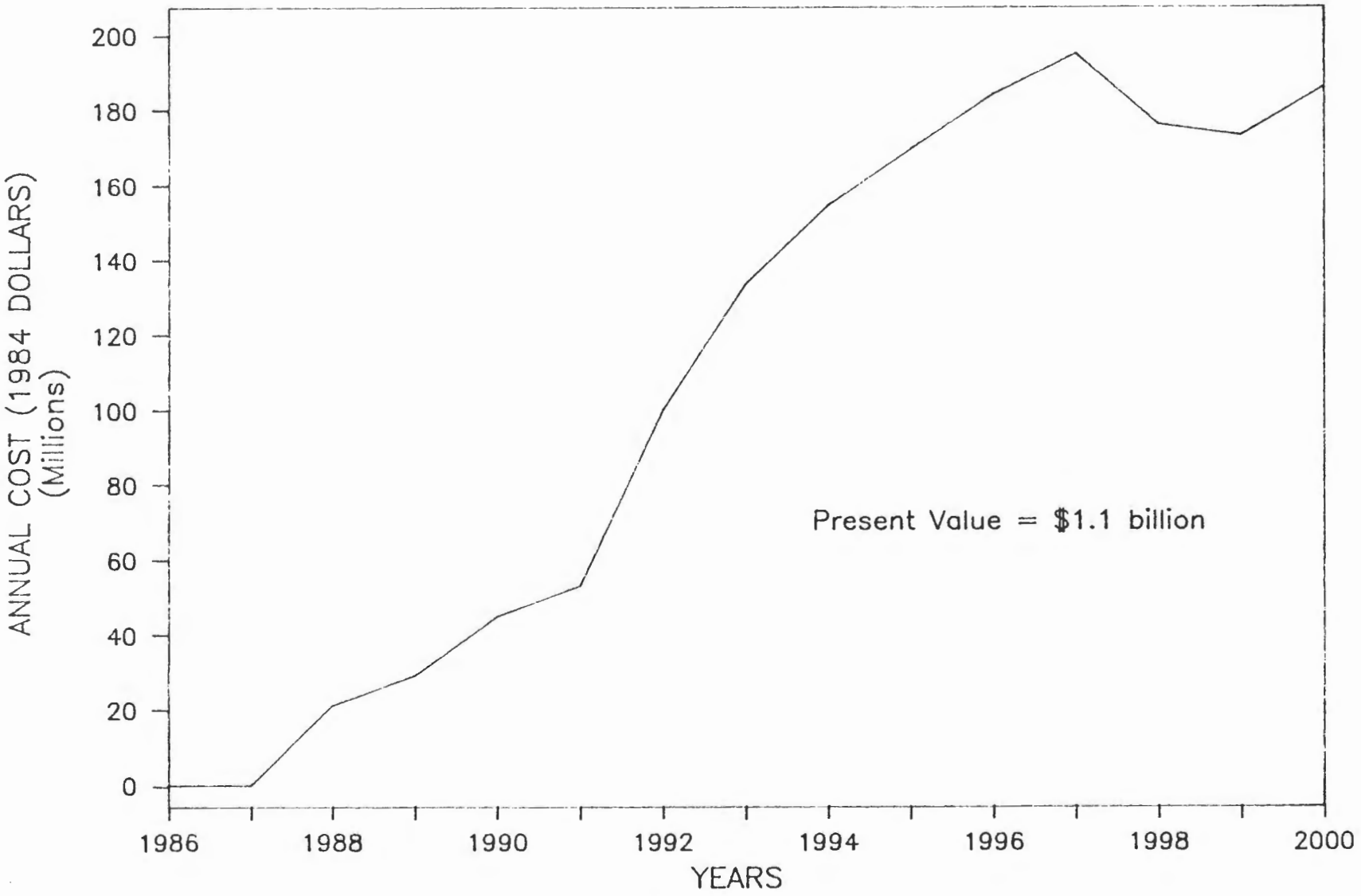
- In general, public policy should be formulated to provide long-run incentives for substitution or change. There is no benefit to be gained by stimulating short-term shortages and price increases beyond industry's ability to respond in the short term. A weighted production freeze helps to ensure that this goal is attained.

