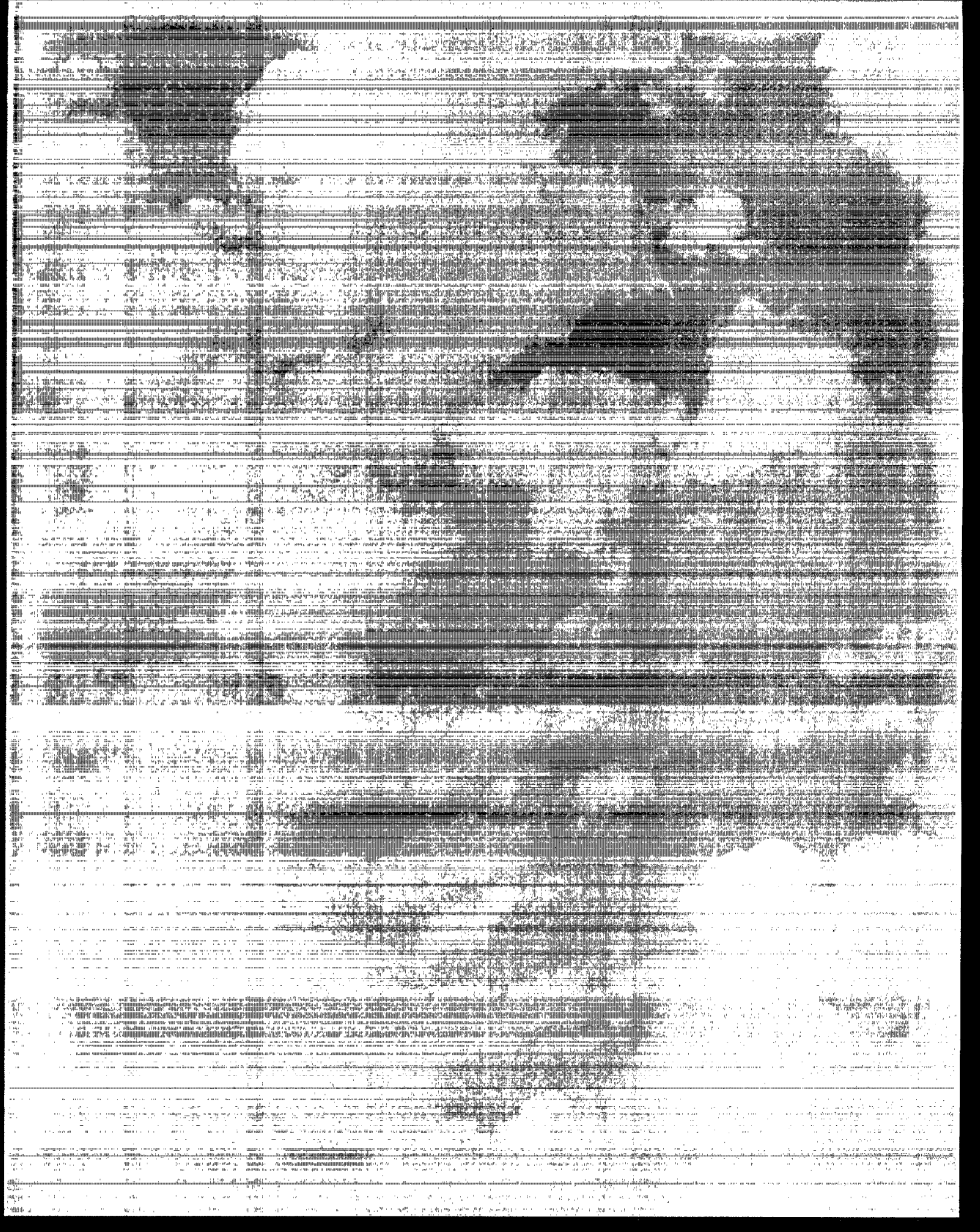




# Champions of the World

## Stratospheric Ozone Protection Awards





# A Note From the Assistant Administrator

**I**t is entirely fitting that the U.S. Environmental Protection Agency (EPA) recognize the individuals and organizations that have been champions of stratospheric ozone protection. Without these champions, ozone layer protection would have been slower, more costly, and less environmentally successful. Since 1990, EPA has rewarded extraordinary leadership with the Stratospheric Ozone Protection Award. "Champions of the World" further honors these achievements with detailed descriptions of individual and team awards. These profiles of environmental leadership impress and inspire us all to redouble our efforts to protect the earth for future generations.

I am particularly proud of the stratospheric ozone protection milestones that occurred during my watch as EPA Assistant Administrator of Air and Radiation. These milestones include completing the phaseout of halons in 1993 and chlorofluorocarbons (CFCs) in 1995. We have also established an orderly path towards phaseout for methyl bromide, the last major ozone-depleting compound to be identified.

September 16, 1997, marks the 10th anniversary of the Montreal Protocol on Substances that Deplete the Ozone Layer. Before then, manufacturers of CFCs and many of their industrial customers argued that CFCs had not yet been proven to destroy stratospheric ozone, that these chemicals were irreplaceable in the many products containing or made with them, that there were no safe substitutes, and that potential alternatives would be ineffective and costly. Today it is clear that these claims were invalid, but unfortunately similar claims are still being repeated in some quarters in arguments for delaying action to protect against climate change. Thanks to the champions described in this book, we are effectively saving the ozone layer. And thanks to their efforts we can find reasons for technical optimism in the daunting task of protecting the climate.

Mary D. Nichols

Assistant Administrator for Air and Radiation  
United States Environmental Protection Agency  
November 1993 to August 1997

# Acknowledgments

The primary authors of this book were Dr. Stephen O. Andersen, Deputy Director, Stratospheric Protection Division (SPD), U.S. Environmental Protection Agency (EPA); Clayton Frech, Environmental Protection Specialist, SPD; and E. Thomas Morehouse, Institute for Defense Analysis. Garren Campbell Bird and Philip Nicholas completed editing of the book while working as EPA Interns.

We are indebted to many other substantial contributors, including Ward Atkinson, Suntest; G. Victor Buxton, Environment Canada; Elizabeth Cook, World Resources; Catharine Cyr, U.S. Navy; Dr. Stephen DeCanio, University of California; David Doniger, EPA; Yuichi Fujimoto, Japan Industrial Conference for Ozone Layer Protection; John Hoffman, EPA; Paul Horwitz, EPA; Drusilla Hufford, EPA; Dr. William Kenyon, Global Centre for Process Change; Dr. Lambert Kuijpers, UNEP Technology and Economic Assessment Panel; Jeffrey Levy, EPA; Jean Lupinacci, EPA; Denise Mauzerall, Harvard University; Alan Miller, University of Maryland; Peter Mullenhard, U.S. Navy CFC and Halon Clearinghouse; Simon Oulouhojian, Mobile Air Conditioning Society; Sally Rand, EPA; Dr. William Rhodes, EPA; Kevin Rosseel, EPA; Stephen Seidel, EPA; Gary Taylor, Taylor-Wagner; Dr. Helen Tope, Victoria Australia Environmental Protection Authority; and Mia Zmud, EPA.

We are also indebted to the individual, association, and corporate winners of the Stratospheric Protection Award who submitted text and reviewed early drafts of this book. We particularly thank those Award winners who contributed the quotes that appear in boxed text, including James A. Baker, Jim Beyreis, Joseph W. Bow, Ross Bowman, Nicholas T. Castellucci, David Chittick, Elizabeth Cook, David Doniger, Arthur D. FitzGerald, Don Grob, Kaichi Hasegawa, John Hoffman, Robert G. Holcomb, Dr. Margaret Kerr, Alan Miller, E. Thomas Morehouse, Tsuneya Nakamura, Dick Nusbaum, Rick Osterman, Ralph Ponce de Leon, Dr. Mostafa K. Tolba, Stephen Seidel, Ronald W. Sibley, Gary D. Vest, and F.A. Vogelsberg.



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# Foreword

Each year, a few individuals, companies, and organizations from around the world earn the Stratospheric Ozone Protection Award. Since the program began in 1990, 320 winners from 25 countries—Australia, Belgium, Brazil, Canada, Chile, France, Germany, India, Ireland, Japan, Kenya, Malaysia, Malta, Mexico, Netherlands, Norway, Poland, Singapore, Sweden, Switzerland, Taiwan, Thailand, United Kingdom, United States, and Venezuela—have been honored.

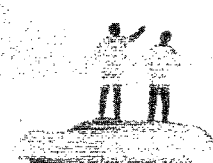
The Awards program recognizes exceptional leadership, personal dedication, and technical achievements in eliminating ozone-depleting substances (ODSs). The Awards distinguish those who have accomplished the extraordinary. They also serve as reminders to stand up for beliefs, as encouragement to take risks, and as inspiration to protect the global environment.

This report covers the impressive and varied accomplishments of the Stratospheric Ozone Protection Award winners from 1990 to 1996. Inside you will find a summary of each Award winner's activity, a time line detailing corporate leadership "firsts," and essays covering industry sectors that were successful in eliminating ODSs. These essays are concise illustrations; they are not intended to cover all the sectors that have ever used ozone-depleting chemicals, or to describe all Award winners.

You are encouraged to contact the winners. Ask them what they did to earn their Award, how they did it, and what they learned. Most of them will tell you that they sacrificed significant time and energy to protect the earth, but that it was a highlight of their professional and personal lives. Leadership is its own reward.

Dr. Stephen O. Andersen

Deputy Director, Environmental Protection Agency  
Stratospheric Ozone Protection



# Acronym List

A/C	air-conditioning
AEA	American Electronics Association
AFB	Air Force Base
AFCAM	Association of Fluorocarbon Consumers and Manufacturers of Australia
AIA	Aerospace Industries Association
APTOC	Aerosol Products, Sterilants, Miscellaneous Uses and Carbon Tetrachloride Technical Options Committee
ARE	Alternative Refrigerants Evaluation Program Task Force and Technical Committee
ARI	Air-Conditioning & Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
AT&T	American Telephone and Telegraph
BP	British Petroleum
CANACINTRA	Camara Nacional de la Industria de la Transformacion
CDNSWC	Carderock Division of the Naval Surface Warfare Center
CECOM	U.S. Army Communications-Electronics Command
CEITWG	Countries with Economies in Transition Working Group
CFC	chlorofluorocarbon
CSIRO	Commonwealth Scientific and Industrial Research Organization (Australia)
DASCEM	Australia's Department of Administrative Services Centre for Environmental Management
DEC	Digital Equipment Corporation
DoD	U.S. Department of Defense
EMPF	Electronics Manufacturing Productivity Facility
EOC	Economics Options Committee
EPA	U.S. Environmental Protection Agency
FAA	U.S. Federal Aviation Administration
FDA	U.S. Food and Drug Administration
FOE	Friends of the Earth
FPI	Foodservice and Packaging Institute
FTOC	Foams Technical Options Committee
HAG	U.K. Halon Users Group
HARC	Halon Alternatives Research Corporation



HBFC	hydrobromofluorocarbon
HCFC	hydrochlorofluorocarbons
HFC	hydrofluorocarbon
HRAI	Heating, Refrigeration, and Air-Conditioning Institute of Canada
HRBSC	Halon Recycling & Banking Support Committee
HTOC	Halons Technical Option Committee
HUNC	U.K. Halon Users National Consortium
IBM	International Business Machines
ICBM	Intercontinental Ballistic Missile
ICEL	International Cooperative for Environmental Leadership
ICIP	ICI Polyurethanes
ICOLP	Industry Cooperative for Ozone Layer Protection
IIR/IIF	International Institute of Refrigeration/Institut International Du Froid
IMACA	International Mobile Air-Conditioning Association
IPC	Institute of Interconnecting and Packaging Electronic Circuits
ISO	International Standards Organization
ITRI	Industrial Technology Research Institute
IUWG	Inadvertent Uses Working Group
JEMA	Japan Electrical Manufacturer's Association
JICC	Japan Industrial Conference on Cleaning
JICOP	Japan Industrial Conference for Ozone Layer Protection
LAWG	Laboratory and Analytical Uses Working Group
MACS	Mobile Air-Conditioning Society
MBTOC	Methyl Bromide Technical Options Committee
MDI	metered-dose inhaler
MITI	Ministry of International Trade and Industry
NAFED	National Association of Fire Equipment Distributors
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NAVAIR	Naval Air Systems Command
NAVSEA	Naval Sea Systems Command
NFPA	National Fire Protection Association



NGO	nongovernmental organization
NOAA	National Oceanographic and Atmospheric Administration
NRDC	Natural Resources Defense Council
NRL	U.S. Naval Research Laboratory
ODP	ozone-depletion potential
ODS	ozone-depleting substance
PATF	Process Agents Task Force
PAWG	Process Agents Working Group
PCB	printed circuit board
PIMA	Polyisocyanurate Insulation Manufacturers Association
PSB	Singapore Productivity and Standards Board
PUF	polyurethane foam
RSES	Refrigeration Service Engineers Society
RTF	Replenishment Task Force
RTOC	Refrigeration, Air Conditions and Heat Pump Technical Options Committee
SAE	Society of Automotive Engineers
SAP	Science Assessment Panel
SISIR	Singapore Institute of Standards and Industrial Research
SPO	System Program Office
STOC	Solvents, Coatings, and Adhesives Technical Options Committee
TEAP	Technology and Economic Assessment Panel
3M	Minnesota Mining and Manufacturing
TOC	Technical Options Committee
UL	Underwriters Laboratories
UNEP	United Nations Environment Programme
UV	ultraviolet
VOC	volatile organic compound



# EPA Stratospheric Ozone Protection Awards

**T**he U.S. Environmental Protection Agency's (EPA's) Stratospheric Protection Division established the Stratospheric Ozone Protection Awards to recognize exceptional leadership, personal dedication, and technical achievements in eliminating ozone-depleting substances (ODSs). Since 1990, some 320 individuals and organizations from 25 countries have earned this prestigious award. Winners come from Australia, Belgium, Brazil, Canada, Chile, France, Germany, India, Ireland, Japan, Kenya, Malaysia, Malta, Mexico, Netherlands, Norway, Poland, Singapore, Sweden, Switzerland, Taiwan, Thailand, United Kingdom, United States, and Venezuela.

The ozone layer forms a thin shield in the stratosphere, protecting life on Earth from harmful ultraviolet (UV) radiation. The strong scientific consensus is that certain manufactured chemicals are destroying this protective layer. These substances are transported by wind currents to the stratosphere. There, UV radiation breaks them apart, releasing chlorine and bromine atoms that destroy ozone. As the ozone layer is destroyed, UV radiation increases the incidence of skin cancer and cataracts and weakens human immune systems. This radiation also endangers the environment by threatening important crops and natural ecosystems. ODSs, including chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), halons, carbon tetrachloride, methyl bromide, and methyl chloroform, are used widely in industry and elsewhere as fire extinguishing agents, foams, pesticides, refrigerants, and solvents, and to produce or operate numerous other products.

Around the world, individuals, organizations, businesses and governments are working to protect the ozone layer. Over 150 nations have ratified the Montreal Protocol, agreeing to phase out the production of ODSs. In November 1992, the parties revised the Protocol, accelerating the phaseout of CFCs, carbon tetrachloride, and methyl chloroform to January 1996 and halons to January 1994. In December 1995, the parties to the Montreal Protocol targeted methyl bromide and HCFCs for a complete phaseout by 2010.

"Tending to world environmental problems—such as protecting the ozone layer, preventing global warming, and developing countermeasures for acid rain—is the common responsibility of all of us on Earth, and is a task which should be confronted by concentrating the wisdom of mankind. For the purpose of solving the intrinsic problem, two concepts become important: 1) that this challenge now exceeds national borders, and 2) that countries, businesses, or even individuals behave as though the problem is their own. There are many, many problems which mankind must overcome, but I think that the kind of global technological cooperation experienced during the ozone layer protection movement can serve as a valuable model for similar activities in the future."

*Tsuneya Nakamura*  
*Former President*  
*Seiko Epson Corporation*





Title VI of the 1990 U.S. Clean Air Act mandates a comprehensive national program to protect the ozone layer. Since then, EPA has accelerated this effort and eliminated the production of most ODSs (with limited exceptions for essential uses). EPA has also implemented other programs to protect the ozone layer, including recycling refrigerants, labeling products, banning nonessential uses, and reviewing compound substitutes to determine their environmental acceptability.

Applicants for the Stratospheric Protection Award must demonstrate originality and public purpose, persuasive moral and/or organizational leadership, and must actually eliminate chemical emissions. Nominations are reviewed by the past winners, who make recommendations to EPA. Candidates may be from anywhere in the world and can come from the public or private sector.



# Corporate Leadership and Ozone Layer Protection

**B**efore the Montreal Protocol was signed in 1987, much public debate arose about whether CFC emissions were depleting the ozone layer. Initially, CFC manufacturers and many of their industrial customers aggressively fought against controls to restrict CFCs. They argued that scientists had not yet proven that CFCs destroyed stratospheric ozone, that no safe substitutes existed, that potential substitutes would be ineffective and costly, and that the products made with or containing CFCs were absolutely vital to society.

The **DuPont** company began changing its position in 1986 and by 1987 was advocating a global solution to stratospheric ozone protection. In September 1987, 16 founding countries signed the Montreal Protocol on Substances That Deplete the Ozone Layer (the Protocol). At the Montreal meeting, however, only the U.S. Air Force and a few small businesses expressed technical optimism that sufficient alternatives and substitutes could be successfully implemented to satisfy the 50 percent reduction in CFC use and freeze in halon production prescribed by the 1987 protocol.

By 1988, the ozone trends panel report by the **National Aeronautics and Space Administration (NASA)**, the **National Oceanographic and Atmospheric Administration (NOAA)**, and the **World Meteorological Organization** conclusively linked ozone depletion to ODSs, including CFCs and halons. The parties to the Protocol decided that technically and economically feasible steps should be taken to phase out ODSs. The availability of technical solutions and corporate support allowed the parties to make strong political decisions.

Corporate leadership played a key role in the negotiation of the original and subsequent Montreal Protocol phaseout schedules. Private and public leaders commercialized and implemented new technology eliminating the need for ODSs. As a result of this leadership, regulatory phaseout targets were more easily strengthened and achieved.

"Protection of the ozone layer was judged technically impossible until industry rolled up its sleeves and made it a priority. The Awards are a testimony to those who worked the hardest and accomplished the impossible. When you read about the extraordinary people and organizations you will begin to understand why and how business and environmental strategy can be merged. You will be inspired to join efforts to protect the global environment, including its fragile climate."

*Margaret Kerr (Award 1990)  
Vice President  
Nortel/Northern Telecom*



## Corporate Leadership "Firsts"

**1975** The first instance of U.S. corporate leadership for protection of the stratospheric ozone layer award occurred on June 18, 1975, when the **S.C. Johnson** company announced its plan of a corporate phaseout of CFCs as aerosol product propellants. This action preceded the Montreal Protocol by 12 years and was 2 years sooner than the May 1977 announcement by the U.S. Food and Drug Administration (FDA), the Consumer Product Safety Commission, and EPA that most CFC-based aerosol products would be banned in the United States. **S.C. Johnson** demonstrated that hydrocarbon propellants were more economical and that their customers preferred products that were protective of the ozone layer. By March 1978, when EPA banned CFCs as propellants in cosmetic products, consumers had already virtually halted the purchase of products that contained CFCs.

**1978** The United States banned the manufacture and sale of most cosmetic products containing CFCs. Following the U.S. action, Canada banned production and import, and Norway and Sweden (nonproducing, importing countries) banned import.

**1985** Vienna Convention for the Protection of the Ozone Layer was held.

"Through the 20-plus year history of the stratospheric ozone issue, DuPont has been on the receiving end from many organizations due to our significant involvement in the manufacture and sale of ozone-depleting substances. DuPont's involvement has not always been praised, so we were very proud to have been an active leader in the CFC industry effort to phase out CFCs in a time frame that most of industry believed was unattainable."

*F.A. (Tony) Vogelsberg, Jr.  
Environmental Manager  
DuPont Fluoroproducts*

**1986** The Natural Resources Defense Council (NRDC) brought suit against EPA for failing to discharge its responsibility under the Clean Air Act to protect the ozone layer. EPA agreed to take unilateral action unless an international agreement could be reached. This motivated U.S. industry to support an international agreement.

**1987** By 1987, scientific evidence of potential ozone depletion from continued growth in CFC emissions and predictions of the ecological and human health consequences increased to the point that **DuPont** (Award 1990) and the **Alliance for Responsible CFC Policy** (Award 1990) began the international approach to protecting stratospheric ozone. This action encouraged and motivated CFC manufacturers and customers to reevaluate their corporate positions.



In May 1987, an EPA-sponsored panel of experts from Germany, Japan, the United Kingdom, and the United States concluded that the absence of a market for higher priced chemicals—rather than technical or environmental issues—was the principal barrier to commercialization of less harmful replacement chemicals.

**Dr. Masaaki Yamabe** (Award 1993) announced that **Asahi Glass** (Award 1994) could produce HCFC-225 as a replacement for CFC-113.

The U.S. Air Force, with the technical support of **Major E. Thomas Morehouse, Jr.**, (Award 1991), was principally responsible for including halons in the 1987 Protocol through its leadership in developing technologies for reducing halon use, eliminating discharges from testing and training, and reducing accidental discharges.

The Montreal Protocol of Substances That Deplete the Ozone Layer was signed by the following 24 nations and the Economic Union on September 16, 1987:

Belgium	Italy	Poland
Canada	Japan	Senegal
Denmark	Kenya	Sweden
Egypt	Mexico	Switzerland
Finland	Netherlands	Togo
France	New Zealand	United Kingdom
Germany	Norway	United States of America
Ghana	Panama	Venezuela

**1988** In January 1988 at the **Conservation Foundation/EPA/Environment Canada** “International Conference on Alternatives and Substitutes to CFCs and Halons,” **AT&T** (Award 1992)—with the leadership of **David Chittick** (Award 1990) and **Dr. Leslie Guth** (Award 1990)—and **Petroferm** and inventor **Dr. Michael Hayes** (Award 1993) announced a new semi-aqueous solvent made from oranges that cleaned as well as, or better than, CFC-113. This announcement signaled that CFCs were no longer essential for sophisticated electronics manufacturing and launched a global quest for new manufacturing processes. Electronics corporations began to take decisive action.

**Digital Equipment Corporation (DEC)** (Award 1990) successfully used aqueous cleaning techniques and then actively distributed the “how-to” information.

**Dr. Mostafa Tolba** (Award 1993), **G. Victor Buxton** (Award 1996), and **Dr. Stephen O. Andersen** organized the **United Nations Environment Programme (UNEP)** Technical Conference in The Hague, Netherlands, to demonstrate the importance of industry participation in assessing the feasibility of better protecting the ozone layer.

The **Foodservice and Packaging Institute (FPI)** (Award 1990), with the leadership of **Jack Buffington** from **Dolco Packaging** (Award 1990) and the support of **Elizabeth Cook** (**Friends of the Earth [FOE]**, Award 1991), **David Doniger** (**NRDC**, Award 1991), and **Alan Miller** (**World Resources Institute**, Award 1992), announced that U.S. foodservice packaging companies would phase out CFC use



"Because AT&T was the first to take a leadership role in the elimination of CFC solvents in its manufacturing processes, I had the special honor of being among the initial winners of this prestigious award. The Award was for leadership that was built on our confidence in the path-breaking work of engineers in the manufacturing facilities and at AT&T's Bell Laboratories. There are teams of unsung heroes around the world who helped protect the global environment. It gave me enormous pleasure to have been a part of this important work."

*David Chittick (Award 1990)*  
*Vice President*  
*AT&T*

by December 1988, the world's first voluntary national CFC phaseout.

Under the Leadership of Dr. Margaret Kerr (Award 1990) and Arthur FitzGerald (Award 1990), Nortel/Northern Telecom (Award 1991) and Seiko Epson (Awards 1992 and 1995) under the leadership of Hideaki Yasukawa (Award 1994), Yasuo Mitsugi (Award 1993), and Kaichi Hasegawa (Award 1996) announced corporate goals of a complete CFC-113 phaseout on accelerated schedules.

The Institute of Interconnecting and Packaging Electronic Circuits (IPC) (Award 1990) helped organize the benchmarking of CFC-113 solvent cleaning and the test protocol for substitute solvents. EPA agreed that new technology must clean "as good or better" than CFC and that the U.S. Department of Defense (DoD) would have final authority over its acceptance of any new technology.

Arthur FitzGerald (Award 1990) and Dr. Margaret Kerr (Award 1990) organized the Nortel/Northern Telecom (Award 1991) program for phasing out ODS solvents and chemicals, as well as the company's outreach program.

## 1989

By 1989, the Mobile Air-Conditioning Society (MACS) (Award 1990) led by Simon Oulouhojian (Award 1990); the Society of Automobile Engineers led by Ward Atkinson (Award 1990); automotive manufacturers, led by James Baker (Award 1990); and EPA, led by headquarters and Research Triangle Park scientists, developed a CFC recycling standard. Alfa Romeo, Aston Martin Lagonda, Audi, Austin Rover, BMW, Chrysler Corporation (Award 1992), Daihatsu, Excalibur, Ford (Awards 1992 and 1994), Freightliner, General Motors (Award 1994), Grumman Olson, Honda, Hyundai, Isuzu, Jaguar, Maserati, Mazda, Mercedes-Benz (Award 1992), Mitsubishi, Navistar, Nissan Motor Company (Award 1991), Paccar, Peugeot, Porsche, Rolls-Royce, Rover, Saab, Subaru, Suzuki, Toyota (Award 1994), Volkswagen, Volvo (Award 1993), and Yugo accepted the recycling standard for servicing cars and light trucks under factory warranties. Chrysler Corporation (Award 1992), Ford (Awards 1992 and 1994), General Motors (Award 1994), Mercedes-Benz (Award 1992), Toyota (Award 1994), and Nissan Motor Company (Award 1991) announced that their franchised dealers would employ the new recycling technology.

In August 1989, Nissan Motor Company (Award 1991) became the first automobile manufacturer to announce its commitment to phase out all CFC use.

In July 1989, Woolworths Australia set a goal of halting the use of CFC refrigerants.



In October 1989, IPC (Award 1990) published the solvent test plan IPC-TR-580, which included the Phase 1 Benchmark test results that could be used to compare alternative cleaning processes. U.K. and Nordic verification teams patterned their efforts on the work of the **EPA/DoD/IPC Ad Hoc Solvent Working Group**. **Dr. Leslie Guth** (Award 1990) became chair of the Test Monitoring and Validation Team and monitored testing of new solvents. **AlliedSignal** (Award 1993), led by **Joel E. Rodgers**, submitted the first solvent for testing and earned the honor of being first to pass—cleaning “as good or better” than CFC-113. Twenty other solvents were tested and approved within the next year.

Prime Minister **Margaret Thatcher** and the United Kingdom hosted the global conference to encourage corporate and government leadership in protecting the ozone layer. U.S. President **Ronald Reagan** consulted with Prime Minister **Thatcher**.

The First Meeting of the Parties to the Montreal Protocol was held from May 2 to 5 in Helsinki, Finland.

The first **UNEP Technology Assessment Panel**, including five **Technical Options Committees (TOCs)**, was formed by 110 experts from 22 countries (Australia, Austria, Belgium, Brazil, Canada, China, Denmark, Egypt, France, Germany, India, Italy, Japan, Netherlands, New Zealand, Norway, Sweden, Switzerland, Union of Soviet Socialist Republics, United Kingdom, United States, and Venezuela).

The **Industry Cooperative for Ozone Layer Protection (ICOLP)**, now reorganized as the **International Cooperative for Environmental Leadership (ICEL)** (Awards 1991 and 1993), was founded to cooperate in eliminating ozone-depleting solvents. Founding members were **AT&T** (Award 1992), **The Boeing Company** (Awards 1992 and 1993), **DEC** (Award 1990), **Ford** (Awards 1992 and 1994), **General Electric**, **Honeywell** (Award 1994), **Motorola** (Awards 1991 and 1993), **Nortel/Northern Telecom** (Award 1991), and **Texas Instruments** (Awards 1993 and 1995). **Gary J. Shapiro** (**Electronics Industries Association**) and **Braden Allenby** (**AT&T**) masterminded the organization under the little-used National Cooperative Research Act of 1984. The first chair was **David Chittick** of **AT&T**.

The **Halon Alternatives Research Corporation (HARC)** (Award 1992) was founded by **Gary D. Vest**—then Deputy Assistant Secretary of the U.S. Air Force (**Environment, Safety, and Occupational Health**) (Award 1993)—and **Dr. Stephen O. Andersen** to encourage and coordinate the search for fire protection alternatives to halons. **Daniel Piliero** (**Piliero, Tobin & Mazza**) developed the legal framework under the National Cooperative Research Act of 1994.

Japanese industrial organizations established the **Conference for Promotion of the Rational Use of Specified CFCs**, which in 1990 was renamed the **Japan Industrial Conference for Ozone Layer Protection (JICOP)** (Award 1993). By the end of 1996 JICOP had 61 industrial organizations as members.



"I began my career as an environmentalist in the 1970s fighting with companies making and using CFCs. It was not a pleasant experience. In contrast, the spirit of cooperation engendered by the Montreal Protocol has been extremely rewarding and provides many lasting lessons. When people stop fighting and accept a common challenge, there is nothing we cannot accomplish. The greatest barriers are not technical or economic, but our beliefs and attitudes."

*Alan Miller (Award 1992)  
University of Maryland*

Ford (Awards 1992 and 1994) and IBM (Awards 1992 and 1993) established aggressive goals to eliminate CFCs from their worldwide manufacturing processes and products (Ford by 1993, IBM by year-end 1993).

The American Electronics Association unanimously adopted industry-wide goals to reduce CFC emissions 50 percent by 1993—5 years earlier than the 1987 Montreal Protocol—and to eliminate CFC emissions by 2000. They also pledged to reduce methyl chloroform emissions 40 percent by 2000.

The Australian Governments, with the leadership of the Association of Fluorocarbon Consumers and Manufacturers of Australia (AFCAM) (Award 1996), decided that halon production and import would be phased out by December 31, 1995.

## 1990 The first EPA Stratospheric Ozone Protection Awards were presented.

The Second Meeting of the Parties to the Montreal Protocol was held from June 27 to 29 in London, England. Amendments and Adjustments were passed that mandated a CFC phaseout in 2000 and a 1,1,1-trichloroethane (methyl chloroform) phaseout in 2005.

The DoD/EPA Ad Hoc Solvents Working Group, a panel of over 230 experts from industry and government, tested and certified that an Allied-Signal (Awards 1993 and 1996)-Genesolv/Baron Blakeslee HCFC cleaning solution is capable of cleaning printed circuit boards as well or better than CFC-113. The panel recommended that DoD specifications be revised to allow the use of products passing their cleaning performance test.

The National Fire Protection Association (NFPA) (Award 1990) eliminated halon testing requirements, clarified that training with halon was not required, and accelerated the acceptance of new alternatives.

DEC (Award 1990), with the encouragement of Polly T. Strife and Ann Fullerton, generously donated patented aqueous cleaning technology to the public domain in order to speed CFC elimination.





# 1991

Daikin, DuPont (Award 1990), ICI, and Showa Denko became the first companies to produce commercially HFC-134a, an alternative for automobile air-conditioning (A/C) and refrigeration.

Asahi Glass (Award 1994) completes the world's first HCFC-225 production plant.

In April 1991 Mercedes-Benz (Award 1992) became the world's first automobile manufacturer to introduce CFC-free A/C, a full year ahead of the competition.

Honda, Mazda, and Mercedes-Benz (Award 1992) joined Nissan Motor Company (Award 1991) in pledging CFC-free automobile manufacturing.

"The First International North Atlantic Treaty Organization (NATO) Conference on the Role of the Military in Protecting the Ozone Layer" was held in Williamsburg, Virginia, from September 11 to 13.

The Royal Norwegian Navy Material Command (Award 1992) announced the first military acceptance of alternatives for halons used on combat vessels. The announcement and subsequent work with NATO helped build necessary confidence in alternatives.

DoD, with the guidance and leadership of Joe Felty (Award 1990) of Texas Instruments, adopted MIL-STD-2000 (Revision A) permitting new and existing contracts to use non-ozone depleting solvents and cleaning processes for most electronics assemblies. DoD also recommended that CFC solvents "be phased out" by contractors and military maintenance organizations.

By 1991 the following electronics and precision products manufacturers had pledged CFC phaseouts: Apple Computer, Asahi Optical, Canon, Copol, Ericsson, Fujitsu, Hewlett Packard (Award 1994), Hitachi (Award 1991), Honeywell (Award 1994), IBM (Awards 1992 and 1993), Intel, Konica, Litton, Minolta, Mitsubishi Electric (Award 1994), Motorola (Awards 1991 and 1993), Nikon, Nippon Electric, Nortel/Northern Telecom (Award 1991), Olympus, Raytheon, Sanyo Electric (Award 1995), Seiko Epson (Awards 1992 and 1995), Sharp (Award 1995), Shiseido, Sony, Texas Instruments (Awards 1993 and 1995), 3M (Award 1991), and Toshiba (Award 1995).

The first United States-Japan-Russia Environmental Executive Leadership Workshop was held in Woods Hole, Massachusetts, to promote technological cooperation between the nations on behalf of stratospheric ozone layer protection.

The Third Meeting of the Parties to the Montreal Protocol was held from June 19 to 21 in Nairobi, Kenya.

IBM (Awards 1992 and 1993) established a goal to eliminate methyl chloroform from its manufacturing processes and products worldwide by year-end 1995.

In December 1991 Nortel/Northern Telecom (Award 1991) became the first multinational telecommunications company in the world to eliminate CFC-113 from its global manufacturing operations.



Camara Nacional de la Industria de la Transformacion (CANACINTRA) (Award 1992), Nortel/Northern Telecom (Award 1991), ICOLP/ICEL (Awards 1991 and 1993), and EPA formed a partnership to phase out CFCs in Mexico by 2000. This leadership inspired other developing countries to consider the advantages of rapid technical progress as an alternative to the grace period under the Montreal Protocol.

The Refrigeration Service Engineers Society (RSES) became the first major organization to establish voluntary certification of heating, ventilating, and A/C technicians in refrigerant recovery and recycling.

**1992** NATO took the unprecedented step of writing directly to UNEP Executive Director Mostafa Tolba (Award 1993) supporting the proposed accelerated phaseout of ODSs. NATO also endorsed technology cooperation, exchange of information regarding halon banks, and the harmonization of standards to promote production and maintenance of military equipment without the use of chemicals that deplete the ozone layer.

The Fourth Meeting of the Parties to the Montreal Protocol was held from November 23 to 25 in Copenhagen, Denmark. The Copenhagen Amendments and Adjustments required developed countries to phase out halon by 1994; to phase out CFCs, methyl chloroform, and carbon tetrachloride by 1996; and to freeze methyl bromide production.

Seiko Epson (Awards 1992 and 1995) became the first global precision instrument and electronic company to eliminate CFC-113 from its manufacturing operations.

