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PRELIMINARY ANALYSIS OF COSTS AND BENEFITS OF STRATOSPHERIC OZONE PROTECTION

U.S. EPA
OFFICE OF AIR AND RADIATION

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OUTLINE OF BRIEFING

- Principles of Analysis
- Costs
  - -- Process to develop cost estimates
  - -- Review of cost estimating approach
  - -- Technical control options and estimated costs
  - -- Estimates of yearly and aggregate cost
- Benefits
  - -- Basic concepts
  - -- Preliminary estimates of magnitude

PRINCIPLES OF ANALYSIS

- Include all potential benefits (direct and indirect)
- Include all potential costs (direct and indirect)
- Treat uncertainty by using a range of cost or benefit estimates

PROCESS TO DEVELOP COST ESTIMATES

- Contractor studies
  - -- Radian Corporation
  - -- Midwest Research Institute
  - -- ICF Incorporated
  - -- Industrial Economics Corporation
  - -- Rand (work mainly obsolete)

PROCESS TO DEVELOP COST ESTIMATES

- INDUSTRY INPUTS
  - -- REVIEW OF CONTRACTOR STUDIES
  - -- ESTIMATES MADE PUBLIC (E.G., DUPONT PUBLISHED ESTIMATE OF 1 1/2 TO 5 TIMES CURRENT PRICE OF CFCS FOR SUBSTITUTES)

PROCESS TO DEVELOP COST ESTIMATES

- o International substitutes panel
  - -- Chaired by Dick Lagow, University of Texas
  - -- Academic and industrial participation
  - -- Chemists from several countries (Japan, FRG, UK)

REVIEW OF COST ESTIMATING APPROACH

COMPOUNDS AND THEIR OZONE-DEPLETING POTENTIAL

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o **Compounds Included in U.S. Proposal:**

CFC-11:	1.00
CFC-12:	0.86
CFC-113:	0.80
CFC-114:	A/
CFC-115:	A/
Halon-1211:	2.69 B/
Halon-1301:	11.43 B/

o **Compounds Excluded from US Proposal:**

CFC-22:	0.05
Methyl Chloroform:	0.08-0.15
Carbon Tetrachloride: C/	1.14

A/ Estimate not available.

B/ Preliminary estimate. Values are uncertain.

C/ Excluded because majority of production is not emitted.

STRUCTURE OF ANALYSIS

- **Categories of Data Analysis:**

  -- Use Categories: 7
  -- Application Categories: 81
  -- Control Options: 623

- **Analysis:**

  -- Individual Control Costs

  - Start-up/one time costs
  - Recurring capital costs
  - Annual costs
  - Salvage costs

  -- Societal Costs

  - Energy costs
  - Other penalties

  -- Industry Impacts

  -- Overall Regulatory Impacts

STRUCTURE OF ANALYSIS
(CONTINUED)

- SOURCES:
  - -- TECHNICAL CONTROL OPTION STUDIES
  - -- INPUTS FROM INDUSTRY
  - -- MARKET ANALYSES

SUMMARY OF CURRENT USES

USE CATEGORY	1985 UNWEIGHTED USE	1985 WEIGHTED USE A/	TIMING OF EMISSIONS	COMPOUNDS
SOLVENTS	41,369	33,095	PROMPT	CFC-113
REFRIGERATION	78,987	68,770	PROMPT	CFC-11; CFC-12
FOAM BLOWING	70,430	68,577	PROMPT/ DELAYED	CFC-11; CFC-12
FIRE EXTINGUISHING AGENT	6,250	47,097	DELAYED	HALON-1211; HALON-1301
STERILIZATION	12,133	10,435	PROMPT	CFC-12
AEROSOL PROPELLANT	8,000	7,328	PROMPT	CFC-11; CFC-12
OTHER MISCELLANEOUS	7,083	6,169	PROMPT	CFC-11; CFC-12; CFC-113

A/ DOES NOT INCLUDE UNACCOUNTED FOR USE.

FOAM BLOWING APPLICATIONS

Extruded Polystyrene Boardstock

Extruded Polystryene Sheet

-- Egg Cartons
-- Single Service
-- Single Service Hinged Containers
-- Stock Food Trays

Flexible Polyurethane Foam

-- Molded
-- Slabstock

Rigid Polyurethane Foam

-- Boardstock - Furniture
-- Boardstock - Construction - Building
-- Boardstock - Construction - Industry
-- Laminated - Construction - Building
-- Poured - Construction - Building
-- Poured - Construction - Industrial
-- Poured - Packaging
-- Poured - Refrigeration
-- Poured - Transportation
-- Sprayed - Construction - Building
-- Sprayed - Construction - Industrial
-- Sprayed - Transportation

REFRIGERANT APPLICATIONS

CENTRIFUGAL CHILLERS

COLD STORAGE

DEHUMIDIFIERS

FREEZERS

ICE MACHINES

MOBILE AIR CONDITIONERS

PROCESS REFRIGERATION

RECIPROCAL CHILLERS

REFRIGERATED TRANSPORTATION

REFRIGERATORS

RETAIL FOOD

VENDING MACHINES

WATER COOLERS

SOLVENT APPLICATIONS

METAL CONVEYORIZED VAPOR DEGREASING

METAL COLD CLEANING

METAL OPEN TOP VAPOR DEGREASING

ELECTRIC AND ELECTRONIC EQUIPMENT CLEANING AND DEGREASING

DRY CLEANING

STERILIZATION APPLICATIONS

ANIMAL LABS

BEEHIVE FUMIGANT (DEPARTMENT OF AGRICULTURE)

COMMERCIAL RESEARCH AND DEVELOPMENT LABS

CONTRACT STERILIZATION

HOSPITALS

LIBRARIES

MEDICAL EQUIPMENT

NON-COMMERCIAL RESEARCH AND DEVELOPMENT LABS

PHARMACEUTICAL

SPICE FUMIGANT

FIRE EXTINGUISHING APPLICATIONS

LOCAL APPLICATION SYSTEMS

PORTABLE - MILITARY

PORTABLE - CIVILIAN - ELECTRICAL

PORTABLE - CIVILIAN - FLAMMABLE LIQUID

PORTABLE - CIVILIAN - GENERAL

PORTABLE - CIVILIAN - RESIDENTIAL

TOTAL FLOODING - MILITARY

TOTAL FLOODING - CIVILIAN - ELECTRICAL

TOTAL FLOODING - CIVILIAN - FLAMMABLE LIQUID

TOTAL FLOODING - CIVILIAN - OTHER

MISCELLANEOUS APPLICATIONS

Floating Agent for Coal Cleaning

Freezing Agent in Liquid Food Freezing Process

Heat Detectors

Skin Chillers/Cleaners

Warning Devices

AEROSOL APPLICATIONS

ESSENTIAL APPLICATIONS

NON-ESSENTIAL APPLICATIONS (BANNED IN THE U.S.)