A PRODUCTION FREEZE WILL HAVE SIGNIFICANT CONSEQUENCES FOR CONSUMERS AND INDUSTRY.

- The economic consequences of a production freeze reflect:
  - The cost of activities undertaken by firms to reduce CFC use through substitution or by emission reduction technologies;
  - The cost to consumers who pay higher prices for CFC products or switch to alternative products which may be of inferior quality;
  - The magnitude of wealth transfers which will ultimately be paid by consumers.

- Our analysis of a weighted production freeze indicates that it would:
  - Cost the economy approximately $1 billion during the period 1988-2000 (see Exhibit 4). Annual costs would exceed $180 million in the mid 1990s.
  - Increase real CFC prices about three times by 2000 (as indicated earlier; see Exhibit 1).

COST OF WEIGHTED PRODUCTION FREEZE
BY YEAR, 1986–2000



SOURCE: Putnam, Hayes & Bartlett, Inc., 17 April 1987.

A PRODUCTION FREEZE WILL HAVE SIGNIFICANT CONSEQUENCES FOR CONSUMERS AND INDUSTRY (continued).

- A weighted production freeze would cause substantial wealth transfers away from consumers and user industries, since the freeze-induced CFC shortage would increase prices above pre-regulation levels. Total wealth transfers would be approximately $8 billion -- eight times larger than the cost of the freeze.

IV B. 95 PERCENT PHASEDOWN FINDINGS

A 95 PERCENT PRODUCTION PHASEDOWN BY 1993, AS REQUIRED IN S 571, IS INFEASIBLE AND WOULD CREATE EXTENSIVE DISRUPTION AMONG CONSUMERS AND INDUSTRY.

- The primary reasons for this conclusion are:

  - The phasedown schedule is infeasible because the allowable amount of CFC production falls far short of the service needs of installed equipment.

  - A lack of available substitutes hinders industry's ability to adapt to the rapid phasedown schedule. The rapid phasedown violates sound public policy since substantial capital stocks would become obsolete.

  - As a consequence of the rapid phasedown schedule, millions of consumers would be unable to use existing products such as home and auto air conditioners, and office building air conditioners.

  - The economic consequences of early capital obsolescence (which could easily run into the billions), skyrocketing CFC prices, closures of entire CFC-user industries, and enormous wealth transfers would be staggering.

  - As a result of the massive consumer dissatisfaction, a repeal of CFC restrictions probably would be demanded. The societal consensus for CFC restrictions would dissipate when confronted with substantial consumer dissatisfaction and economic consequences.

A 95 PERCENT PHASEDOWN SCHEDULE BY 1993 IS INFEASIBLE.

- Currently, 37 percent of CFC 11 and 12 production is used to service installed equipment (see Exhibit 5). This equipment has no flexibility to use substitutes in the short run.

  - Better work practice in the service industry could reduce the 28 percent figure somewhat. Industry surveys on conservation efforts -- soon to be available -- will indicate the size of such savings.

  - However, even if substitutes were introduced for all CFC applications starting in 1990, the service requirements of installed equipment by 1993 would be about 15 percent of the 1986 production level (assuming a 10-15 year remaining equipment lifetime).

  - Application of retrofit technology might lower the CFC demand of installed equipment. However, the availability of this technology is speculative.

- If CFC producers and user firms were forced to comply with a 95 percent phasedown schedule in 1993, then capital stocks would be prematurely obsolete for many consumers and CFC-user industries.

  - For example, approximately 18 million auto air conditioners could be rendered useless in 1993 if CFCs could not be obtained. Hence, for this category alone, the annual cost of capital stock depletion is approximately $6 billion.

EXHIBIT 5

AFTERMARKET USE OF CFC-11 AND CFC-12

(1986 Metric Tons)

End Use	Total CFC 11 and 12 Use	Aftermarket Use
Retail Food Refrigeration	19,200	
Home Refrigeration	5,000	
Centrifugal Chillers	14,800	
Reciprocal Chillers	700	
Subtotal	39,700	
85% Aftermarket Use		33,700
Mobile Air Conditioning	61,300	
75% Aftermarket Use		46,000
Total Aftermarket Use		79,700
Total CFC 11 and 12 Use		215,000
Percent of Total (CFC 11 and 12) Use		37%
Percent of Total (CFC 11 and 12) Weighted Use		34%

SOURCE: Industry Data.