General Dynamics (Award 1992), now Lockheed Martin Tactical Aircraft Systems, was the first company to eliminate virtually all ozone-depleting solvents from aircraft manufacture (the F-16 fighter), and Lufthansa (Award 1993) became the first commercial airline to halt the use of most ozone-depleting solvents in aircraft maintenance.

The U.S. Undersecretary of Defense directed the military to rapidly eliminate the use of ODSs from all weapons acquisition programs and directed the Defense Logistics Agency (Award 1993) to establish and manage a reserve of ODSs for mission-critical uses.

Military, scientific, and commercial space programs—pushing the envelope of technical feasibility—began solvent elimination from sophisticated and critical systems. Thiokol (Award 1993), under the leadership of Ross Bowman and Rick P. Golde, and NASA, under the leadership of J. Steven Newman and Paul Goozh, announced phaseout strategies. ICOLP/ICEL (Awards 1991 and 1993) asked all the rocket manufacturers to cooperate by contributing technical information to its aerospace solvent alternatives project.

By 1992, additional electronics and precision products manufacturers pledged CFC phaseouts. Citizens Watch, Fuji Electric, Matsushita Electric (Award 1993), NEC, Honda, Nissan Motor Company (Award 1991), Mazda, and Toyota (Award 1994) pledged phaseouts of CFCs used in foaming and/or cleaning.



Toyota (Award 1994) pledged CFC-free automobile manufacturing (phaseout of ozone-depleting solvents, foam, and A/C).

The Japan Electrical Manufacturer's Association (JEMA) (Award 1991) and JICOP (Award 1993), with the leadership of the Ministry of International Trade and Industry of Japan (MITI) and EPA, organized the Thailand Leadership Initiative of companies that pledged to eliminate rapidly the use of ODSs from their operations in Thailand. Leadership companies included AT&T (Award 1992), Dai-Ichi Densikogyo, DEC (Award 1990), Ford (Awards 1992 and 1994), Fujikura Cable, Fujitsu, Hitachi (Award 1991), Honda, Honeywell (Award 1994), IBM (Awards 1992 and 1993), INOAC, Matsushita (Award 1993), Minebea (Award 1993), Mitsubishi Electric (Award 1994), Motorola (Awards 1991 and 1993), NEC, NHK Spring, Nippondenso, Nissan Motor Company (Award 1991), Nissin Electric, Nitsuko, Nortel/Northern Telecom (Award 1991), Philips Semiconductor, Signetics, Sanyo (Award 1995), Seiko Epson (Awards 1992 and 1995), Sharp (Award 1995), Sundstrand, Texas Instruments (Awards 1993 and 1995), 3M (Award 1991), Toshiba (Award 1995), Toyota (Award 1994), Yamaha, and ZEXEL.

In July 1992, IBM (Awards 1992 and 1993) eliminated CFC-113 from its disk drive manufacturing facility in San Jose, California, and received an EPA Administrator's Pollution Prevention Award from William Reilly. This facility pioneered the use of aqueous cleaning technology for the disk drive industry and contributed to EPA's publication on "Alternatives for CFC-113 and 1,1,1-trichloroethane (methyl chloroform) in Metal Cleaning." They hosted more than 75 other companies, including direct competitors, for discussions and demonstrations of the aqueous cleaning technology at the site and authorized marketing of key cleaning technology to other companies.

Nissan Motor Company (Award 1991) was the first automobile manufacturer to complete conversion of all models to HFC-134a A/C.

The Coca-Cola Company (Award 1993) halted the purchase of CFC refrigerated equipment. Other beverage companies soon followed. Coca-Cola leadership, with its market clout, rapidly mobilized manufacturers in developed and developing countries to meet new customer demands.

The second United States-Japan Executive Environmental Leadership Workshop was held at Yountville, California, to organize multinational technology cooperation and to promote the responsible sourcing of products and components made with and containing ODSs.

The European Community regulation scheduled the phaseout of CFCs and carbon tetrachloride for January 1, 1995—one full year faster than the Montreal Protocol.

"Eliminating ozone-depleting substances from the processes used to manufacture Space Shuttle Solid Rocket Motors was a great challenge to the NASA-Thiokol team. With the outstanding help from the U.S. EPA, industry leaders, and the Montreal Protocol Solvents Technical Options Committee, a plan was prepared and is being implemented. The excellent results were possible due to great teamwork on the part of many government and industry leaders who are dedicated to protecting the Stratospheric Ozone Layer. We appreciate their unselfish sharing of information and technology."

Ross Bowman  
Space Operations  
Thiokol Corporation (Award 1993)



# 1993

Cadbury (Award 1993), J. Sainsbury (Award 1993), and Woolworth's Limited Australia (Award 1993) completed conversion of their food stores to non-CFC alternatives. Shaw's Supermarkets (Award 1993) was the first U.S. company to completely retrofit to non-CFC equipment.

Military phaseout programs were so successful by 1993 that Awards were earned by the Defense Supply Center Columbus (formerly the Defense Electronics Supply Center) (Award 1993) Defense Logistics Agency (Award 1993), U.S. Chief of Naval Operations, Hill Air Force Base (AFB) (Award 1993) Kelly AFB (Award 1993) Cherry Point Naval Aviation Depot (Award 1993), Norfolk Naval Aviation Depot (Award 1993), Rockwell International/U.S. Air-to-Ground Missile Systems (Award 1993), and the U.S. Air Force Air Base Fire Protection and Crash Rescue Systems (Award 1993).

Australia's Department of Administrative Services Centre for Environmental Management (DASCEM) (Award 1995) established a National Halon Bank.

In May 1993 Motorola (Awards 1991 and 1993) completely eliminated ODSs from its manufacturing processes.

JEMA (Award 1991), JICOP (Award 1993), ICOLP/ICEL (Awards 1991 and 1993), MITI, and EPA organized the Malaysia-US-Japan Technical Meeting on Protecting the Ozone Layer. Motorola (Awards 1991 and 1993) volunteered to manage a local network of experts to speed the phaseout of ozone-depleting solvents.

The Third Japan-United States Environmental Executive Leadership Conference was held at Osaka, Japan, during the "New Earth '93" Global Technology Conference to promote alternatives and substitutes to ODSs and to explore business opportunities for "green" technology.

IBM (Awards 1992 and 1993) eliminated CFCs and methyl chloroform from its worldwide manufacturing processes and products in August 1993—four months ahead of its CFC phaseout goal and two years ahead of its methyl chloroform phaseout goal.

"Who could have imagined that so many companies would phase out CFCs and halons faster than required. The real winners are those who discovered that solutions can have multiple benefits for the environment and the bottom line. When motivated, the human spirit can do almost anything."

*Elizabeth Cook (Award 1991)  
Senior Associate  
Climate, Energy, and Pollution Program  
World Resources Institute*

Matsushita (Award 1993) was the first major multinational company to manufacture diversified household consumer equipment (kitchen appliances, entertainment, air conditioners, and other products) without the use of CFCs.

The Fifth Meeting of the Parties to the Montreal Protocol was held from November 17 to 19 in Bangkok, Thailand.

Minebea (Award 1993), the company previously consuming the largest quantities of ODS in Thailand, completely eliminated those substances at the end of March 1993.



Nissan Motor Company (Award 1991) and Volvo (Award 1993) introduced their first CFC-free air conditioning.

Bosch-Siemens completed its phaseout.

In October 1993, the first 12 organizations were approved by EPA under its mandatory air conditioning technician certification program.

**1994** On January 1, 1994, halon production halted in developed countries.

On January 24 and 25, 1994, "The Second International NATO Conference on the Role of the Military in Protecting the Ozone Layer" was held in Brussels, Belgium. The conference was organized by DoD; U.S. EPA Stratospheric Protection Division, EPA Office of International Activities; Center for Global Change, University of Maryland; NASA; Aerospace Industries Association (AIA); American Electronics Association (AEA); Electronics Industry Association; and ICOLP/ICEL (Awards 1991 and 1993). Participants from Algeria, Belarus, Belgium, Brazil, Canada, Denmark, France, Germany, Hungary, India, Italy, Japan, Kenya, Latvia, Lithuania, Norway, Pakistan, Poland, Portugal, Romania, Russia, Spain, Slovakia, Sweden, Taiwan, Thailand, Netherlands, Turkey, Ukraine, United Kingdom, United States, and Uruguay attended.

Virtually every new automobile air conditioning system used HFC-134a.

JEMA (Award 1991), JICOP (Award 1993), ICOLP (Awards 1991 and 1993), MITI, and EPA organized the Indonesia-United States-Japan Technical Meeting on Protecting the Ozone Layer and the first progress meeting on the Thailand Leadership Initiative.

A Japan-United States team conducted preparatory meetings in Vietnam.

The Sixth Meeting of the Parties to the Montreal Protocol was held from October 6 to 7 in Nairobi, Kenya.

The U.S. Air Force Aerospace Guidance and Metrology Center (Award 1994), the Boeing Company (Awards 1992 and 1993), Hughes Aircraft (Award 1993), Lockheed Martin (Awards 1994 and 1996), Martin Marietta (Awards 1993 and 1994), Northrop Grumman (Award 1994), Saab-Scania (Award 1994), and the U.S. Air Force Wright Patterson Aeronautical Systems Center (Award 1994) each contributed significant technologies to the aerospace phaseout. Their leadership was particularly influential in building confidence in alternatives for complex ODS uses involving flight and human safety systems.

The U.S. Air Force Titan Launch Vehicle Program (Award 1995), under the leadership of Lt. Col. Douglas A. Van Mullem, Maj. Rockford Reiners, and Lt. Col. John Joseph Shirtz (U.S. Air Force), embarked on a project with NASA to communicate and cross-feed ODS reduction activities and technologies for space vehicle launch systems. These reductions involved critical processes and procedures requiring extensive material qualification testing to ensure that the integrity of the space vehicle was not compromised. This was critical when reducing



methyl chloroform in the critical bonds of large solid rocket motors where bond failure would have catastrophic results.

The United States began an extensive, worldwide effort to eliminate all CFC-12 based air-conditioners from tactical communications and electronics shelters by 1995.

**1995** On January 1, 1995, CFC production for all but export and essential uses was halted in the European Union.

The fourth Japan-United States Environmental Executive Leadership Conference was held in Nara, Japan, to promote cooperation between the United States and Japan on industrial activities, research and development, support for developing nations, and other matters that affect the global environment, including ozone layer protection.

JEMA (Award 1991) and JICOP (Award 1993), ICOLP (Awards 1991 and 1993), MITI, and EPA organized the Vietnam-United States-Japan Technical Meeting on Protecting the Ozone Layer.

With encouragement from Dr. Nguyen Duc Ngu and Dr. Dao Duc Tuan (Hydrometeorological Service of Vietnam), Dr. Stephen O. Andersen, Yuichi Fujimoto (Award 1993), Dr. Margaret Kerr (Award 1990), and Dr. Viraj Vithoontien (UNEP Regional Network Coordinator) organized more than 40 multinational companies from seven countries to pledge to help the Government of Vietnam protect the ozone layer by investing only in modern, environmentally acceptable technology in their Vietnam projects. These companies are: Asahi Glass (Award 1994), Asea Brown Boveri, AT&T (Award 1992), British Petroleum, British Petroleum Vietnam, Carrier (Award 1994), The Coca-Cola Company (Award 1993), Daihatsu, DuPont (Award 1990), Ford (Awards 1992 and 1994), Fuji Electric, Fuji Heavy Industries, Hewlett-Packard (Award 1994), Hino, Hitachi (Award 1991), Honda, Honeywell (Award 1994), ICI (Award 1992), Isuzu, Kawasaki Heavy Industries, Lufthansa (Award 1993), Matsushita Electric (Award 1993), Mazda, Meidensha, 3M (Award 1991), Mitsubishi Electric (Award 1994), Mitsubishi Heavy Industries, Mitsubishi Motors, Motorola (Awards 1991 and 1993), Nissan Motor Company (Award 1991), Nissan Diesel, Nortel/Northern Telecom (Award 1991), Sanyo (Award 1995), Seiko Epson (Awards 1992 and 1995), Sharp (Award 1995), Suzuki, Taiwan Fertilizer Company, Toshiba (Award 1995), Toyota (Award 1994), Trane (Award 1992), Yamaha, Yaskawa, Vulcan Materials, and UNISYS.

3M launched the world's first CFC-free metered-dose inhaler (MDI).

Dr. Paul Crutzen, Dr. Mario Molina, and Dr. Sherwood Rowland (Award 1993) received the Nobel Prize in Chemistry for their ground-breaking work in the 1970s on the process of stratospheric ozone depletion.

UNEP presented its first Stratospheric Protection Awards honoring 20 individuals and three organizations "...who have made outstanding contributions towards



the success of ozone layer protection." Individual award winners were Dr. Daniel L. Albritton (Award 1994), Dr. Stephen O. Andersen, Dr. Rumen D. Bojkov, Ms. Eileen Claussen (Award 1993), Dr. Paul Crutzen, Dr. Joe Farman, Mr. Tang Meng Leng, Mr. Juan Antonio Mateos, Dr. Mario Molina, Dr. Sherwood Rowland (Award 1993), Mr. Patrick Szell, Mr. Gary Taylor (Award 1990), Dr. Manfred Tevini, Dr. Jan C. Van der Leun, Dr. Robert Watson (Award 1994), and Mr. John Whitelaw. Organizations winning the award were Alternative Fluorocarbons Environmental Acceptability Study (AFEAS) and Programme for Alternative Fluorocarbon Toxicity Testing, FOE Canada, and JEMA (Award 1991).

The Seventh Meeting of the Parties to the Montreal Protocol was held from November 28 to December 7 in Vienna, Austria.

The final "Strategic Guidance and Planning for Eliminating Ozone-Depleting Chemicals from U.S. Army Applications" was published just one year after it was first proposed.

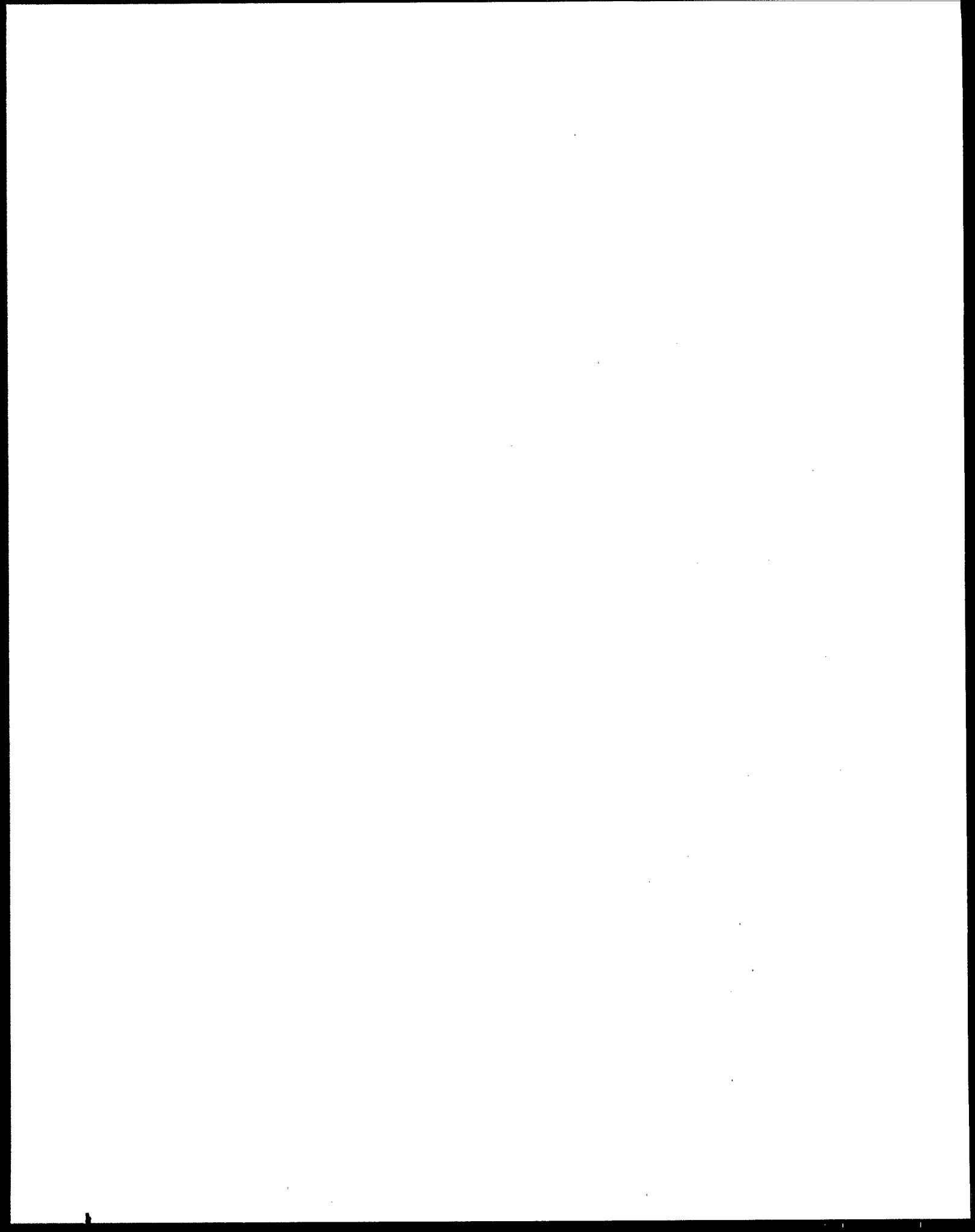
**1996** On January 1, 1996, CFC and methyl chloroform production was halted in developed countries (with exceptions for exports to Article 5[1] Parties and for essentials and feedstock use).

Six Japanese companies (Hitachi, Matsushita Electric Industrial, Mitsubishi Electric, Sanyo Electric, Sharp, and Toshiba) with a total of seven joint ventures (Hitachi Consumer Products, A.P. National, Kang Yong Electric, Sanyo Universal Electric, Sharp Appliances, Toshiba Consumer Products, and Thai Toshiba Electric Industries) to produce refrigerators in Thailand announced they will halt by January 1997 the manufacture of CFC refrigerators in Thailand. The Government of Thailand will prohibit manufacture and import of new refrigerators containing CFCs as insulating foam or refrigeration. Thailand is also the first developing country in the world to use trade controls to protect the global environment. This achievement was the result of the Japan-USA-Thailand Trilateral Leadership Initiative undertaken in 1991. Organizers of the leadership initiative included the Department of Industrial Works of Thailand, MITI, EPA, JEMA (Award 1991), JICOP (Award 1993), ICOLP/ICEL (Awards 1991 and 1993), and the Paris and Asia/Pacific offices of UNEP. Many experts contributed to the success including Stephen O. Andersen, Tadatoshi Banse, Yuichi Fujimoto (Award 1993), Takuichirou Nakajima, Masaharu Tanahasi, Tetsuo Nishide, Wiraphon Rajadanuraks, Rajendra M. Shende, Kamol Upalanond, Takashi Ueda, Viraj Vithoontien, and Kiyoshige Yokoi (Award 1996).

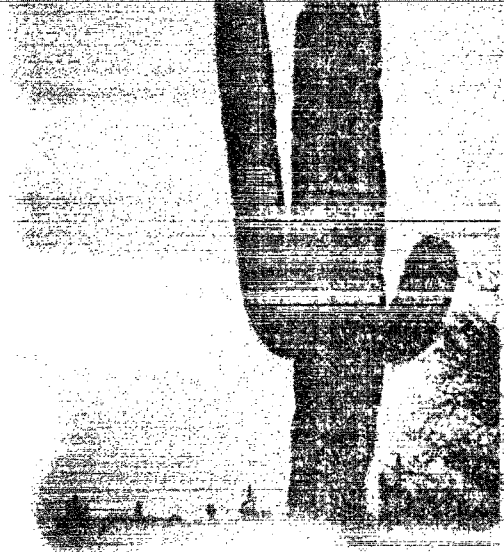
The Eighth Meeting of the Parties to the Montreal Protocol was held from November 25 to 27 in San Jose, Costa Rica.







# Military Leadership and Ozone Layer Protection



**T**he first ODSs identified as significant to the military were halons. At the time, the U.S. military used a significant proportion of the U.S. national halon production to protect its facilities, aircraft, ships, and tanks. By 1987, however, the military—primarily the Air Force Air Base Fire Protection and Crash Rescue Systems Branch (Award 1993)—was already leading the effort to identify, adopt, and publicize halon alternatives, mainly for economic reasons. Captain E. Thomas Morehouse, Jr., (Award 1991) attended the Montreal Protocol negotiations and presented a display of technologies under development by the U.S. Air Force to reduce dependence on halons.

Gary Vest (Award 1993), then Deputy Assistant Secretary of the Air Force, realized the significance of this issue and the responsibility the Air Force had to eliminate its use of ODSs. Under his leadership, the Air Force became the first federal agency to join ICOLP/ICEL (Awards 1991 and 1993). Gary Vest also led the Air Force in cofounding HARC (Award 1992). He gave his full support to the technical and policy initiatives to protect the ozone layer and advanced the cause immeasurably.

The search for halon alternatives quickly became a joint effort among all the military services and the private sector. Much of the theoretical work and empirical testing to find new total flooding fire suppression agents was done by the Navy Technology Center for Safety and Survivability of the Naval Research Laboratory (Award 1995). Beginning in the 1970s, the U.S. Navy began investigating many alternatives, such as inert gases, fine water mists, and fine solid aerosols. These efforts included computer modeling and laboratory- and full-scale fire tests utilizing a wide range of candidate agents. The technology to recycle halons, an important step in the process that enabled an early phaseout under the Protocol, was developed and commercialized by the Naval Air Warfare Center Aircraft Division in Lakehurst, New Jersey (Award 1992). Franklin Sheppard, Jr., (Award 1994), Office of the Chief of Naval Operations, Safety and Occupational Health Division, and Chief Warrant Officer Leroy "Sandy" Sanderson, U.S. Marine Corps, were among the key leaders who not only worked with private industry to ensure commercialization of the equipment but also traveled to many developing countries to demonstrate its use.

When the lack of accepted specifications initially prevented the use of recycled halons in military systems, Dr. Daniel Verdonik (Award 1995), U.S. Army, spearheaded an effort with industry to establish a new international standard for recy-



cluded halons. Army managers cleverly encouraged the **International Standards Organization (ISO)** to publish an international standard of purity for recycled halons and rapidly cited that standard for military operations. **Dr. Verdonik's** efforts cleared the way for halon banking as a viable technique for managing existing halon. Under this concept, new halon production could be phased out, and recycled halon could be used to satisfy remaining critical uses. **Thomas A. Bush** (Award 1996) initially managed the Ozone-Depleting Chemicals Elimination Program of the U.S. Army Communications-Electronics Command, where he was responsible for replacing halon 1301 handheld fire extinguishers and CFC-12 air conditioners from critical command and control communications systems. Later he implemented the halon banking program envisioned by **Dr. Daniel Verdonik** (Award 1995).

Some halon is still being used today because alternatives have not yet been developed. One significant critical use has been halon used onboard aircraft. To solve this problem, the military, the U.S. Federal Aviation Administration (FAA) under the leadership of **Richard Hill**, the **International Civil Aviation Organization**, and the private sector organized by **Robert E. Glaser** and **Richard Shafer** (**Walter Kidde Aerospace**) came together in 1992 to begin a program with the goal of enabling aircraft to obtain airworthiness certification without the use of halon. The **Wright Laboratory Aircraft Halon Replacement Team** (Award 1994) uses instrumented aircraft engines, nacelle mockups, and other test machinery to develop new agents and delivery systems under the Joint Military Service Aircraft Halon Replacement Program. Other critical military uses include armored personnel carriers, main battle tanks, fighting vehicles, munition resupply vehicles, shipboard machinery spaces, and gas turbine engine/generator modules. The U.S. Army Tank-Automotive Research, Development, & Engineering Center's **Halon Replacement Team** (Award 1996) spearheads the effort to eliminate halon 1301 use in Army ground combat vehicles. The team's work will result in the recovery of 225 metric tonnes of halon 1301. Without their efforts, the Army would have purchased additional halon. Their verification of alternatives will eliminate the Army's current use of halon 1301 and will also directly influence choices of halon replacement agents by other militaries. The **Aberdeen Test Center** of the U.S. Army (Award 1995) is developing new technologies to evaluate potential agents coupled with sophisticated delivery systems. It is standardizing test fixtures for engine and crew area compartments, instrumentation to measure agent concentration levels, temperature, pressure, toxic byproducts, and fire suppression effectiveness to thoroughly evaluate new agent/system combinations. The new fire suppression technologies being developed for armored combat vehicles and troop carriers include alternate gases, liquids, powders, gels, and water mists; delivery systems such as polytechnic gas generators, which are similar to air bag safety devices in automobiles, are being used to disperse the agents. The latest evaluation techniques are also being used for other applications including Army aircraft, watercraft, and shelters.

The U.S. Navy is also conducting a very aggressive program to replace halon in its aircraft. In 1995, the Navy announced that the new fighter/attack aircraft, the F/A 18-E/F and the V-22 aircraft, would use inert gas generators for engine nacelle and dry bay fire protection instead of halon 1301. These systems use solid



propellant materials to produce large quantities of inert gas to fill unoccupied compartments. In 1995, skeptics claimed that technology would never be able to replace halon 1301 on an aircraft; by early 1996, these inert gas generators were already installed and flying on a pre-production F/A-18-E/F.

After a multiyear research and testing program, which included everything from small-scale cup-burner testing in a laboratory to real-scale test fires on the navy test ship EX-SHADWELL, the U.S. Navy announced its two newest ships—the amphibious transport ship LPD-17 and the aircraft carrier CVN-76—would use non-halon systems such as fine water mist and HFC-227ea as refrigerants.

In India, the **Defence Institute for Fire Research** (Award 1995), under the direction of **H.S. Kaprawan**, has been a leader in adopting halon alternatives within the military in India and has guided the establishment of new standards for dry chemical, foam, and other alternatives for use in the private sector.

Until additional technologies are developed, recycled halons are still necessary for certain fire protection uses. The halon banking concept was established to match used halon sellers with buyers. In the United Kingdom, **Marion McQuaide** (Award 1994) of the **U.K. Ministry of Defence** established one of the first reserves of recycled halons, solvents, and refrigerants for military uses. The United States established the world's most extensive physical reserve under the leadership of **Ronald Sibley** (Award 1994) at the **Defense Logistics Agency** (Award 1993). Minimizing the need for halons is critical to sound management of the halon bank. **The Falcon Halon Team** (Award 1994) developed policies and strategies to reduce the use of halons in the U.S. Air Force F-16, which is one of the greatest offenders; the U.S. Navy also ceased conducting fire-suppression discharge testing with halon, reducing consumption by 60 percent.

After the Protocol was signed, the magnitude of military influence over the use of ODSs as solvents also became evident. Based on a survey of industrial solvent uses, particularly in high technology areas such as electronics, it was discovered that the U.S. military not only used significant quantities of ozone-depleting solvents, but that military specifications and standards prescribing ODSs had been adopted as de facto industry standards around the world. The **Navy Avionics Center** in Indianapolis is the principal U.S. military organization responsible for these technical standards. Under the leadership of **Robin Sellers** (Award 1990), it led in revising these standards to make them more performance-based and to allow the use of alternatives. Other military organizations responsible for prescribing solvent use joined the effort to help define standards for cleanliness and materials compatibility that the new alternatives would have to meet. With help from **Dr. John Fischer** (Award 1993) of the **Naval Air Warfare Center**, a unique partnership was formed between DoD, private industry, and EPA to identify and verify the acceptability of non-ODS solvents for military uses. The **Defense Logistics Agency** (Award 1993) and the **Defense Electronics**

"Winning the EPA Award has contributed to the credibility of Department of Defense and Defense Logistics Agency's efforts and illustrates the cooperative spirit among the civilian agencies and the DoD."

*Ronald W. Sibley (Award 1994)  
Program Manager  
Department of Defense ODS Reserve*



Supply Center (Award 1993), were leaders in changing the military specifications and standards for electronic components and products to remove ODS requirements.

Some processes proved to be particularly difficult to execute without ODSs, such as cleaning oxygen life support systems on board aircraft, submarines, and diving applications. These systems consist of long runs of thin tubes, assorted valves, and complex geometries. Any contamination posed possible flammability problems because of the oxygen-enriched atmosphere. Neil Antin (Award 1995) of the Naval Sea Systems Command led an effort to find a solution. In June 1995 the Naval Sea Systems Command and OCTAGON Process received a joint patent for a non-flammable, non-ODS cleaner, that is easily recycled and disposed of. Thanks in large part to this technology, Naval Sea Systems Command was able to reduce its CFC-113 consumption from over 455 metric tonnes per year to 32 metric tonnes per year—a 93 percent reduction.

Testing alternatives in the laboratory did not guarantee acceptance in the field, so a handful of brave experts tried them on the production line. They came from both industry and the military, believing that protecting the ozone layer was critical and that their individual efforts could make a difference. One of the early successes was at the Air Force Guidance and Metrology Center (Award 1994), where, with the encouragement of Don E. Hunt, delicate and complex inertial guidance systems were cleaned to the most demanding standards. They proved the viability of aqueous cleaners to replace CFC-113. The Naval Aviation Depot at Cherry Point (Award 1993) under the leadership of Mary Beth Fennell (Award 1994), the Naval Aviation Depot at Norfolk (Award 1993), and the depots at Hill Air Force Base (AFB) in Utah (Award 1993) under the leadership of Steve Rasmussen (Award 1994) and Kelly AFB in Texas (Award 1993) under the leadership of Terry Schaumberg (Award 1993) made similar extraordinary breakthroughs in non-ODS cleaning of sophisticated electrical optical and precision components. Mark V. Stanga (Litton) and Mary Morningstar (Lockheed Martin) conceived the plan to require DoD to report phase-out progress to Congress and to identify barriers to prompt action, allowing the military to solve most problems before the time of reporting.

After the Clean Air Act was amended in November 1990, The Titan Launch Vehicle Program created the Titan IV Program ODS Reduction Team (Award 1995) to address the use of ODSs in the manufacture and launching of space vehicles. This team, composed of military and civilian experts, included all Titan vehicle contractors. The team coordinated its efforts with the NASA, Space Shuttle, Delta, and Atlas programs. They reduced ODS use in manufacture and launch programs by 46 percent from 1989 to 1993. By August of 1995, the use of ODSs in these programs had been reduced to 1 percent of 1989 levels. The Titan IV Program ODS Reduction Team—with DoD, EPA, ICOLP/ICEL (Awards 1991 and 1993), and NASA—subsequently published a handbook entitled *Eliminating Use of Ozone Depleting Substances in Solid Rocket Manufacturing* (1996). They have made their work available worldwide as a guide to reducing the use of ODSs in rocket motors.



These efforts led to measurable successes. At the Air Force depot responsible for refurbishing B-52s, **Captain Cynthia Lingg** (Award 1995) led a team that implemented new alternatives and reduced the use of ODSs on the B-52 airframe by 2.5 metric tonnes per year. Defense contractors also took the lead to eliminate ozone-depleting solvents from their production lines, often taking risks to convince their military customers to accept the changes they proposed. With leadership from **Stephen P. Evanoff III** (Award 1992) and **Tony Phillips** (Award 1992), **General Dynamics' Fort Worth Division** (now **Lockheed Martin Tactical Aircraft Systems**) (Award 1992) rapidly eliminated more than 90 percent of their ozone-depleting solvent use from their F-16 production line by painstakingly testing alternatives until they found one which met all their performance requirements. They developed and implemented the non-ODS technologies for cleaning of gaseous oxygen and hydraulic tubing for aircraft and space launch systems; later, they eliminated all ODS use. Technologies developed by **Lockheed-Martin** (Awards 1996) have been implemented at major manufacturing facilities around the world.

The military also played a significant role in the phaseout of ozone-depleting chemicals as refrigerants. The U.S. Navy began a fleet-wide conversion program to change shipboard A/C and refrigeration systems from CFC-12 to HFC-134a. Military leadership was particularly influential in the ODS phaseout challenge. Although civilian companies faced many difficult technical challenges, the military often faced even greater challenges due to the need for equipment to perform and maintain reliability in the harshest of wartime conditions aboard mobile weapon platforms such as ships, aircraft, and armored vehicles. In addition to the normal facility A/C and refrigeration systems, cooling is required onboard aircraft, ships, and armored personnel carriers to keep critical weapons control and communications systems functioning.

The Navy faced a particular challenge. Many of its systems were designed to use CFC-114 because it provided quiet operation to escape submarine detection, reduced equipment volume, and compatibility with existing submarine atmosphere control equipment—all critical features for warship systems. Since CFC-114 was not used extensively by the private sector for refrigeration, there was little incentive for commercial companies to develop alternative refrigerants to replace it. Also, since the primary use of CFC-114 by the private sector was for foam-blowing applications, once the foam industry converted to other alternatives, the availability of CFC-114 to support existing systems became a major concern. To solve this problem, the **Carderock Division of the Naval Surface Warfare Center** (CDNSWC) (Award 1995) began work with the **Naval Sea Systems Command** (NAVSEA) to identify alternative refrigerants. After work with several alternatives proved unsuccessful, EPA's **Atmospheric Protection Branch** and the **National Institute for Standards and Testing** identified HFC-236fa as an alternative to CFC-114 for use in existing equipment. CDNSWC and NAVSEA also tested and approved HFC-134a as an alternative to CFC-12. Following this, they began a fleetwide program to convert nearly 1,100 existing chillers and refrigeration units on Navy ships.



Navies also began developing non-CFC systems for new ships. In 1995, the U.S. Navy announced that the new amphibious ship LPD-17, the aircraft carrier CVN-76, and the new attack submarine NSSN would all be designed and built without the use of CFCs or HCFCs. Also in 1995, the U.K. Royal Navy announced HFC-134a would be used on their Trafalgar-class submarines. In 1995 and 1996, the U.S. Navy provided support to Taiwan and Spain for conversion of their equipment from CFC-12 to HFC-134a.

Once the technology was proven, implementing the new equipment to achieve an ODS phaseout depended on military-initiated proactive efforts. The Army Communications-Electronics Command (CECOM) and Tobyhanna Army Depot (Award 1994) began replacing all CFC-12 air conditioners in thousands of tactical shelters worldwide.

Officials responsible for developing new military systems also had to support the new substitutes in order to prevent future dependence on ODSs. As Commander of the U.S. Air Force's Aeronautical Systems Center (Award 1994), Lt. Gen. James A. Fain, Jr., (Award 1994) was responsible for developing the new F-22 fighter aircraft and other systems. He demonstrated vision and leadership by making sure the new F-22 and other new systems would be ODS-free, with the exception of halon 1301. The AGM-130 Systems Program Office (Award 1995) of the U.S. Air Force eliminated 100 percent of the ODSs used in the manufacturing of its solid rocket motors, a reduction of over 26 metric tonnes of CFC.

Because the military transports perishable commodities around the globe, methyl bromide is also an important issue. Navy Lieutenant Commander Robert Gay (Award 1995) of the Defense Logistics Agency developed a controlled atmosphere technique to replace methyl bromide use by reducing respiration, slowing ethylene production, inhibiting pathogen reproduction, and killing insects within the storage environment.