AN EXAMPLE SET OF CONTROLS

COMPOUND: CFC-11
APPLICATION: SLABSTOCK POLYURETHANE FOAMS; 1985 USE = 11,500 METRIC TONS
CONTROL OPTIONS:

- AVAILABLE IN SHORT TERM
  - -- COTTON BATTING
  - -- MINIMUM FOAM DENSITY SPECIFICATION
  - -- MINIMUM FOAM DENSITY SPECIFICATION WITH METHYLENE CHLORIDE BLOWING AGENT
  - -- ALTERNATIVE BLOWING AGENTS
  - -- VERTICAL FOAM CHAMBER
  - -- WATER-BLOWN SYSTEMS
- AVAILABLE IN MEDIUM TERM
  - -- CARBON ADSORPTION/RECYCLE
  - -- FORMIC ACID "AB" PROCESS
  - -- VERTICAL FOAM CHAMBER AND CARBON ADSORPTION
- AVAILABLE IN LONG TERM
  - -- CFC-123
  - -- CFC-141B
  - -- PLASTICS/SEMI-FLEXIBLE FOAM

CONTROL OPTIONS FOR SLABSTOCK POLYURETHANE FOAMS -- SHORT TERM

Control Options	Applies to: New Plants	Applies to: Existing Plants	Expected Maximum Penetration (%)	Expected Reduction Effectiveness (%)
Cotton Batting	Yes		20	100
Minimum Foam Density Specification	Yes	Yes	70	40
Minimum Foam Density Specification with Alternative Blowing Agents	Yes	Yes	70	80
Vertical Chamber	Yes	Yes	2 (existing plants) 20 (new plants)	20
Water-Blown Systems		Yes	70	60

Preliminary estimates subject to peer review and revision.

COST ESTIMATE FOR MINIMUM FOAM DENSITY SPECIFICATION FOR CONTROLLING CFC-11 IN SLABSTOCK POLYURETHANE FOAMS A/

Annualized Cost /kg (1985 $)	Recurring Capital Cost B/ (10^6 1985 $)	Non-Recurring Costs (10^6 1985 $) C/	Annual Operating Cost D/ (10^6 1985 $)	Annualized Savings E/ (10^6 1985 $)	Energy or Other Cost Penalties F/ (10^6 1985 $)	Salvage of Original Capital (Percent of Capital Cost)
3.3	7.0	0.7	10.1	0.0	--	0

A/ Assessments of non-monetary product quality effects have been made; quality may be reduced or enhanced.

B/ Capital expenditures (e.g., for equipment) that are required each time the control is implemented (costs amortized over equipment life).

C/ One-time start-up costs and R&D.

D/ Labor, materials, supplies, utilities.

E/ Includes savings due to no longer using CFCs.

F/ Includes increased energy costs due to reduced insulating properties or operating efficiencies, and other costs not included separately.

Preliminary estimates subject to peer review and revision.

CONTROL OPTIONS FOR SLABSTOCK POLYURETHANE FOAMS NOT AVAILABLE IN THE SHORT TERM THAT ARE ANTICIPATED TO BE AVAILABLE IN THE MID-TERM AND/OR LONG TERM

CFC-123

CFC-141B

CARBON ADSORPTION/RECYCLE

FORMIC ACID "AB" PROCESS

PLASTICS/SEMI-FLEXIBLE FOAM

VERTICAL CHAMBER AND CARBON ADSORPTION

AN EXAMPLE SET OF CONTROLS

USE: CFC-12
APPLICATION: CENTRIFUGAL CHILLERS; 1985 USE = 2,000 METRIC TONS
CONTROL OPTIONS:

- AVAILABLE IN SHORT TERM
  - -- ALTERNATE LEAK TESTING GAS
  - -- RECOVERY AT DISPOSAL
  - -- RECOVERY AT SERVICE
- AVAILABLE IN MEDIUM TERM
  - (NONE)
- AVAILABLE IN LONG TERM
  - -- CFC-22
  - -- FC-134A

CONTROL OPTIONS FOR CENTRIFUGAL CHILLERS -- SHORT TERM

Control Options	Applies to: New Systems	Applies to: Existing Systems	Expected Maximum Penetration (%)	Expected Reduction Effectiveness (%)
Alternate Leak Testing Gas		Yes	80	90
Recovery at Disposal	Yes	Yes	50	80
Recovery at Service	Yes	Yes	50	59

COST ESTIMATE FOR ALTERNATIVE LEAK TESTING GAS FOR CONTROLLING CFC-12 IN CENTRIFUGAL CHILLERS[A/]

Annualized Cost/kg (1985 $)	Capital Cost[B/] (10^3 1985 $)	Other Non-Recurring Costs[C/] (10^3 1985 $)	Annual Operating Cost[D/] (10^3 1985 $)	Annualized Savings[E/] (10^3 1985 $)	Energy or Other Cost Penalties[F/] (10^3 1985 $)	Salvage of Original Capital (Percent of Capital Cost)
1.2	0	0	370.0	270.0	--	0

A/ Assessments of non-monetary product quality effects are included; quality may be reduced or enhanced.

B/ Capital expenditures (e.g., for equipment) that are required each time the control is implemented (costs amortized over equipment life).

C/ One-time start-up costs and R&D.

D/ Labor, materials, supplies, utilities.

E/ Includes savings due to no longer using CFCs.

F/ Includes increased energy costs due to reduced insulating properties or operating efficiencies, and other costs not included separately.

Preliminary estimates subjec to peer review and revision.

CONTROL OPTIONS FOR CENTRIFUGAL CHILLERS NOT AVAILABLE IN THE SHORT TERM THAT ARE ANTICIPATED TO BE AVAILABLE IN THE MID-TERM AND/OR LONG TERM