A 95 PERCENT PHASEDOWN IN 1993 WOULD RESULT IN MASSIVE CONSUMER DISSATISFACTION.

- Refrigerant and coolant applications of CFCs will require considerable time to develop substitutes suitable for commercial deployment. Hence, a rapid phasedown schedule would significantly affect these uses.

- If CFC use were limited to five percent of its 1986 level, then the CFC allowance would have to be allocated among the user or service industries. Only one of the following industries could obtain sufficient CFCs to operate at current levels.

  - Servicing retail refrigeration systems currently accounts for 5.7 percent of the 1986 CFC use. These systems are found in approximately 500,000 retail food establishments.

  - Servicing mobile air conditioning currently accounts for 16 percent of the 1986 CFC use. Over 20 million new or used cars require CFCs every year.

  - Chillers, used to air condition virtually all office, commercial, and industrial buildings, currently account for 5.4 percent of the 1986 CFC use.

A 95 PERCENT PHASEDOWN IN 1993 WOULD RESULT IN MASSIVE CONSUMER DISSATISFACTION (continued).

- Additionally, "essential" uses of aerosols currently exempt from CFC restrictions equal approximately 3.3 percent of the 1986 CFC use. Hence, little CFC production would be available for other uses.

- Since substitutes for the above products would not be available, industry and millions of consumers would be frustrated in their attempts to purchase new products or keep existing equipment working.

CFC RESTRICTIONS WILL AFFECT INTERNATIONAL TRADE AND U.S. COMPETITIVENESS.

- Foreign imports may increase as a result of CFC restrictions.

  - In the appliance industry, foreign producers have been unsuccessful in making inroads in the U.S. market. Domestic producers have well developed distribution channels, customers, production capabilities, and so forth (i.e., U.S. producers have a distinct advantage over foreign suppliers). CFC restrictions might cause changes in appliance design and manufacture which would favor foreign producers over domestic producers.

- Exports will suffer as product quality declines and prices rise.

  - In the electronics industry, where "critical cleaning" is crucial to some applications, those products cleansed with CFC-113 substitutes may have lower performance levels.

  - If air conditioning equipment, which currently accounts for more than $1 billion in exports, becomes less energy efficient using CFC substitutes, then demand for those products is likely to fall.

ECONOMIC CONSEQUENCES OF A RAPID PHASEDOWN ARE STAGGERING.

- A 95 percent CFC phasedown by 1993 would cause enormous shortages, which would cause CFC prices to skyrocket as consumers bid up prices.

- Firms that depend on CFCs and have low valued applications would be unable to purchase CFCs. These firms would either need to invest in substitutes or shut down their operations. Many small firms would be unable to make the needed investments. User industries particularly at risk are:

  - CFC foam blowers.

  - Small electronics manufacturers.

- Installed capital equipment which uses CFCs would quickly become obsolete unless CFCs could be obtained. For example, auto air conditioners and office air conditioning equipment using CFC-11 will become high risk categories.

  - Further analysis on this issue is needed to determine the cost of premature capital obsolescence. However, the capital stock loss in auto air conditioners alone could exceed $6 billion per year.

A RAPID PHASEDOWN WILL ENCOURAGE THE USE OF HAZARDOUS SUBSTANCES.

- An important reason for the growth of CFC use in solvents and foam applications has been its low toxicity.

- Possible major solvent substitutes include:

  - Methyl chloroform, which has a workplace exposure standard three times as stringent as CFC-113, is likely to be the substitute of choice for up to 40 percent of the market.

  - Methylene chloride, which is considered by EPA as a possible carcinogen, has been replaced in some applications by CFC-113 because of health and environmental concerns.

  - Water-based solvents that present water pollution concerns.

  - Flammable hydrocarbons that present safety concerns.

- Major foam blowing substitutes include methylene chloride and hydrocarbons, which are highly flammable. Most polystyrene foamers have used CFCs 11 and 12 in the last 10 to 15 years because of flammability concerns.