To enable all these successes, commitment to ozone layer protection by military leadership was essential. The Office of the U.S. Secretary of Defense under the direction of top environmental executives from 1986 to the present (Carl Schafer, William H. Parker, III, Thomas E. Baca, and Sherri W. Goodman) fully supported protection of the ozone layer. William D. Goins expertly provided the necessary staff continuity. Gary Vest, Principal Assistant Deputy Under Secretary of Defense (Environmental Security) (Award 1993) was the first senior-level advocate within DoD and enabled many initiatives to become successful. Joel Krinsky (Award 1994) of the Naval Sea Systems Command began many of the efforts that led to alternatives to halon and CFC use onboard navy ships. Joel Krinsky established the Navy CFC & Halon Clearinghouse (Award 1995), supporting development and commercialization efforts for recycling equipment, changing military specifications to allow the use of ODS alternatives, and developing the overall Navy strategy for compliance with the Montreal Protocol. David Breslin (Award 1995) of the Naval Sea Systems Command staff, who managed the shipboard refrigeration conversion program, initiated the Navy's responsible use policy and established technical support that was largely responsible for the program's success. Policies by the Chief of





Naval Operations (Award 1993) quickly extended many of the successful programs Navywide. The Army Pollution Prevention Support Office (Award 1992) enacted one of the most rigid policies on halon use of any of the U.S. military services. By defining critical uses as only those on armored combat vehicles, they increased the pace of conversion to alternatives. Under the leadership of James Vincent (Award 1994) of the Aviation and Troop Command, the U.S. Army implemented the first halon alternative on aircraft by changing helicopter cockpit extinguishers from halon 1211 to carbon dioxide.

The military had the exceptionally difficult task of not only finding suitable alternatives to ozone-depleting chemicals and processes, but also changing important safety specifications in order to implement any new technology. Although these obstacles were omnipresent, champions in the military, private industry, and government worked together to research, approve, and use new technologies that are safe for stratospheric ozone.

## Military-Related Awards Summaries

The Advanced Amphibious Assault Vehicle, U.S. Marine Corps (Award 1996)

The Advanced Amphibious Assault Vehicle, U.S. Marine Corps, was constructed under one of the first programs to develop an "ODS-free" design philosophy for a sophisticated, multipurpose technology. The specifications of the Advanced Amphibious Assault Vehicle expressly prohibit CFCs, methyl chloroform, halons, carbon tetrachloride, HBFCs, and HCFCs. The direct reporting program manager issued a pollution prevention policy statement that expressly prohibits ODSs in the design of the Advanced Amphibious Assault Vehicle and commits to fielding the best technology in an environmentally responsible manner.

Thomas Daum, Defense Reutilization & Marketing Service (Award 1991)

Thomas Daum, Defense Reutilization & Marketing Service, developed procurement procedures to encourage the acceptance of ODS-free alternatives by DoD.

Department of the Navy, U.S. Chief of Naval Operations (Award 1993)

Department of the Navy, U.S. Chief of Naval Operations, took on a leadership role in the elimination of ODSs in military applications by issuing an ODS policy in 1992. The policy focused on proactive replacement and responsible use of ODSs. It established December 31, 2000, as the deadline for Navy-wide elimination of all non-mission critical shore-based ODS applications and adopted a maximum ODP of 0.05 or less for alternatives. In addition, the Chief of Naval Operations policy called for fleetwide recovery and recycling of ODSs, a policy which served to minimize Navy consumption and eliminate unnecessary emissions to the atmosphere. The Department of the Navy policy was the first of its kind in the U.S. military and is the crux of the Navy ODS Elimination Program.



ICBM SPO, U.S. Air Force  
(Award 1996)

ICBM SPO, U.S. Air Force, published the U.S. Air Force's first weapon system pollution prevention program plan and screened over 35,000 SPO technical documents that govern operations, maintenance, and sustainability of ICBM weapon systems. This program eliminated thousands of outdated technical orders and other documents, provided the U.S. government with a significant cost savings, and reduced the quantity of ODSs purchased by over 98 percent. The program has been recognized as the "model weapon system pollution prevention program" by the U.S. Air Force Pentagon staff. An Air Force Inspector General audit found the program's approach "an outstanding example of how to work pollution prevention issues on a future fielded system."

John King, Manager,  
ODS Removal Program,  
San Antonio Air  
Logistics Center, Texas  
(Award 1996)

John King, Manager, ODS Removal Program, San Antonio Air Logistics Center, Texas, initiated, coordinated, and led an effort in late 1992 to begin the identification, removal, and replacement of ODSs used in thousands of technical orders managed by the center. This work consolidated more than 6.5 million pages of information, including 45,000 technical orders, to create a database on technical orders governing the use of ODSs in the U.S. Air Force. In 1996, the effort had revised 94 percent of more than 26,000 technical orders. Teaming with other services (particularly with NAVSEA for oxygen cleaning) and industry made this success possible. Strategies for the remaining 6 percent involving difficult halon applications were developed and implemented and business strategies involving refrigerants were implemented.

Peter Mullenhard, U.S.  
Navy's CFC & Halon  
Clearinghouse Team  
(Award 1996)

Peter Mullenhard, U.S. Navy's CFC & Halon Clearinghouse Team, since 1991 has provided the untiring leadership and initiative responsible for the team's successes in providing data on alternative chemicals and processes. Under his direction, the Clearinghouse won the Stratospheric Protection Award in 1995. Each business day, he sends an electronic bulletin called ODS NEWS, which provides news on technical advancements to over 250 subscribers around the world.

Naval Air Warfare Center  
Aircraft Division  
Lakehurst  
(Award 1992)

The Naval Air Warfare Center Aircraft Division Lakehurst developed, acquired, and implemented the first halon 1211 recycling technology. Additionally, it participated in recycling technology cooperation with dozens of developing countries.

Ronald Sibley, Defense  
Logistics Agency  
(Award 1994)

Ronald Sibley headed the Defense Logistics Agency's efforts to establish and operate a CFC and halon reserve. The centralized management eliminated duplication of efforts and standardized the terms and definitions of ODS recycling and banking. Mr. Sibley personally oversaw plans to create the reserve. Since then, he has led the reserve's very successful efforts in recycling, reclamation, and reuse of ODSs. He has also organized site visits and study tours to share operational concepts, technical approaches, and lessons learned with high-level delegations from throughout the world, including China and Russia.



Gary D. Vest, Principal  
Assistant Deputy  
Undersecretary of  
Defense  
(Award 1993)

Gary D. Vest, Principal Assistant Deputy Undersecretary of Defense (Environmental Security), has been the senior leadership driving the US Air Force's and DoD's programs to phase out ODS dependence since 1987. Under his leadership, DoD adopted one of the most aggressive phaseout programs inside or outside government. He directed the establishment of the Halon Alternatives Research Consortium, which eventually evolved into the industry-led HARC (Award 1992). He also authorized the U.S. Air Force to provide technical support on halon alternatives to the Parties to the Protocol during initial treaty negotiations in 1987. He signed an agreement with the ICOLP/ICEL (Awards 1991 and 1993), making the U.S. Air Force the first government organization to become a member after its founding. He established a contract giving all DoD access to OZONET, making the Air Force the first institutional user of this international database on CFC alternatives. He directed, organized, and chaired the "Williamsburg Conference" and the "Brussels Conference" on the Role of the Military in Implementing the Montreal Protocol. These meetings resulted in NATO's Committee for the Challenges of a Modern Society sending a letter to UNEP Executive Director Dr. Mostafa Tolba formally endorsing the proposed Copenhagen Amendments which accelerated CFC and halon phaseout. He also directed a variety of U.S. Air Force policies which eliminated many of the largest uses of halons and CFCs. Many of these policies were firsts in either the public or private sectors. They include stopping the atmospheric release of halon for firefighter training, replacing halon 1211 in flight-line crash/rescue fire vehicles with dry chemicals, mandating the use of non-CFC chillers, stopping the use of fixed halon systems to protect computer and communications facilities, and eliminating the practice of halon discharge testing. Mr. Vest's contributions to protecting the ozone layer are world class and world renown. His personal commitment, history of strong consistent leadership, and impressive record of accomplishments make him one of the most dedicated and successful public servants in the area of environmental protection.





# Foams

## Foam Food Packaging Phaseout

**C**ontrary to popular beliefs, most molded foam food service packaging—including the familiar white foam cups—never contained CFCs. Until 1988, however, approximately 35 percent of extruded plastic products, such as the McDonalds' "hot-side hot, cold-side cold" hamburger clamshell, were manufactured with CFC-12.

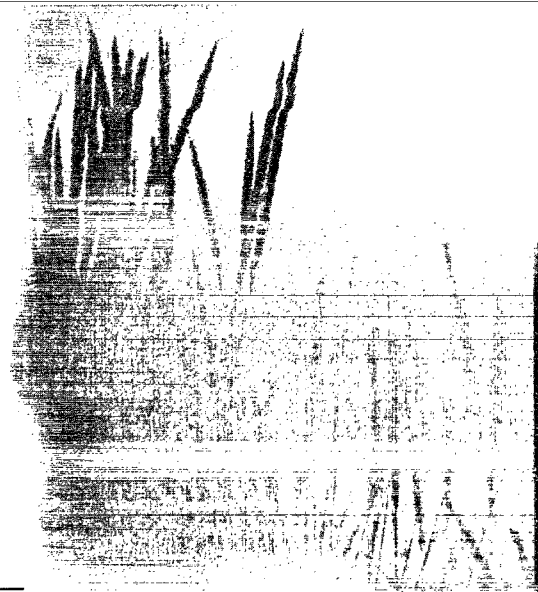
Environmental activists, including teachers, children, and international activists at FOE, NRDC, and Environmental Defense Fund mounted increasingly effective consumer boycotts and legislative campaigns against foam packaging. Elizabeth Cook (Award 1991), Alan Miller (Award 1992), David Doniger (Award 1991), and other environmental leaders protested the destruction of the ozone layer, litter and solid waste, and plastics in general. By 1988, McDonalds and several other restaurant companies were becoming increasingly sensitive to these consumer and environmental efforts and began to negotiate with their suppliers for non-CFC foam containers and even to consider eliminating foam packaging.

Foam foodservice packaging could be economically manufactured using hydrocarbons, but only by isolating the flammable manufacturing facilities from populated areas and only in locations where smog-causing volatile organic compound (VOC) emissions were allowed by environmental authorities. Plant relocation would take time and money, and investments could only be recovered if restaurants continued to use foam food packaging. Some suppliers to McDonalds were afraid that they were about to lose their best (or only) customer.

In January 1988, Dolco Packaging (Award 1990) and DuPont (Award 1990) sought help from EPA. They were confident that HCFC-22 could replace CFC-12 to make foam packaging. HCFC-22 has an ozone-depletion potential (ODP) of 0.05, compared to an ODP of 1.0 for CFC-12. In this project, Dolco faced two daunting problems:

"The CFC phaseout effort remains one of FPI's proudest moments and will have a lasting, positive legacy."

*Joseph W. Bow, President  
Foodservice & Packaging Institute  
(Award 1990)*



- ◆ HCFCs would require approval of the FDA because food would be coming into contact with the plastic surface. FDA had a backlog of work and it would take more than one year to begin investigations.

- ◆ The public and McDonalds would have to believe that the new packaging would not harm the ozone layer. Environmental organizations might not agree that a 95 percent reduction in ODP was sufficient. The public might not be able to distinguish foam made without CFC from CFC foam.

The EPA stratospheric protection staff—including Dr. Stephen O. Andersen, John Hoffman (Award 1994), Jean Lupinacci (Award 1996), Stephen Seidel (Award 1996), and Maria Tikoff—tried to prove that in some sectors it was technically feasible to reduce CFC use and that voluntary cooperation could be more flexible and cost effective than traditional regulation. In 1988, most CFC manufacturers and their customers steadfastly refused to acknowledge technical and economic feasibility of alternatives and reduction techniques until the science was proven. Furthermore, EPA feared a backlash against ozone layer protection if the public initially thought that factories using CFCs would be forced to close and jobs would be lost.

EPA first sought expedited approval from FDA for Dolco's (Award 1990) proposed HCFC-22. The FDA food packaging specialist confirmed that the actual review would only take a few days if the technical submission were fully adequate but adjustment in work priorities would require high-level approval. EPA Administrator Lee Thomas wrote to FDA requesting prompt action. The FDA specialist volunteered to work nights and weekends so that no other FDA actions would be affected.

"FPI's announcement...that U.S. industry would cease manufacture of containers made with CFCs by the end of 1988 was a positive step which helped prevent further damage to the ozone layer. It is an act of statesmanship and on behalf of UNEP I congratulate and commend your Institute for this exemplary decision."

*Dr. Mostafa K. Tolba (Award 1993)  
Executive Director  
United Nations Environment Program*

## Awards for Foam Food Packaging

- ◆ Dolco Packaging (Award 1990)
- ◆ FPI (Award 1990)
- ◆ Elizabeth Cook, (Award 1991)
- ◆ David Doniger (Award 1991)
- ◆ Alan Miller (Award 1992)

Coming to an agreement with McDonalds and environmentalists was much more difficult than motivating FDA. McDonalds refused to talk to Jean Lupinacci (Award 1996) about packaging. "We are hamburger people," they said, "not packaging people." One critical environmental organization balked at first because its president was reluctant to diminish the fund-raising and political success of the overall campaign against foam packaging by solving the ozone-depletion issue. Another environmental organization was concerned that it would draw fire from its members for cooperating with the corporate "enemy." The foodservice packaging industry was initially skeptical that EPA could help at all or that environmentalists could be trusted to keep their side of any potential bargain.



Remarkably, by April 1988 FDA had approved the new process, and manufacturers and environmentalists made a ground-breaking voluntary agreement to phase out CFCs. The agreement was signed by the FPI (Award 1990), the 12 significant U.S. foam foodservice manufacturers, FOE, NRDC, and the **Environmental Defense Fund**. **Elizabeth Cook** (Award 1991), **David Doniger** (Award 1991), and **Alan Miller** (Award 1992) were instrumental in the agreement, and steadfast in honoring and defending the compromise against critics.

Foodservice companies agreed to phase out CFCs as soon as possible, but no later than December 31, 1988; to utilize any new, economically feasible foam blowing agents that offered greater stratospheric ozone layer protection than HCFC-22, assuming they satisfied other safety and environmental standards; and to encourage the international foodservice disposables industry to initiate similar phaseout programs.

The food packaging announcement of the agreement in March 1988 came just 3 months after AT&T (Award 1992) announced its new solvent to replace CFC-113. Combined, these announcements reinforced technical optimism, encouraged voluntary actions, proved that institutional barriers to innovation (including government approval) could be overcome, and introduced the concept of a complete phaseout using "transition" HCFC substances.

In February 1989, FPI (Award 1990) announced the completion of its successful CFC phaseout and published full technical descriptions to allow worldwide conversion. By 1991, virtually every facility in the world had halted CFC use for foodservice packaging.

## Flexible Foam Phaseout

**T**he flexible foam industry was forced to deal with multiple problems while attempting to phase out ODSs. One of the leading potential alternatives, methylene chloride, was not itself environmentally friendly. Although ideal as a blowing agent in a variety of foam applications, many states restricted methylene chloride use because it did not meet their toxicity requirements. Other CFC alternatives produced foams of questionable quality, thereby adding to the phaseout dilemma.

At the urging of EPA's **Jean Lupinacci** (Award 1996), the industry actively discovered, tested, and considered numerous solutions, leading to innovative changes in equipment, processes, and blowing agents. For example, the automobile industry had early success in applying new technologies to eliminate the use of CFCs in the manufacture of automotive flexible foam. Innovations regarding foam application and quality also were developed for flexible foam used in furniture, bedding, and other areas. As more and more alternatives were successfully applied, members of the industry developed manuals to help others worldwide transform their operations. These manuals were instrumental in the phaseout of CFCs in the flexible foam industry before the mandated deadline.



### Awards for Flexible Foam Phaseout

- ◆ Ford Motor (Awards 1992 and 1994)
- ◆ Mercedes Benz (Award 1992)
- ◆ Recticel (Award 1992)
- ◆ ICI Polyurethanes (Award 1994)
- ◆ Craig Barkhouse (Award 1995)

Individuals, companies, and associations all played important roles in developing better products to fit specific needs, all without the use of CFCs, ultimately leading to the early CFC phaseout in flexible foam.

### Foam Insulation Products

**B**ecause of the need to maintain or improve energy efficiency, alternatives to CFCs in insulation products required careful consideration. A number of cooperative projects began in order to evaluate the effectiveness of substitute blowing agents and to protect the integrity of the final product. It became clear early on that the diversity of insulation products and uses, in addition to other standards, would make the ultimate choice of alternatives complex.

In response to these difficulties, worldwide cooperation and information exchange led quickly to the introduction of new blowing products. This spirit of innovation and cooperation facilitated the rapid introduction and use of CFC alternatives.

### Awards for Foam Insulation Products

- ◆ Polyisocyanurate Insulation Manufacturers' Association (Award 1993)
- ◆ Mike Jeffs (Award 1993)
- ◆ John Minsker (Award 1995)





# Foams-Related Awards Summaries

**Asahi Glass**  
(Award 1994)

**Asahi Glass** developed and responsibly marketed CFC alternatives for blowing agents, as well as refrigerants and cleaning solvents. The company is a strong advocate of environmental leadership and a signatory to the pledge to help the Government of Vietnam protect the ozone layer by investing only in modern, environmentally acceptable technology in the company's Vietnam projects.

**Craig Barkhouse**  
(Award 1995)

**Craig Barkhouse** played a major role in the phaseout of CFC use in the flexible foam industry and has the distinction of being the first flexible foam industry representative to be nominated to the **UNEP Flexible and Rigid Foams TOC**. As early as the mid-1980s, while many other industry representatives worked against controls on CFCs, he documented alternatives and made the information publicly available. After the Protocol was signed, he developed sector-specific reduction strategies and promoted these strategies within the industry. He is past chair of the Standing Technical Committee of the Canadian Flexible Foam Manufacturers' Association and is current chair of the Association's CFC Subcommittee and represents the Canadian foam industry in all CFC-related international activities.

**Dixie-Narco**  
(Award 1995)

**Dixie-Narco** initiated a phaseout strategy in 1990 and since then has played a leading role in switching to carbon dioxide blowing agents for its foams applications. It has also helped suppliers of foam blowing agents set criteria for performance.

**Dolco Packaging**  
(Award 1990)

Until 1988, approximately 35 percent of extruded plastic products were manufactured with CFC-12. **Dolco Packaging** responded to public pressure for ozone layer protection by perfecting the transitional use of HCFC-22. Its technical leadership included a shift in thinking that inspired engineers to consider a wide variety of alternative foam-blowing processes. The company teamed with **DuPont** (Award 1990) and EPA to get approval by FDA for the use of HCFC-22 in food products, and helped organize the first national voluntary phaseout of any CFC application. **Dolco's** work formed an early link in the chain of announcements that turned industry opposition to industry leadership for stratospheric ozone protection.

**Ford Motor Company**  
(Awards 1992  
and 1994)

**Ford Motor Company** led in implementing alternatives for a full range of automobile uses including A/C, flexible and safety foam, and electronics and parts cleaning. Ford initiated efforts to eliminate all CFC uses from its manufacturing processes worldwide by the end of 1993, and its new cars and light trucks were CFC-free by the end of 1994. The company converted its models to HFC-134a air-conditioners more quickly than other companies. Ford also succeeded in eliminating CFCs in its foam blowing processes for seat cushions. Ford is a founding member of **ICOLP/ICEL** and has shared its experience as a leader in international technology transfer activities.

**FPI** (Award 1990)

**FPI** demonstrated leadership in encouraging the phaseout of CFCs in food packaging. In addition to work in the United States that led to the elimination of CFCs in 1989, **FPI** organized and published information on technical conversions, giving other countries access to alternative chemicals and substitutes and thereby promoting further ODS reduction.



**General Motors  
(Award 1994)**

General Motors led in development, commercialization, and market acceptance of CFC recycling under new-car warranties; made technical breakthroughs in foam spray and molding applications; and joined in technology cooperation with corporate partners worldwide. General Motors was also instrumental in finding polymers capable of containing HFC-134a and in verifying the performance of HFC-134a lubricants. It was the first U.S. vehicle manufacture to mandate CFC-12 recycling in its plants and dealerships, first to mandate HFC-134a in its plants and dealerships, first to mandate refrigerant contaminant identifiers, and first to begin releasing CFC-12 to HFC-134a retrofit procedures for vehicles under warranty. General Motors personnel sponsored and championed Society of Automobile Engineers (SAE) standards and recommended practices for safe handling and recycling, leak detection equipment and methodology, retrofit refrigeration criteria, and other topics.

**ICI Chemicals and  
Polymers (Award 1992)**

ICI Chemicals and Polymers developed a wide range of CFC-free insulating foam alternatives.

**ICI Polyurethanes  
(ICIP) (Award 1994)**

ICI Polyurethanes (ICIP) developed an innovative flexible foam product, using CFC-free materials and production processes. As a replacement for CFC-11 and alternatives such as methylene chloride in the foaming process, ICIP created a product using entirely water-based foaming. The new flexible foam product (called "Waterily") contains no CFCs or HCFCs, uses only low-volatility chemicals, and uses no halogenated substances for production or for meeting flammability tests. The product is thus better designed for recycling and helps to promote a safer workplace. ICIP's research and product development represents a multilayered approach to ozone- and environment-friendly manufacturing.

**Dr. Mike Jeffs  
(Award 1993)**

Dr. Mike Jeffs has led ICIP's CFC phaseout program since 1986. He actively worked on the issue of ozone-depletion and provided information on emerging alternative technologies to phase out CFCs. He made presentations on these issues at conferences in North and South America, Europe, Africa, the Middle East, Asia, Japan, and Australia. Dr. Jeffs worked extensively with Chinese industry to share information on alternatives and new technologies, and organized and participated in symposia with refrigerator manufacturers, the construction industry, and the appliance industry. He has served as a member of the UNEP Foams TOC and has been the foams representative to the World Bank Ozone Operations Resource Group since its inception.

**Jean Lupinacci,  
Atmospheric Pollution  
Prevention Division,  
EPA (Award 1996)**

Jean Lupinacci, Atmospheric Pollution Prevention Division, EPA, was a founding member of the UNEP Technology and Economic Assessment Panel (TEAP) and the founding chair of the Flexible and Rigid Foams TOC. She has encouraged private and public sector initiatives, and made concrete developments by fostering an atmosphere of trust.



Mercedes-Benz  
(Award 1992)

Mercedes-Benz, began initial CFC elimination work in 1989, and in 1991 became the world's first automaker to introduce a CFC-free model line, the 1992 S-Class. The S-Class vehicles contained A/C systems that substituted HFC-134a for CFC-12, foams whose production used water and other non-CFCs, and electronic parts cleaned by aqueous and other methods. Mercedes-Benz has eliminated CFCs from all its vehicles worldwide, preceding all other automobile manufacturers by at least one year.

John Minsker  
(Award 1995)

John Minsker has been a leader in the extruded polyolefin and polystyrene foam industries for the phaseout of ozone-depleting chemicals. As the Global Foams Technical Leader for Dow Plastics, he influenced and facilitated the company's March 1988 announcement to eliminate CFCs in the production of these plastics. Dow was the first foam manufacturer to announce a worldwide phaseout of CFCs in all of its facilities. Mr. Minsker's responsibilities encompassed all technical issues for polyolefin and polystyrene plastics from research to application issues. As a result of his expertise, he was nominated to the UNEP Foams TOC when it was formed in 1989 and has been a valuable contributor for over 6 years. Through his commitment to the issue of ozone depletion, he has earned tremendous respect from his colleagues in industry and government for being a readily accessible source of technical knowledge, political insight, and good judgement.

Nissan Motor  
Company  
(Award 1991)

Nissan Motor Company, after first announcing its commitment to seek alternative refrigerants in an effort to phase out CFCs in August 1989, was the first automobile manufacturer to install CFC recycling equipment in its dealerships. By the end of 1993, Nissan had converted A/C systems for all Infiniti/Nissan cars and trucks from CFC-12 to HFC-134a and halted the use of CFCs in foams and as solvents in their worldwide operations.

Polyisocyanurate  
Insulation  
Manufacturers  
Association  
(PIMA) (Award 1993)

Polyisocyanurate Insulation Manufacturers Association (PIMA) designed a tactical plan in the late 1980s to achieve the year-end 1993 conversion goal. PIMA took the lead in organizing the U.S. Department of Energy, EPA, the Society of Plastics Industry, and the National Roofing Contractors Association to phase out the use of CFCs in polyisocyanurate insulation as soon as possible rather than wait for its mandated elimination in the year 1996. PIMA's leadership helped to ease the conversion process for both industry and government to the benefit of the environment.

Recticel (Award 1992)

Recticel was the first flexible polyurethane foam (PUF) manufacturer to establish voluntary CFC reduction programs. Recticel pioneered CFC replacement technologies for flexible foams, including activated charcoal scrubbing, manufacturing under reduced pressure, and chemical alternatives. One of the most significant contributions was the development and disclosure of alternative blowing technology for rigid PUF panels.



Carmen C. Waschek  
(Award 1992)

Carmen C. Waschek was the senior engineer who persuaded the Coca-Cola Company to develop a comprehensive program of CFC containment, recycling, and banking and to purchase only CFC-free new refrigeration equipment.

Dr. Udo Wenning  
(Award 1993)

Dr. Udo Wenning researched the suitability of various alternatives to CFC-11 in appliance foams. He studied the energy efficiency implications of various substitutes, as well as the performance of hydrocarbons as foam blowing agents. His company, Bosch-Siemens, completed the changeover to pentane in August 1993.



# Halons

In 1987, when the Montreal Protocol was signed, halons were considered the most irreplaceable ODS. In fact, industry experts were reluctant to include them in the Protocol. While CFCs were eventually scheduled for a 50 percent reduction, halon production was merely frozen at the base-year level. As a result of industry and military leadership, however, halon ultimately became the first ODS to be phased out by developed countries (January 1994). Aggressive identification, development, validation, and implementation of alternatives, and establishing a workable halon bank to meet recurring needs in those critical applications for which alternatives had not yet been identified, made this possible. This substantial contribution to ozone layer protection was achieved by a small number of ozone champions working primarily through fire protection associations, military organizations, several multinational companies, and the fire protection community.

In 1986, NFPA (Award 1990) planned to require mandatory discharge testing of new halon 1301 fire protection systems because of concern that halon systems would be improperly designed or installed. EPA's Dr. Stephen O. Andersen was concerned about those emissions as well as the possibility that owners of existing systems, local fire authorities, or insurance companies might also require such testing. NFPA asked Gary Taylor (Award 1990), chair of the NFPA Halon Technical Committee, to meet with EPA. As a result of the meeting, the NFPA technical committee prepared comprehensive technical requirements to eliminate all non-fire related emissions of halons and strengthen nonemissive requirements to ensure reliable operation.

Also in 1986, EPA started to build its relationship with the military, an integral player in the struggle to phase out halons. EPA and contracted military operations expert Dr. Mike Ryan began working extensively with Gary Vest (Award 1993), the senior environmental policy maker in the U.S. Air Force. Gary Vest identified Captain E. Thomas Morehouse, Jr. (Award 1991), of the Air Base Fire Protection and Crash Rescue Systems Branch at Tyndall AFB (Award 1993), as the point-of-contact for EPA initiatives. Captain Morehouse worked quickly with EPA staff and with EPA

"People dedicate themselves to the fire protection profession because they believe passionately in protecting lives and property. Once the threat halons posed to mankind was understood, the community worked to find solutions with that same passion they bring to fighting fires."

*E. Thomas Morehouse, Jr. (Award 1991)  
Institute for Defense Analyses*



contractors Dr. Mike Ryan and Dr. Donald L. Fox (University of North Carolina) to develop and implement changes in U.S. Air Force halon use policy including: 1) restricting use to "mission-critical essential applications," 2) prohibiting discharge testing, 3) limiting training, 4) ultimately replacing noncritical uses and banking of available halon for essential military uses, and 5) working with AIA and Boeing Commercial Airplane Group (Award 1993) to organize a worldwide working group of military and civilian aviation corporations and regulatory authorities to find alternatives.

In 1989, the Naval Research Laboratory (Award 1995) identified and qualified a suitable substitute to halon 1301 for testing halon fire-suppression systems. Following recommendations made by the Naval Research Laboratory (Award 1995), the Naval Sea Systems Command eliminated the use of halon 1301 in the testing of shipboard fire-suppression systems in 1990. This single act reduced the Navy's consumption of halon 1301 by 60 percent.

DASCEM's Australian National Halon Essential Uses Panel (Award 1994) was set up in 1990 by the Environment Protection Authority in Victoria to limit the sale and use of halons to essential uses only. As a result of its work, Australia had virtually halted the use of newly manufactured halons several years prior to the 1994 production phaseout. The panel had support both from industry and government and has been effective in halon end-use control. The Halon Essential Uses Panel-EPA, Victoria, Australia (Award 1992) successfully limited the sale and use of halons to essential uses only. The panel, with widespread support from industry and government, has been an effective system of halon end use control, leading to the virtual halt in the use of newly manufactured halon in Australia. Under the leadership of Dr. Hans U. Wäckerlig (Award 1995) and in cooperation with Dr. Walter Brunner (Award 1994), the Swiss Institute for the Promotion of Safety & Security organized three international halon conferences.

NFPA (Award 1990) and Casey Grant (Award 1995) worked closely and quickly with EPA. They withdrew the proposal for mandatory discharge testing and approved a nonchemical pressure test as a substitute for discharge testing. They also organized conferences worldwide to explain and promote the elimination of halon emissions caused by testing, training, leaks, and accidental discharges. Later they promoted halon substitutes by developing model consensus standards to facilitate the implementation of new alternatives to halons. Specifically, they generated the Standard on Clean Agent Fire Extinguisher Systems (NFPA 2001), and the Standard on Water Mist Fire Protection Systems (NFPA 750), both of which provide essential design, installation, maintenance, and operation criteria for these important replacement technologies. Under the direction of James Beyreis (Award 1990), Underwriter Laboratories (UL) (Award 1990) changed testing procedures and streamlined acceptance criteria for alternatives.

In another important industry section, the electronics industry, AT&T (Award 1992), GTE, IBM (Awards 1992 and 1993), and Nortel/Northern Telecom (Award 1991) took the lead. AT&T (Award 1992) halted purchase of new halon systems and designed an internal halon banking scheme. Nortel/Northern Telecom (Award 1991) announced a goal of a virtual phaseout and worked with insurance



companies to design facilities that did not require halons. GTE introduced less flammable materials such as insulating cables as a way of reducing fire risk. IBM (Awards 1992 and 1993) had never extensively used halons and worked to prove that electronics could be protected with water or carbon dioxide.

Once again, the military took an active role in completing the halon phaseout. The U.S. Army Acquisition Pollution Prevention Support Office (Award 1992), under the leadership of Dr. Daniel P. Verdonik (Award 1995) and Carmen DiGiandomenico, was the first of the U.S. Military Services to establish an acquisition office to address this issue and crafted a successful halon elimination and management program. These efforts led to a General Officer Steering Committee to address ODS within the Army. In addition, the Army worked with the American Society of Testing and Materials, a member of ISO, to change specifications to allow the use of recycled halons and subsequently persuaded the U.S. military to adopt those changes. The Army was the leading service to centrally manage a comprehensive ODS elimination program. The Defense Logistics Agency (Award 1993), under the management of Ronald Sibley (Award 1994), developed the world's largest halon reserve to satisfy future mission-critical military needs, which has become a test-bed for process management including long-term storage container research, reclamation equipment analysis, and system cylinder handling safety procedures. The DoD Ozone Depleting Substances Reserve managed by the Defense Logistics Agency has become a model for other countries and commercial interests, including Russia and China, which are developing similar operations serving military and/or civilian sectors. The Army's Aberdeen Test Center (Award 1995) developed test protocols for evaluating several different types of agents, including gases, liquids, powders, gels, foams, and water mist as an alternative in combat vehicles, which are one of the most technically challenging critical uses.

The Navy Technology Center for Safety & Survivability (Award 1995) developed and approved alternative chemicals for discharge testing. With team leader Franklin Sheppard, Jr., (Award 1994), the Naval Air Warfare Center Aircraft Division Lakehurst (Award 1992) developed, procured, and implemented the first halon 1211 recycling technology and assisted dozens of Article 5(1) countries in technology cooperation. Under the leadership of Joel Krinsky (Award 1994) of the U.S. Naval Sea Systems Command, Navy Technology Center for Safety and Survivability, U.S. Naval Research Laboratory (Award 1995) began a program to identify halon 1301 alternatives for shipboard use. This program greatly expanded an earlier program enacted throughout the 1980s under the sponsorship of the Navy Office of Advanced Technology and the Office of Naval Technology (both now the Office of Naval Research). In 1995, this culminated in the selection of HFC-227 and fine water mist for use on the amphibious ship LPD-17 and the aircraft carrier CVN-76. Joel Krinsky (Award 1994) also launched the U.S. Navy CFC/Halon Information Clearinghouse oper-

"The U.S. Department of Defense is a remarkably effective, mission-oriented organization. Once eliminating halons and CFCs became part of the mission, the results were astounding."

Gary D. Vest (Award 1993)  
Principal Assistant Deputy Under Secretary of Defense  
(Environmental Security)



ated by GEO-CENTERS (Award 1995), under the leadership of Peter Mullenhard (Award 1996). This project also guided the review of approximately 8,000 military specifications that required the use of ODS. David A. Breslin (Award 1995), working for the Naval Sea Systems Command, managed the U.S. Navy's CFC & Halon Elimination Program Office.

The U.S. Air Force Air Base Fire Protection and Crash Rescue Systems Branch (Award 1993) was the lead DoD agency to fund significant research in the development of halon 1211 replacements. Their development of a halon recycling system, innovative firefighter training methods without halon 1211, and the removal and replacement of all halon 1211 with dry chemical extinguishing agents on the entire U.S. Air Force Crash Rescue Firefighting Vehicle Fleet eliminated over 70 percent of the halon 1211 used in the Air Force. The Falcon Halon Team, Wright-Patterson AFB (Award 1994) implemented halon-free in-flight fire protection. The Wright Laboratory Aircraft Halon Replacement Team (Award 1994), with funding and cooperation from the U.S. Army, the U.S. Navy, and FAA developed test procedures and a full-scale test apparatus for joint use by military and civilian aircraft designers. Thus, the military's support and enthusiasm played an integral role in the successful phaseout of halons in the United States. In addition to the joint aviation work with the Air Force at Wright Laboratory, Naval Air Systems Command (NAVAIR) conducted tests on an innovative new fire extinguishing technology based on an offshoot of automobile air bag inflation devices. These modified air bag inflation devices, known as "inert gas generators," proved so successful that NAVAIR immediately began implementing the technology in the two newest aircraft being designed for the fleet. By 1996, preproduction units of the V-22 medium lift aircraft and the F/A-18 E/F fighter/attack aircraft were already flying with the technology.

A number of dedicated researchers—such as Dr. Robert Tapscott (Award 1993) of the New Mexico Engineering Research Institute, Dr. Philip DiNenno (Award 1992) of Hughes Associates, and the Naval Research Laboratory (Award 1995)—provided the scientific basis for many of the breakthroughs in products and methods.