CFC-22

FC-134A

VINTAGING OF EXISTING STOCK

IS CONSIDERED WHERE NECESSARY

- CURRENT STOCK OF CENTRIFUGAL CHILLERS USING CFC-12

NEW :	5%
1-5 YEARS OLD :	20%
6-10 YEARS OLD :	20%
11-20 YEARS OLD:	40%
20 YEARS OLD:	15%
TOTAL	100%

- USEFUL LIFE = 25 YEARS

- DURING REMAINING USEFUL LIFE, CFC-12 WILL BE REQUIRED

CONTROL OPTIONS AND ESTIMATED COSTS

POTENTIAL SHORT-TERM CONTROL OPTIONS

Compound	Application Name	Control Option Description	Available in Period
1. Controls costing less than $.15 reduce compound use by 30%			
CFC-152A	Centrif Chillers	Alt Leak Test Gas	ST
CFC-152A	Centrif Chillers	Recovery at Service	ST
CFC-152A	Centrif Chillers	Recovery at Disposal	ST
CFC-152A	Centrif Chillers	CFC-22	ST
CFC-12	Rgd PU Foam-Prd-Packag	Other Packaging Materials	ST
CFC-11	Rgd PU Foam-Prd-Packag	Other Packaging Materials	ST
CFC-12	Pharmaceutical	Explosion Proof Cond/Recl	ST
CFC-12	Spice fumigant	Explosion Proof Cond/Recl	ST
CFC-11	Flex PU Foam-Slabstock	Vertical Foam Chamber	ST
Halon 1211	PrtCiv Resid	Use VCRs and Flms for Trnn	ST
Halon 1211	PrtCiv Elect	Use VCRs and Flms for Trnn	ST
Halon 1211	PrtCiv General	Use VCRs and Flms for Trnn	ST
Halon 1211	PrtCiv FlamLqd	Use VCRs and Flms for Trnn	ST
CFC-12	Commercial R&D Labs	Explosion Proof Cond/Recl	ST
CFC-113	Dry Cleaning	Replace Seals	ST
Halon 1211	TFCiv Other	Incr Time Delay for Activn	ST
Halon 1211	TFCiv Other	Use Non-Dstrctv Tst Mthds	ST
Halon 1211	TF Military	Incr Time Delay for Activn	ST
Halon 1211	Local App Syst	Incr Time Delay for Activn	ST
Halon 1211	TF Military	Use Non-Dstrctv Tst Mthds	ST
Halon 1211	TFCiv Elect	Incr Time Delay for Activn	ST
Halon 1211	Local App Syst	Use Non-Dstrctv Tst Mthds	ST
Halon 1211	TFCiv Other	Use Mnual Actvn When Occup	ST
CFC-12	Retail Food	Refrigerant Dye	ST
Halon 1211	TFCiv Elect	Use Non-Dstrctv Tst Mthds	ST
Halon 1211	TFCiv Other	Secure the Actvtng Devices	ST
CFC-12	Contract Sterilization	Explosion Proof Cond/Recl	ST
CFC-12	Medical Equipment	Explosion Proof Cond/Recl	ST
CFC-12	Hospitals	10/90 (EO/CO2)	ST
Halon 1211	TF Military	Use Mnual Actvn When Occup	ST
CFC-113	Dry Cleaning	Carbon Adsorption	ST
CFC-113	Open Top Vpr Degreasin	Cvr, Drainage, Incrsd Frbr	ST
CFC-113	Cnvyrzd Vapor Degreasi	Cvr Opngs & Thrmstts	ST
CFC-113	Elec/Elec Equp Clng &	Cvr Opngs & Thrmstts	ST

Preliminary analysis of controls; subject to revision.

POTENTIAL SHORT-TERM CONTROL OPTIONS (CONTINUED)

Compound	Application Name	Control Option Description	Available in Period
Halon 1211	TF Military	Secure the Actvtng Devices	ST
CFC-113	Cold Cleaning	Cvr, Drainage, & Incrsd Fr	ST
CFC-113	Cnvyrzd Vapor Degreasi	Rfrgrtd Frbrd Chllr with C	ST
CFC-113	Elec/Elec Equp Clng &	Rfrgrtd Frbrd Chllr with C	ST
CFC-113	Open Top Vpr Degreasin	Rfrgrtd Frbrd Chllr with C	ST
Halon 1211	Local App Syst	Use Mnual Actvn When Occup	ST
CFC-12	Liquid Food Freezing	Air Blast	ST
CFC-12	Spice fumigant	N2 Purge, Then Pure EO	ST
CFC-12	Contract Sterilization	N2 Purge, Then Pure EO	ST
CFC-12	Medical Equipment	N2 Purge, Then Pure EO	ST
CFC-12	Commercial R&D Labs	N2 Purge, Then Pure EO	ST
Halon 1211	Local App Syst	Secure the Actvtng Devices	ST
CFC-12	Pharmaceutical	N2 Purge, Then Pure EO	ST
Halon 1211	TFCiv Elect	Use Mnual Actvn When Occup	ST
CFC-113	Cold Cleaning	Perchloroethylene and Blen	ST
CFC-113	Cnvyrzd Vapor Degreasi	Drng Tnnl/Rttng Bskt Drng	ST
CFC-113	Elec/Elec Equp Clng &	Methylene Chloride and Ble	ST
CFC-113	Cnvyrzd Vapor Degreasi	Methylene Chloride and Ble	ST
CFC-113	Elec/Elec Equp Clng &	Drng Tnnl/Rttng Bskt Drng	ST
CFC-12	Contract Sterilization	10/90 (EO/CO2)	ST
Halon 1211	TFCiv Other	Raise Ext Activn Lvl	ST
CFC-113	Cold Cleaning	Methylene Chloride and Ble	ST
CFC-12	Reciprocal Chillers	Recovery at Service	ST
CFC-113	Open Top Vpr Degreasin	Methylene Chloride and Ble	ST
CFC-113	Cnvyrzd Vapor Degreasi	Crbn Adsrptn Drng Tnnl w/	ST
Halon 1211	Local App Syst	Raise Ext Activn Lvl	ST
CFC-113	Elec/Elec Equp Clng &	Crbn Adsrptn Drng Tnnl w/	ST
Halon 1211	TFCiv Elect	Secure the Actvtng Devices	ST
CFC-113	Cold Cleaning	Trichloroethylene and Blen	ST
Halon 1211	TFCiv Other	Use Alt Agnt for Disch Tst	ST
Halon 1211	TF Military	Raise Ext Activn Lvl	ST
CFC-113	Cold Cleaning	Petroleum Solvents	ST
Halon 1211	TFCiv Elect	Raise Ext Activn Lvl	ST
CFC-11	Centrif Chillers	Recovery at Service	ST
Halon 1211	Local App Syst	Use Alt Agnt for Disch Tst	ST
Halon 1211	TF Military	Use Alt Agnt for Disch Tst	ST
CFC-12	Refrig Transport	Helium Leak Test	ST

Preliminary analysis of controls; subject to revision.

POTENTIAL SHORT-TERM CONTROL OPTIONS (CONTINUED)

Compound	Application Name	Control Option Description	Available in Period
Halon 1211	TFCiv Elect	Use Alt Agnt for Disch Tst	ST
Halon 1301	PrtCiv General	Use VCRs and Flms For Trnn	ST
Halon 1301	PrtCiv Elect	Use VCRs and Flms for Trnn	ST
Halon 1301	PrtCiv Resid	Use VCRs and Flms For Trnn	ST
Halon 1301	PrtCiv FlamLqd	Use VCRs and Flms for Trnn	ST
CFC-113	Cold Cleaning	Methyl Chloroform	ST
CFC-12	Medical Equipment	10/90 (EO/CO2)	ST
CFC-12	Libraries	Explosion Proof Cond/Recl	ST
Halon 1301	TFCiv Other	Incr Time Delay for Activn	ST
CFC-12	Refrigerators	Helium Leak Test	ST
Halon 1301	TFCiv Other	Use Non-Dstrctv Tst Mthds	ST
Halon 1301	TF Military	Incr Time Delay for Activn	ST
CFC-12	Animal Labs	10/90 (EO/CO2)	ST
CFC-12	Mobile Air Conditioner	Alt Leak Test Gas	ST
Halon 1301	TF Military	Use Non-Dstrctv Tst Mthds	ST
Halon 1301	Local App Syst	Incr Time Delay for Activn	ST
Halon 1301	TFCiv Elect	Incr Time Delay for Activn	ST
CFC-113	Dry Cleaning	Aqueous Cleaning	ST
Halon 1301	TFCiv FlamLqd	Use Non-Dstrctv Tst Mthds	ST
Halon 1301	Local App Syst	Use Non-Dstrctv Tst Mthds	ST
Halon 1301	TFCiv Elect	Use Non-Dstrctv Tst Mthds	ST
CFC-12	Animal Labs	N2 Purge, Then Pure EO	ST
Halon 1301	TFCiv Other	Use Mnual Actvn When Occup	ST
Halon 1301	TFCiv Other	Secure the Actvtng Devices	ST
CFC-12	Centrif Chillers	Recovery at Service	ST
CFC-12	Animal Labs	Explosion Proof Cond/Recl	ST
Halon 1301	TF Military	Use Mnual Actvn When Occup	ST
CFC-12	Non-Commercial R&D Lab	Explosion Proof Cond/Recl	ST
CFC-12	Pharmaceutical	Acid-H2O Scrubb & Cond/Rec	ST
CFC-12	Commercial R&D Labs	10/90 (EO/CO2)	ST
CFC-12	Freezers	Helium Leak Test	ST
CFC-12	Reciprocal Chillers	Recovery at Disposal	ST
Halon 1301	TF Military	Secure the Actvtng Devices	ST
CFC-12	Spice fumigant	Acid-H2O Scrubb & Cond/Rec	ST
Halon 1301	TFCiv FlamLqd	Use Mnual Actvn When Occup	ST
CFC-12	Commercial R&D Labs	Acid-H2O Scrubb & Cond/Rec	ST
CFC-12	Retail Food	Recovery at Disposal	ST

Preliminary analysis of controls; subject to revision.

POTENTIAL SHORT-TERM CONTROL OPTIONS (CONTINUED)

Compound	Application Name	Control Option Description	Available in Period
CFC-12	Contract Sterilization	Acid-H2O Scrubb & Cond/Rec	ST
CFC-12	Medical Equipment	Acid-H2O Scrubb & Cond/Rec	ST
Halon 1301	TFCiv FlamLqd	Secure the Actvtng Devices	ST
CFC-12	Centrif Chillers	Recovery at Disposal	ST
Halon 1301	Local App Syst	Use Mnual Actvn When Occup	ST
CFC-12	Hospitals	N2 Purge, Then Pure EO	ST
CFC-12	Ext PS Sht-Stck Fd Try	Plastic trays, plastic fil	ST
CFC-113	Cold Cleaning	Emulsion Cleaning	ST
Halon 1301	TFCiv FlamLqd	Use Alt Agnt for Disch Tst	ST
CFC-113	Elec/Elec Equp Clng &	Emulsion Cleaning	ST
CFC-113	Cnvyrzd Vapor Degreasi	Emulsion Cleaning	ST
CFC-113	Open Top Vpr Degreasin	Emulsion Cleaning	ST
CFC-12	Ext PS Sht-Egg Crtns	Macerated paper cartons	ST
Halon 1301	TFCiv Elect	Use Mnual Actvn When Occup	ST
Halon 1301	Local App Syst	Secure the Actvtng Devices	ST
Halon 1301	TF Military	Use Alt Agnt for Disch Tst	ST
2. Controls costing less than $.30 reduce compound use by 35%			
Halon 1301	TFCiv Elect	Use Alt Agnt for Disch Tst	ST
Halon 1301	TFCiv Other	Use Alt Agnt for Disch Tst	ST
Halon 1301	Local App Syst	Use Alt Agnt for Disch Tst	ST
Halon 1301	TFCiv Elect	Secure the Actvtng Devices	ST
Halon 1301	TFCiv FlamLqd	Raise Ext Activn Lvl	ST
Halon 1301	TF Military	Raise Ext Activn Lvl	ST
Halon 1301	TFCiv Elect	Raise Ext Activn Lvl	ST
Halon 1301	TFCiv Other	Raise Ext Activn Lvl	ST
Halon 1301	Local App Syst	Raise Ext Activn Lvl	ST
CFC-12	Rgd PU Foam-Prd-Packag	CFC-11/CFC-22	ST
CFC-11	Rgd PU Foam-Prd-Packag	CFC-11/CFC-22	ST
CFC-11	Rgd PU Foam-Prd-Refrig	CFC-11/CFC-22	ST
CFC-12	Rgd PU Foam-Prd-Refrig	CFC-11/CFC-22	ST
CFC-12	Rgd PU Foam-Prd-Trans	CFC-11/CFC-22	ST
3. Controls costing less than $1.10 reduce compound use by 40%			
CFC-11	Rgd PU Foam-Prd-Trans	CFC-11/CFC-22	ST

Preliminary analysis of controls; subject to revision.

POTENTIAL SHORT-TERM CONTROL OPTIONS (CONTINUED)

Compound	Application Name	Control Option Description	Available in Period
CFC-12	Rgd PU Foam-Prd-Cons-B	CFC-11/CFC-22	ST
CFC-11	Rgd PU Foam-Prd-Cons-B	CFC-11/CFC-22	ST
CFC-11	Rgd PU Foam-Prd-Cons-I	CFC-11/CFC-22	ST
CFC-12	Rgd PU Foam-Prd-Cons-I	CFC-11/CFC-22	ST
CFC-12	Centrif Chillers	Recovery at Service	ST
CFC-12	Non-Commercial R&D Lab	10/90 (EO/CO2)	ST
CFC-12	Centrif Chillers	Alt Leak Test Gas	ST
CFC-12	Reciprocal Chillers	Alt Leak Test Gas	ST
CFC-12	Non-Commercial R&D Lab	N2 Purge, Then Pure EO	ST
CFC-12	Dehumidifiers	Helium Leak Test	ST
CFC-113	Dry Cleaning	Perchloroethylene	ST
CFC-12	Spice fumigant	10/90 (EO/CO2)	ST
Halon 1301	PrtCiv Resid	Incr Personnel Training	ST
Halon 1301	PrtCiv FlamLqd	Incr Personnel Training	ST
Halon 1301	PrtCiv Elect	Incr Personnel Training	ST
Halon 1301	Prt Military	Incr Personnel Training	ST
Halon 1301	PrtCiv General	Incr Personnel Training	ST
CFC-113	Cnvyrzd Vapor Degreasi	Methyl Chloroform	ST
CFC-113	Open Top Vpr Degreasin	Methyl Chloroform	ST
CFC-113	Elec/Elec Equp Clng &	Methyl Chloroform	ST
CFC-12	Refrig Transport	Recovery at Rework	ST
CFC-12	Cold Storage	Recovery at Disposal	ST
CFC-11	Rgd PU Foam-Spd-Cns-In	CFC-11/CFC-22	ST
CFC-12	Rgd PU Foam-Spd-Cns-In	CFC-11/CFC-22	ST
4. Controls costing less than $2.30 reduce compound use by 45%			
CFC-11	Rgd PU Foam-Spd-Cns-Bl	CFC-11/CFC-22	ST
CFC-12	Rgd PU Foam-Spd-Cns-Bl	CFC-11/CFC-22	ST
CFC-12	Rgd PU Foam-Spd-Trans	CFC-11/CFC-22	ST
CFC-11	Rgd PU Foam-Spd-Trans	CFC-11/CFC-22	ST
CFC-12	Reciprocal Chillers	CFC-22	ST
CFC-12	Centrif Chillers	Alt Leak Test Gas	ST
CFC-12	Refrigerators	Recovery at Rework	ST
CFC-12	Freezers	Recovery at Rework	ST
CFC-113	Cnvyrzd Vapor Degreasi	Trichloroethylene and Blen	ST
CFC-113	Open Top Vpr Degreasin	Trichloroethylene and Blen	ST

Preliminary analysis of controls; subject to revision.