Important international players have also made significant contributions to the halon phaseout. Outside the United States, military organizations in India, Norway, and the United Kingdom were also instrumental. The Indian Defence Institute of Fire Research (Award 1995) built public awareness and brought together other fire protection organizations to establish standards for dry chemical firefighting foams and portable extinguishers for use by industry as replacements for halon. The Royal Norwegian Navy Materiel Command (Award 1992) approved the use of foam to replace water halon in combat ships. Under the leadership of Marion McQuaide (Award 1994), the United Kingdom pioneered military halon banking, established one of the first national commercial halon banks, and prohibited many halon applications.

Nonmilitary government organizations and civilian associations also took proactive stances throughout the world. Under the leadership of Dr. Barbara Kucnerowicz-Polak (Award 1994), of the State Fire Service Headquarters, Poland





became a driving force in environmental education and technology cooperation. **C.K. Marfatia** (Award 1995), vice president for international marketing and government business, also heads **Real Value Appliances**, which was the single largest manufacturer of halon-1211 portable fire extinguishers in India with an installed capacity of 1,000 tons per annum. When **Real Value** realized the serious threat to the ozone layer posed by halon-1211 and India became a party to the Montreal Protocol, he voluntarily stopped the use of halon-1211 overnight and switched to ABC dry chemical powder. The result was dramatic: sales dipped, profit was slashed, and expenses increased due to the expense of advertising ABC Powder. The company withstood this onslaught with firm determination and two years later came out healthier and happier—and India as a whole reduced the use of halon-1211 by about 70 percent. **C.K. Marfatia** traveled all over the country interacting with various agencies and users propagating the use of alternatives and the phasing out of halon-1211. In Malta, **Victor Gatt** (Award 1994) instituted one of the most proactive programs of any developing country by placing controls on all halon imports, including extinguishers, and requiring users to register their needs in order to prevent hoarding. Malaysia banned halon in most educational and other public laboratories.

Halon banking was developed by **Gary Taylor** (Award 1990) as an essential element of the strategy that enabled the early phaseout of halon production while satisfying the needs of critical uses and providing more time to develop alternatives for difficult remaining halon applications. The architects of the U.S. halon banking concept included **David V. Catchpole** (Award 1993) and **Steve Taylor** (Award 1993), both of **British Petroleum (BP)**. In Europe, the United Kingdom, with leadership from **Marion McQuaide** (Award 1994); Switzerland, with leadership from **Dr. Walter Brunner** (Award 1994); and Netherlands moved quickly to establish halon banks. **HARC** (Award 1992) developed the first commercial halon banking in the United States and coordinated the search for alternatives for critical uses. The **National Association of Fire Equipment Distributors** (Award 1994) launched an aggressive publicity campaign with its members to create awareness about ozone depletion and halon banking, and to offer the most cost-effective suitable alternatives. **DASCEM** (Award 1995) also implemented halon banking.

Some of the most impressive awards are for corporate and management leadership. **TEAM Aer Lingus** (Award 1991) developed its own halon 1301 recycling technology. **Unitor Ships Service** (Award 1993) offered halon banking and alternative fire protection at its Singapore operations.

These champions are making the halon phaseout a success story that stands as a shining example of science, technology, government, and industry recognizing the existence of a problem and working together to find a solution. The halon phaseout that was achieved in developed countries in 1994 would not have been possible without the interdisciplinary, international cooperation and leadership by individuals who were in positions to make a difference.



## Halons-Related Awards Summaries

**Aberdeen Test Center, U.S. Army (Award 1995)**

Aberdeen Test Center, U.S. Army served as the primary test facility for alternative fire suppression agents and technologies to replace halon 1301 in vehicle engine compartments, combat vehicle explosion suppression, and ground combat vehicles. Engineers also developed test protocols to evaluate several different types of agents, including gases, liquids, powders, gels, foams, and water mist, as halon alternatives in combat vehicles. Halon has critical uses in combat vehicles, and finding substitutes was one of the most technically challenging problems faced by the industries.

**AT&T (Award 1992)**

As a leader in the electronics industry, AT&T again took a proactive role in ODS elimination. It halted purchase of new halon-dependent systems and designed an internal halon banking scheme. AT&T is a signatory to the Thailand Leadership Initiative and the Vietnam Pledge.

**Australia's DASCEM (Award 1995)**

Australia's DASCEM established an Australia-wide halon bank with a network that enables all Australians—individuals, small businesses, and large corporations—to safely dispose of their halon. As of July 1995, the bank had collected 980 metric tonnes of halon 1211 and 400 metric tonnes of halon 1301. The Australia Halon Bank maintains Australia's essential use halon stock, and provides halon for approved uses. The Halon Bank will destroy surplus halon 1211 using plasma arc technology.

**Boeing Commercial Airplane Group (Award 1993)**

Boeing Commercial Airplane Group worked with AIA, FAA, HARC (Award 1992), and DoD to organize a worldwide working group of military and civilian aviation corporations and regulatory authorities to find alternatives to halon for aircraft and aerospace applications. In addition, Boeing developed strategies for sustaining aircraft production with existing or recycled halons, gradual removal of halon from ground facilities, recycling and banking of halons, providing updates to customers, and supporting research and development. Boeing was a founding member of the ICOLP/ICEL.

**David A. Breslin, Naval Sea Systems Command (Award 1995)**

David A. Breslin, Naval Sea Systems Command, managed the Navy's CFC & Halon Elimination Program Office.

**Dr. Walter Brunner, envico (Award 1994)**

Dr. Walter Brunner, envico, contributed significantly to the work of the UNEP Halons TOC since it started in 1989, organized the first international conference on Halons and the Environment, and has played a major role in developing a halon bank in Switzerland. He serves as national halon expert to the Swiss government, helping develop Switzerland's halon usage reduction policy, and has given numerous presentations domestically and internationally on the phaseout of halons and ozone protection. Dr. Brunner has been a leading force in the orderly transition to halon alternatives worldwide.



**Thomas Bush,**  
Director, U.S. Army  
ODS Elimination  
Program  
(Award 1996)

**Thomas Bush, Director of the U.S. Army ODS Elimination Program,** led the communications and electronics command Army efforts to replace halon 1301 handheld fire extinguishers and CFC-12 from mobile tactical communications equipment. He helped establish an Army-wide policy that requires all U.S. Army installations and facilities to eliminate use of ODSs by 2003; provided guidance to develop project plans and fund programs; and helped execute the projects to phase out CFCs. He also initiated the development of a software tool to assist U.S. Army personnel in the selection of alternatives for halon 1301 in facility total flooding fire suppression systems. He is a member of the UNEP Halon TOC and the DoD Liaison to HARC (Award 1992).

**David V. Catchpole,**  
BP Exploration Alaska  
(Award 1993)

**David V. Catchpole, BP Exploration Alaska,** was an architect of the halon banking concept, and has contributed significantly to the work of the UNEP Halons TOC. He helped organize and conduct a worldwide assessment of BP's use of halocarbons and helped form the BP Halocarbon Working Group. Since 1991 he has worked full time with BP and other North Slope Oil and Gas Producers, HARC (Award 1992), the Halons TOC, and various national governments to craft a halon strategy.

**Defence Institute**  
of Fire Research, India  
(Award 1995)

**Defence Institute of Fire Research, India,** is a leader in building public awareness about the damage to the ozone layer caused by halons. This organization, under the leadership of H. S. Kaprwan, worked closely with other fire protection organizations and industry to establish new standards for dry chemicals, firefighting foams, and portable fire extinguishers for use throughout India.

**The Defense Logistics**  
Agency (Award 1993)

**The Defense Logistics Agency** developed the world's largest halon reserve to satisfy future mission-critical military needs.

**Dr. Philip DiNenno,**  
Hughs Associates  
(Award 1992)

**Dr. Philip DiNenno, Hughs Associates** along with other dedicated researchers, provided the scientific basis for breakthroughs in alternative products and methods.

**F/A-18 Program Office**  
and V-22 Program  
Office of the  
U.S. Naval Air  
Systems Command  
(Award 1996)

**F/A-18 Program Office and V-22 Program Office of the U.S. Naval Air Systems Command** researched and tested a new fire suppression technology using inert gas generators. As a result, the two newest aircraft that will enter into service, the F/A-18 E/F fighter/attack aircraft and the V-22 tilt-rotor medium-lift aircraft, will no longer require the use of halon 1301. The use of this alternative fire extinguishing agent will reduce DoD's overall halon 1301 reserve requirement.

**The Falcon Halon Team**  
at Wright Patterson  
AFB (Award 1994)

**The Falcon Halon Team at Wright Patterson AFB** was created to reduce the use of halon 1301 in F-16 fuel tank inerting systems. This initiative saves over 18 metric tonnes of halon per year for approximately 2,000 aircraft.



**GEO-CENTERS**  
(Award 1995)

GEO-CENTERS, under the leadership of Peter Mullenhard, successfully operated the U.S. Navy CFC & Halon Clearinghouse since its origin in 1991, responding to more than 7,000 individual information requests and publishing a newsletter, "CFC/Halon News," that currently has over 3,000 subscribers worldwide.

**Casey Grant, NFPA**  
(Award 1995)

Casey Grant, NFPA, helped raise public awareness of the concerns related to the use of halon fire extinguishants. He wrote several timely articles in fire protection publications and has also been a key organizer of conferences, workshops, and seminars to explain these concerns and assist the fire protection industry in the safe transition from the use of halons.

**The Halon Essential Uses Panel, Victoria Australia EPA**  
(Award 1992)

The Halon Essential Uses Panel, Victoria Australia EPA effectively controlled the end uses of halons, virtually eliminating the use of newly manufactured halons. The panel received widespread support from government and industry.

**The Halon Recycling & Banking Support Committee (HRBSC)**  
(Award 1996)

The Halon Recycling & Banking Support Committee (HRBSC) was founded in July 1993 and established the reclamation and banking system for the existing halons in Japan. The committee completed a nationwide inventory of halons and registered about 400,000 cylinders/extinguishers at 55,000 installation sites, with a total quantity of 17,000 metric tons of halons. A database and reporting system enables HRBSC to effectively manage and control the use of halons. As the result of these efforts, a total of 88 metric tons of used halons have been reclaimed by member companies in 1994-1995 for recycling. HRBSC has raised public awareness of ozone layer protection and promoted halon conservation. HRBSC also participates in UNEP and other international ozone protection activities.

**HARC (Award 1992)**

HARC was founded in 1989 to encourage and coordinate the search for fire protection alternatives to halons.

**IBM**  
(Awards 1992  
and 1993)

IBM, a leader of the electronics industry, had never extensively used halons. It worked to prove that electronics could be protected with water or carbon dioxide. IBM is a signatory to the Thailand Leadership Initiative.

**Joel Krinsky, Naval Sea Systems Command**  
(Award 1994)

Joel Krinsky of Naval Sea Systems Command was instrumental as the U.S. Navy's CFC & Halon Program Director in devising the U.S. Navy's ODS program management and compliance strategy. Through his efforts and support, the U.S. Navy was the first U.S. DoD component to receive approval and funding for a comprehensive ODS elimination program.

**Dr. Barbara Kucnerowicz-Polak, State Fire Service Headquarters, Poland**  
(Award 1994)

Dr. Barbara Kucnerowicz-Polak, State Fire Service Headquarters, Poland (Award 1994), played a leading role in the early development of Poland's halon phaseout strategy, and was thereby influential in shaping the phaseout process throughout Eastern Europe. Her activities involved limiting halon use and emission, introducing suitable alternatives, supporting the needs of critical uses, and developing an information clearinghouse for technological and environmental issues related to



halon phaseout. She organized training, education, and informational events such as workshops and seminars for government representatives, users, and fire engineers. These included an International Workshop on Problems Related to Halon Phaseout in 1994; participants included experts from Eastern European countries, and proceedings were published in Russian to maximize accessibility in those countries. She co-chairs the UNEP Halon TOC.

**Dr. Mohinder Malik,**  
Lufthansa  
(Award 1994)

**Dr. Mohinder Malik, Lufthansa,** worked with the **European Airlines Committee for Materials Technology** to create a task force that collects and distributes information on halons phaseout and alternative products. Consequently, the reduction of these products among member airlines has accelerated. He co-chairs the **UNEP Solvents, Coatings and Adhesives TOC**.

**C.K. Marfatia,**  
**Real Value Appliances,**  
**India**  
(Award 1995)

**C.K. Marfatia, Real Value Appliances, India,** was the largest producer of halon 1211 portable fire extinguishers in India, consuming approximately 200 metric tonnes of halon 1211 annually in their manufacture. When he became aware of the serious threat to the ozone layer posed by halon 1211, he voluntarily stopped manufacturing halon 1211 fire extinguishers and developed a portable dry chemical extinguisher.

**Marion McQuaide,**  
**UK Ministry**  
**of Defence**  
(Award 1994)

**Marion McQuaide, UK Ministry of Defence,** played a leading role in the phaseout of halons both in the United Kingdom and internationally. She has made valuable contributions to the work of the **UNEP Halons TOC** and has been a leading member of a team established in 1989 to coordinate halon banking within the **UK Ministry of Defence**. She was also a founding member of the **UK Halon Users National Consortium (HUNC)** and chaired the **UK Halon Alternatives Group (HAG)**, founded in August 1993, to assist current users of halon in the United Kingdom to find suitable alternatives.

**Major E. Thomas**  
**Morehouse, Jr.,**  
**U.S. Air Force**  
(Award 1991)

**Major E. Thomas Morehouse, Jr., U.S. Air Force,** acted as the point of contact for Air Force cooperation with EPA and led the organization responsible for ensuring Air Force compliance with the Montreal Protocol. Working together, the Air Force and EPA agreed on substantial changes in halon use policy, including limiting halon use in essential applications, prohibiting discharge testing, limiting training, and ultimately helping to organize a working group of international aviation corporations and regulatory authorities to find alternatives to the use of halons in aviation. Major Morehouse served as co-chair of the **UNEP Halons TOC** from 1989 to 1996.

**National Association**  
**of Fire Equipment**  
**Distributors (NAFED)**  
(Award 1994)

**National Association of Fire Equipment Distributors (NAFED),** with 1,200 member companies, was immediately alerted to the relationship of ozone depletion and halon issues. Under the leadership of **Joe Ziemba, Stephen B. Waters (Fireline), William D. Hard (Hard Fire Suppression Systems),** and others, **NAFED** began a comprehensive educational program, focusing initially on the reduction of halon use, then on the use of alternative agents and proper halon recovery, and finally on plans for the complete elimination of halons.



**The Naval Air Warfare Center, Aircraft Division, Lakehurst (Award 1992)**

The Naval Air Warfare Center, Aircraft Division, Lakehurst, developed, acquired, and implemented the first halon 1211 recycling technology. Additionally, it participated in recycling technology cooperation with dozens of developing countries.

**The Navy Technology Center for Safety & Survivability, U.S. Naval Research Laboratory (NRL) (Award 1995)**

The Navy Technology Center for Safety & Survivability, U.S. Naval Research Laboratory (NRL), conducted research and testing that laid the groundwork for commercialization of many of the halon alternatives in commercial use today. In addition, NRL's comprehensive research and testing program to identify shipboard replacements for halon 1301 culminated in the Navy's decision to build the first two new design ships of the 21st century without halon fire protection systems. NRL evaluated many other non-ODS fire protection systems and has presented alternative fire protection technologies to other countries.

**NFPA (Award 1990)**

NFPA withdrew its proposal that would have required mandatory testing of new halon 1301, and generated new standards (NFPA 2001, NFPA 750) that facilitated the implementation of technology to replace halons.

**John O'Sullivan, British Airways (Award 1996)**

John O'Sullivan of British Airways demonstrated leadership in the aviation industry to eliminate the use of halons. As a strong supporter of halon banking programs, he has worked to eliminate all non-critical use of halons within British Airways and set up one of the first company halon banks. He played an active role in the U.S. FAA Halon Alternatives Group, the Aviation International Halons Working Group, HUNC, and HAG. Mr. O'Sullivan is a member of the UNEP Halons TOC and a director of HUNC.

**The Royal Norwegian Navy Materiel Command (Award 1992)**

The Royal Norwegian Navy Materiel Command approved the use of foam to replace halon in combat ships. This was the world's first conversion to eliminate halons on warships.

**Dr. Ronald Sheinson, NRL (Award 1996)**

Dr. Ronald Sheinson of NRL (Award 1996) has been involved in the search for environmentally acceptable and efficient fire-suppression technologies since the mid-1970s. Working as the Navy's senior researcher for shipboard halon alternatives, he formulated the U.S. Navy's comprehensive Halon Replacement Research and Development Program, which supports government and industry efforts worldwide. He also pioneered the use of a hybrid gaseous-water spray cooling extinguishment system that reduces corrosive hydrogen fluoride concentrations formed by deployment of HFC-based alternatives.

**Franklin Sheppard, Jr., Office of the Chief of Naval Operations (Award 1994)**

Franklin Sheppard, Jr., Office of the Chief of Naval Operations, led research, development, and implementation of the first halon 1211 recycling technology. He went on to share this technical information with developing countries.



The Tank-Automotive Research, Development, & Engineering Center, Survivability Technology Area, Halon Replacement Team (Award 1996)	The Tank-Automotive Research, Development, & Engineering Center, Survivability Technology Area, Halon Replacement Team, worked to eliminate halon dependence in the Army's fleet of armored vehicles. The team's work will result in the recovery of 230 metric tonnes of halon 1301. Without its efforts, the Army would have been forced to purchase an additional 682 metric tonnes of halon. Its work to find alternatives for halon in explosion suppression will eliminate current Army requirements for 391 metric tonnes of halon 1301.
Dr. Robert E. Tapscott, the New Mexico Engineering Research Institute (Award 1993)	Dr. Robert E. Tapscott of the New Mexico Engineering Research Institute, along with other dedicated researchers, provided the scientific basis for breakthroughs in alternative products and methods. Under sponsorship of the U.S. Air Force, he investigated and reported on HCFCs, HFCs, and hydrobromofluorocarbons (HBFCs) as near-term ("first generation") halocarbon halon replacement agents. Subsequently, he directed work to develop and evaluate replacements for halon 1301 used for explosion and fire protection in oil production facilities.
Gary Taylor, Taylor/Wagner (Award 1990)	Gary Taylor of Taylor/Wagner was persuaded by the growing scientific evidence linking halons and ozone destruction. As chair of the NFPA Halon Technical Committee, he designed a strategy to limit halon emissions. His plans ultimately developed into a successful program of halon bank management. Mr. Taylor also served as co-chair of the UNEP Halons TOC from 1989 to the present time.
Steven D. Taylor, BP Exploration Alaska (Award 1993)	Steven D. Taylor, BP Exploration Alaska, was an early architect of the halon banking concept and chair of HARC.
TEAM Aer Lingus (Award 1991)	TEAM Aer Lingus developed its own halon 1301 recycling technology to satisfy strict aerospace purity standards.
Unitor Ships Service in Singapore (Award 1993)	Unitor Ships Service in Singapore offered halon banking and alternative types of fire protection for commercial ships.
The U.S. Air Force's Air Base Fire Protection and Crash Rescue Systems Branch (Award 1993)	The U.S. Air Force's Air Base Fire Protection and Crash Rescue Systems Branch motivated DoD to provide funding for significant research in the development of halon 1211 replacements. The development of a halon recycling system, innovative firefighter training methods without halon 1211, and the replacement of all halon 1211 with dry chemical and foam extinguishing agents on the entire U.S. Air Force Crash Rescue Firefighting Vehicle Fleet, eliminated over 70 percent of the halon 1211 used in the U.S. Air Force.
The U.S. Army Acquisition Pollution Prevention Support Office (Award 1992)	The U.S. Army Acquisition Pollution Prevention Support Office developed a successful halon elimination and management program. The office also worked with ISO to develop specifications that would allow the use of recycled halons and then persuaded the U.S. military to adopt those new commercial standards. The "Strategic Guidance and Planning for Eliminating Ozone-Depleting Chemicals From U.S. Army Applications" presented the entire U.S. Army strategy to replace



all but one use of ODSs on its weapon systems. The Army strategy could not identify a near- or mid-term substitute for halon explosion suppression in ground combat vehicles during combat, but is undertaking a research program to develop long-term solutions.

**Dr. Daniel P. Verdonik,  
Hughes Associates  
(Award 1995)**

Dr. Daniel P. Verdonik of Hughes Associates was instrumental in building the highly successful U.S. Army ODS Elimination Program. Under his leadership, the Army's ODS program was recognized outside DoD both by industry and by other countries. Also, Dr. Verdonik was a member of the UNEP Halon TOC, the DoD liaison to HARC (Award 1992), and a special advisor to the Army Science Board and the World Bank on halon issues.

**James Vincent,  
U.S. Army Aviation  
and Troop Command  
(Award 1994)**

James Vincent, U.S. Army Aviation and Troop Command, initiated numerous projects, including the development of the Army Watercraft program to test water mist alternatives to halon 1301 for fire suppression, and implementation of the program to modify halon 1301 recharger/recovery units to prevent unnecessary venting.

**Dr. Hans U. Wackerlig,  
Swiss Institute for the  
Promotion of Safety  
& Security  
(Award 1995)**

Dr. Hans U. Wackerlig, Swiss Institute for the Promotion of Safety & Security, along with other organizations led and organized three International Halon Conferences. At the first conference, in June 1988, attendees identified and defined the problem. In October 1990, participants in the second conference further discussed problems and explained the meaning of "essential use." In 1994, people at the third conference focused on solutions to these problems.

**Wright Laboratory's  
Aircraft Halon  
Replacement Team,  
Wright-Patterson AFB  
(Award 1994)**

At Wright-Patterson AFB, Wright Laboratory's Aircraft Halon Replacement Team led government aircraft research to select halon alternatives and identify new fire protection engineering and aircraft design requirements. Accomplishments to date include the reactivation of a world-class, live-fire aircraft engine nacelle test facility; development of new laboratory bench apparatus for aircraft fire scenarios; technical screening and down selection of alternative agents; a comprehensive review and assembly of aircraft fire suppression design requirements; and derivation of critical technical fire parameters of in-flight aircraft fires.

**Wright Patterson AFB,  
Aeronautical Systems  
Center  
(Award 1994)**

At Wright-Patterson AFB, the Aeronautical Systems Center F-15 System Program Office (SPO) implemented key projects that identified and changed how ozone-depleting chemicals are used in manufacturing processes. As of June 1995, 90 percent of the F-15 Eagle's 1,867 technical orders were changed to avoid ODSs. Implementing specially designed manufacturing equipment using aqueous and water soluble media resulted in the elimination of methyl chloroform from the cleaning and degreasing processes of F-15 aircraft, reducing methyl chloroform usage by approximately 18,000 pounds per year.





# Refrigeration and Air-Conditioning

## Recycling From Automobile A/C Systems

In 1987, automobile air-conditioners were the largest single source of controllable CFC emissions in the United States. Normal CFC leakage through rubber hoses, connectors, and seals was very high, and typical repair procedures intentionally released large amounts of CFCs into the air. CFCs were inexpensive, and no acceptable machines were available to capture and reclaim the CFCs. When confronted with a poorly functioning air-conditioner, a service technician typically diagnosed the problem by recharging the system in order to find the leak. The technician would then vent the refrigerant into the atmosphere and repair, recharge, and leak test the system. Do-it-yourself car owners saved money by merely recharging leaking systems—often several times a year, without fixing the leak. CFCs also entered the atmosphere when an A/C component had to be removed to gain access to other automobile systems.

In January 1988, EPA organized its first meeting of the **Ad-Hoc Automobile Recycling Working Group**. The group selected **Simon Oulouhojian** (Award 1990), **Robert W. Bishop**, and **Dr. Stephen O. Andersen** to chair their work. **Jean Lupinacci** (Award 1996) was project manager for EPA. **Simon Oulouhojian** was the owner of the **Speedway** radiator/air-conditioner repair shop in Upper Darby, Pennsylvania, and Executive Director of **MACS** (Award 1990). **Robert W. Bishop** was an engineer with the **General Motors** (Award 1994) **Air-Conditioning Division**, and was later replaced on the committee by **James A. Baker** (Award 1990). **Dr. Stephen O. Andersen** worked at EPA. Other key founding members of the Ad-Hoc working group were **Ward Atkinson** (Award 1990), **Art Hobbs** (Award 1993), and **Kenneth W. Manz** (Award 1993). **Ward Atkinson** was the owner of **Sun Test Engineering** and was also chair of the **SAE Interior Climate Control Standards Committee** and **ISO's Interior Climate Control Committee**. Before founding **Sun Test**, **Ward Atkinson** was responsible for developing heating and A/C systems at

"I was honored with the 1990 Stratospheric Ozone Protection Award for "Engineering Excellence and Corporate Leadership" for my participation on the team that developed the technology to recycle mobile air-conditioning refrigerants. Such global efforts on behalf of the ozone layer stand as a testimonial that mankind can and will rally to protect the environment. Industry and government, working together, combining knowledgeable people with enlightened environmental consciousness and a will to succeed, can lead us toward a more sustainable symbiosis with our environment."

*James A. Baker (Award 1990)  
Delphi Harrison Thermal Systems, General Motors  
Corporation (Award 1994)*



Chevrolet Motor Division and was a member of the General Motors corporate team established in the 1970s to reduce the CFC emissions from mobile A/C systems.

"Underwriters Laboratories was unsure how we could help protect the ozone layer when we joined the EPA/MACS working group on CFC recycling. Our experts helped develop a voluntary standard of purity for recycled CFC that was accepted by automobile manufacturers for new car warrantee service. At that point the EPA/MACS working group asked UL to certify that recycling machines could clean up dirty CFC to the stringent standard. Until then UL had never certified performance of products—only safety of use. We accepted the challenge, persuaded our management of importance of our work, and moved quickly to help get certified recycling machines into the market. The experience was so successful that UL went on to assist other green programs including green product labeling."

*James R. Beyreis (Award 1990)*

*Don Grob (Award 1990)*

*Underwriters Laboratories (Award 1990)*

Hitachi (Award 1991), James Kamm Technologies, Murray, NAPA Temp Products, Parker Hannifin, Rapidfill, Refrigerant Recovery Systems, Robinair/SPX, G.G.L. Enterprises, ThermaFlo, Van Steenburgh Engineering Laboratories, Vanguard/ARA Automotive Group, and White Industries.

Environmental nongovernmental organizations (NGOs) included the University of Maryland CGC, FOE, and NRDC.

Experts representing automobile manufacturers stressed the economic importance of maintaining A/C performance and reliability. Automobile designers were exposing more car interiors to sunlight with aerodynamic designs and sunroofs, thereby increasing the challenge of cooling. Consumers were demanding extended warranties and higher reliability. Car owners might be reluctant to jeopardize valuable cars with recycled chemicals. Experts representing the automobile repair business and repair equipment suppliers stressed the importance of promoting changes that were profitable to mechanics and acceptable to customers. CFC-12 was selling for less than \$2 per kilogram, so a typical repair included a refrigerant cost of only

Art Hobbs was vice president of MACS in 1988 and 1989. He testified before the U.S. Senate and the Department of Energy and worked with state and local governments on CFC issues. In 1990, at EPA's invitation, he delivered a paper on the introduction of CFC recycling to developing nations at the world conference in Singapore. He served as president of MACS during 1991 and 1992, shaping the Society's role in response to the CFC/ozone-depletion issue. From 1990 through 1992, he also served on the SAE Interior Climate Control Division committees that addressed CFC-related issues.

Technical representatives participated from other trade organizations and technical societies, including the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), AIA, the Motor Vehicle Manufacturers Association of the United States, and UL; from other motor vehicle manufacturers including Chrysler Corporation (Award 1992), Ford (Awards 1992 and 1994), NAVISTAR, Nissan Motor Company (Award 1991), Toyota (Award 1994), and Volvo (Award 1993); and from manufacturers of air-conditioner parts and service equipment including A'Gramkow, Applied Ecological Systems, Davco Manufacturing, DRAF Industries, Fentech, High Frequency Products,



\$2 to \$4. Repair shop owners predicted that recycling would only be successful if equipment and training were mass produced and if government regulations compelled all shop owners to recycle. NGOs threatened to organize against automobile companies if they blocked recycling and emphasized the potential for state regulation if EPA failed in its voluntary approach. EPA explained its authority to impose command-and-control regulations but offered cooperation in designing a recycling program on the condition that industry would make good-faith efforts to develop and promote the program.

At first the working group was deadlocked. No commercial recycling equipment was available to test, and it was unclear whether car owners would pay extra to protect the ozone layer. The breakthrough came when the chairs decided to promote a performance-based standard for recycling. James A. Baker (Award 1990) believed that when air-conditioner systems were opened, only the refrigerant, but not the lubricating oil, was vented and vaporized, and so contaminants remained in the system. The proposed standard was based on the idea that some level of CFC contamination would be acceptable, that it was the obligation of recycling equipment manufacturers to design equipment capable of cleaning to a standard acceptable to automobile manufacturers, and that equipment would have to be tested by an independent laboratory to prove its cleaning performance.

The EPA/MACS Working Group agreed on a performance standard, and identified an acceptable level of contamination. Next, they determined how contaminated CFC refrigerant could get in a worst-case situation. They then designed a procedure to test whether recycling equipment could clean a worst-case CFC sample to the acceptable level of cleanliness. Finally, they secured acceptance of recycling under new-car warranties by automobile manufacturers. It was anticipated that public education, market forces, and regulations would then promote recycling.

The group tested CFC samples from 220 vehicles. The samples included new, normally-operating auto air-conditioners with mid- and high-mileage, and those with failed systems. This provided the greatest sampling range of used refrigerant. The goals were to determine an acceptable level of contamination and to test CFCs from highly contaminated systems that either were very old or had experienced catastrophic failures, including metal particle contamination and thermal failure. The EPA Office of Research and Development, under the guidance of William Rhodes, Paul S. Shapiro, Dr. Dean Smith, and Dale Harmon, funded and conducted the laboratory work, while automobile repair shops donated their time, and group members were encouraged to observe the work to satisfy their own concerns. The Sampling Team included Acurex, ARA, Barney Gross Auto Air, Budget, Hertz, Houston Auto Air, J&N Auto Air, MACS (Award 1990), Murray, Robinair, Triple L, West End Auto Air, White Industries, and many more. Automobile manufacturers conducted confidential research to confirm the results. UL (Award 1990) experts Donald P. Grob (Award 1990), Larry Kettwich, Robert A. Kingsbury, and Frank Przybylski simultaneously experimented with designs of prototype test equipment.



The group's efforts resulted in a proposed standard of purity for recycled CFCs, a standard "cocktail" of contaminated CFCs that would be used to test the performance of recycling equipment, and an SAE test procedure specifying how the equipment would be operated and how the recycled CFCs would be tested for purity. EPA drafted a simple letter of agreement and circulated it by fax to international automobile manufacturers for their acceptance. Within a few weeks a sufficient number of automobile companies had agreed to allow refrigerant recycling according to the program. In January 1989, the MACS convention in San Diego featured a national press conference with live recycling demonstrations. The extensive television and print coverage sensitized the automobile industry and the public to the importance of recycling as a fundamental part of stratospheric ozone layer protection.

When automobile manufacturers accepted recycled refrigerant for use in vehicles under warranty, recycling gained the credibility needed for the service equipment industry to begin developing recycling equipment. No recycling equipment was commercially available at the time, no test laboratories offered certification, and no repair shops had pledged to use recycling equipment.

As the recycling team commercialized the technology, FOE and NRDC began promoting state laws to protect the ozone layer. CFC emissions from car air-conditioners were one target of these efforts. Because industry and NGOs were working together, NGOs had the advantage of receiving industry input to regulatory initiatives. In addition, the industry had the advantage of learning how regulations could

help reduce costs by capturing economies of scale in the manufacturing of recycling machines, training, and infrastructure. The industry-NGO cooperation enabled the design of workable legislation.

Massachusetts, Maryland, Hawaii, Vermont, California, Florida, and several other states considered mandatory recycling and a ban on small CFC refrigerant cans. The availability of small cans of CFC-12 facilitated recharge without repair by do-it-yourselfers who did not have the training, instructions, or proper equipment to minimize emissions. The state laws, particularly California's—sponsored by Assemblyman Tom Hayden—offered a model for congressional staff as they drafted the stratospheric ozone section of the Clean Air Act Amendments of 1990. Under that law, motor vehicle A/C recycling was the first CFC recycling mandate to take effect nationally.

With automobile manufacturer acceptance, market forces took over. The working group estimated that recycling would be cost effective if CFC prices were \$4.40 per kilogram. UL (Award 1990) acted quickly to approve its first certification of equipment performance—previously, UL had only certified safety of operation. Equipment was promptly designed, tested by UL, and marketed. Environmental organizations, recycling equipment suppliers, EPA, and repair organizations promoted recycling.

## Automobile Manufacturers First to Accept Recycled Refrigerant Under Warranty

Alfa Romeo, Aston Martin Lagonda, Audi, Austin Rover, BMW, Chrysler Corporation (Award 1992), Daihatsu, Excalibur, Ford (Awards 1992 and 1994), Freightliner, General Motors (Award 1994), Grumman Olson, Honda, Hyundai, Isuzu, Jaguar, Maserati, Mazda, Mercedes-Benz (Award 1992), Mitsubishi, Navistar, Nissan Motor Company (Award 1991), Paccar, Peugeot, Porsche, Rolls-Royce, Rover, Saab, Subaru, Suzuki, Toyota (Award 1994), Volkswagen, Volvo (Award 1993), and Yugo



Involvement by the chairs of international standards organizations and automobile manufacturers helped speed global acceptance. SAE standards that established the refrigerant equipment performance and purity requirements were rapidly developed. In addition, SAE established technician guidelines for servicing mobile A/C systems and for the proper operation of recovering/recycling equipment.

Progressive repair shops began to offer recycling as a service and began to lobby for mandatory recycling and a halt of CFC sales to businesses and individuals without recycling equipment. The automobile industry supported uniform national standards to simplify business and to level the playing field for repair shops that chose to make the extra effort to recycle. At the MACS annual meeting in San Diego in 1989 owners of repair shops unanimously supported mandatory legislation to complement their market promotion of recycling.

Thus, the FOE and NRDC public education and regulatory efforts, inspired by the EPA/MACS group, were already well advanced when recycling equipment reached the market. Through participation in the EPA/MACS group, FOE and NRDC were aware of the purity standard, the importance of certified equipment, and the time needed for a smooth transition to new equipment and technician training. Furthermore, FOE and NRDC were able to become partners with the automobile industry in persuading and reassuring the public that these changes were in the world's environmental interest.

The automobile press praised the recycling agreement. Within one year, over \$60 million worth of equipment had been sold in the United States. By 1995, American manufacturers had sold \$4 billion worth of equipment worldwide. Independent private organizations have certified 850,000 technicians. At the same time, these voluntary efforts have reduced the amount of CFCs used to service automobile air conditioners by 50 percent.

Working in a cooperative fashion with all stakeholders generated both a broad understanding of all the issues and an ultimate consensus on the solution.