POTENTIAL SHORT-TERM CONTROL OPTIONS (CONTINUED)

Compound	Application Name	Control Option Description	Available in Period
CFC-113	Elec/Elec Equp Clng &	Trichloroethylene and Blen	ST
CFC-12	Pharmaceutical	10/90 (EO/CO2)	ST
Halon 1211	TFCiv Other	Use Sprinkler Back-Up	ST
CFC-12	Retail Food	Alt Leak Test Gas-At Inst	ST
CFC-12	Cold Storage	Alt Leak Test Gas	ST
CFC-12	Ice Machines	Helium Leak Test	ST
CFC-11	Flex PU Foam-Slabstock	Min Foam Density Spec w/ M	ST
CFC-12	Process Refrig	CFC-22	ST
CFC-11	Centrif Chillers	Alt Leak Test Gas	ST
Halon 1301	TFCiv Other	Use Sprinkler Back-Up	ST
CFC-113	Cnvyrzd Vapor Degreasi	Perchloroethylene and Blen	ST
CFC-113	Open Top Vpr Degreasin	Perchloroethylene and Blen	ST
CFC-113	Elec/Elec Equp Clng &	Perchloroethylene and Blen	ST
CFC-113	Cnvyrzd Vapor Degreasi	Aqueous Cleaning	ST
5. Controls costing less than $7.90		reduce compound use by 50%	
CFC-11	Flex PU Foam-Slabstock	Methylene Chloride	ST
CFC-113	Elec/Elec Equp Clng &	Aqueous Cleaning	ST
CFC-12	Dehumidifiers	Recovery at Rework	ST
Halon 1301	TF Military	Use Sprinkler Back-Up	ST
CFC-11	Flex PU Foam-Slabstock	Min Foam Density Spec	ST
CFC-113	Cnvyrzd Vapor Degreasi	Reclaim Waste Solvent	ST
Halon 1301	TFCiv FlamLqd	Use Sprinkler Back-Up	ST
CFC-12	Process Refrig	CFC-502	ST
CFC-12	Centrif Chillers	CFC-22	ST
CFC-113	Elec/Elec Equp Clng &	Reclaim Waste Solvent	ST
CFC-113	Dry Cleaning	Methyl Chloroform	ST
CFC-12	Libraries	10/90 (EO/CO2)	ST
CFC-113	Dry Cleaning	Reclaim Wastes	ST
CFC-12	Libraries	N2 Purge, Then Pure EO	ST
Halon 1211	PrtCiv Resid	Incr Personnel Training	ST
Halon 1211	TF Military	Use Sprinkler Back-Up	ST
Halon 1211	PrtCiv General	Incr Personnel Training	ST
Halon 1301	Local App Syst	Use Sprinkler Back-Up	ST
CFC-12	Retail Food	Recovery at Service	ST
Halon 1211	Prt Military	Incr Personnel Training	ST

Preliminary analysis of controls; subject to revision.

POTENTIAL SHORT-TERM CONTROL OPTIONS (CONTINUED)

Compound	Application Name	Control Option Description	Available in Period
CFC-12	Cold Storage	Recovery at Service	ST
CFC-12	Ice Machines	Recovery at Rework	ST
Halon 1211	PrtCiv Elect	Incr Personnel Training	ST
Halon 1301	TFCiv Elect	Use Sprinkler Back-Up	ST
CFC-11	Flex PU Foam-Molded	Min Foam Density Spec	ST
CFC-11	Centrif Chillers	Recovery at Disposal	ST
Halon 1301	Local App Syst	Incr Personnel Training	ST
Halon 1301	TFCiv FlamLqd	Incr Personnel Training	ST
Halon 1301	TFCiv Elect	Incr Personnel Training	ST
Halon 1301	TF Military	Incr Personnel Training	ST
Halon 1301	TFCiv Other	Incr Personnel Training	ST
CFC-12	Cold Storage	CFC-502	ST
CFC-12	Liquid Food Freezing	Cryogenic	ST
Halon 1211	PrtCiv FlamLqd	Incr Personnel Training	ST
CFC-12	Retail Food	CFC-502	ST
Halon 1211	Local App Syst	Use Sprinkler Back-Up	ST
CFC-11	Flex PU Foam-Slabstock	Water-Blown Systems	ST
CFC-12	Bee Hive Fumigant-DOA	N2 Purge, Then Pure EO	ST
6. All controls reduce compound use by 61%			
CFC-12	Vending Machines	Helium Leak Test	ST
CFC-12	Water Coolers	Helium Leak Test	ST
Halon 1211	TFCiv Elect	Use Sprinkler Back-Up	ST
CFC-12	Bee Hive Fumigant-DOA	10/90 (EO/CO2)	ST
Halon 1211	TFCiv Other	Incr Personnel Training	ST
Halon 1211	Local App Syst	Incr Personnel Training	ST
CFC-11	Flex PU Foam-Molded	MDI-TDI/Wtr-Blwn Systms in	ST
Halon 1211	TF Military	Incr Personnel Training	ST
CFC-12	Refrig Transport	Recovery at Disposal	ST
Halon 1211	TFCiv Elect	Incr Personnel Training	ST
CFC-12	Retail Food	CFC-22	ST
CFC-113	Open Top Vpr Degreasin	Aqueous Cleaning	ST
CFC-12	Mobile Air Conditioner	Recovery at Disposal	ST
CFC-11	Flex PU Foam-Molded	Min Foam Density Spec w/ M	ST
CFC-12	Retail Food	Recover Leak Test Gas at I	ST
CFC-12	Refrig Transport	Recovery at Service	ST

Preliminary analysis of controls; subject to revision.

POTENTIAL SHORT-TERM CONTROL OPTIONS (CONTINUED)

Compound	Application Name	Control Option Description	Available in Period
CFC-113	Open Top Vpr Degreasin	Reclaim Waste Solvent	ST
CFC-12	Vending Machines	Recovery at Rework	ST
CFC-12	Water Coolers	Recovery at Rework	ST
CFC-12	Centrif Chillers	Recovery at Disposal	ST
CFC-12	Rgd PU Foam-Spd-Trans	Fiberglass Board	ST
CFC-11	Rgd PU Foam-Spd-Trans	Fiberglass Board	ST
Halon 1211	TFCiv FlamLqd	Use Non-Dstrctv Tst Mthds	ST
CFC-12	Rgd PU Foam-Prd-Trans	Fiberglass Board	ST
CFC-11	Rgd PU Foam-Prd-Trans	Fiberglass Board	ST
CFC-12	Mobile Air Conditioner	Recovery at Service	ST
CFC-12	Mobile Air Conditioner	Refrigerant Dye	ST
CFC-11	Flex PU Foam-Slabstock	Cotton Batting	ST
CFC-12	Ice Machines	Recovery at Disposal	ST
CFC-12	Non-Commercial R&D Lab	Acid-H2O Scrubb & Cond/Rec	ST
CFC-12	Animal Labs	Acid-H2O Scrubb & Cond/Rec	ST
CFC-12	Ice Machines	Recovery at Service	ST
Halon 1211	TFCiv FlamLqd	Use Mnual Actvn When Occup	ST
CFC-113	Cold Cleaning	Aqueous Cleaning	ST
CFC-12	Dehumidifiers	Recovery at Service	ST
Halon 1211	TFCiv FlamLqd	Secure the Actvtng Devices	ST
CFC-11	Flex PU Foam-Molded	Cotton Batting	ST
CFC-12	Freezers	Recovery at Service	ST
Halon 1211	TFCiv FlamLqd	Use Alt Agnt for Disch Tst	ST
CFC-113	Cold Cleaning	Reclaim Waste Solvent	ST
CFC-12	Dehumidifiers	Recovery at Disposal	ST
Halon 1211	TFCiv FlamLqd	Raise Ext Activn Lvl	ST
CFC-12	Freezers	Recovery at Disposal	ST
CFC-12	Refrigerators	Recovery at Service	ST
CFC-12	Rgd PU Foam-Prd-Refrig	Fiberglass Board	ST
CFC-11	Rgd PU Foam-Prd-Refrig	Fiberglass Board	ST
CFC-12	Refrig Transport	Modified Stirling Cycle	ST
CFC-12	Libraries	Acid-H2O Scrubb & Cond/Rec	ST
CFC-12	Vending Machines	Recovery at Service	ST
CFC-12	Water Coolers	Recovery at Service	ST
CFC-11	Rgd PU Foam-Prd-Cons-B	Alternative Insulating Mat	ST
CFC-12	Vending Machines	Recovery at Disposal	ST
CFC-12	Water Coolers	Recovery at Disposal	ST

Preliminary analysis of controls; subject to revision.

POTENTIAL SHORT-TERM CONTROL OPTIONS (CONTINUED)

Compound	Application Name	Control Option Description	Available in Period
CFC-12	Refrigerators	Recovery at Disposal	ST
CFC-12	Bee Hive Fumigant-DOA	Acid-H2O Scrubb & Cond/Rec	ST
CFC-12	Rgd PU Foam-Prd-Cons-B	Alternative Insulating Mat	ST
CFC-12	Rgd PU Foam-Spd-Cns-Bl	Alternative Insulating Mat	ST
CFC-11	Rgd PU Foam-Spd-Cns-Bl	Alternative Insulating Mat	ST
CFC-12	Mobile Air Conditioner	Ban Retail Sale of Small C	ST
CFC-11	Rgd PU Foam-BStk-Cns-B	Other Insulation Materials	ST
CFC-11	Rgd PU Foam-Lam-Cons-B	Other Insulation Materials	ST
CFC-11	Rgd PU Foam-Prd-Cons-I	Fiberglass Board	ST
CFC-12	Rgd PU Foam-Prd-Cons-I	Fiberglass Board	ST
CFC-12	Retail Food	Rtrft Exstg Sys to CFC-22/	ST
CFC-12	Rgd PU Foam-Spd-Cns-In	Fiberglass Board	ST
CFC-11	Rgd PU Foam-Spd-Cns-In	Fiberglass Board	ST
CFC-12	Bee Hive Fumigant-DOA	Explosion Proof Cond/Recl	ST
CFC-12	Ext PS Bdstk	Other Sheathing Materials	ST
Halon 1211	TFCiv FlamLqd	Use Sprinkler Back-Up	ST
CFC-12	Refrigerators	Modified Stirling Cycle	ST
Halon 1211	TFCiv FlamLqd	Incr Personnel Training	ST
CFC-11	Rgd PU Foam-BStk-Cns-I	Other Insulation materials	ST
CFC-12	Freezers	Modified Stirling Cycle	ST

Preliminary analysis of controls; subject to revision.

CHEMICAL SUBSTITUTES

- DuPont claims substitutes (123 and 134a can reach market in 5 years)* at 1-1/2 to 6 times current price <u>if financial incentives exist</u>

- Contractor study findings

  -- CFC-123 appears good substitute for CFC-11 (but much lower ozone depleting potential)
  -- CFC-134a appears excellent substitute for CFC-12 (but no ozone depleting potential)
  -- Many countries and companies have 134a and 123 patents
  -- Preliminary toxicology testing encouraging
  -- Costs likely to be higher than CFC-11 and -12 even in long-term

- International substitutes panel

  -- Includes industrial and academic chemists from many countries
  -- Discussion has identified additional substitutes
  -- Discussion indicates keys to substitute availability are:
     - Toxicology testing
     - Use testing
     - Adequate incentives for firms to make R&D investments

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* DuPont Fluorocarbon/Ozone Update, March, 1987.

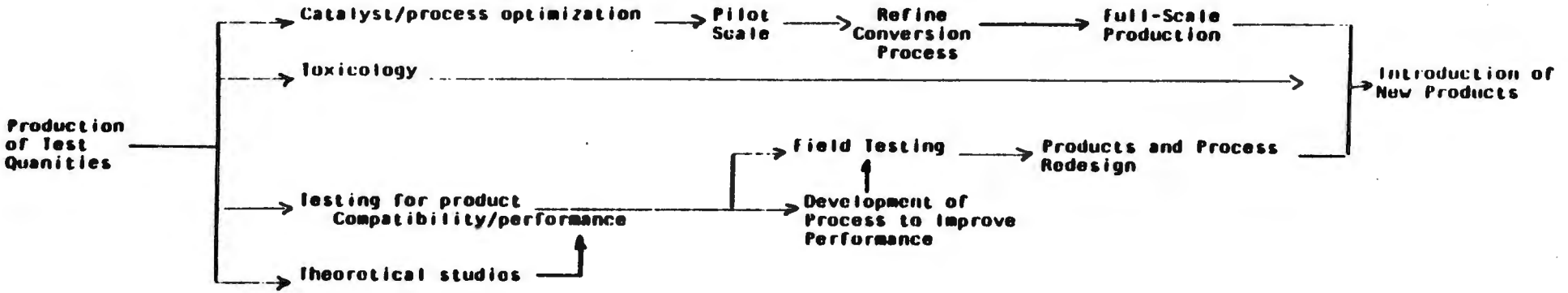
STATUS OF CHEMICAL SUBSTITUTES DEVELOPMENT

Compound	Potential Applications	Toxicology	Availability for Testing
CFC-123	Blowing Agent Refrigerant Solvent	Low	Currently being sold in small quantities by Halocarbon Corp.
CFC-124	Refrigerant Foam Blowing	Low	2 years
CFC-125	Refrigerant	Unknown	2 years
CFC-132b	Cleaning Agent	Incomplete	2 years
CFC-134a	Refrigerant	Incomplete	6 months
CFC-141b	Propellant Blowing Agent	Incomplete	Small quantity available
CFC-143a	Refrigerant	Incomeplete	2 years