## Awards for Automobile A/C Recycling

- ◆ Ward Atkinson (Award 1990)
- ◆ James Baker (Award 1990)
- ◆ James R. Beyreis (Award 1990)
- ◆ Elizabeth Cook (Award 1991)
- ◆ David Doniger (Award 1991)
- ◆ Don Grob (Award 1990)
- ◆ Art Hobbs (Award 1993)
- ◆ Alan S. Miller (Award 1992)
- ◆ Simon Oulouhojian (Award 1990)
- ◆ MACS (Award 1990)
- ◆ UL (Award 1990)

## HFC Substitutes for CFC A/C

**T**he initial search for a suitable replacement for CFC-12 in automobile A/C was desperate. EPA investigated experimental compressors (e.g., Rovac air systems, Stirling Cycles), venting alone or in combination with low-capacity A/C systems (e.g., tinted windows, solar vents, induction vents), and hard-plumbed systems using electrically driven high pressure HCFC refrigerants with electricity supplied by innovative charging systems.



When EPA presented these ideas to the automobile industry, it was greeted with disbelief, skepticism, and outrage. Some of the technologies had already been extensively tried and rejected, while others offered decreased performance that automobile manufacturers believed would be unacceptable to consumers.

Several CFC manufacturers worked internally and with major automobile manufacturers to solve several technical problems, primarily lubrication, to make HFC-134a a suitable replacement for CFC-12 in automobile air conditioning. The leading companies included Nissan Motor Company (Award 1991), Chrysler Corporation (Award 1992), Ford (Awards 1992 and 1994), Mercedes-Benz (Award 1992), Volvo (Award 1993), General Motors (Award 1994), and Toyota (Award 1994). Nissan was first to announce that it had selected HFC-134a as its replacement refrigerant in new automobiles. General Motors (Award 1994), Volvo (Award 1993), and Mercedes-Benz (Award 1992) were the first companies to put HFC-134a systems in their cars and trucks.

In parallel, automotive A/C component manufacturers, such as Nippondenso (Award 1993) and Sanden (Award 1996), played a significant role in developing the required compressors to meet the HFC-134a challenge. Significant resources were committed, culminating in a successful replacement of all CFC-12 in new vehicles with HFC-134a systems.

In 1992, regulatory jargon and contradictions within some building, mechanical, and fire codes significantly impeded the introduction of alternative refrigerants and associated technologies. An Air-Conditioning & Refrigeration Institute (ARI) project, with the assistance of Michael E. Dillon (Award 1993), Jean Lupinacci (Award 1996), and experts from Trane (Awards 1991 and 1995), was mounted to quickly redraft and seek adoption of revised language that would cure the problem. By 1993, updated language was adopted and subsequently published in the 1994 editions of the Uniform Building Code, Uniform Mechanical Code, and Uniform Fire Code.

By 1996, the U.S. Navy had converted over 200 shipboard A/C and refrigeration systems with a total installed charge of 23,000 kilograms of refrigerant, and was operating 35 "CFC-free" ships. In addition, the Navy is active in exporting CFC-free technology to other foreign militaries through the Foreign Military Sales Program. For example, in 1995 and 1996 the U.S. Navy converted three ships bound for Taiwan and also converted the Spanish frigate CANARIAS (F86) from CFC-12 to HFC-134a. During the Spanish ship conversion, the U.S. Navy also provided training to Spanish technicians to enable them to convert the remainder of their fleet.

### Awards for Automobile A/C HFC Substitutes

- ◆ Chrysler Corporation (Award 1992)
- ◆ Ford Motor (Awards 1992 and 1994)
- ◆ General Motors (Award 1994)
- ◆ Mercedes-Benz (Award 1992)
- ◆ Nippondenso (Award 1993)
- ◆ Nissan Motor Company (Award 1991)
- ◆ Toyota (Award 1994)
- ◆ Sanden (Award 1996)



## Domestic Refrigeration

In the refrigeration sector, an initial obstacle to successful CFC elimination turned out to be another environmental issue: energy efficiency. In the mid-1980s, national energy efficiency standards were adopted in an effort to reduce energy consumption. Simultaneous acceptance that CFCs destroyed stratospheric ozone created pessimism among refrigerator manufacturers. The potential substitute chemicals, they believed, were unacceptable given the new energy-reduction standards and other factors, including cost, reliability, and safety.

EPA, in cooperation with environmental groups such as NRDC, pushed for a massive overhaul of refrigerator, compressor, and factory design that would permit energy efficiency and CFC reduction at the same time. Dr. Lambert Kuijpers (Award 1993) working for Phillips was the first company expert to publicly advocate a new look at available and emerging options.

Unfortunately, market forces were insufficient because little market incentive propels manufacturers to invest capital and resources in efficient refrigerators if consumers are unwilling to pay more for quality and economy.

NRDC, under the leadership of Dr. David Goldstein and David Doniger (Award 1991), suggested offering economic incentives to manufacturers to design refrigerators that were both CFC-independent and energy efficient. The most likely candidates for funding this program were the utility companies that already gave their customers subsidies for buying efficient products. Cash incentives, given to manufacturers for research, development, and production, showed the industry that energy efficiency and CFC elimination are not mutually exclusive.

In 1993, the "Golden Carrot" incentives program was launched using funds provided by utility companies. After intense competition, Whirlpool won a \$30 million incentive contract to design and produce a CFC-free, super-efficient refrigerator. In less than 1 year, Whirlpool introduced a competitively priced CFC-free refrigerator.

The refrigerator manufacturers, after much initial pessimism concerning the acceptability of substitute chemicals and the need to maintain energy efficient stan-

"I won my Stratospheric Protection Award while working for the Natural Resources Defense Council as an environmental attorney. NRDC started the ball rolling by working with EPA to develop an ozone protection strategy. But the private sector came forward with the technical changes that we never could have compelled and business acted more quickly than regulation could. Business leaders proved that cooperative programs worked. I am proud to be associated with the Award winners."

*David Doniger (Award 1991)*

*Counsel to the Assistant Administrator for  
Air and Radiation, U.S. EPA*

### Awards for Appliance, Commercial, and Industrial Refrigerant Recycling

- ◆ Denis Clodic (Award 1995)
- ◆ Industrial Technician Certification Team (Award 1994)
- ◆ Refrigerant Reclaim Australia (Award 1995)
- ◆ Sea-Land Service (Award 1995)
- ◆ Carmen C. Waschek, Coca-Cola (Award 1993)



dards, rose above the challenges. EPA, NGOs, and manufacturers worked together to find a truly innovative solution.

UL's James Beyreis (Award 1990) and Donald Grob (Award 1990) led the research into recycling equipment that could produce CFCs able to meet existing quality standards. Once CFC recovery and recycling became possible, many groups demonstrated their support for this innovative approach. The **Industrial Technician Certification Team** (Award 1995) was responsible for training technicians on proper procedures to use the recycling technology.

Internationally, corporations and governments worked extensively to come up with the technology for successful CFC recycling, and to implement programs that recovered CFCs from appliances that had reached the end of their useful lives. Denis Clodic (Award 1995), while co-chair of the French National CFC Commission, urged recovery and limitation of leakage in refrigerators as a means of reducing ODS emission. In Australia, the CFC recovery and recycling association **Refrigerant Reclaim Australia** (Award 1995) has successfully reduced CFC emissions by recovering approximately 5 tons of CFC per month, about half of which is able to be reprocessed for reuse. They hold the remainder in storage pending resolution of a technology for its safe destruction.

Once the alternative technology was created, champion members of industries reliant on refrigeration jumped on board. Corporations including **Beverage-Air** (Award 1995), **Cadbury** (Award 1993), **Coca-Cola** (Award 1993) under the leadership of Carmen C. Waschek (Award 1993), **Hussmann** (Award 1994), **J. Sainsbury** (Award 1993), **Sea-Land Service** (Award 1995), **Shaw's Supermarkets** (Award 1993), **Texas Instruments** (Award 1995), and **Woolworths Australia** (Award 1993) converted their facilities to non-CFC refrigeration systems. Without this cooperation, the success of the CFC phaseout in the refrigeration sector would have been in serious jeopardy.

## A/C- and Refrigeration-Related Awards Summaries

### **AlliedSignal (Award 1993)**

AlliedSignal played a leading role in the development and commercialization of advanced technology for the phaseout of CFCs. It invented a number of HFC-based refrigerants for refrigeration and A/C, including R-507 to replace R-502 and HCFC-22 in low- and medium-temperature refrigeration systems and R-410A to replace HCFC-22 in new A/C equipment.

### **Carrier Corporation/ AlliedSignal (Award 1993)**

AlliedSignal/Carrier Corporation jointly developed a chlorine-free, non-ozone-depleting replacement for HCFC-22 and a residential A/C unit to utilize it. R-410a is a blend of HFC-32 and HFC-125. This refrigerant allows A/C equipment manufacturers to produce smaller, more energy efficient systems using a refrigerant with zero ODP.





- Annapolis Detachment, Carderock Division, Naval Surface Warfare Center (Award 1995)**  
Annapolis Detachment, Carderock Division, Naval Surface Warfare Center research will allow transition to the use of HFC-236fa in all ships commencing in 1999.
- ARI (Awards 1991 and 1995)**  
ARI established Standard 700 for refrigerant purity to help ensure that reclaimed refrigerant does not damage equipment. ARI also established Standard 740 to help ensure consistent performance ratings of recovery/recycling equipment to limit refrigerant emissions and assist consumers in making informed buying decisions. In addition, ARI developed Guideline K, a recommended guide of good practices for all who supply, use, store, or transport containers of ozone-depleting refrigerants. ARI also established a program, which has been successfully operating since 1991, to incorporate alternative refrigerants and state-of-the-art refrigeration technology developed in response to ozone-depletion in major model codes in the United States.
- ARI's Alternative Refrigerants Evaluation Program Task Force and Technical Committee (ARE) (Award 1994)**  
ARI's Alternative Refrigerants Evaluation Program Task Force and Technical Committee (ARE) is a leading force in the development of alternative refrigerants to R-22 and R-502. It represents a productive partnership of competing manufacturers in both the United States and abroad. ARE has led private companies to commit their own resources to help develop non-ozone-depleting refrigerants for use within the industry.
- Asahi Glass, Japan (Award 1994)**  
Asahi Glass, Japan, developed and responsibly marketed alternatives for refrigerants, blowing agents, and cleaning solvents. Experts from Asahi Glass participated in technology cooperation and technical assessments including study tours, conferences, and workshops throughout the world. The company is a strong advocate of environmental leadership and is a signatory to the Vietnam Pledge to help the Government of Vietnam protect the ozone layer by investing only in modern, environmentally acceptable technology in the company's Vietnam projects.
- Ward Atkinson, Sun Test Engineering (Award 1990)**  
Ward Atkinson, Sun Test Engineering was a key founding member of the EPA/MACS Working Group. He was chair of the SAE's Interior Climate Control Standards Committee and the ISO's Interior Climate Control Committee. Before founding Sun Test, Mr. Atkinson was responsible for developing heating and A/C systems at Chevrolet Motor Division and was a member of the General Motors (Award 1994) corporate team established in the 1970s to reduce the CFC emissions from mobile A/C systems.
- James A. Baker, General Motors (Award 1990)**  
James A. Baker, General Motors, co-chaired the team that developed the technology to recycle mobile A/C refrigerants. He believed that when air-conditioner systems were vented, contaminants remained in the system. This hypothesis helped persuade vehicle manufacturers to consider the use of recycled CFCs under warranty. Mr. Baker helped gain approval for a proposed standard based on the idea that some level of CFC contamination would be acceptable, that it was the obligation of recycling equipment manufacturers to design equipment capable of cleaning to a standard acceptable to automobile manufacturers, and that equipment would have to be tested by an independent laboratory to prove its cleaning performance.



**Beverage-Air**  
(Award 1995)

Beverage-Air converted most of its commercial refrigerator models using CFC-12 to HFC-134a, resulting in a savings of 80 metric tonnes of CFC-12 refrigerant. Additionally, they developed a field retrofit procedure that will result in an estimated annual additional savings of 180 to 230 kilograms of CFC-12.

**James A. Beyreis, UL,**  
(Award 1990)

James A. Beyreis, UL, coordinated the UL program to certify that recycling machines could clean up used CFCs to meet the previously approved standards. The program then moved quickly to help get certified recycling machines into the market.

**David Breslin, U.S.  
Naval Sea  
Systems Command**  
(Award 1995)

David Breslin, U.S. Naval Sea Systems Command, has served as Program Manager for the U.S. Navy CFC & Halon Elimination Program Office since 1993. As a direct result of informational messages and surveys on ODS use distributed at his request, refrigerant consumption in the fleet has been reduced by nearly 30 percent (45 metric tonnes) in just over a year.

**Cadbury**  
(Award 1993)

Cadbury, the U.K. chocolate company, began to retrofit from CFC-12 to HFC-134a in 1991. In August 1992 it built a refrigeration plant to test blends. By September 1992 it was the first refrigeration plant to retrofit from HCFC-22 to a blend of HFC-32 and HFC-134a. At that time it was not known whether such a zeotropic blend would work reliably in a practical situation and there were real doubts as to the stability of these blends for long-term operational use. A number of other blends with different compositions—including a ternary blend of HFC-32, HFC-125, and HFC-134a—were also tested. The development program led Cadbury to specify one of the tested blends (designated by ASHRAE as R-407c) for large refrigerant and A/C systems only 11 months after HFC-32 was first experimentally available. The dramatic shortening of development was possible through the use of parallel engineering techniques and the enthusiastic commitment of employees and suppliers.

**Carrier**  
(Award 1994)

Carrier introduced the world's first HFC-134a residential chlorine-free central air-conditioner and introduced a new turbine technology that will significantly improve the operating efficiencies of its HFC-134a commercial centrifugal chillers. Carrier helps customers move away from CFC refrigerants by offering a broad range of refrigerant planning programs and products. The company is a signatory to the Vietnam Pledge.

**Carrier Corporation/  
AlliedSignal**  
(Award 1993)

Carrier Corporation/AlliedSignal jointly developed a chlorine-free, non-ozone-depleting replacement for HCFC-22 and a residential A/C unit to utilize it. R-410a is a blend of HFC-32 and HFC-125. This refrigerant allows A/C equipment manufacturers to produce smaller, more energy efficient systems using a refrigerant with zero ODP.

**Chrysler Corporation**  
(Award 1992)

Chrysler Corporation was a leading developer of HFC-134a technology to replace CFC-12 in auto air-conditioners. It eliminated CFCs from 50 percent of its 1993 model year vehicles' A/C systems. The Jeep Grand Cherokee was the first full-scale production vehicle produced in the United States equipped with a CFC-free A/C system.



Denis Clodic, Ecole  
des Mines de Paris,  
Centre d'Energetique  
(Award 1995)

Denis Clodic, Ecole des Mines de Paris, Centre d'Energetique, while serving as research co-chair in the French National CFC Commission, identified and urged refrigeration recovery and limitation of leakage as direct methods for reducing the emission of ODSs. In 1990, he organized and managed a working group whose conclusions were used in French regulations. He also wrote "Vade-Mecum de la Recuperation des CFC."

The Coca-Cola  
Company  
(Award 1993)

The Coca-Cola Company halted the purchase of CFC refrigerated equipment. Other beverage companies soon followed. Coca-Cola leadership, with its market clout, rapidly mobilized manufacturers in developed and developing countries to meet new customer demands. In many developing countries, the leadership of Coca-Cola has been the single most important catalyst for halting the use of CFC-12 refrigerants. Coca-Cola is a signatory to the Vietnam Pledge.

Elizabeth Cook, FOE  
(Award 1991)

Elizabeth Cook of FOE helped organize regulatory and public education efforts to protect stratospheric ozone. Principal leadership projects included the voluntary phaseout of CFC used in foam food packaging and the voluntary standard of purity for CFC-12 recycled from vehicle air-conditioners. She has been an important coordinator of the campaigns of international NGOs. She is also the editor of the book *Ozone Protection in the United States*, World Resources Institute, 1996.

Copeland  
(Award 1993)

Copeland began work in 1987 with principal refrigerant and lubricant manufacturers to develop substitutes for the use of CFCs. Copeland was first to market chlorine-free semi-hermetic products in October 1992 with a 90 percent market penetration in refrigeration applications by the end of 1993. Copeland has an ongoing commitment to bring next-generation refrigerants to market after satisfactory testing and confirmation of environmental acceptability.

Michael Earl Dillon,  
Dillon Consulting  
Engineers  
(Award 1993)

Michael Earl Dillon of Dillon Consulting Engineers, without compensation and with considerable time and effort, was successful in a single code change cycle in modifying the building, fire, and mechanical codes for much of the western part of the United States to allow the use of alternative refrigerants and refrigerant technologies. This effort included rewriting four chapters of the Uniform Mechanical Code, two sections and one chapter of the Uniform Building Code, and four sections and one article of the Uniform Fire Code. All of these appeared for the first time in fully coordinated format in the 1994 editions of these documents.

David Doniger,  
NRDC  
(Award 1991)

David Doniger of NRDC was one of the attorneys who worked with EPA to compel regulatory protection of stratospheric ozone. He was an important participant in the voluntary phaseout of CFCs used in foam food packaging, the voluntary standard of purity for CFC-12 recycled from vehicle air-conditioners, and the activities leading to the change in military specifications to encourage alternatives to CFC-113 for manufacture of electronic products. He also helped organize the regulatory and public education efforts to protect stratospheric ozone including major efforts in conjunction with other NGOs. He is currently Counsel to the Assistant Administrator for Air and Radiation, EPA.



- Electrical & Mechanical Services Department of the Hong Kong Government (Award 1995)** Electrical & Mechanical Services Department of the Hong Kong Government retrofitted or replaced 26 chillers in government buildings and equipped other chillers with recovery units, high-efficiency purge units, pressurization systems, and rupture disc type pressure valves, eliminating approximately 19 metric tonnes of CFCs. Also, a halon phaseout program, initiated in April 1994, replaced halon fire-fighting installations that had contained approximately 8 metric tonnes of halon.
- Ford (Awards 1992 and 1994)** Ford initiated efforts to eliminate all CFC uses from its worldwide manufacturing processes by the end of 1993. It was a founding member of ICOLP/ICEL, a critical contributor to the commercialization of no-clean soldering, and a frequent participant in technology cooperation projects worldwide. Ford experts were members of numerous working groups to commercialize CFC recycling, to change military specifications, and to persuade suppliers to phase out CFCs. Ford is a signatory to the Thailand Leadership Initiative and the Vietnam Pledge.
- General Motors (Award 1994)** General Motors eliminated the use of CFC solvents at the beginning of 1995. General Motors had already replaced CFC-12 refrigerant with R-134a in over 97 percent of vehicle A/C systems when it received this award. CFC-12 was eliminated with the introduction of 1995 model vehicles. General Motors was the first domestic vehicle manufacturer to provide retrofit A/C kits.
- Herbert T. Gilkey, Engineering Consultants (Award 1995)** Herbert T. Gilkey of Engineering Consultants significantly contributed to stratospheric ozone protection through his leadership as chairman of the ASHRAE Guideline Project Committee, which wrote ASHRAE Guideline 3-1990. He served on three ASHRAE presidential commissions to write CFC phaseout position statements and has served as a member of the UNEP Refrigeration TOC.
- Donald Grob, UL (Award 1990)** Donald Grob of UL coordinated the UL program to certify that recycling machines could clean up used CFCs to meet the previously approved standards. The program then moved quickly to help get certified recycling machines into the market.
- Heating, Refrigeration, and Air Conditioning Institute of Canada (HRAI) (Award 1993)** Heating, Refrigeration, and Air-Conditioning Institute of Canada (HRAI) mobilized its members in 1990 to jointly select new technology, and to educate its customers on the importance of containment, recycling, retrofit, and replacement. The training package "HRAI Action Guideline for Reduction of Use of Controlled CFCs" was developed for designers, architects, engineers, installers, and service personnel. During the same period HRAI developed and approved a code of practice for industry. In 1993, HRAI participated in bilateral international technology transfer projects with Environment Canada in Brazil and China.
- Arthur G. Hobbs, Jr., Four Seasons Division of Standard Motor Products (Award 1993)** Arthur G. Hobbs, Jr., Four Seasons Division of Standard Motor Products was a key leader in the CFC/ozone-depletion issue. As vice president and subsequent president of MACS, he worked extensively with governments on CFC issues. In addition, he introduced CFC recycling techniques to developing nations at an international conference in Singapore.



**Hussmann**  
(Award 1994)

Hussmann developed refrigeration products that eliminate the use of CFC refrigerants. The designs reduce the amount of refrigerant piping needed in a system by approximately 75 percent by modifying placement of condensing units, thus partially offsetting the increased cost of HFC-134a refrigerants. The systems are applied in an increasing variety of installations, such as convenience stores and food service operations in European, North and South America, and Asian markets.

**The Industrial Technician Certification Team**  
(Award 1995)

The Industrial Technician Certification Team became a leading force in the development and maintenance of the technician certification program, which is a key component of the United States National Recycling Program. Combined, the programs that make up this team are responsible for the certification of the majority of Section 608 technicians and provide a valuable continuing educational resource. RSES used conferences, classes, and satellite telephone conferences to certify over 150,000 technicians by 1996. Team participants included Air-Conditioning Refrigeration Institute, the Air-Conditioning Contractors of America, the National Association of Plumbing, Heating, Cooling Contractors, the Mechanical Contractors of America, the Mechanical Service Contractors of America, the Refrigeration Service Engineers Society, and the United Association.

**International Institute of Refrigeration (IIR)/Institut International Du Froid (IIF)**  
(Award 1996)

International Institute of Refrigeration (IIR)/Institut International Du Froid (IIF), with Commission and Associate Members from 100 countries, is the premier technical and scientific organization promoting phaseout of ozone-depleting refrigerants. IIR/IIF has published and distributed 11 technical reports to governments and organized numerous conferences and workshops in Argentina, Australia, Burkina Faso, Germany, Italy, Morocco, New Zealand, and the United States. It worked to organize the world's technology experts to assist in the formulation and implementation of ODS refrigerant phaseout programs. IIR/IIF has been uniquely placed to implement courses and national refrigeration-development plans in developing countries, conferences on the various technical options, and objective technical advice to governments and industry. In 1994 IIR/IIF published "Environmentally Friendly Compression Cycles" and "Ammonia as a Refrigerant" and launched two series of conferences on refrigerants including "natural refrigerants."

**International Mobile Air Conditioning Association (IMACA)**  
(Award 1996)

International Mobile Air Conditioning Association (IMACA) informed the automotive aftermarket about the CFC-12 phaseout and provided recycling testing and retrofit training to over 250,000 technicians. IMACA consistently developed new ideas in order to serve its members and the motoring public and has a longstanding history of working cooperatively with EPA to educate the public about the phaseout of ODSs.

**JICOP**  
(Award 1993)

JICOP organized domestic and international ozone protection projects including training, workshops, conferences, publications, and partnerships. It has sponsored important environmental leadership projects, including the Thailand Leadership Initiative and the Vietnam Pledge. It has also been successful in organizing projects to encourage and insist that suppliers provide products not made with ODSs. It has been very important in keeping its members informed of the latest technologies.



**William Kopko, York International**  
(Award 1991)

William Kopko of York International identified promising refrigerants that were later considered as "third generation" refrigerants.

**Dr. Lambert Kuijpers, UNEP TEAP**  
(Award 1993)

Dr. Lambert Kuijpers, UNEP TEAP, working for Phillips, prompted Phillips to become the first company expert to publicly advocate a new look at available and emerging options. He is co-chair of the UNEP Refrigeration, Air-Conditioning, and Heat Pump TOC and co-chair of the UNEP TEAP. He was chair of TEAP working groups and task forces on Countries with Economies in Transition and other technical topics.

**MACS**  
(Award 1990)

MACS cooperated extensively with EPA to reduce CFC emissions via recycling and eventually eliminate them from automobile air-conditioners. MACS was the first A/C association to take a proactive approach to minimizing CFC emissions, pioneered many of the most successful strategies for working with governments, and was a commanding voice in local and state deliberations over vehicle A/C recycling. MACS is also a leader in international technology cooperation.

**Kenneth W. Manz, Robinair Division (SPX)**  
(Award 1993)

Kenneth W. Manz, Robinair Division of SPX, demonstrated individual leadership in commercializing recycling equipment technology, setting equipment performance standards, and promoting acceptance of recycled refrigerants. He advocated the field sampling of refrigeration contamination and the strategy of first setting standards of purity and then improving recycling equipment capabilities to satisfy those standards. He was the committee chairman who shaped ARI standard 740 performance of refrigerant recovery and recycling equipment and convener for the ISO equivalent standard. He authored the book "The Challenge of Recycling Refrigerants," and played a key role in developing industry recycling guides for handling and reuse of refrigerants.

**Martin Marietta**  
(Award 1994)

Martin Marietta initiated aggressive retrofits and replacement of A/C and refrigeration systems.

**Thomas J. Mathews, Hannaford Brothers**  
(Award 1993)

Thomas J. Mathews of Hannaford Brothers was the team leader in ambitious efforts to eliminate the use of CFCs in food retail store equipment.

**McQuay International**  
(Award 1992)

McQuay International (formerly Snyder-General) announced that it would stop marketing CFC-based A/C equipment effective June 1992. Its entire CFC-based line of products was then converted to HFC-134a by the end of 1992, effectively sending the message to consumers that CFC technology was obsolete.

**Mercedes-Benz**  
(Award 1992)

Mercedes-Benz was the world's first automobile manufacturer to introduce a CFC-free A/C, beating the competition by one full year.

**National Refrigerants**  
(Award 1993)

National Refrigerants established a large-scale refrigerant supply service including recycling, stockpiling, and remanufacturing. It organized one of the most extensive centralized refrigerant recycling services, and also supplied alternative refrigerants.



- New York State Energy Research and Development Authority**  
(Awards 1993)
- The New York State Energy Research and Development Authority developed the "HFC Supermarket Refrigeration Demonstration" to test the energy performance of non-CFC refrigerants. The project determined that energy efficiency was equal or slightly better than CFC in advanced screw-type compressors and demonstrated refrigerant conservation. As a result of this project, the new 60,000 square foot Shop 'n Save store in Glens Falls, New York, became the first CFC-free supermarket. The demonstration team included ALCO Controls, AlliedSignal, Brown Engineering/Bitzer, Carlyle Compressor, Castrol, CPI Engineering Services, Demand Defrost Systems, Eastern Heating and Cooling, E.I.L. Instruments, Electric Power Research Institute, Empire State Electric Energy Research, Hannaford Brothers, Hill Refrigeration, Howden Compressors, New York State Energy Research and Development Authority, Niagra Mohawk Power Corporation, Phoenix Refrigeration Systems, Spectronics, and Sporlan Valve Company.
- Nippondenso**  
(Award 1993)
- Nippondenso used competitive design teams to develop new compressors that are energy efficient, durable, and affordable.
- Nissan Motor Company**  
(Award 1991)
- Nissan Motor Company, in 1989, became the first automobile manufacturer to announce its commitment to phase out all CFC use. This declaration led to the complete conversion of all models to HFC-134a A/C by 1993.
- Simon Oulouhjian, MACS**  
(Award 1990)
- Simon Oulouhjian of MACS was a visionary co-chair of the Ad-Hoc Automobile Recycling Working Group. He developed educational and advertising campaigns to promote recycling, designed technician certification programs, and guided state and federal regulators to make recycling mandatory. Mr. Oulouhjian continues to lead industry efforts to minimize refrigerant contamination and to promote retrofit of automobile air-conditioners to HFC-134a.
- Philadelphia Detachment of the Carderock Division of the Naval Surface Warfare Center, U.S. Navy**  
(Award 1996)
- Philadelphia Detachment of the Carderock Division of the Naval Surface Warfare Center, U.S. Navy, established a program in 1993 to convert CFC-12 systems to ozone-friendly HFC-134a and convert the Navy's 1,100 CFC-12 plants to HFC-134a by the year 2000. By the close of fiscal year 1996, it will have led the conversion of 300 systems aboard U.S. Navy ships from Mayport, Florida, to Yokosuka, Japan, with a total installed charge in excess of 35 tons of CFC-12. It also will have converted or assisted in the conversion of over 70 "CFC-12 free" foreign and U.S. naval ships. The Navy shares this technology throughout DoD and around the world.
- The Refrigerant Import Committee of the Alliance for Responsible Atmospheric Policy**  
(Award 1996)
- The Refrigerant Import Committee of the Alliance for Responsible Atmospheric Policy was formed in September 1994 to work with various government agencies to stem the flow of illegal imports of CFCs into the United States. It obtained a regulatory interpretation letter from the Internal Revenue Service explaining that U.S. law requires the payment of the federal excise tax on all imports of CFCs, whether newly manufactured or not, thus providing a financial disincentive to mislabel shipments. It helped to formulate two new EPA rules that require imports of CFCs to obtain a prequalification prior to the date the



shipment is to leave the exporting country. It also focused the media's attention on the issue of illegal imports at an international level in an effort find a global solution. These efforts led to the first criminal conviction under the Clean Air Act and the first extradition of a suspect in a global environmental crime.

**Refrigerant Reclaim  
Australia  
(Award 1995)**

Refrigerant Reclaim Australia has been recovering approximately 5 metric tonnes of ODSs every month since 1992. Of this material, approximately half is able to be reprocessed while the other half is held in storage pending the resolution of technology for its safe disposal.

**J. Sainsbury  
(Award 1993)**

J. Sainsbury stopped using CFCs in its stores and undertook technology cooperation, particularly in the United Kingdom. It was among the first companies in the United Kingdom to require refrigeration containment and recycling and worked with its suppliers to select and finance suitable procedures and equipment. J. Sainsbury encouraged its refrigeration service providers to also offer containment and recycling to other building customers, and the company published technical reports on its progress in eliminating ODSs.

**Sanden  
(Award 1996)**

Sanden took a leadership role by committing the necessary resources to successfully implement HFC-134a and eliminate all CFC from its manufacturing processes. Sanden pioneered the development of the electric compressor for automotive use as the first technically feasible replacement for CFCs. Although the electric compressor was not commercialized for fueled vehicles, it has been introduced for electric vehicle A/C.

In 1988, Sanden and General Electric (Dr. Warren F. Bessler) presented this technological innovation at the meeting of the UNEP at The Hague. Since 1992, Sanden has supplied 12.2 million HFC-134a compressors to the mobile industry. It eliminated the use of CFC in its manufacturing processes in 1987, and promoted the phaseout of CFCs in Asian countries by sponsoring seminars and hosting training programs at its manufacturing facilities.

**Sea-Land Service  
(Award 1995)**

Sea-Land Service has successfully retrofitted over 4,000 refrigerated containers to HFC-134a from CFC-12. Additionally, it equipped all ships and maintenance facilities with HFC-134a and CFC-12 recovery equipment.

**Shaw's Supermarkets  
(Award 1993)**

Shaw's Supermarkets was among the first retail food companies to establish a CFC elimination policy, choosing to immediately halt the use of CFC in new stores and to phase out existing uses with a staged replacement during store remodeling. Shaw's successfully minimized refrigerant charge (through remote circuit piping headers and with split condensers during low ambient temperature operation); reduced leaks with detection and alarms; implemented recovery, reuse, recycle, and reclaim of oil and refrigerants; and optimized energy efficiency through application of floating discharge pressure, total mechanical subcooling, gas defrost, variable speed compressor and condenser control, computer controls, heat reclaim and storage, and heat recovery. This refrigerant management and replacement policy has been highly successful.





**The Swedish Refrigeration Foundation**  
(Award 1996)

The Swedish Refrigeration Foundation developed the "ODS phaseout in the Refrigeration Sector" Project to coordinate the cooperative private and public sector effort to develop the Swedish Refrigeration Code. Starting in 1988 as the result of this code, Sweden's refrigeration industry substantially reduced its emissions of CFCs and HCFCs and eliminated its use of newly imported CFC two years ahead of its domestic schedule.

**Tecumseh Products**  
(Award 1994)

Tecumseh Products worked closely with leading chemical companies during the introduction of HFC-134a compressors to increase energy efficiency.

**Texas Instruments**  
(Award 1995)

Texas Instruments implemented a refrigerant management plan that stopped all purchase of new or reclaimed CFC refrigerants worldwide by 1994 and has resulted in a 66 percent reduction (2.3 metric tonnes per year) in CFC refrigerant emissions. Information has been gathered on about 3,500 pieces of equipment worldwide and approximately 150 large building chillers are ranked and prioritized for conversion or replacement over the next two decades. Texas Instruments was a founding member of ICOLP/ICEL.

**Toyota**  
(Award 1994)

Toyota, in addition to exemplary work in the foam and solvents sectors, completed its conversion of vehicle A/C refrigerants from CFC-12 to HFC-134a and developed a retrofit system so that older vehicles could be converted to use HFC-134a. Toyota was also a leader in promoting CFC-12 recycling in Japan and in developing and commercializing retrofit kits, and is a signatory to the Thailand Leadership Initiative and the Vietnam Pledge.

**Trane**  
(Award 1992)

Trane was one of the first companies to announce the removal of CFC-based equipment from the market. It developed high energy efficient A/C equipment that is often more cost effective than retrofitting existing equipment, announced early that it would eliminate the use of CFC refrigerants in its centrifugal chillers, and improved the energy efficiency in new non-CFC chillers by almost 40 percent. This action was taken on January 1, 1993, a full three years prior to the phaseout of CFC production in developed countries. Trane's market leadership served as a clear message to customers that CFC technology is obsolete. Trane is a signatory to the Vietnam Pledge.

**Tyler Refrigeration**  
(Award 1996)

Tyler Refrigeration (Award 1996) developed a system of refrigerant control, which reduces the initial refrigerant charge by as much as 45 percent, and provides early warning of condenser fan failures and refrigerant leaks. This system is estimated to have reduced by 125 tons the amount of refrigerant required for the supermarket industry.

**UL**  
(Award 1990)

UL developed a purity standard for recycled CFCs, which was later accepted by automobile manufacturers. At the request of the EPA/MACS Working Group on vehicle CFC recycling, it developed certification standards for recycling machines and then worked to get certified machines into the market.



**The U.S. Army Communications-Electronics Command and Tobyhanna Army Depot, (Award 1994)**

The U.S. Army Communications-Electronics Command and Tobyhanna Army Depot implemented replacement of all CFC-12 air-conditioners mounted on over 2,000 tactical command, control, and communications shelters worldwide.

**U.S. General Services Administration (Award 1993)**

The U.S. General Services Administration, under the leadership of John Iaconis and his maintenance team from Public Buildings Service, initiated a comprehensive "Refrigerant Management Plan" that required a proactive approach to reduce the impact of ODSs upon the environment. The program initially targeted building A/C systems using non-CFC refrigerants (an aggregate chiller capacity of 325,000 tons) to economically select replacement chillers, reduce refrigerant losses, and maximize refrigerant recycling by recovery, reclamation, and banking for reuse.

**James Vincent, U.S. Army Aviation and Troop Command (Award 1994)**

James Vincent, U.S. Army Aviation and Troop Command, implemented numerous projects including the development of A/C and refrigeration technician certification training, replacement of CFC-12 air-conditioners on tactical shelters, and implementation of the program to replace CFC-12 in field kitchens.