Source: Fluorocarbon/Ozone Update. DuPont. March. 1987

CRITICAL PATH FOR SUBSTITUTES DEVELOPMENT

IS DIFFICULT TO COMPRESS



This path can occur in 5-7 years, but is difficult to compress

POTENTIAL MID-TERM CONTROL OPTIONS

Compound	Application Name	Control Option Description	Available in Period
1. Controls costing less than $.15 reduce compound use by 35% *			
Halon 1301	TFCiv Elect	Use Alt Test Agent	MT
Halon 1301	Local App Syst	Use Non-Destructive Test	MT
Halon 1301	TFCiv Elect	Use Non-Destructive Test	MT
Halon 1211	Local App Syst	Use Non-Destructive Test	MT
Halon 1211	TF Military	Use Alt Test Agent	MT
Halon 1301	TFCiv Other	Use Alt Test Agent	MT
Halon 1211	TFCiv Elect	Use Non-Destructive Test	MT
Halon 1211	TFCiv FlamLqd	Use Non-Destructive Test	MT
Halon 1301	Local App Syst	Use Alt Test Agent	MT
Halon 1211	Local App Syst	Use Alt Test Agent	MT
Halon 1301	Prt Military	Use Non-Destructive Test	MT
Halon 1211	TFCiv Elect	Use Alt Test Agent	MT
Halon 1301	PrtCiv Elect	Use Alt Test Agent	MT
Halon 1301	TFCiv FlamLqd	Use Non-Destructive Test	MT
Halon 1301	Prt Military	Use Alt Test Agent	MT
Halon 1211	TFCiv Other	Use Alt Test Agent	MT
Halon 1301	PrtCiv General	Use Non-Destructive Test	MT
Halon 1211	TFCiv FlamLqd	Use Alt Test Agent	MT
Halon 1211	TF Military	Use Non-Destructive Test	MT
Halon 1301	TF Military	Use Alt Test Agent	MT
Halon 1211	Prt Military	Use Non-Destructive Test	MT
Halon 1301	PrtCiv FlamLqd	Use Non-Destructive Test	MT
Halon 1211	Prt Military	Use Alt Test Agent	MT
Halon 1301	TF Military	Use Non-Destructive Test	MT
Halon 1211	PrtCiv FlamLqd	Use Non-Destructive Test	MT
Halon 1301	TFCiv Other	Use Non-Destructive Test	MT
Halon 1211	PrtCiv Resid	Use Non-Destructive Test	MT
Halon 1301	PrtCiv Resid	Use Alt Test Agent	MT
Halon 1301	PrtCiv Resid	Use Non-Destructive Test	MT
Halon 1301	PrtCiv Elect	Use Non-Destructive Test	MT
Halon 1211	TFCiv Other	Use Non-Destructive Test	MT
Halon 1301	PrtCiv General	Use Alt Test Agent	MT
Halon 1211	PrtCiv Resid	Use Alt Test Agent	MT
Halon 1211	PrtCiv FlamLqd	Use Alt Test Agent	MT

* Includes short-term controls (not listed).

Preliminary analysis of controls; subject to revision.

POTENTIAL MID-TERM CONTROL OPTIONS (CONTINUED)

Compound	Application Name	Control Option Description	Available in Period
Halon 1301	TFCiv FlamLqd	Use Alt Test Agent	MT
Halon 1301	PrtCiv FlamLqd	Use Alt Test Agent	MT
CFC-12	Mobile Air Conditioner	Improved Control of Leakag	MT
CFC-12	Animal Labs	CFC-134A/EO Mixture	MT
CFC-12	Non-Commercial R&D Lab	CFC-134A/EO Mixture	MT
Halon 1211	PrtCiv Elect	Use Alt Test Agent	MT
Halon 1211	PrtCiv General	Use Alt Test Agent	MT
CFC-12	Commercial R&D Labs	CFC-134A/EO Mixture	MT
CFC-12	Medical Equipment	CFC-134A/EO Mixture	MT
CFC-12	Pharmaceutical	CFC-134A/EO Mixture	MT
CFC-12	Hospitals	CFC-134A/EO Mixture	MT
CFC-12	Contract Sterilization	CFC-134A/EO Mixture	MT
CFC-12	Spice fumigant	CFC-134A/EO Mixture	MT
Halon 1211	TFCiv Other	Use Alt Tst to Repl Dschg	MT
CFC-12	Libraries	CFC-134A/EO Mixture	MT
Halon 1211	TF Military	Use Alt Tst to Repl Dschg	MT
Halon 1211	Local App Syst	Use Alt Tst to Repl Dschg	MT
Halon 1211	TFCiv Elect	Use Alt Tst to Repl Dschg	MT
CFC-12	Ext PS Sht-Stck Fd Try	Hydrocarbon Blowing Agent	MT
CFC-12	Ext PS Sht-Egg Crtns	Hydrocarbon Blowing Agent	MT
CFC-12	Ext PS Sht-Sgl Srvc	Hydrocarbon Blowing Agent	MT
CFC-12	Ext PS Sht-SS Hngd Cnt	Hydrocarbon Blowing Agent	MT
CFC-12	Ext PS Sht-Stck Fd Try	Pent Blwng Agnt w/o Carb A	MT
CFC-12	Ext PS Sht-Sgl Srvc	Pent Blwng Agnt w/o Carb A	MT
CFC-12	Ext PS Sht-Egg Crtns	Pent Blwng Agnt w/o Carb A	MT
CFC-12	Ext PS Sht-SS Hngd Cnt	Pent Blwng Agnt w/o Carb A	MT
CFC-12	Ext PS Sht-Stck Fd Try	Hydr Blwng Agnt with Carb	MT
CFC-12	Ext PS Sht-Egg Crtns	Hydr Blwng Agnt with Carb	MT
CFC-12	Ext PS Sht-Sgl Srvc	Hydr Blwng Agnt with Carb	MT
CFC-12	Ext PS Sht-SS Hngd Cnt	Hydr Blwng Agnt with Carb	MT
CFC-12	Ext PS Sht-Stck Fd Try	Pent Blwng Agnt with Carb	MT
CFC-12	Ext PS Sht-Egg Crtns	Pent Blwng Agnt with Carb	MT
CFC-12	Ext PS Sht-Sgl Srvc	Pent Blwng Agnt with Carb	MT
CFC-12	Ext PS Sht-SS Hngd Cnt	Pent Blwng Agnt with Carb	MT
Halon 1211	PrtCiv Elect	Use Non-Destructive Test	MT
Halon 1301	TFCiv Other	Use Alt Tst to Repl Dschg	MT
Halon 1301	TF Military	Use Alt Tst to Repl Dschg	MT

Preliminary analysis of controls; subject to revision.

POTENTIAL MID-TERM CONTROL OPTIONS (CONTINUED)

Compound	Application Name	Control Option Description	Available in Period
Halon 1301	TFCiv FlamLqd	Use Alt Tst to Repl Dschg	MT
Halon 1301	TFCiv Elect	Use Alt Tst to Repl Dschg	MT
Halon 1301	Local App Syst	Use Alt Tst to Repl Dschg	MT
CFC-12	Ext PS Sht-Sgl Srvc	Expandable bead products;	MT
CFC-12	Ext PS Sht-SS Hngd Cnt	Paperboard containers, sol	MT
CFC-12	Bee Hive Fumigant-DOA	CFC-134A/EO Mixture	MT
2. Controls costing less than $.30 reduce compound use by 40% *			
CFC-12	Ext PS Sht-Stck Fd Try	CFC/CO2 Blowing Agent	MT
CFC-12	Ext PS Sht-Sgl Srvc	CFC/CO2 Blowing Agent	MT
CFC-12	Ext PS Sht-Egg Crtns	CFC/CO2 Blowing Agent	MT
CFC-12	Ext PS Sht-SS Hngd Cnt	CFC/CO2 Blowing Agent	MT
Halon 1301	TFCiv Other	Segment the System	MT
Halon 1211	TFCiv Other	Use Lwr Conc Req't in Dsch	MT
CFC-11	Flex PU Foam-Slabstock	Formic Acid Process	MT
CFC-12	Ext PS Sht-Stck Fd Try	Carbon Adsorption	MT
CFC-12	Ext PS Sht-Egg Crtns	Carbon Adsorption	MT
CFC-12	Ext PS Sht-Sgl Srvc	Carbon Adsorption	MT
CFC-12	Ext PS Sht-SS Hngd Cnt	Carbon Adsorption	MT
CFC-12	Ext PS Sht-Stck Fd Try	Incinerate Plant Exhaust	MT
CFC-12	Ext PS Sht-Egg Crtns	Incinerate Plant Exhaust	MT
CFC-12	Ext PS Sht-Sgl Srvc	Incinerate Plant Exhaust	MT
CFC-12	Ext PS Sht-SS Hngd Cnt	Incinerate Plant Exhaust	MT
CFC-11	Rgd PU Foam-BStk-Cns-I	Carbon Adsorption	MT
CFC-11	Rgd PU Foam-BdStk-Furn	Carbon Adsorption	MT
CFC-11	Rgd PU Foam-BStk-Cns-B	Carbon Adsorption	MT
Halon 1301	TFCiv Other	Use Lwr Conc Req't in Dsch	MT
3. Controls costing less than $1.90 reduce compound use by 50% *			
Halon 1301	TF Military	Use Lwr Conc Req't in Dsch	MT
Halon 1301	TF Military	Segment the System	MT
CFC-11	Flex PU Foam-Molded	Formic Acid Process	MT
Halon 1211	TF Military	Use Lwr Conc Req't in Dsch	MT
Halon 1301	TFCiv FlamLqd	Use Lwr Conc Req't in Dsch	MT
Halon 1301	Local App Syst	Use Lwr Conc Req't in Dsch	MT

* Includes short-term controls (not listed).

Preliminary analysis of controls; subject to revision.

POTENTIAL MID-TERM CONTROL OPTIONS (CONTINUED)

Compound	Application Name	Control Option Description	Available in Period
Halon 1301	TFCiv Elect	Use Lwr Conc Req't in Dsch	MT
Halon 1211	TFCiv Other	Segment the System	MT
CFC-11	Flex PU Foam-Slabstock	Carbon Adsorption/Recycle	MT
CFC-11	Flex PU Foam-Slabstock	Vertical Foam Chamber & Ca	MT
Halon 1211	Local App Syst	Use Lwr Conc Req't in Dsch	MT
CFC-11	Rgd PU Foam-BStk-Cns-I	Incinerate Plant Exhaust	MT
CFC-11	Rgd PU Foam-BdStk-Furn	Incinerate Plant Exhaust	MT
Halon 1301	Local App Syst	Segment the System	MT
CFC-11	Rgd PU Foam-BStk-Cns-B	Incinerate Plant Exhaust	MT
Halon 1211	TFCiv Elect	Use Lwr Conc Req't in Dsch	MT
Halon 1301	TFCiv Elect	Segment the System	MT
Halon 1301	TFCiv FlamLqd	Segment the System	MT
CFC-12	Mobile Air Conditioner	CFC-22/142B	MT
4. Controls costing less than $6.60 reduce compound use by 60% *			
CFC-11	Rgd PU Foam-BStk-Cns-B	Insulation Brick	MT
CFC-11	Rgd PU Foam-Lam-Cons-B	Insulation Brick	MT
Halon 1211	TF Military	Segment the System	MT
CFC-12	Mobile Air Conditioner	CFC-22	MT
CFC-11	Rgd PU Foam-Lam-Cons-B	Carbon Adsorption	MT
CFC-12	Freezers	Reciprocating Compressors	MT
CFC-12	Refrigerators	Reciprocating Compressors	MT
Halon 1211	Local App Syst	Segment the System	MT
Halon 1301	TFCiv Other	Use Halon Detctn & Ctrl Eq	MT
CFC-12	Ext PS Bdstk	Carbon Adsorption	MT
Halon 1301	TF Military	Use Halon Detctn & Ctrl Eq	MT
Halon 1211	TFCiv Elect	Segment the System	MT
Halon 1301	TFCiv FlamLqd	Use Halon Detctn & Ctrl Eq	MT
Halon 1301	Local App Syst	Use Halon Detctn & Ctrl Eq	MT
Halon 1301	TFCiv Elect	Use Halon Detctn & Ctrl Eq	MT
CFC-12	Ext PS Bdstk	Insulation Brick	MT
Halon 1211	TFCiv Other	Use Halon Detctn & Ctrl Eq	MT
Halon 1211	TF Military	Use Halon Detctn & Ctrl Eq	MT
Halon 1211	Local App Syst	Use Halon Detctn & Ctrl Eq	MT
CFC-12	Refrig Transport	CFC-22/142B	MT
Halon 1211	TFCiv Elect	Use Halon Detctn & Ctrl Eq	MT

* Includes short-term controls (not listed).

Preliminary analysis of controls; subject to revision.

POTENTIAL MID-TERM CONTROL OPTIONS (CONTINUED)

Compound	Application Name	Control Option Description	Available in Period
CFC-12	Refrigerators	CFC-22/142B	MT
CFC-11	Rgd PU Foam-Lam-Cons-B	Incinerate Plant Exhaust	MT
CFC-12	Freezers	CFC-22/142B	MT
CFC-12	Ext PS Bdstk	Incinerate Plant Exhaust	MT
CFC-12	Dehumidifiers	CFC-22/142B	MT
Halon 1211	TFCiv FlamLqd	Use Alt Tst to Repl Dschg	MT
CFC-12	Ice Machines	CFC-22/142B	MT
CFC-12	Refrig Transport	CFC-22	MT
CFC-12	Refrig Transport	CFC-502	MT
CFC-12	Refrigerators	CFC-22	MT
CFC-12	Refrigerators	CFC-502	MT
CFC-12	Freezers	CFC-22	MT
5. All controls reduce compound use by 76% *			
CFC-12	Freezers	CFC-502	MT
Halon 1301	Prt Military	Use Smltrs to Trn Prsnnl	MT
CFC-12	Dehumidifiers	CFC-22	MT
CFC-12	Dehumidifiers	CFC-502	MT
CFC-12	Ice Machines	CFC-22	MT
CFC-12	Ice Machines	CFC-502	MT
CFC-12	Vending Machines	CFC-22/142B	MT
CFC-12	Water Coolers	CFC-22/142B	MT
CFC-11	Flex PU Foam-Molded	Carbon Adsorption/Recycle	MT
CFC-12	Ice Machines	Modified Stirling Cycle	MT
Halon 1211	TFCiv FlamLqd	Use Lwr Conc Req't in Dsch	MT
Halon 1211	Prt Military	Use Smltrs to Trn Prsnnl	MT
CFC-12	Water Coolers	Modified Stirling Cycle	MT
CFC-12	Vending Machines	CFC-22	MT
CFC-12	Water Coolers	CFC-22	MT
CFC-12	Vending Machines	CFC-502	MT
CFC-12	Water Coolers	CFC-502	MT
Halon 1211	TFCiv FlamLqd	Segment the System	MT
Halon 1211	PrtCiv General	Use Non-Destructive Test	MT
CFC-12	Vending Machines	Modified Stirling Cycle	MT
Halon 1211	TFCiv FlamLqd	Use Halon Detctn & Ctrl Eq	MT

* Includes short-term controls (not listed).

Preliminary analysis of controls; subject to revision.