**Volvo (Award 1993)**

Volvo was among the first vehicle manufacturers to put HFC-134a systems in its automobiles. Volvo was a strong supporter of CFC recycling standards and among the first companies to implement recycling at new vehicle dealers.

**Carmen C. Waschek (Award 1993)**

Carmen C. Waschek, the senior engineer for The Coca-Cola Company, led development of a comprehensive program to contain, recycle, and bank CFCs and to purchase only CFC-free new refrigeration equipment. As one of the world's largest seller of refrigerated beverages, this decision had a profound and global impact on the company's suppliers.

**James Wolf, American Standard (Award 1995)**

James Wolf, American Standard, has played an important role as chairman of the Alliance for Responsible Atmospheric Policy (Award 1990) in promoting the phaseout of CFCs in A/C and the use of industry alternatives approved by EPA's Significant New Alternatives Policy (SNAP) program. He has given over 100 speeches and presentations on the Montreal Protocol to businesses and professional groups. His activities have been instrumental in changing the attitudes of many people about CFCs and the need for alternatives. James Wolf has held positions in ARI and ASHRAE. He also participated extensively in public seminars and industry leader roundtables to inform and mold the opinions of decision-makers regarding CFC policies and phaseout strategies.



Woolworths Australia  
(Award 1993)

Woolworths Australia decided in July 1989 to halt the use of CFC refrigerants. In September 1989 it began shifting to HCFC-22. By 1991 HFC and transitional blends were announced and by 1992 small test quantities were available. To reduce duplication of effort and to speed development, Woolworths helped organize the industry to work together. With the help of chemical, equipment, and lubrication suppliers, Woolworths was able to proceed quickly and by June 1993 completed the world's first CFC-free retail store. Woolworths eventually became the first national retail merchandise company to convert all its stores to CFC alternatives.

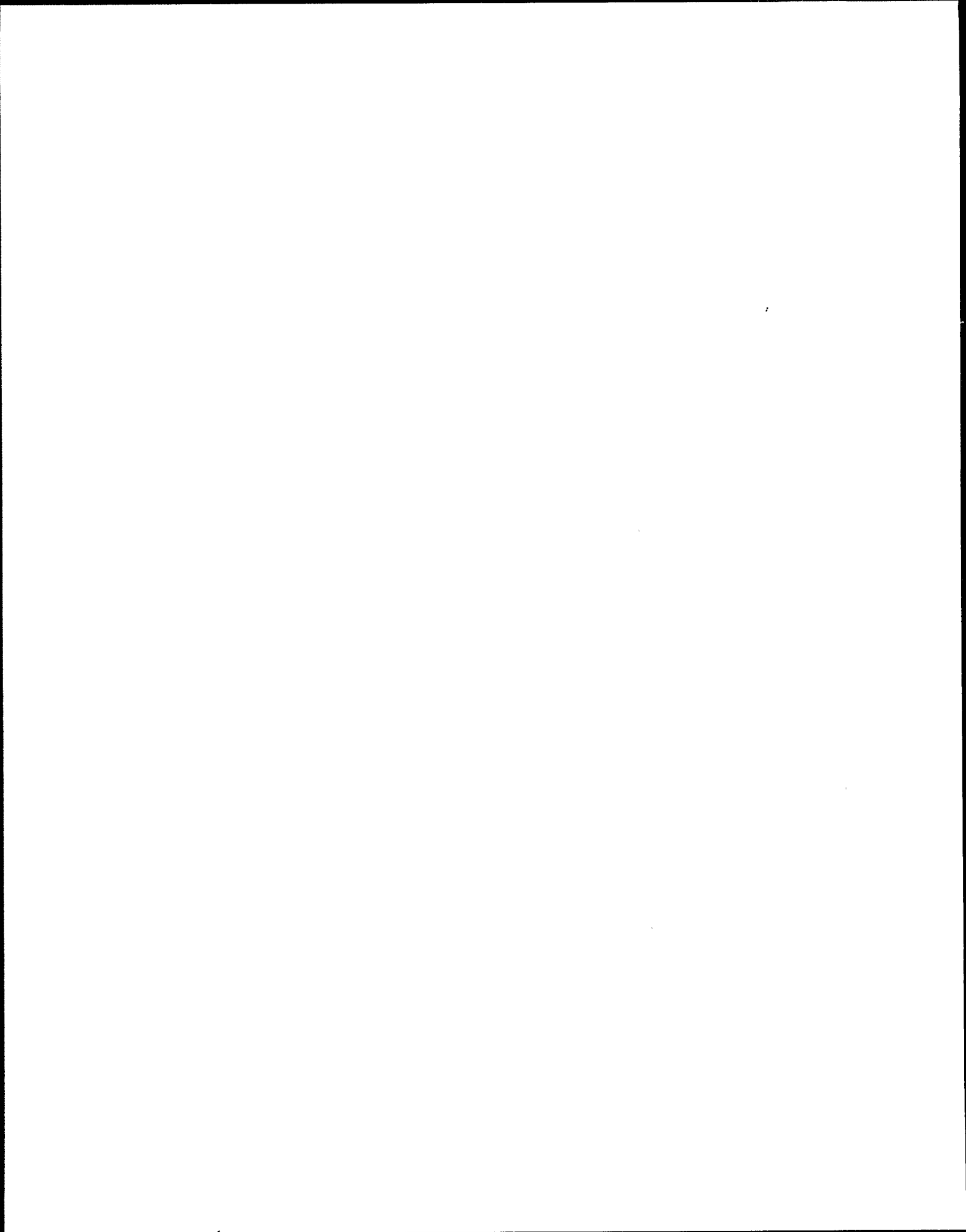
Kiyoshige Yokoi,  
Matsushita Refrigeration  
(Award 1996)

Kiyoshige Yokoi of Matsushita Refrigeration led a project team to improve the reliability of HFC-134a compressors for refrigeration manufacturers in Thailand. Thanks to these efforts, the manufacturers in Thailand have improved their products and were able to phase out the use of CFC in domestic refrigeration by January 1, 1997.

York  
(Award 1992)

York developed energy efficient, CFC-free A/C and refrigeration equipment and participated in U.S. and international committees to develop recycling, containment, and technician certification for CFCs and HCFCs. In addition, York helped develop new technical standards for HFCs and third generation refrigerants.





# Solvents



For over 40 years, ODSs were widely used in the electronics manufacturing industry for the post-solder defluxing of printed circuit boards (PCBs). CFC-113, the most common ODS used, was an obvious choice because of its excellent cleaning properties, low toxicity, non-flammability, and relatively low cost. The signing of the Vienna Convention for the Protection of the Ozone Layer in 1985 and the subsequent drafting of the Montreal Protocol on Substances that Deplete the Ozone Layer in 1987 raised serious doubts about the future of solvent cleaners in the electronics and other industries. The Montreal Protocol mandated a 50 percent reduction in ODS production by the year 2000. This galvanized many companies in the electronics industry to begin investigating alternative cleaning methods immediately.

Leadership companies including AT&T (Award 1992), Ford (Awards 1992 and 1994), IBM (Awards 1992 and 1993), Motorola (Awards 1991 and 1993), Nortel/Northern Telecom (Award 1991), Texas Instruments (Awards 1993 and 1995), and Seiko Epson (Awards 1992 and 1995) made early announcements that they intended to halt the use of CFCs ahead of the Montreal Protocol schedule and that they were seeking technology to enable this change. The technical and market clout of these leadership companies motivated suppliers to support new technical developments.

One of the most influential "corporations" in the area of electronics manufacturing turned out to be the military. Not only is the U.S. military a large consumer of electronics, but the military standards became the de facto world standard. In order to build reputations for quality, many manufacturers used the same military specification compliant equipment to produce goods for both the private sector and governments. In the late 1980s, it was believed that 50 percent of CFC-113 use in the electronics sector worldwide resulted directly from the influence of these military specifications.

In January 1988, EPA, AT&T (Award 1992), and Petroferm jointly announced that AT&T was using a naturally derived Petroferm product to deflux electronic

"Nortel committed to a CFC phaseout long before suitable replacement technologies were identified. Our manufacturing management took chances by trusting that research engineers and production managers could solder without CFCs. EPA took risks by trusting industry to find its own solutions. Trust and teamwork paid off for the people and for the planet."

*Dr. Margaret Kerr (Award 1990)  
Nortel (formerly Northern Telecom)*



circuit assemblies. This was significant because at the time it was widely thought impossible to replace CFC-113 for electronics defluxing, and that it might even be necessary to exempt this application from control under the Montreal Protocol. With the knowledge that commercially viable defluxing alternatives were not only feasible but available, the way was cleared for the EPA/DoD/IPC Ad Hoc Solvent Working Group to develop procedures for evaluating non-ODS for electronics assembly cleaning. Numerous such materials were subsequently approved and commercialized. Electronics defluxing became one of the first use sectors to essentially eliminate ODSs.

In December 1987 DuPont's (Award 1990) solvent cleaning master Dr. William Kenyon (Award 1990), Joe Felty (Texas Instruments, Award 1990), and Dr. Leslie Guth (AT&T, Award 1990) met to design a test board for IPC (Award 1990) to be used as a benchmark for the cleanliness of surface mount technology, the state-of-the-art circuit board design. In spring 1988 at the China Lake Soldering Symposium, DuPont announced a reduced-CFC solvent that they believed would clean better than CFC-113 but was not acceptable under prescriptive military standards requiring traditional CFC-113 formulations. Dr. Stephen O. Andersen and Dr. William Kenyon (Award 1990) organized a meeting early the next morning with Dr. Warren R. Steinacker (DuPont), Harold Peacock (China Lake Navy Weapons Center Electronics Manufacturing Productivity Facility [EMPF]) and Kathi Johnson (EMPF Materials & Processes Laboratory, Award 1990). They agreed to proceed with tests of new solvents using the EMPF as the venue. One week later this organizing group met with Art Gillman (Unique Industries), Joe Felty (Award 1990) (Texas Instruments), Robert L. Cohen (DuPont) and Robert H. Kasch (DuPont) and began to develop a test plan.

In March 1988, Dr. Stephen O. Andersen of EPA with contractor Dr. Sudhakar Kesavan (ICF/Kaiser) initiated the EPA/DoD/IPC Ad Hoc Solvents Working Group to develop uniform procedures for evaluating new non-ODS cleaning materials for electronics assembly cleaning. DoD authorized Dr. Andersen to chair the EPA/DoD/IPC Ad Hoc Solvents Working Group and appointed him to the Military Electronics Technology Advisory Group. Soon EMPF confirmed that they would host the tests, and IPC volunteered to coordinate meeting logistics and technical correspondence and later organized donations of test materials. Leslie Guth (AT&T, Award 1990), Robin Sellers (Naval Avionics Center, Award 1990), Kathi Johnson (EMPF, Award 1990), Tim Crawford (EMPF, Award 1993), Phil Wittmer (Magnavox), James Maguire (The Boeing Company), Dr. Kirk Bonner (AlliedSignal), Pete Phillips (Honeywell), Heather Getty (Honeywell), and Carl Koernig (Baron-Blakeslee) became virtually full-time volunteers. Three Nortel/Northern Telecom engineers moved to China Lake for three months to supervise the test equipment setup. Meetings were being held as frequently as every week and the team grew to 100 experts or more. By March 1989 the Test Plan was finalized. The three-phase test plan characterized the cleaning ability of a CFC-based solvent in Phase 1 and established the cleanliness results as a benchmark to which alternative candidates would be later compared. Phase 2 of the plan tested CFC alternative candidates using the same processes and procedures that were established



in Phase 1 and compared the results for a "better than," "as good as," or "worse than" rating. Phase 3 evaluated alternative flux chemistries and processes.

The clear mission of the Working Group was to address issues related to the phaseout of ozone-depleting solvents in the United States, with a special emphasis on military applications, and to certify that alternative technologies and methods for cleaning were "as good as or better than" CFC-113-based cleaning. Motivated by the belief that a complete phaseout was possible, they set an interim target of a 50 percent phaseout of ODSs.

Representatives of the **EPA/DoD/IPC Ad Hoc Solvents Working Group** were from U.S. Government agencies (with significant membership from the military), electronics manufacturers, flux and solvent suppliers, laboratories, equipment manufacturers, and NGOs. DoD and IPC (Award 1990) played key leadership roles in the deliberations of this group.

The Working Group's consensus led to the development in 1988 of a three-phase testing program that compared the performance of alternatives to the CFC-113 benchmark. Initially, the **EPA/DoD/IPC Ad Hoc Solvents Working Group** designed a test vehicle, an assembly process plan, and test procedures; completed four benchmark runs; published their results; and got all of these actions endorsed by DoD.

During Phase 2, many substitute cleaning agents were tested and judged acceptable as ODS substitutes for use in electronics cleaning applications.

Finally, in Phase 3 the Working Group evaluated the acceptability of alternative technologies, such as water-soluble fluxes and no-clean processes. The test program was widely accepted by both industry and DoD as the means to gain acceptance for new technologies. The Phase 3 Program identified three areas of research including water soluble fluxes, controlled atmosphere soldering, and low-solids/no-clean fluxes. The success of this program was due in large part to hard work by dedicated individuals from the **Naval Air Warfare Center Aircraft Division, Lakehurst** (Award 1992), **IPC** (Award 1990), and **EPA**.

As a result of the testing done by the **EPA/DoD/IPC Ad Hoc Solvents Working Group**, in February 1991 the U.S. military adopted MIL-STD-2000, Revision A. This standard conditionally permitted the use of non-rosin fluxes and non-ODSs and cleaning processes for most electronics assembly and contracts retroactively. MIL-STD-2000 (Rev. A) also recommends that CFC solvents be "phased out." This standard opened the door for non-ozone-depleting technologies to break into the electronics sector.

"Phasing out CFCs looks to most of us today as a relatively smooth transition. But we should not forget that it was only a few years ago that many were concerned that substitutes would not be available, would cost too much, or be more dangerous. When industry accepted the scientific basis behind the need to phase-out CFCs, it quickly and effectively responded to the challenges of finding and shifting to alternatives. The personal and corporate leadership of those initiating this change in thinking made all the difference."

*Stephen Seidel*  
*Director*

*EPA Stratospheric Protection Program*



The results of the EPA/DoD/IPC Ad Hoc Solvents Working Group were presented to a large audience of industry representatives at the National Electronics Packaging Conference.

Methyl chloroform has a significantly lower ODP than CFCs, but is far more widely found in many common products such as adhesives. This pervasiveness, in conjunction with the number of applications, large and small, made its elimination extremely challenging. As one of the largest CFC-113 and methyl chloroform users in IBM (Awards 1992 and 1993), IBM Endicott (Award 1992) demonstrated impressive leadership in the elimination of these substances.

In 1987, IBM Endicott (Award 1992) emitted 1,180 metric tonnes of ODSs (CFCs and methyl chloroform), making the company the largest industrial emitter in the United States. Aggressively pursuing IBM's goals of CFCs and methyl chloroform elimination, IBM Endicott (Award 1992) converted the site's circuit board manufacturing from solvent-based (CFC-113, methyl chloroform, methylene chloride) photo lithographic processing to aqueous-based processing in 1989. IBM Endicott also converted a multidisciplinary team of engineers to work on the elimi-

nation of remaining ODSs in manufacturing. Many of the remaining applications involved specific uses, including many small uses, and were associated with a number of products. Tedious work took place in developing alternatives both by IBM's laboratory and in cooperation with suppliers, IBM Endicott succeeded in eliminating all Class 1 ODSs from its manufacturing processes in April 1993.

In 1988, AT&T (Award 1992), led by David Chittick (Award 1990) and Dr. Leslie Guth (Award 1990), revised its corporate environmental policy to address explicitly growing concerns over ODS use.

In 1989, two organizations were formed that would prove to be major leaders in the movement to eliminate ozone-depleting industrial solvent use: ICOLP/ICEL (Awards 1991 and 1993) and the UNEP Solvents, Coatings, and Adhesives TOC.

*Arthur D. FitzGerald (Award 1990)  
Consultant  
International Finance Corporation*

ICOLP/ICEL (Awards 1991 and 1993) was organized under the Cooperative Research Act to encourage competing companies to cooperate on the development and implementation of environmentally protective industrial technologies. Since its founding, member corporations included AT&T (Award 1992); The Boeing Company (Awards 1992 and 1993); British Aerospace (Award 1992) led by Bryan Baxter (Award 1992); Compaq (Award 1993); DEC (Award 1990); Ford (Awards 1992 and 1994), led by Jay Baker (Award 1990); Hitachi (Award 1991), under the

"Through my participation in the UNEP Solvents Technical Options Committee, through technology exchange visits to many countries, and through opportunities to help organize technology cooperation workshops in developing countries, I came to appreciate and admire the contributions of the diverse group of professionals who made a difference in protecting the earth's ozone layer. Their commitment to environmental protection and the friendships that have been established provide an incentive to continue this spirit of cooperation between individuals, industry, governments, non-governmental organizations and others."





leadership of Tetsuro Fukushima (Award 1994) and Yoshiyuki Ishii (Award 1992); Honeywell (Award 1994); Hughes Aircraft Company (Award 1993); IBM (Awards in 1992 for Endicott, New York, and Rochester, Minnesota, and in 1993 for Austin, Texas) with Cynthia Pruett (Award 1993); Lockheed-Martin (Awards 1994 and 1996) led by Stephen P.

Evanoff III (Award 1992); Matsushita Electric (Award 1993); Mitsubishi Electric (Award 1994); Motorola (Awards 1991 and 1993), led by Ralph Ponce de Leon, Robert Pfahl (Award 1991), and Robert Holcomb (Award 1994); Nortel/Northern Telecom (Award 1991), with the leadership of Art FitzGerald (Award 1990), Dr. Margaret Kerr (Award 1990), and Elizabeth Rose; Ontario Hydro (Award 1995); Texas Instruments (Award 1993), led by Joe Felty (Award 1990), Carole Ellenberger (Award 1993), Michael Leake (Award 1995), Angie Schurig

(Award 1993), and Jack Swindle (Award 1994); and Toshiba (Award 1995) led by Shigeo Matsui (Award 1992). ICOLP/ICEL helped to fast-track implementation of innovative technologies by fostering a spirit of collaboration rather than competition among industry rivals. ICOLP/ICEL then transferred their successes by sharing their findings with the electronics industry worldwide. ICOLP/ICEL worked with EPA and its contractor ICF/Kaiser, led by Dr. Sudhakar Kesavan, to develop and review seven technical manuals on phasing out ozone-depleting solvents for various applications. With support from the World Bank, ICOLP/ICEL organized and ran technology cooperation workshops and demonstrations projects in Brazil, China, India, Malaysia, Mexico, Thailand, and Turkey.

Also in 1989, the UNEP Solvents, Coatings, and Adhesives TOC was formed consisting of an international group of experts from industry, government, and the scientific community. The Solvents TOC created a forum for identifying and documenting promising technology, in addition to increasing global awareness of the role of the electronics industry in ozone layer protection. The TOC was established to fulfill the requirement to assemble a body of experts to advise the parties to the Montreal Protocol on the availability of alternative methods and technologies to replace CFC-113 and methyl chloroform in their various use sectors. Membership of the group was based on nominations by national governments. The group disseminates the latest developments in solvent technologies and advises the parties on the need for essential use exemptions to allow continued use of ODSs. Their contributions have been critical in the development of domestic ozone protection regulations by many countries' governments.

"This book is testimony to the environmental leadership displayed by all of the winners from across the globe. Eliminating the use of ozone-depleting substances was one of the most challenging technological problems ever faced, but the efforts of mankind worldwide prevailed and solutions were found. The real winners from this truly global effort will be the future generations of this earth who will continue to enjoy the protection of the ozone layer."

*Robert G. Holcomb, Corporate Director (Award 1994)*

*Environmental External Affairs*

*Motorola (Awards 1991 and 1993)*



The history of the UNEP Solvents TOC is a story that exemplifies the power of proactive thinking and cooperation. In 1989 the German company SEHO demonstrated a controlled atmosphere soldering technology to the Solvents TOC, which immediately recognized its potential but realized that the German equipment developers had only basic soldering skills. Upon close examination, the TOC realized that the component parts were oxidized, the flux was mismatched, and the soldering wave was poorly formed. The promise of the technology was so compelling, however, that TOC members from AT&T (Award 1992), Ford (Awards 1992 and 1994), and Nortel/Northern Telecom (Award 1991) persuaded their companies to experiment with the technology.

### Awards for "No-Clean" Technology

- ◆ AT&T (Award 1992)
- ◆ Ford (Awards 1992 and 1994)
- ◆ Nortel/Northern Telecom (Award 1991)
- ◆ Motorola (Awards 1991 and 1993)

Some experts concentrated on the flux composition, while others believed that the flux was chemically suitable and worked ways to apply it to the board more precisely. Still others concentrated on the mixture of gases in the soldering chamber. Several months into development, one company discovered that gas monitoring and control calibrations were critical. Better calibrations dramatically improved the soldering quality. The

team consulted with flux suppliers who grasped the opportunity for developing and commercializing new products and intensified development in cooperation with the electronics manufacturers. EPA encouraged the work by documenting and publicizing the global environmental advantages that such a technology could provide.

Meanwhile, engineers at AT&T Bell Laboratories (Award 1992) were developing state-of-the-art spray fluxing machines to apply precisely the optimal amount of flux to the locations in the printed circuit boards where necessary. Nortel/Northern Telecom was developing equipment to verify flux concentrations on production boards, and Motorola (Awards 1991 and 1993) was experimenting with soldering ultra-miniaturized circuits with hybrid components including optical devices and flexible connectors. One by one, companies satisfied internal quality controls and moved from lab-scale to pilot and finally to full implementation. During implementation, experts from the intercompany team continued to cooperate to debug operations and optimize performance.

It is impossible to say just when the engineering team realized that its no-clean technology would revolutionize electronics assembly. Engineers who had cautiously reported as-good performance began to report improved performance. Line managers cautiously increased the speed of soldering to rates never achieved with conventional soldering and found that in some cases defect rates actually decreased.

EPA and its contractors tracked and documented the technical development and operating parameters, and in cooperation with ICOLP/ICEL (Awards 1991 and 1993) published the first no-clean handbook in order to make the know-how and technology available worldwide.

Champions such as DEC (Award 1990) and Nortel/Northern Telecom (Award 1991) donated patented technology to the public domain in order to speed ozone layer protection. Nortel/Northern Telecom (Award 1991) and AT&T (Award



1992) opened new production facilities in China, Mexico, and elsewhere that used the no-clean process. Public tours and technical cooperation projects helped promote use in all countries.

Thanks to ICOLP/ICEL (Awards 1991 and 1993) and UNEP, as well as the EPA/DoD/IPC Ad Hoc Solvents Working Group, as early as 1990 the information exchange process grew at an enormous rate as these organizations worked with industry to produce numerous conferences and publications that permitted rapid technology sharing. At the Second International Conference on Solder Flux Technology, sponsored by the Carnegie Mellon Research Institute and IPC (Award 1990), topics included low solid and no-clean fluxes, solder pastes, water-soluble fluxes, alternate cleaning processes, and ionic contamination. In September 1991, the EPA Region 1 Conference on Ozone Layer Protection Technology Transfer offered concurrent sessions on the use of alternative solvents for electronics cleaning. The May 1993 National No-Clean Conference, also sponsored by IPC (Award 1990), focused on topics such as the evaluation of a no-clean flux for use on military electronics assemblies.

To improve distribution of this knowledge throughout the electronics industry, ICOLP/ICEL (Awards 1991 and 1993) and EPA jointly sponsored the publishing of a series of technical manuals. The first, published in June 1991, describes aqueous and semi-aqueous cleaning processes and how they can be applied in post-solder defluxing of electronic assemblies. The second manual was published in October 1993 and presents detailed information on a variety of no-clean soldering techniques that allow users to completely eliminate the cleaning process during PCB assembly. These manuals are available worldwide free of charge, and hundreds of copies of each have been distributed since their publication. In addition, to make the documents even more useful to developing countries, ICOLP/ICEL has sponsored the translation of the manuals into Chinese and Russian.

Several national governments followed industry's early, proactive lead. By 1991, Sweden halted use of CFC-113 from many applications (with exceptions for dry-cleaning, military, and some other applications). By January 1993, Switzerland reported that it had phased out use of ozone-depleting solvents in most applications (with exemptions for dry cleaning) and Germany phased out use of CFC-113 in virtually all applications. Industry leaders from all over the world, including Canada, Germany, Japan, Norway, Switzerland, and the United Kingdom, as well as the United States, adopted alternatives to ozone-depleting solvents.

The EPA/DoD/IPC Ad Hoc Solvents Working Group, ICOLP/ICEL (Awards 1991 and 1993), and the Solvents TOC worked together strategically and have successfully provided the global electronics industry with the leadership, technology, and momentum necessary to eliminate dependence on ODSs. This innovative public/private partnership has also served as a model for addressing other environmental challenges. For example, ICOLP has evolved into ICEL, to assess the environmental performance of industrial technologies and investigate more benign and efficient alternatives. The consensus on an early phaseout in Canada, Germany, Japan, Sweden, Switzerland, and the United States would not have been possible



without these three important groups. Together they assessed the industry's needs and took the initiative to identify alternative technologies, certify their effectiveness, and provide this information quickly and effectively throughout the industry worldwide.

Using a grant from the Ministry of Finance, the **Singapore Productivity and Standards Board (PSB)**—formerly named the **Singapore Institute of Standards and Industrial Research (SISIR)**—(Award 1995) initiated a project in 1989 to assist local industries in eliminating their use of CFCs. A comprehensive range of technical services in cleanliness evaluation, process troubleshooting, and materials compatibility of CFC substitutes and alternative processes was quickly made available to both multinational and local electronics companies. To assist Singapore industries in the conservation of CFCs as an interim measure, PSB/SISIR provided technical consulting on the recovery and recycling of CFCs. A recycling system was set up, and about 110 metric tonnes of CFC-113 were recycled in 1990-1991 for the disk-drive manufacturing industry. In June 1993, with support from the Economic Development Board of Singapore, PSB/SISIR launched the ODS-Free Product and Process Verification Scheme. This program was designed to provide

recognition for companies with successful conversions to non-ODS manufacturing processes and third-party verification for local companies to meet customers' and export requirements for non-ODS processes and products. Companies, comprising both multinational and local supporting industries, have been certified.

"Motorola has been fortunate to have been the recipient of many awards, including the prestigious Malcolm Baldrige Award for Management Excellence. However, we are particularly proud of our Stratospheric Ozone Protection Awards because they exemplify our strong commitment to the environment. Motorola teams worked tirelessly and overcame seemingly impossible technical challenges to eliminate the use of ozone-depleting substances from our manufacturing processes. Ultimately, they were successful; and because of our commitment to global environmental responsibility, we share that technology with the world. My personal congratulations goes to all the winners."

*Ralph Ponce de Leon*  
*Motorola (Awards 1991 and 1993)*



## Solvents-Related Awards Summaries

- Advanced Cruise Missile DSO, U.S. Air Force (Award 1995)** Advanced Cruise Missile DSO, U.S. Air Force, eliminated ODSs from its operations well ahead of schedule and at virtually no cost. It reviewed 95 operation and maintenance manuals and identified 55 specifications that mandate the use of Class I ODSs, later verifying all specifications and drawings. This program is used as a model for other defense programs.
- The Aerospace Guidance and Metrology Center (Award 1994)** The Aerospace Guidance and Metrology Center, at Newark AFB in Ohio, successfully reduced its use of CFC-113 for its precision cleaning processes, including cleaning of sophisticated guidance systems. The center has realized cost savings of approximately \$3.5 million a year by reducing its annual purchase of CFC-113.
- AGM-130 Systems Program Office, U.S. Air Force (Award 1995)** AGM-130 Systems Program Office, U.S. Air Force, eliminated 100 percent of the ODSs used in the manufacture of rocket motors, a reduction of 26 metric tonnes over the life of the program.
- Neil Antin (Award 1995)** Neil Antin, of the U.S. Naval Sea Systems Command, led a U.S. Navy effort to identify environmentally acceptable alternatives for the use of CFC-113 in the cleaning of oxygen systems. The project culminated when the Naval Sea Systems Command and OCTAGON Process received a joint patent for the Navy Oxygen Cleaner, a nonflammable cleaner that is easily recycled and usually requires minimal treatment prior to discharge to local sewage systems.
- Asahi Glass, Japan (Award 1994)** Asahi Glass, Japan, developed HCFC-225, the first chemical alternative to CFC-113, and has undertaken its responsible marketing as a transitional replacement for CFC-113 in critical electronic, optical, and precision applications. Its marketing program fully discloses that HCFC-225 is only to be used when zero-ODP alternatives are not technically suitable and offers customers technical assistance in selecting other products. Asahi Glass was a signatory to the Thailand Leadership Initiative.
- AT&T (Award 1992)** AT&T set the first aggressive phaseout goal of any electronics manufacturer: 50 percent reduction by 1991 and complete elimination of ODS use by 1994. Experts from AT&T Bell Laboratories were critical to development of new solvent test standards and invented equipment critical to no-clean soldering. Top executives and technical experts were members of international delegations for technology cooperation and for promotion of stratospheric ozone protection. AT&T was a founding member of ICOLP/ICEL and a signatory to the Thailand Leadership Initiative and the Vietnam Pledge.
- Jay Baker, Ford Electronics (Award 1990)** Jay Baker of Ford Electronics aggressively sought alternatives to ozone-depleting solvents as Director of Technical Programs at Ford. He was one of the first engineers to appreciate the potential for no-clean soldering and organized his soldering technical teams to cooperate with experts from outside Ford to overcome the



daunting challenges of commercialization. He was also instrumental in recognizing the significance of ultrasonic metal forming without oil and "evaporating oil," which allow metal fabrication with reduced or no cleaning. He has been a member of the UNEP Solvents, Coatings, and Adhesives TOC since its inception.

**Bryan H. Baxter, Chief Material Scientist with Precision Products Group at British Aerospace (Award 1992)**

Bryan H. Baxter, Chief Material Scientist with Precision Products Group at British Aerospace spearheaded efforts by British Aerospace to phase out use in commercial and military uses of CFC solvents, developed a CFC-free precision cleaning system, and served on the ICOLP/ICEL Board of Directors. He pioneered and developed alcohol/PFC cleaning systems for cleaning precision parts and bearings for navigation and weapons devices. He has participated in numerous national and international efforts to protect and preserve the stratospheric ozone layer and is a member of the UNEP Solvents, Coatings, and Adhesives TOC.

**Baxter Limited (Award 1996)**

Baxter Limited committed in 1992 that by 1996 all of its facilities in Malta would eliminate CFCs from manufacturing activities. To achieve this goal, it introduced the concept of Cleaning Molding in its plastic department, eliminated the CFC washing process needed for washing parts, and reduced its annual emissions of CFC by 16 metric tonnes.

**David Bergman, IPC (Award 1990)**

David Bergman of IPC masterminded industry technical and financial support for the EPA/DoD/IPC Ad Hoc Solvents Working Group and coordinated technical reports. He was critical to maintaining membership and momentum and in ensuring that contributed materials were available as needed.

**The Boeing Company (Award 1992)**

The Boeing Company worked with its customers and suppliers to eliminate ozone-depleting solvents and provided technical support for EPA's global aircraft project. It worked with British Aerospace Airbus (Award 1992) to eliminate CFCs from aircraft riveting operations. After extensive research and trials, they developed a satisfactory alternative system. Boeing was a founding member of ICOLP/ICEL.

**British Aerospace Airbus (Award 1992)**

British Aerospace Airbus and The Boeing Company (Award 1992), with the cooperation of ICOLP/ICEL, of which British Aerospace Airbus was a member, worked together to eliminate CFCs from aircraft riveting operations. CFCs had been used as a lubricant and coolant, particularly for drilling, rivet insertion, and rivet head milling of thick stacks of aluminum sheet metal. After extensive research and trials, they developed a satisfactory alternative system.

**Robert V. Burress, SEHO USA (Award 1995)**

Robert V. Burress of SEHO USA was a key individual in several projects leading to the success of low residue (no-clean) soldering processes throughout the electronics industry. He lead the effort to convert 60 military programs that had utilized rosin-based flux and subsequent cleaning to a low-residue, controlled atmosphere soldering process.



**Dr. Frank Cala, Church & Dwight (Award 1996)**

Dr. Frank Cala of Church & Dwight developed a completely new type of non-ozone-depleting aqueous cleaning agent for electronic circuit assemblies that delivered economic, environmental, and worker safety benefits. He then chaired a Church & Dwight task force that implemented an orderly transition from the prototype to the marketplace. Dr. Cala also recently coauthored a book on cleaning technology for electronic assemblies that helps users choose among cleaning alternatives. His work has been recognized in over a dozen patents.

**Robert Carter, Waste Reduction Resource Center for the Southeast (Award 1993)**

Robert Carter, Waste Reduction Resource Center for the Southeast, worked with dozens of clients to eliminate ozone-depleting solvent use and advised dozens of companies in the selection of suitable alternatives to CFCs and methyl chloroform solvents.

**Nicholas T. Castellucci, Northrop Grumman (Award 1993)**

Nicholas T. Castellucci of Northrop Grumman invented a mechanical gap treatment to replace organic caulking substances for advanced aircraft as well as commercial airlines. In addition, the concept can be utilized in extremely large markets such as automobile, train, bus, ship, submarine, and construction businesses. This device eliminates all total toxic organics, VOCs, and CFCs. 1993

**The Center for Emissions Control (Award 1993)**

The Center for Emissions Control promoted the replacement of methyl chloroform in cooperation with other associations, EPA Regional Offices, and EPA's Stratospheric Ozone Protection Division with the leadership of John Sparks. With the leadership of Steve Risotto, they organized and sponsored nine regional seminars with an attendance of over 1,000 participants. Technical information was sent to several thousand more users. As a result, the Center for Emissions Control helped to increase industry awareness of the pending phaseout of ozone-depleting solvents and guided users to environmentally acceptable alternatives.

"Winning these awards has enhanced the reputation of the Northrop Grumman environmental team, both within and outside the company. A number of additional environmental activities have developed because of these awards, including developing a coatings removal tool, aqueous paint systems, chromate elimination, new wipe solvents, and in general eliminating all chlorofluorocarbons used in process at Northrop Grumman. EPA has certainly played a role in allowing the continued pursuit of new and ongoing environmental projects at Northrop Grumman."

*Rick Osterman & Nicholas T. Castellucci (Award 1993)*  
*Northrop Grumman (Award 1994)*

**The Center for Technical Excellence for ODC Solvents at the Corpus Christi U.S. Army Depot (Award 1996)**

The Center for Technical Excellence for ODC Solvents at the Corpus Christi U.S. Army Depot focused on industrial processes using ozone-depleting solvents at Army depots, arsenals, and government-owned, contractor-operated facilities. Their production, manufacturing, and repair activities served as the test beds for alternative chemicals, processes, and technologies. As a result, depot maintenance activities are now either ODS-free or have equipment identified and planned for replacement by the end of the year.



David Chittick, Vice  
President of AT&T  
(Award 1990)

David Chittick, Vice President of AT&T, was cofounder and chair of ICOLP/ICEL. In 1987, many companies claimed that CFC-113 was essential to manufacturing sophisticated PCBs for high-reliability applications. Companies that expressed technical optimism were subject to peer criticism and market retaliation. In this setting, Mr. Chittick stunned the world by announcing in January 1987 that AT&T had proven that an aqueous cleaner made from orange peels could clean as well as CFC-113. He announced that AT&T planned to quickly eliminate 30 to 50 percent of its CFC use. The announcement helped stimulate innovation and proved that large electronics companies were ready and willing customers for CFC-free production. Along with other top electronics executives, Mr. Chittick worked to change military and civilian specifications that required the use of CFCs. He was a leader in combining resources, research, and funds to accelerate the phaseout of ODSs in the electronics, metal cleaning, and aircraft servicing industries. Mr. Chittick and Ms. Eileen Chittick traveled on diplomatic missions to China, Japan, Hungary, and Russia to advocate ozone layer protection.

Compaq  
(Award 1993)

Compaq announced a goal to phase out CFC solvents in May 1993 and was a leader in requiring suppliers and subcontractors to halt their uses. The elimination was completed two years ahead of schedule by two teams, one that evaluated and implemented changes in the existing process to minimize emissions and a second that reviewed potential alternatives to the use of CFC cleaning materials. Compaq is a member of ICOLP/ICEL.

Jorge Corona,  
CANACINTRA  
(Award 1991)

Jorge Corona, CANACINTRA, led the formation of a partnership between CANACINTRA, the Mexican government, Nortel/Northern Telecom, ICOLP/ICEL, and EPA to eliminate CFC and methyl chloroform solvents by the year 2000. He also promoted accelerated ODS phaseout programs for several other developing countries.

Timothy Crawford,  
EMPF (Award 1993)

Timothy Crawford, EMPF, played a key role in the development and execution of the EPA/DoD/IPC Ad Hoc Solvents Working Group program to evaluate cleaning alternatives for electronics manufacturing. He continued the program by overseeing the testing of 18 Phase 2 approved CFC alternative cleaning materials.

DEC  
(Award 1990)

DEC is an ICOLP/ICEL founding member and has been a leader in global information sharing. It successfully developed and implemented aqueous cleaning techniques and donated the patented technology to the public domain for distribution without charge. The company is a signatory to the Thailand Leadership Initiative.

Defense Electronics  
Supply Center  
(Award 1993)

Defense Electronics Supply Center changed procurement practices to favor non-ODS options and guided suppliers to environmentally preferable solutions.

Draper Laboratory  
(Award 1996)

Draper Laboratory helped the U.S. Air Force eliminate the use of ODS in the production of inertial guidance systems used in the Peacekeeper Missile and converted the cooling media in the Peacekeeper guidance system from R-12 to R-134a. Both of these projects were technically complex and significantly reduced the U.S. Air Force's ODS emissions.





- Carl Eckersley, Compaq**  
(Award 1993)
- Carl Eckersley, Compaq, was the company champion in CFC phaseout and a key supporter of global cooperation for ozone layer protection within the electronics industry.
- Bjorn Egeland, Consolve**  
(Award 1995)
- Bjorn Egeland of Consolve was the primary contributor to the elimination of CFC usage in defluxing processes in Norway. He arranged and conducted a workshop that provided information that would allow Norwegian electronics manufacturers to achieve an immediate reduction of 35 percent of CFC-113 usage for PCB defluxing. This development allowed the Norwegian electronics industry to complete its phaseout of CFC-113 on a schedule well ahead of that required by the Montreal Protocol.
- Carole K. Ellenberger**  
(Award 1993)
- Carole K. Ellenberger was the lead engineer of the Texas Instruments team that identified, evaluated, and recommended alternative cleaning agents and technologies to replace the use of ODSs in electronics manufacturing and assembly operations.
- Brian Ellis, Protonique**  
(Award 1994)
- Brian Ellis of Protonique has served since 1989 on the UNEP Solvents, Coatings, and Adhesives TOC and has been the Swiss National Solvent Expert for domestic policy. He has chaired electronics committees, organized workshops, participated in conferences, and has published books and technical papers on electronics cleaning and contamination control. He led efforts to promote the commercialization of aqueous cleaning and recycling systems that are able to satisfy the strictest water discharge criteria.
- Epson Hong Kong Group**  
(Award 1995)
- Epson Hong Kong Group eliminated 13 metric tonnes per year of CFC-113, based on peak consumption in 1993, and 16 metric tonnes per year of methyl chloroform. Additionally, it helped 36 major suppliers in Hong Kong and neighboring countries to eliminate ODSs. Seiko Epson is a signatory to the Thailand Leadership Initiative and the Vietnam Pledge.
- Stephen P. Evanoff III, General Dynamics**  
(Award 1992)
- Stephen P. Evanoff III of General Dynamics (now Lockheed Martin Tactical Aircraft Systems) was vital to the replacement of the CFC-113 based cleaner, particularly in the implementation of the low-vapor pressure cleaner, the education of the workers concerning the new cleaner, and overall coordination with senior management of General Dynamics. General Dynamics operated the Air Force Plant No. 4 in Fort Worth, Texas, where the F-16 fighter is built and various fighter aircraft are updated. Stephen P. Evanoff worked with the U.S. Air Force, EPA, and the Texas Air Control Board to select and implement technologies to replace ozone-depleting solvents. Additionally, he made invaluable contributions to the development of the aqueous cleaner technology that replaced methyl chloroform degreasers. He has been a member of the UNEP Solvent TOC since its inception and is the current chairman of ICEL.



**Lt. General James A. Fain, Jr., Commander, Aeronautical Systems Center, U.S. Air Force (Award 1994)**

Lt. General James A. Fain, Jr., Commander, Aeronautical Systems Center, U.S. Air Force, provided continuous leadership, guidance, and support for the multitude of ODS-elimination programs at Wright-Patterson AFB's Aeronautical Systems Center. During his tenure, General Fain has become personally involved in the day-to-day activities of the Environmental Protection Program and has assumed the chairmanship of the Environmental Protection Committee.

**Joe Felty, Texas Instruments (Award 1990)**

Joe Felty, Texas Instruments, has served since 1989 on the UNEP Solvents, Coatings, and Adhesives TOC. He managed the Texas Instruments team that identified, evaluated, and recommended alternative cleaning agents and technologies to replace the use of ODSs in electronics manufacturing and assembly operations. He was one of the original founders of the EPA/DoD/IPC Ad Hoc Solvents Working Group, an early cooperative effort in the ODS phaseout that developed a standardized test protocol and test vehicle for consistent, quantitative evaluation of alternative cleaning chemistries and alternative technologies such as semi-aqueous cleaners, low residue/no clean fluxes and controlled atmosphere soldering. He was also a member of the DoD/Industry Soldering Technology Standardization Working Group that generated MIL-STD-2000, a series of military soldering specifications, that eliminated the requirement to clean with ODSs. He is currently a member of the Ozone Operations Resource Group of the World Bank which provides specialized sector-based technical advice and assistance to developing countries regarding ODS phaseout.

**Mary Beth Fennell, Naval Aviation Depot, Cherry Point (Award 1994)**

Mary Beth Fennell, Naval Aviation Depot, Cherry Point, led the evaluation of alternatives to ozone-depleting cleaning solvents, working with suppliers, manufacturers, and Navy technicians to determine the most viable alternatives for ODSs. The Cherry Point facility used ozone-depleting solvents for repair and rework of engines, components, and support equipment for a variety of military aircraft (both fixed and rotary wing). She has also led Navy efforts to eliminate ODSs in nondestructive inspection tasks and cleaning prior to bonding and sealing.

**John Fischer, Naval Air Warfare Center, China Lake (Award 1993)**

John Fischer, Naval Air Warfare Center, China Lake (Award 1993), was tasked with leading the effort to eliminate ODSs from U.S. Navy weapons systems without compromising reliability, safety, and performance. With his staff and contractors, he developed test methods and selection criteria for acceptance of new manufacturing and maintenance procedures for critical weapons systems. These programs have resulted in complete elimination of ODS requirements and use from weapons research, development, testing, evaluation, production, and maintenance.

**Arthur FitzGerald, Nortel/Northern Telecom (Award 1990)**

Arthur FitzGerald, Nortel/Northern Telecom, led Nortel/Northern Telecom's technical program for phasing out ozone-depleting solvents and other ODSs, as well as the company's outreach program. He was president of ICOLP/ICEL and was the solvent advisor to the World Bank for two years. He coauthored a solvents conservation and phaseout manual that became a model for later ICOLP/ICEL technical manuals. He also developed OZONET, an electronic online database for solvents alternatives. Mr. FitzGerald organized workshops on solvent alternatives in Mexico, Turkey, China, and India, and continues to be a member of the UNEP Solvents, Coatings, and Adhesives TOC.



- Ford**  
(Awards 1992 and 1994) Ford has been a leader in implementing alternatives to ODSs in parts cleaning. It was a founding member of ICOLP/ICEL and a signatory to the Thailand Leadership Initiative and the Vietnam Pledge. Its "no-clean" soldering technique is widely recognized as the most environmentally acceptable substitute for ozone-depleting solvents. Ford has been a prominent member in groups to commercialize CFC recycling, to change military specifications, and to persuade suppliers to phase out ODS use.
- Yuichi Fujimoto**  
(Award 1993) Yuichi Fujimoto, as the head of JEMA, led Japanese efforts to phase out CFCs in electronics manufacturing. He continued to work for ozone protection by contributing to Japan's extensive technology-share program focused largely in Southeast Asia. He also organized the Thailand and Vietnam volunteer industry leadership initiatives, is a senior advisor to the UNEP TEAP, and is a key member of the UNEP Solvents, Coatings, and Adhesives TOC.
- Tetsuro Fukushima, Hitachi**  
(Award 1994) Tetsuro Fukushima of Hitachi was chairman of the **Ozone Layer Protection Committee of JEMA** from 1990 to 1992 and was instrumental in achieving targets for CFC-113 elimination. He is also responsible for eliminating ODSs at Hitachi (Award 1991). Moreover, he has engaged in cooperative efforts with the UNEP Solvents, Coatings, and Adhesives TOC.
- H.B. Fuller**  
(Award 1995) H.B. Fuller accomplished a complete phaseout, in May 1994, of methyl chloroform by replacing methyl chloroform as a formulating ingredient and developing new products that do not require methyl chloroform as an ingredient.
- General Dynamics**  
(Award 1992) General Dynamics, Space Systems and Fort Worth Divisions (now Lockheed Martin Tactical Aircraft Systems), in 1992 became the first aerospace facility to replace an ozone-depleting general purpose cleaner with a low-vapor pressure cleaner. With the implementation of this new technology, General Dynamics Fort Worth eliminated CFC-113 emissions (235 tons per year in 1989) from the general purpose cleaner operations. Additionally, General Dynamics Fort Worth aggressively implemented water based degreasers to replace methyl chloroform degreasers.
- GET-Marconi, Hirst Research Centre**  
(Award 1993) GET-Marconi, Hirst Research Centre, organized the first European testing of CFC solvent alternatives and coordinated European contributions to the United States' alternatives and publications projects.
- Captain Michael C. Grieco, ICBM System Program Office, U.S. Air Force**  
(Award 1995) Captain Michael C. Grieco, ICBM System Program Office, U.S. Air Force, founded the ICBM Pollution Prevention Concept, centralizing several ODS elimination and pollution prevention initiatives under one program that has been recognized by U.S. Air Force headquarters as the "Model Program" for weapon system pollution prevention.
- Dr. Leslie Guth, AT&T**  
(Award 1990) Dr. Leslie Guth of AT&T was an active participant in international and domestic task forces working to end ODS use in cleaning applications; chaired the Test Validation Committee for the IPC CFC benchmarking projects; and invented the AT&T precision fluxing machines.



**Kaichi Hasegawa, Seiko Epson**  
(Award 1996)

Kaichi Hasegawa, Seiko Epson, in a tireless pursuit of excellence in global technological cooperation, has helped make Seiko Epson a world leader in ozone protection. Seiko Epson was the first global company to eliminate its use of CFC-113 in precision cleaning. It has been a strong member of projects in Japanese, regional, and international groups and has created industry initiatives to protect stratospheric ozone through programs such as the Thailand Leadership Initiative and the Vietnam Pledge.

**Dr. Michael Hayes, Petroferm**  
(Award 1993)

Dr. Michael Hayes of Petroferm developed with AT&T (Award 1992) the terpene based semi-aqueous cleaning process that demonstrated an ability to clean surface-mount electronic components to cleanliness standards equal or better than those cleaned with CFCs. When this process was publicly disclosed in 1988, it was commonly believed that no viable alternative to CFC-113 for defluxing electronic assemblies existed. This invention was the initial catalyst leading to development of a wide range of products, some of which are variations developed to handle specific cleaning applications.

**Hewlett-Packard**  
(Award 1994)

Hewlett-Packard successfully met its goal of complete ODS elimination on May 15, 1993, well ahead of the time lines established under the Montreal Protocol. It has since worked to ensure that all suppliers meet ODS elimination requirements as well.

**Hill AFB**  
(Award 1993)

Hill AFB servicemen and officers pioneered, demonstrated, and promoted aircraft maintenance procedures to replace CFC and methyl chloroform.

**Hitachi**  
(Award 1991)

Hitachi was a leader both within Japan and globally in encouraging testing and implementation of alternatives to ozone-depleting solvents, refrigerants, and insulating foams. It was a member of ICOLP/ICEL and a signatory to the Thailand Leadership Initiative and the Vietnam Pledge.

**Robert Holcomb, Motorola**  
(Award 1994)

Robert Holcomb of Motorola was integral in Motorola's successful effort to eliminate the use of ODSs from its worldwide manufacturing operations (CFCs by 1992 and other ODSs by May 1993). He has been one of the industry's most active participants in a broad range of international activities to help accelerate the phaseout of ODSs worldwide.

**Honeywell**  
(Award 1994)

Honeywell eliminated over 95 percent of its ODS use from manufacturing by 1992. Only a few specialized applications in its military and space programs required the continued use of ODSs after 1992. Honeywell senior managers served on the Board of Directors and Technical and New Initiatives Committees of ICOLP. Honeywell was a founding member of ICOLP, and is a signatory to the Thailand Leadership Initiative and the Vietnam Pledge.

**Hughes Aircraft**  
(Award 1993)

Hughes Aircraft worked with suppliers and customers to halt a wide range of ODS uses.



IBM  
(Awards 1992 and 1993)

IBM never extensively used halons and worked to prove that electronics could be protected with water or carbon dioxide. IBM's task in eliminating CFCs was difficult for three reasons: (1) IBM was highly dependent on CFCs, using over 5,450 metric tonnes in 1987; (2) IBM used CFCs in a wide range of applications covering the manufacture of disk drives, chip carriers, circuit boards, semiconductors, and products meeting military specifications; and (3) IBM used CFCs at 44 locations worldwide. In July 1992, IBM eliminated CFC-113 from its disk drive manufacturing facility in San Jose, California. This facility pioneered the use of aqueous cleaning technology for the disk drive industry and contributed to EPA's publication on "Alternatives for CFC-113 and Methyl Chloroform in Metal Cleaning." IBM San Jose hosted more than 75 other companies, including direct competitors, for discussions and demonstrations of the aqueous cleaning technology at the site and authorized marketing of key cleaning technology to other companies. IBM shared its technical knowledge through international conferences, patents, papers, and publications. IBM also took specific steps to assist and influence its suppliers by establishing numerous supplier programs. IBM was a member of ICOLP/ICEL and is a signatory to the Thailand Leadership Initiative and the Vietnam Pledge.

IBM Endicott,  
New York; Rochester,  
Minnesota  
(Award 1992)

IBM Endicott, New York, and Rochester, Minnesota, cooperated to speed elimination of ozone-depleting solvents in the manufacture of high-reliability, sophisticated electronic and mechanical devices such as the elimination of ODSs from circuit board photo lithographic processes.

IBM Austin, Texas  
(Award 1993)

IBM Austin, Texas, successfully eliminated CFC-113 from its manufacturing process.

ICOLP/ICEL  
(Award 1993)

ICOLP/ICEL spearheaded technology transfer to developing countries and sponsored technical publications and electronic databases for use worldwide.

ICOLP/ICEL  
(Award 1991)

ICOLP/ICEL provided a forum for the open discussion among industries of alternatives to ODSs in solvents applications, organized industry to cooperate on technology implementation, and published with EPA the most influential handbooks on cleaning without ODSs. Its members included **The Boeing Company** (Awards 1992 and 1993); **British Aerospace** (Award 1992); **Compaq** (Award 1993); **DEC** (Award 1990); **Ford** (Awards 1992 and 1994); **Hitachi** (Award 1991); **Honeywell** (Award 1994); **Hughes Aircraft Company** (Award 1993); **IBM** (Awards in 1992 for Endicott, New York, and Rochester, Minnesota, and in 1993 for Austin, Texas); **Lockheed-Martin** (Awards 1994 and 1996); **Matsushita Electric** (Award 1993); **Mitsubishi Electric** (Award 1994); **Motorola** (Awards 1991 and 1993); **Nortel/Northern Telecom** (Award 1991); **Ontario Hydro** (Award 1995); **Texas Instruments** (Award 1993); and **Toshiba** (Award 1995). ICOLP/ICEL helped to fast-track implementation of innovative technologies by fostering a spirit of collaboration rather than competition among industry rivals. ICOLP/ICEL then transferred its successes by sharing its findings with the electronics industry worldwide. ICOLP/ICEL worked with EPA and its contractor ICF/Kaiser to develop and review seven technical manuals on phasing out ozone-depleting solvents for various applications. With support from the **World Bank**, ICOLP/ICEL organized and ran technology cooperation workshops and demonstrations projects in Brazil, China, India, Malaysia, Mexico, Thailand, and Turkey.



IPC  
(Award 1990)

IPC played a very active role in the EPA/DoD/IPC Ad Hoc Solvents Working Group, chairing the components management, operating the database, and maintaining momentum through a variety of team building and technical support activities.

Yoshiyuki Ishii, Hitachi  
(Award 1992)

Yoshiyuki Ishii, Hitachi, is a key champion of the Japanese technical and policy leadership in ozone layer protection. Since 1990, he has been a member of the UNEP Solvents, Coatings, and Adhesives TOC and served on the Board of Directors of ICOLP/ICEL. He has been instrumental in negotiating with various Japanese industries and manufacturing associations to eliminate CFCs in their cleaning operations.

Japan Industrial  
Conference on Cleaning  
(JICC)  
(Award 1996)

Japan Industrial Conference on Cleaning (JICC) was established in April 1994 by approximately 130 companies, including manufacturers of detergents, cleaning machines, and peripheral equipment. JICC provides technical assistance and information on alternatives and conversion from methyl chloroform, evaluates and analyzes the effects of alternative cleaning materials and equipment, and actively supports developing countries' efforts in this field through training and education.

JEMA  
(Award 1991)

JEMA served a similar purpose to ICOLP/ICEL's. It provided for extensive information sharing among Japanese electronics companies and then actively distributed the resulting conclusions. In November 1991, JEMA established the Environmental Policy Committee comprising officers responsible for environmental issues in major member companies. Hiroshi Sonoyama, former vice president of Hitachi (Award 1991), became the first chairman and helped the committee set clear measures on stratospheric ozone protection. JEMA and four of its member companies—Hitachi (Award 1991), Toshiba (Award 1995), Matsushita Electric (Award 1993), and Mitsubishi Electric (Award 1994)—joined ICOLP/ICEL (Awards 1991 and 1993), strengthening JEMA's system to protect the ozone layer and enabling it to carry out more aggressive activities. JEMA has been a cosponsor, organizer, or participant in numerous conferences and workshops in Brazil, China, Hong Kong, Korea, Japan, Malaysia, Philippines, Singapore, Thailand, United States, and Vietnam.

JICOP  
(Award 1993)

JICOP organized domestic and international ozone protection projects including training, workshops, conferences, publications, and partnerships. It has sponsored important environmental leadership projects including the Thailand Leadership Initiative and the Vietnam Pledge. It has also been successful in organizing projects to encourage and insist that suppliers provide products not made with ODSs.

Kathi Johnson, China  
Lake Navy Weapons  
Center EMPF  
(Award 1990)

Kathi Johnson, China Lake Navy Weapons Center EMPF, was a founding member of the EPA/DoD/IPC Ad Hoc Solvents Working Group and manager of equipment and materials coordination.

Barbara Kanegsberg,  
BFK Solutions  
(Award 1996)

Barbara Kanegsberg, BFK Solutions, has since 1988 identified, qualified, and implemented alternatives to ozone-depleting solvents in commercial and critical military applications. She has managed corporate ODS elimination efforts, assisted regulatory agencies, and conducted workshops and seminars for industry.



Takeshi Kawano,  
Dai-Ichi Kogyo Seiyaku  
(Award 1996)

Takeshi Kawano, Dai-Ichi Kogyo Seiyaku, promoted substitute aqueous detergents to replace CFCs and methyl chloroform solvents. He promoted strategies for replacing ODSs for domestic and overseas customers in Southeast Asian countries, participated in an advisory committee of detergent systems experts in Japan and in ICOLP, and created a manual for reduction/phaseout of methyl chloroform. The water-based detergent he developed helped over 200 enterprises eliminate the use of ODSs. He participated more than 160 times in technical seminars organized by the Japanese government for local public groups, newspapers, and private companies.

Kelly AFB, Texas  
(Award 1993)

Kelly AFB, Texas, became an Air Force center of excellence for a wide range of ODS elimination efforts including solvents, refrigerants, and halons. Methyl chloroform and CFC-113 solvents were replaced by aqueous or semi-aqueous cleaners; refrigerant emissions were reduced by best practices including high efficiency purge units for low pressure chillers; and halons emissions were minimized by implementing a state-of-the-art halon containment and recycling program.

Dr. William Kenyon,  
DuPont  
(Award 1990)

Dr. William Kenyon of DuPont was a founding member of the EPA/DoD/IPC Ad Hoc Solvents Working Group, a member of the UNEP Solvents, Coatings, and Adhesive TOC, and part of almost every other critical team working to eliminate ozone-depleting solvents. He was key in securing the in-kind and financial support of IPC (Award 1990) and its members for work on benchmark testing and verification of alternatives to CFC-113. He is a consultant to the World Bank for ozone-depleting solvent elimination in Article 5(1) countries.

Dr. Margaret Kerr,  
Nortel/Northern  
Telecom  
(Award 1990)

Dr. Margaret Kerr, Nortel/Northern Telecom, championed the phaseout of CFCs in international electronics manufacture, developed the first fully successful integration of environmental and business strategies, co-organized and chaired ICOLP/ICEL, and motivated government and private environmental managers.

Masatoshi Kinoshita  
(Award 1995)

Masatoshi Kinoshita successfully led JICC to organize manufacturers who are dedicated to supplying substitutes and alternative technologies, and to encourage and assist in the phaseout of ODSs. JICC has also supported technology transfer to developing countries in cooperation with UNEP, EPA, and ICOLP/ICEL (Awards 1991 and 1993) by participating in conferences in Southeast Asia.

Hiroshi Kurita, Japan  
Association for Hygiene  
of Chlorinated Solvents  
(Award 1995)

Hiroshi Kurita, Japan Association for Hygiene of Chlorinated Solvents, continuously provided technical data and the expert advice necessary to support a variety of activities related to ozone layer protection. He has been a key member of the UNEP Solvents, Coatings, and Adhesives TOC; the UNEP Aerosols, Sterilants, Miscellaneous Uses and Carbon Tetrachloride TOC; the UNEP Inadvertent Loss Committee; and the UNEP Process Agents Working Group.

Colin Lea, National  
Physical Laboratory, U.K.  
(Award 1991)

Colin Lea, National Physical Laboratory, U.K., is the master contamination specialist who spearheaded testing of alternatives to ozone-depleting solvents for European military and civilian applications. He organized industrial groups to accelerate dissemination of information on the ozone issue, alternatives, and entirely new environmentally acceptable processes.



Michael J. Leake, Texas Instruments (Award 1995)	Michael J. Leake, Texas Instruments, worked to gain support for the adaptation of NAS 411 as a substitute commercial standard for pollution prevention requirements and coauthored an industry white paper highlighting DoD procurement policy barriers to implementing environmentally conscious design and process changes. As a result of his efforts, Texas Instruments has virtually eliminated Class I ODSs from its manufacturing processes for military electronics.
Colin Lewis, UK Ministry of Defence (Award 1992)	Colin Lewis, UK Ministry of Defence, served as the European focal point for global technical coordination of ozone-depleting solvent elimination and other military issues.
Captain Cynthia Lingg, U.S. Air Force (Award 1995)	Captain Cynthia Lingg, U.S. Air Force, led a 10-member pollution prevention integrated product team tasked with minimizing requirements for hazardous materials for airfield and depot maintenance activities. Her efforts have resulted in the reduction of over 2.5 metric tonnes per year of ODSs from B-52 airframe maintenance from a 1992 baseline.
Lockheed (Award 1994)	Lockheed replaced cleaners with a heated aqueous alkaline immersion cleaning system and with a custom cleaning system using a terpene-based degreaser. It also replaced methyl chloroform vapor degreasing and CFC-113 ambient temperature liquid flushing with a heated, aqueous immersion cleaner and flushing operation. Lockheed is a member of ICOLP/ICEL.
Lockheed Martin Aeronautical Systems (Award 1996)	Lockheed Martin Aeronautical Systems developed an alternative to methyl chloroform for use in cleaning inboard fuel tanks and as a general handwipe solvent for airplane parts. The first project involved replacing methyl chloroform with an aqueous cleaner to remove contaminants from fuel tanks on C-130 aircraft. The other project involved replacing methyl chloroform, which was used in a wide range of hand wipe applications, with five non-ozone-depleting replacement materials. Collectively, these projects allowed for the elimination of 56 metric tonnes annually. The cleaning process has been streamlined, and 95 percent of material costs are saved. Lockheed is a member of ICOLP/ICEL.
Lockheed Martin Skunk Works (Award 1996)	Lockheed Martin Skunk Works in May 1993 used a small multidisciplined team of key employees to begin a program to eliminate the use of ODSs in all facilities by January 1, 1996. To achieve this goal, the company reformulated 12 different proprietary radar absorbing materials, developed and versified a new oxygen tube cleaning process, and implemented aqueous cleaning processes and a UV-curable conformal coating process. Lockheed shared its data and success with other companies at conferences and seminars. Lockheed is a member of ICOLP/ICEL.
The Low-Residue Soldering Task Force (Award 1995)	The Low-Residue Soldering Task Force demonstrated to the electronics industry that no-clean/low-residue processes meet all stringent performance requirements for both commercial and military electronics cleaning.





- Milton E. Lubraico, Ford**  
(Award 1992) **Milton E. Lubraico of Ford** managed the Brazil Ford team in one of the first successful implementations of no-clean soldering, and was a key expert responsible for transferring this advanced technology from developing to developed country facilities.
- Lufthansa German Airlines** (Award 1993) **Lufthansa German Airlines** was the first airline to virtually halt dependence on ozone-depleting solvent in the maintenance of commercial aircraft. It is also a signatory to the Vietnam Pledge.
- Dr. Mohinder Malik, Lufthansa German Airlines**  
(Award 1994) **Dr. Mohinder Malik of Lufthansa German Airlines** played a pioneering role in the reduction of halogenated solvents in the European and international aircraft industry. As early as 1987, he took action through the **International Air Transport Association** by requesting the development of engine cleaning processes that did not involve halogenated solvents, including methyl chloroform and CFC-113. As a direct result, Lufthansa has been able to eliminate completely the use of ozone-depleting solvents from its maintenance without sacrificing quality or safety.
- Hitoshi Mamiya, Honda**  
(Award 1995) **Hitoshi Mamiya of Honda** successfully promoted alternative technologies to replace ozone-depleting solvents used at Honda and 139 other small- and medium-sized companies for cleaning electronics and metal parts. As a result of his efforts, more than 1,174.8 tons of CFC-113 and 4,963.2 tons of methyl chloroform were phased out with savings of up to 70 percent compared to ODS processes. His approach was to plan a phaseout by 1995 in anticipation of stricter regulation under the Protocol and to make reductions before ODS prices increased substantially.
- Martin Marietta**  
(Awards 1993 and 1994) **Martin Marietta** eliminated environmentally harmful solvents from soldering and parts cleaning by a variety of technologies, including a controlled agitation cleaning system for individual circuit cards and no-clean soldering. Resultant cost savings from the process changes implemented have exceeded millions of dollars. Martin Marietta also undertook proactive measures to reduce the quantity of ODSs released from A/C systems including leak detection, retrofits, technician training and certification, and system replacement. Initial efforts reduced emissions by over 130 tons with cost savings from process changes exceeding \$1 million.
- Shigeo Matsui, Toshiba**  
(Award 1992) **Shigeo Matsui, Toshiba**, was the leader of one of the most successful Japanese phaseouts, was a strong team member, and was one of the first experts to be assigned to the **UNEP Solvents, Coatings, and Adhesives TOC**.
- Matsushita Electric**  
(Award 1993) **Matsushita Electric** in 1993 was one of the first proactive consumer products companies to eliminate its use of ODSs and challenge competitors and suppliers to halt their uses. Matsushita supported the phaseout in other companies by participating in **ICOLP/ICEL** (Awards 1991 and 1993), **JICOP** (Award 1993), **JEMA** (Award 1991), and numerous other international conferences and workshops including the **ICOLP/UNEP Singapore Conference**, the **Japan-United States-Thailand Conference**, and the **Japan-United States-Malaysia Conference**. Matsushita was a member of **ICOLP/ICEL** and is a signatory to the **Thailand Leadership Initiative** and the **Vietnam Pledge**.



James A. Mertens, Dow Chemical (Award 1995)	James A. Mertens of Dow Chemical was instrumental in defining the need for system development services to help clients determine alternative cleaning systems and to replace the use of vapor degreasing systems that used ODSs. His early work in industry with the EPA/DoD/IPC Ad Hoc Solvents Working Group and the UNEP Solvents, Coatings, and Adhesives TOC led to the development of alternative cleaners for commercial applications.
Minebea (Award 1993)	Minebea was the company with the highest consumption of ozone-depleting solvents in Thailand in 1992, but through extraordinary efforts phased them out by March 1993. This leadership inspired other multinational companies to encourage their joint-venture companies and suppliers to phase out worldwide on an accelerated timetable. Minebea is also a signatory to the Thailand Leadership Initiative.
Mitsubishi Electric (Award 1994)	Mitsubishi Electric showed leadership internally and internationally by developing and introducing CFC- and methyl chloroform-free products and manufacturing systems in 1995. Mitsubishi is a signatory to the Thailand Leadership Initiative and the Vietnam Pledge and is a member of ICOLP/ICEL.
Yasuo Mitsugi, Seiko Epson (Award 1993)	Yasuo Mitsugi of Seiko Epson is a creative and inspiring manager of environmental health and safety who helped organize the phaseout in 1988 when Seiko Epson's president Tsuneya Nakamura (Award 1993) decided that the company could not continue using a chemical that was so harmful to the global environment. That decision to set the sights high and establish a target of complete elimination shook Seiko Epson into action. Mr. Mitsugi assembled a CFC Elimination Committee composed of technical and management experts, including the heads of production engineering from each profit center. This management team included Kaichi Hasegawa (Award 1996), Yuji Yamazaki (Award 1996), and Hideaki Yasukawa (Award 1994). The team motivated Seiko Epson employees to phase out ozone-depleting solvents on an accelerated schedule. Yasuo Mitsugi also assisted suppliers in accomplishing their own phaseout and, as head of Seiko Epson's CFC-elimination program, promoted the development of alternative cleaning technologies.
Motorola (Award 1991)	Motorola was a founding member of ICOLP/ICEL (Awards 1991 and 1993) and a persistent advocate of technical solutions to difficult problems. Motorola has maintained its positions of global leadership and public service advocate, and is a signatory to the Thailand Leadership Initiative and the Vietnam Pledge.
Motorola Malaysian Project (Award 1993)	Motorola Malaysian Project created a business-to-business partnership to help suppliers and unaffiliated companies from developing countries meet the schedule of developed countries. Motorola is a signatory to the Thailand Leadership Initiative and the Vietnam Pledge.



**Tsuneya Nakamura**  
(Award 1993)

**Tsuneya Nakamura**, as president of Seiko Epson, was responsible for launching the company's CFC-elimination program in 1988 when he decided that the company could not continue using a chemical that was so harmful to the global environment. Under his leadership, Seiko Epson motivated employees, rewarded managers, and used imaginative public relations to inspire global environmental protection.

**The Naval Aviation  
Depots in Cherry Point  
(Award 1993) and  
Norfolk (Award 1993)**

**The Naval Aviation Depots in Cherry Point and Norfolk** developed new innovative operations and maintenance procedures to meet stringent performance standards without ozone-depleting solvents. The Cherry Point and Norfolk facilities eliminated the use of ozone-depleting solvents for repair and rework of engines, components, and support equipment for a variety of military aircraft (both fixed and rotary wing) and undertook efforts to eliminate ODSs in nondestructive inspection tasks and cleaning prior to bonding and sealing.

**Norsk Forsvarsteknologi  
(Award 1994)**

**Norsk Forsvarsteknologi**, in cooperation with the **Norwegian State Pollution Control Authority**, developed an alcohol-based defluxing machine to replace CFC-based solvents in the Norwegian electronics industry using a high-pressure jet spray cleaning process with safety monitors.

**Nortel/Northern  
Telecom  
(Award 1991)**

In 1988 **Nortel/Northern Telecom** became the first multinational telecommunications company to pledge to eliminate CFC-113 solvents from its operations, and in 1991 became the first to do so. Nortel/Northern Telecom was a founding member of the ICOLP/ICEL (Awards 1991 and 1993) and a signatory to the Thailand Leadership Initiative and the Vietnam Pledge.

**Northrop Grumman  
(Award 1994)**

**Northrop Grumman** began ODS elimination activities in 1992 with the goal of eliminating all ODS process usages (primarily solvents) by the end of 1994. It reduced use of ODSs by over 27 metric tonnes per year companywide, eliminating over 40 production vapor degreasers and several hundred ODS-containing materials, processes, and applications. It implemented new, environmentally friendly processes such as "peck" drilling and aqueous degreasing in the production of the B-2 "Stealth" Bomber, F/A-18 and Boeing 747 fuselages, and numerous missile and electronic countermeasure systems such as the AN/ALQ-135 electronic jammer. These changes were implemented at manufacturing locations in California, Georgia, Illinois, and Massachusetts.

**Larry Novak,  
Texas Instruments  
(Award 1996)**

**Larry Novak** of **Texas Instruments** helped a number of companies manufacture integrated circuits without using ODSs. He developed alternatives to processes that used ODSs, received funding to rate these alternatives, worked to make them available worldwide, and helped companies adopt ODS-free manufacturing processes.



**Tsutomu Odagiri,  
JICOP  
(Award 1994)**

Tsutomu Odagiri, JICOP, played a particularly key role in the development and implementation of training seminars on CFC reduction for many developing countries in Southeast Asia, including the United States-Japan-Thailand trilateral seminar on CFC reduction. Currently, he is promoting the final stages of methyl chloroform elimination in Japan and other developed countries. He has been particularly instrumental in the elimination of this substance from Japanese small enterprises, having developed several seminars on this topic for Japanese professional groups.

**Goro Ogino  
(Award 1995)**

Goro Ogino played a key role in the implementation of ODS-phaseout efforts at Minebea, which manufactures miniature ball bearings. As part of ODS phaseout efforts, he organized a CFC Committee to eliminate ODSs in manufacturing operations. In 1993, Minebea completely phased out CFC-113 and methyl chloroform from its operations.

**Ontario Hydro  
(Award 1995)**

Ontario Hydro eliminated the use of CFC-113 in dry cleaning radioactive protective clothing at nuclear stations. As a result of redesigning its monitoring process, just over 1 percent of protective clothing requires dry cleaning, for which an alternative to CFC-113 was found. Ontario Hydro is a member of ICOLP/ICEL.

**Douglas O. Pauls,  
Contamination Studies  
Laboratories  
(Award 1995)**

Douglas O. Pauls, Contamination Studies Laboratories, significantly contributed to the efforts of the EPA/DoD/IPC Ad Hoc Solvents Working Group program to assist the printed wiring board assembly industry in its elimination of CFCs used for defluxing. He provided technical expertise and leadership to all three phases of the Working Group's program.

**Robert C. Pfahl,  
Motorola  
(Award 1991)**

Robert C. Pfahl, Motorola, was one of the earliest promoters of cooperation to protect the ozone layer. He served on management and technical teams of ICOLP/ICEL (Awards 1991 and 1993) and as ozone-depleting solvent elimination chair for AEA.

**Tony L. Phillips  
(General Dynamics,  
now Lockheed Martin  
Tactical Aircraft  
Systems)  
(Award 1992)**

Tony L. Phillips (General Dynamics, now Lockheed Martin Tactical Aircraft Systems) is a co-inventor of a low-vapor pressure cleaner that was implemented to replace the CFC-113-based cleaner. Mr. Phillips was essential in the implementation of the new low-vapor pressure solvent, the education of the workers concerning the new cleaner, and the creation of novel solutions to overcome unforeseen problems during the new cleaner implementation.

**Cynthia Pruett,  
IBM Asia Pacific  
(Award 1993)**

Cynthia Pruett, IBM Asia Pacific, persuaded IBM (Awards 1992 and 1993) to embrace cooperative approaches to ozone layer protection and organized many technology cooperation projects with developing countries in Asia.



**Steven L. Rasmussen,**  
**Hill AFB**  
**(Award 1994)**

**Steven L. Rasmussen, Hill AFB,** has been Project Manager for the Ozone-Depleting Substances Elimination Program since 1991. The program has resulted in a reduction of ODS usage from 198 metric tonnes to 21 metric tonnes per year—an 89 percent reduction in 1993. This is the most significant reduction recorded by a U.S. Air Force depot facility. Mr. Rasmussen was also a member of the original ODSs Policy Development Committee for the Air Force, and was appointed chairman of the Utah Solvent Substitution Committee, which conducts seminars on solvent substitutes for Utah industries.

**Rockwell International**  
**U.S. Army Air-to-Ground**  
**Missile Systems Project**  
**Office (Award 1993)**

**Rockwell International U.S. Army Air-to-Ground Missile Systems Project Office (Award 1993)** eliminated manufacturing maintenance and operations use of ODSs.

**Dr. Wallace Rubin**  
**(Award 1994)**

**Dr. Wallace Rubin,** formerly Technical Director of Multicore UK, made an extraordinary contribution to the successful "low solids/no-clean flux technology." This technology is the basis of one of the major CFC alternatives in electronics assembly. The United Kingdom recognized this accomplishment with the Queen's Award for Environmental Achievement.

**Saab-Scania**  
**(Award 1994)**

**Saab-Scania** successfully eliminated 100 percent of its ODSs used in aerospace manufacturing processes.

**Sanyo Electric**  
**(Award 1995)**

**Sanyo Electric** demonstrated international leadership by successfully developing substitutes for the use of ODSs and then transferring this technology to its facilities in developing countries and participating in several international ozone protection cooperative efforts. Sanyo is a signatory to the Thailand Leadership Initiative and the Vietnam Pledge.

**Terry Schaumberg, San**  
**Antonio Air Logistics**  
**Center (Award 1993)**

**Terry Schaumberg of San Antonio Air Logistics Center** managed the review and modification of military standards to allow and compel the use of alternatives to ODSs.

**Angie Schurig**  
**(Award 1993)**

**Angie Schurig** led the **Texas Instruments** program to eliminate ODSs in its Defense Systems & Electronics and Semiconductor Groups. Through her work as chair of ICOLP/ICEL (Awards 1991 and 1993), she shared the technologies perfected at Texas Instruments with other countries such as Mexico and Russia. Ms. Schurig's leadership also resulted in a number of joint projects with Texas Instruments' military customers, which contributed significantly to more widespread acceptance of non-CFC cleaning technologies for military programs. The program she developed within Texas Instruments resulted in Texas Instruments being CFC-free in 1995 and carbon tetrachloride-free in 1996.



**Seiko Epson**  
(Award 1992)

Seiko Epson achieved the total elimination of CFCs in October 1992 and eliminated methyl chloroform from its worldwide operations in December 1993. It provided technical textbooks in English, Chinese, and Japanese and held many technical forums to share the success of its ODS elimination program with other companies. Seiko Epson has demonstrated global corporate leadership by adopting and practicing a policy that environmental issues are a global concern and that cooperation should outweigh considerations about competition. Seiko Epson is a signatory to the Thailand Leadership Initiative and the Vietnam Pledge.

**Robin Sellers, Naval Avionics Center**  
(Award 1990)

Robin Sellers, Naval Avionics Center, organized and persuaded the U.S. Navy to fully support identification and testing of CFC alternatives suitable for cleaning sophisticated weapons guidance systems.

**Separation Technologists**  
(Award 1994)

Separation Technologists invented and pioneered the "closed-loop wastewater recycling system" that is now a design standard accessory for all aqueous and semi-aqueous batch and in-line cleaners. It eliminates lead from the discharge, recycles the excess heat in the discharge, and recycles 95 percent of the water.

**Sharp**  
(Award 1995)

Sharp eliminated the use of ODSs for cleaning agents and transferred information on alternative technologies to Sharp factories in other countries, giving its employees technical instructions on eliminating ODSs. The company is a signatory to the Thailand Leadership Initiative and the Vietnam Pledge.

**Yoshihide Shibano of S&C**  
(Award 1993)

Yoshihide Shibano of S&C developed unique multiwave ultrasonic aqueous cleaning using highly oxygenated and purified water that is suitable for both large-scale production and for small- and medium-sized enterprises.

**The Singapore PSB**  
(Award 1995)

The Singapore PSB—formerly the SISIR—created a comprehensive range of technical services in cleanliness evaluation, process troubleshooting, and materials compatibility of CFC substitutes. Alternative processes were quickly made available to both multinational and local electronics companies, including an effective recycling system for CFC-113.

**Dr. John R. Stemniski, The Charles Stark Draper Laboratory** (Award 1993)

Dr. John R. Stemniski of The Charles Stark Draper Laboratory encouraged acceptance of alternatives to ozone-depleting solvents for cleaning precision guidance systems in manufacture and maintenance. Dr. Stemniski is also a member of the UNEP Solvent, Coatings, and Adhesives TOC.

**Dr. Richard Stolarski, NASA Goddard Space Flight Center**  
(Award 1991)

Dr. Richard Stolarski of NASA Goddard Space Flight Center was a pioneering investigator of the theory that CFCs deplete the ozone layer and a continuing contributor to the theoretical basis of ozone depletion. He was also a leader in the verification of ozone depletion from observational data.



The Swedish Institute of Production Engineering Research (IVF) (Award 1992)	The Swedish Institute of Production Engineering Research (IVF) initiated and funded in 1988 an inter-Nordic research program to phase out CFCs in electronics production. The program comprised 40 individual projects of fundamental research on reliability and cleanliness. The program actively contributed to a phaseout of CFCs in Scandinavia. Results from the program and experience from the early phaseout have been presented at numerous conferences in Europe as well as in the United States, Thailand, and Singapore. Through UNEP, IVF made special efforts to assist Singapore in its own phaseout program.
Jack Swindle, Texas Instruments (Award 1994)	Jack Swindle, Texas Instruments, actively supported the elimination of all ODS-based solvents in Texas Instruments' manufacturing and assembly operations by championing a five-year effort to assure that adequate funds, facility, and staff are available to address the ODS replacement process. He has also stressed external interactions to support suppliers, customers, and competitors with their respective elimination efforts.
Texas Instruments' Missile Systems Division (Award 1993)	Texas Instruments' Missile Systems Division oversaw the substantial complications of satisfying numerous customers at two federal regulatory authorities to successfully implement ODS-free manufacture of state-of-the-art smart weapons. Texas Instruments was a founding member of ICOLP/ICEL (Awards 1991 and 1993) and a signatory to the Thailand Leadership Initiative.
Thiokol Space Operations (Award 1993)	Thiokol Space Operations took major steps to reduce its use of methyl chloroform in vapor degreasing and cleaning operations by approximately 90 percent and planned only limited use of methyl chloroform for critical bonding operations on the space shuttle until replacements could be qualified.
3M (Award 1991)	3M was the first to implement hydrocarbon solvents for spray-on fabric coatings and is a signatory to the Vietnam Pledge.
Titan IV Program ODS Reduction Team (Award 1995)	Titan IV Program ODS Reduction Team reduced the use of ODSs in the manufacture, assembly, and launch preparation of Titan IV systems by over 99 percent compared to the 1989 baseline year. In 1996, working in concert with the four large solid motor manufacturers in the United States, the team developed a handbook of solid motor rocket manufacturing entitled "Eliminating Use of Ozone Depleting Substances in Solid Rocket Motor Manufacturing." This handbook describes the technologies and process changes that were incorporated to reduce the use of ODSs.
Toshiba (Award 1995)	Toshiba developed a unique, water-free cleaning technology as part of a program designed to eliminate the use of all ODSs for its cleaning operations in every domestic plant. At present, over 200 such systems are in use at Toshiba. Toshiba was a member of ICOLP/ICEL and a signatory to the Thailand Leadership Initiative and the Vietnam Pledge.



Toyota  
(Award 1994)

Toyota, in addition to its achievements in the foams and refrigeration sectors, successfully phased out the use of methyl chloroform as a cleaner in its production processes. Toyota is a signatory to the Thailand Leadership Initiative and the Vietnam Pledge.

Dr. Laura J. Turbini,  
Georgia Institute of  
Technology (Award 1992)

Dr. Laura J. Turbini, Georgia Institute of Technology, conceived, organized, and managed the projects to test no-clean flux in sophisticated electronics production.

Union Carbide/EKCO  
Housewares/Nordson  
(Award 1993)

Union Carbide/EKCO Housewares/Nordson developed ODS-free cleaning capable of preparing metal surfaces for non-stick and anodized coatings.

U.S. Army Acquisition  
Pollution Prevention  
Support Office  
(Award 1992)

U.S. Army Acquisition Pollution Prevention Support Office worked successfully to eliminate CFC use in surface cleaning in Army applications.

USBI  
(Award 1995)

USBI replaced methyl chloroform hand-wipe cleaning on its space shuttle operations with aqueous cleaners, reducing air emissions of ODSs by 2.7 metric tonnes per year. The new solvents cost \$1,000 less per shuttle flight and eliminated hazardous solvent waste, saving \$18,000 per year in disposal costs.

Clare Vinton, National  
Center for Manufacturing  
Sciences (Award 1993)

Clare Vinton, National Center for Manufacturing Sciences, organized and coordinated testing of alternatives to ODSs.

Henry J. Weltman,  
General Dynamics (now  
Lockheed Martin Tactical  
Aircraft Systems)  
(Award 1992)

Henry J. Weltman, General Dynamics (now Lockheed Martin Tactical Aircraft Systems), developed laboratory test methods to screen aqueous cleaners. He is a co-inventor of a low-vapor pressure cleaner that was implemented to replace the CFC-113-based cleaner responsible for 235 tons per year of CFC emissions in 1989. He was essential in the implementation of the new low-vapor pressure solvent and in overcoming a variety of implementation problems of the low-vapor pressure cleaner.

Dr. Udo G. Wenning,  
Bosch Siemens  
(Award 1993)

Dr. Udo G. Wenning of Bosch Siemens (Award 1993) pioneered alcohol cleaning of electronic assemblies and helped organize German industry to cooperate in phasing out ODS.

Xerox  
(Award 1995)

Xerox replaced the use of methyl chloroform and aqueous processes by adapting a jet-engine cleaning process utilizing carbon dioxide pellets that work by being sprayed at high velocities onto the surface to be cleaned. The process leaves no hazardous waste and requires only one step to complete cleaning. It is more effective than previous cleaning with ozone-depleting solvents and allows parts to be recovered that previously had been scrapped when cleaning was inadequate. Additionally, Xerox included ODS phaseout criteria in its vendor (supplier) selection and purchasing decisions and provided written certificates to its customers verifying that products were not made with or contained ODSs.





**Dr. Masaaki Yamabe,**  
**Asahi Glass**  
**(Award 1993)**

Dr. Masaaki Yamabe of Asahi Glass was a member of EPA's first ODS chemical substitution team, is the inventor of HCFC-225—which is used in critical precision cleaning—and is an original member of the UNEP Solvents, Coatings, and Adhesive TOC. He was very active in promoting the elimination of CFCs and has taken technical leadership to develop and commercialize HCFC-225, which was the first drop-in replacement for CFC-113 in the world. Dr. Yamabe significantly contributed to the phaseout of ODSs in developing countries through many presentations on technical alternatives to CFCs.

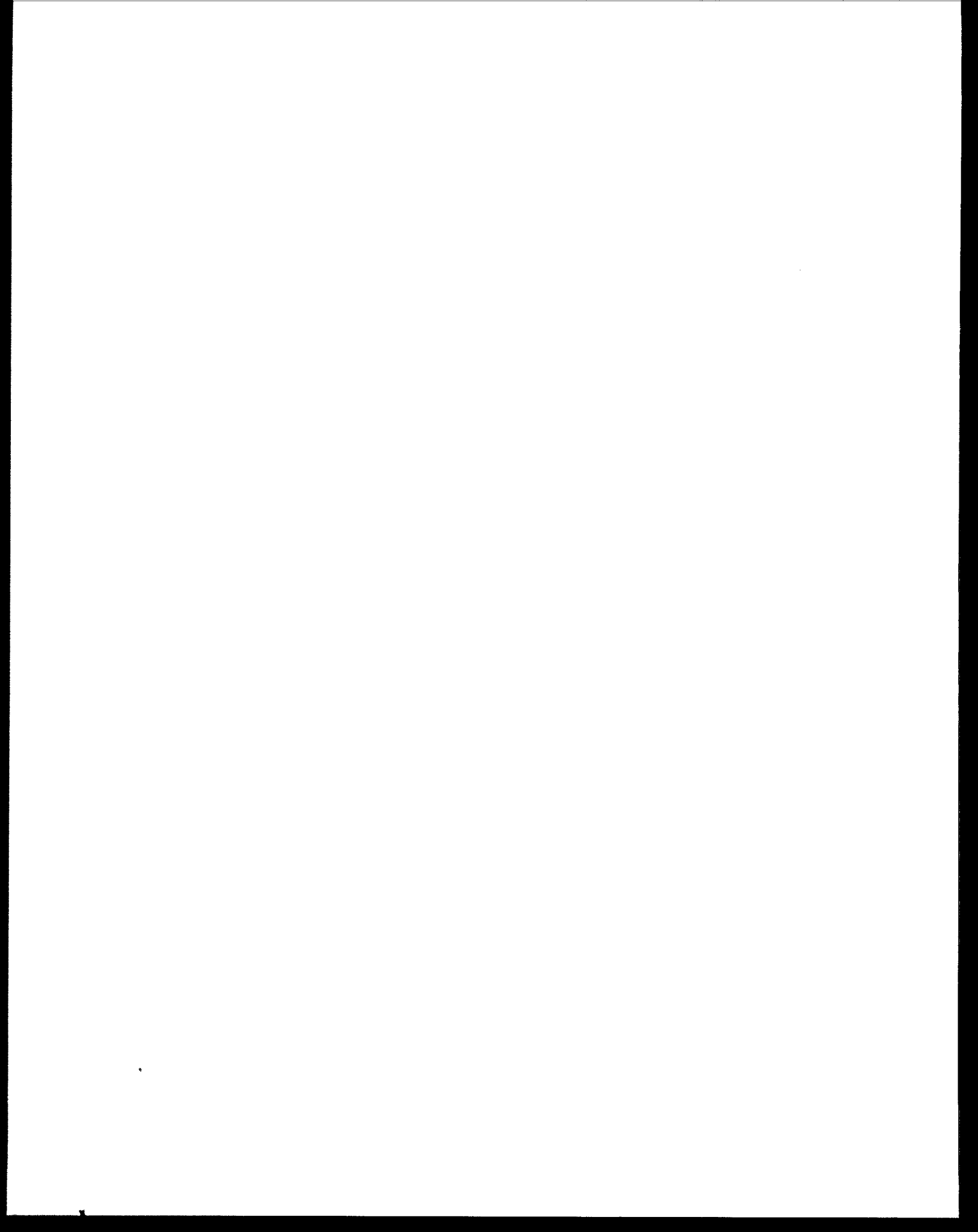
**Yuji Yamazaki**  
**(Award 1996)**

Yuji Yamazaki is the executive in charge of environmental affairs at Seiko Epson concerning ODS elimination. He has led a successful effort to develop vacuum cleaning and drying technology for precision metal parts. The simplicity and versatility of this technology makes it an effective substitute for ODS-based systems in small- and medium-sized precision parts manufacturing companies in developing countries. He also contributed to an early phaseout of ODSs in developing countries by holding technical seminars in Hong Kong, China, and countries of Southeast Asia.

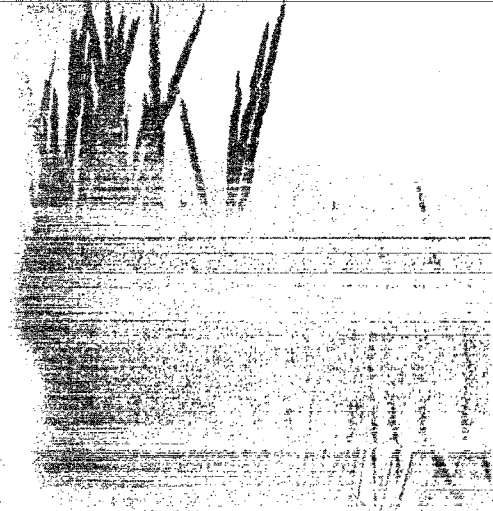
**Hideaki Yasukawa,**  
**Seiko Epson, Japan**  
**(Award 1994)**

Hideaki Yasukawa, Seiko Epson, Japan, successfully contributed to Seiko Epson's efforts to completely eliminate the use of CFCs and methyl chloroform in production processes, and led Seiko Epson's sharing of technical experience with private companies and governments worldwide. Under his leadership, Seiko Epson issued texts on alternative technologies and processes, organized technical seminars on ODS-free cleaning and drying technologies for small- and medium-sized suppliers, and established the Cleaning Center, an economical ODS-free cleaning facility open to suppliers.





# Other Champion Award Winners



## Aerosol Products, Sterilants, and Miscellaneous Uses Champion Award Winners

**CFC Destruction Plasma Project, Clean Japan Center**  
(Award 1995)

**CFC Destruction Plasma Project, Clean Japan Center**, developed a technique to destroy CFCs using plasma, which results in a destruction efficiency of more than 99.99 percent. The plant has destroyed more than 10 tons of waste CFCs and is scheduled to destroy an additional 50 tons of waste CFC-11, CFC-12, R-502, and HCFC-22.

**Charles Hancock, MDT**  
(Award 1994)

**Charles Hancock, MDT**, contributed directly to the technical assessment process of the UNEP TOCs and has participated in providing support to many countries concerning non-CFC sterilization alternatives. He helped his company to convert ethylene oxide sterilization equipment that utilized CFCs to a process that uses carbon dioxide.

**Geno Nardini, Instituto Mexicano del Aerosol**  
(Award 1992)

**Geno Nardini, Instituto Mexicano del Aerosol**, led the elimination of CFCs from aerosol products in Mexico and become a consultant to aerosol product phaseout worldwide. He is a member of the **Aerosol Products, Miscellaneous Uses, Sterilants, and Carbon Tetrachloride TOC**.

**Richard Nusbaum, Pennsylvania Engineering**  
(Award 1991)

**Richard Nusbaum, Pennsylvania Engineering**, developed an HCFC alternative blend to replace CFCs in sterilization of medical devices.

**Jose Pons Pons, Spray Quimica**  
(Award 1995)

**Jose Pons Pons, Spray Quimica**, has served as co-chair of the **UNEP Aerosols, Sterilants, and Miscellaneous Uses TOC** since 1989 and has been a member of the **UNEP TEAP** since 1991. His aerosol company, **Spray Quimica**, was one of the first companies to phase out ODSs anywhere.

**Tsuyoshi Takaichi, Showa Denko**  
(Award 1996)

**Tsuyoshi Takaichi, Showa Denko**, developed alternative fluorocarbons and educational activities to phase out CFCs in Japan. Mr. Takaichi played a major role in the development of CFC alternatives at **Showa Denko**. In 1988, he established the first technology for mass production of HFC-134a. Since 1985, Mr. Takaichi has chaired the **Japan Fluorocarbon Manufacturers Association**, participated in regional and international conferences, and worked on technology transfer projects with developing countries such as Thailand and Indonesia. He also made valuable contributions to projects such as the "CFC Destruction r.f. Plasma Project" and the "Used Refrigerants Reclamation Project."



**3M Pharmaceuticals**  
(Award 1996)

3M Pharmaceuticals, over 10 years, with an international team of more than 100 people, developed the world's first CFC-free MDIs for the relief of asthma symptoms. MDIs are aerosol delivery systems that release a precisely measured dose of medication to the lungs to treat conditions such as asthma and chronic obstructive pulmonary disease. The new technology included advances in the use of cosolvents and surfactants and improvements in the metering valve, seals, and actuator. These improvements help provide consistent dose delivery after prolonged storage, reliable dose delivery down to the last doses of the inhaler, and reliable dose delivery at very low temperatures. In March 1995, the United Kingdom approved 3M's product. It has since been approved by over 36 countries and the U.S. FDA. Components of the new technology, such as valves and canisters, are available to other companies reformulating their own products.

**Kjell Wetterlin (Astra)**  
(Award 1991)

Kjell Wetterlin (Astra) invented a dry-powder inhaler to replace some uses of CFC MDIs for treatment of respiratory and heart disease.

## Association Champion Award Winners

**AFCAM**  
(Award 1996)

AFCAM since 1989 has promoted ozone protection, worked closely with the Australian government to formulate effective ozone protection regulations, and assisted associations such as the Australian Supermarket Institute to phase out CFCs some five years earlier than anticipated at considerable less cost. It also implemented Australia's national refrigerant reprocessing and destruction scheme, which was awarded the Stratospheric Ozone Protection Award in 1995.

**Alliance for Responsible CFC Policy**  
(Award 1990)

The Alliance for Responsible CFC Policy (now the Alliance for Responsible Atmospheric Policy), under the leadership of Kevin Fay (Award 1993) and David Stirpe, represented industry stakeholders on international and U.S. ozone protection policy. Since its founding in 1980, Alliance participants have coordinated industry positions and worked toward establishing feasible and responsible policy to protect stratospheric ozone.

**CANACINTRA**  
(Award 1992)

CANACINTRA formed partnership with the Mexican government, Nortel/Northern Telecom (Award 1991), ICOLP/ICEL (Awards 1991 and 1993), and EPA to eliminate CFC and methyl chloroform solvents by 2000.

**Kevin Fay, Alliance for Responsible CFC Policy**  
(Award 1993)

Kevin Fay, Alliance for Responsible CFC Policy (Award 1993), directed the Alliance and coordinated industry positions for the establishment of feasible and responsible policies for ozone protection.

**Industrial Technology Research Institute (ITRI), Taiwan**  
(Award 1995)

Industrial Technology Research Institute (ITRI), Taiwan, promoted awareness in industry regarding the reduction and recovery of ODSs through new alternative technologies. ITRI assisted the Government of Taiwan in drafting policies and regulations for converting to non-ODS alternatives, resulting in an ODS consumption reduction from 10,000 metric tons in 1986 to 2,500 metric tons in 1994.



Secretaria de Desarrollo  
Urbano y Ecologia  
(Award 1991)

Secretaria de Desarrollo Urbano y Ecologia organized Mexican industry with the assistance of Nortel/Northern Telecom to speed phaseout in Mexico. The unprecedented partnership combined government and corporate leadership with technical cooperation.

## Diplomatic and Regulatory Champion Award Winners

G. Victor Buxton,  
Environment Canada  
(Award 1996)

G. Victor Buxton, Environment Canada, has worked to protect the ozone layer since 1983 when he was a key negotiator and advocate for strict ODS controls. He was an architect of the 1985 Vienna Convention and 1987 Montreal Protocol, a confident and strategic advisor to Dr. Mostafa Tolba (Award 1993), and responsible for organization of the Diplomatic conference in 1987 at which the Protocol was signed. As Canada's chief negotiator at the Protocol negotiations in 1987, he helped move the global community to definitive commitments to phase out ODSs. He helped organize the "Toronto Group" of like-minded nations, which evolved into the "Friends of the Protocol." Mr. Buxton served as Canada's representative at innumerable meetings and developed key concepts that greatly influenced the approach of the Protocol. He actively promoted NGO and industry participation in the Protocol and instigated FOE Canada's and Northern Telecom's early interest. Mr. Buxton also helped organize the technical assessments and served as co-chair of the 1989 Technical Assessment Panel. He also chaired the Open-Ended Working Groups that led to the Meeting of the Parties in London, assisted Dr. Tolba (Award 1993) in the creation of the Executive Committee for the Multilateral Fund, and represented Canada on this committee. He was instrumental in persuading many Canadian companies to become proactive.

Dr. Suely Maria  
Carvalho, Sao Paulo  
Environmental Agency  
Companhia de  
Tecnologia  
(Award 1996)

Dr. Suely Maria Carvalho, Sao Paulo Environmental Agency Companhia de Tecnologia, in 1988 organized the first technical group to investigate alternatives to ODSs in Brazil. Dr. Carvalho helped to establish multilateral funds through her work with industry, established networks for technological cooperation, and serves as co-chair of the UNEP TEAP, a consultant to UNEP's Industry and Environment Office, and an advisor to numerous international organizations.

The Charles County  
Board of Education  
(Award 1993)

The Charles County Board of Education, Maryland, converted school A/C to CFC-free alternatives.

Eileen Claussen, the U.S.  
Department of State  
(Award 1993)

Eileen Claussen of the U.S. Department of State took over EPA's Stratosphere Protector Team at a critical time and carved it into a global leader in policy analysis, diplomatic leadership, and industry cooperation. She achieved highest government honors and was rapidly promoted to manage EPA global air quality issues and environmental policy at the National Security Council, and then to Assistant Secretary of State for Population, Oceans, and Environment.



Dr. Stephen DeCanio,  
Economics Department,  
University of California  
(Award 1996)

Dr. Stephen DeCanio, Economics Department, University of California, as a Senior Staff Economist at the Council of Economic Advisors in 1986-87, helped gain White House support for the Montreal Protocol. He has served as an advisor to EPA on ozone protection and has been a member of the UNEP Economic Options Committee of the TEAP. Dr. DeCanio's academic research and publications on environmental economics and organizational decision-making have contributed to the design of ozone protection policies worldwide.

DuPont  
(Award 1990)

DuPont by 1986 under the leadership of managers Dr. Joseph P. Glas and Dr. Joseph M. Steed, with DuPont atmospheric scientist Dr. Mack McFarland, realized that CFC emissions were growing despite the sharp reduction caused by the U.S. CFC aerosol ban. In addition, they realized that this growth would lead to eventual stratospheric ozone loss. DuPont called on its customers and coproducers to support rational global CFC regulation. Such support solidified U.S. industry behind the 1987 Montreal Protocol. DuPont was the first ODS manufacturer to announce a goal of a complete phaseout of CFC production for sale.

Victor Gatt, Malta  
Department of Industry  
(Award 1994)

Victor Gatt, Malta Department of Industry, was a leading force behind Malta's efforts to control the use of ODSs. He carried out research in 1988 that led to Malta's ratification of the Vienna Convention and the Montreal Protocol. As deputy chairman of the Malta Board of Standards, he successfully banned the use of CFCs in aerosols in 1990, leading to a 67 percent reduction in CFC consumption.

John Hathaway  
(Award 1994)

John Hathaway recognized that public misunderstanding about ozone depletion was impeding efforts to phase out CFC-based refrigerants in Arizona. In response, he spearheaded a public information initiative on refrigerant management, stationary equipment, and automobile servicing. He also worked behind the scenes to address the matter of flammable refrigerants for automobiles in the face of specific complaints to his agency director. His actions are all the more notable considering that A/C is such a contentious issue in Arizona that the state passed a controversial law contravening the Clean Air Act. He also established and managed the state's "Methyl Bromide Replacement Strategies" project, in cooperation with Sonora, Mexico, to mitigate the impact of methyl bromide phaseout on agricultural trade.

"It was very difficult to develop a new chemical sterilant blend to fight infection in health care facilities that would also be safe for the ozone layer. After seven years of hard work our new product was finally commercialized. This was four years after we received the coveted Ozone Protection Award. Through the many obstacles on the way, the EPA—under Stephen Andersen's guidance—supported and encouraged our efforts. They would have never succeeded without their assistance. We are grateful for receiving the award and are glad we were able to help protect the stratospheric ozone layer."

Dick Nusbaum (Award 1991)  
President  
Pennsylvania Engineering Company



Andrea Hinwood,  
Environmental  
Protection Authority,  
Victoria, Australia  
(Award 1993)

Andrea Hinwood, Environmental Protection Authority, Victoria, Australia, developed Victoria's strategy on ozone protection in 1989, which was largely used as a basis for Australia's national Ozone Phase Out Program. She chaired the UNEP Aerosol Products, Sterilants, and Miscellaneous Uses, and Carbon Tetrachloride TOC and served as a member of the UNEP TEAP from 1990 to 1994. During that time she managed the assessment of some of the most complicated technical topics including medical and sterilization uses. She has spoken at UNEP meetings in Bangkok, Caracas, and Washington—communicating the message that the aerosol products, sterilants, and miscellaneous use sectors can stop using CFCs worldwide.

John Hoffman, EPA  
(Award 1994)

John Hoffman, EPA, was instrumental in developing EPA's policy concerning protection of the ozone layer and began the process that eventually led to the negotiation of the Montreal Protocol. He was an architect of the ozone depletion risk assessment, as well as defendant of the critical EPA role in a strong initial Montreal Protocol. Without his exceptional efforts in building a strong foundation for action, the progress made to date would have been impossible.

Nancy Ketcham-Colwill,  
EPA Office of General  
Counsel (Award 1993)

Nancy Ketcham-Colwill, EPA Office of General Counsel, designed flexible implementation of the Montreal Protocol and Clean Air Act to assure protection of the ozone layer but also to allow voluntary approaches.

Steve Lee-Bapty, UK  
Department of the  
Environment  
(Award 1993)

Steve Lee-Bapty, UK Department of the Environment, was co-chair of the UNEP TEAP, served as the U.K. representative at important meetings on ozone layer protection, and chaired the Open-Ended Working Group of the Montreal Protocol.

Eduardo Lopez,  
Fondoin, Venezuela  
(Award 1994)

Eduardo Lopez, Fondoin, Venezuela, actively participated in the process that led to the approval of the London Amendments by the Venezuelan government and the establishment, operation, and consolidation of the Multilateral Fund. He was also an active member of the Multilateral Fund's executive committee, making contributions to the definition of rules and procedures that are used to operate the Fund. He has played an active role in implementing programs in Venezuela and other Article 5(1) programs, particularly in helping to create institutional frameworks for implementing the Montreal Protocol.

P. Trish MacQuarrie,  
Environment Canada-  
Global Air Issues Branch  
(Award 1996)

P. Trish MacQuarrie, Environment Canada-Global Air Issues Branch, organized and chaired the meetings of the UNEP Work Group on Laboratory Uses in 1994 and 1995. The group's report has promoted the awareness of alternatives for analytical techniques that still rely on controlled ODS. In 1995, she was an active member of the UNEP Process Agents Work Group.



**Alan Miller**  
(Award 1992)

Alan Miller, while working for the NRDC in the 1980s, brought the legal suit that ultimately compelled EPA to develop a plan to protect the ozone layer. He was also instrumental in the first voluntary efforts to speed commercialization of alternatives and substitutes to ODSs including the world's first voluntary national CFC phase-out by U.S. foodservice packaging companies in 1988 and the projects to change military specifications to allow and encourage the use of alternatives to CFC solvents used in electronic manufacture. Alan Miller was also a pioneer in advocating the alternatives to ODSs be complementary to anticipated efforts to protect the climate.

**Ministry of Sciences,  
Technology, and the  
Environment, Malaysia**  
(Award 1996)

Ministry of Sciences, Technology, and the Environment, Malaysia, was elected to be vice president of Conference of Parties to the Parties of the Montreal Protocol in 1992 and 1995, was proactive in the executive committee of the Multilateral Fund from 1991 to 1994, was appointed a chairman of EXCOM in 1994 and as one of the experts in the UNEP/IEPAC Advisory Committee, and provided personnel resources to support the UNEP/IEPAC ODS Network in Asia Pacific. In addition, the Government of Malaysia has participated in and was appointed as member of several UNEP TOCs, and is a successful Article 5(1) country in the implementation of the Montreal Protocol.

**National  
Chlorofluorocarbons  
Enforcement Initiative,  
Operation Cool Breeze  
Enforcement Team**  
(Award 1996)

National Chlorofluorocarbons Enforcement Initiative, Operation Cool Breeze Enforcement Team, led by District Attorney Tom Watts-FitzGerald, is composed of criminal investigators from the U.S. Customs Service, EPA, Internal Revenue Service, and the Department of Justice and the U.S. Attorney's Office in Miami. Since October 1993, it has conducted a comprehensive enforcement effort to stem illegal trafficking of CFCs. The team has intercepted over 455 metric tonnes of ODSs and has been responsible for 13 felony convictions. The team trains agents throughout the country to help suppress the ODS black market.

**The Nikkan Kogyo  
Shimbun, LTD**  
(Award 1996)

The Nikkan Kogyo Shimbun, LTD, continues to provide information on the trends and challenges concerning the protection of the stratospheric ozone layer. It has currently launched a two-year publishing and information campaign to encourage the phaseout of methyl chloroform. This program includes a series of 24 timely and comprehensive two-page spreads to be run for a period of two years, which will cover such issues as the importance of measures to protect the ozone layer and international activities on stratospheric ozone depletion.

**Sergio Oxman, KIEN  
Consultants**  
(Award 1993)

Sergio Oxman, KIEN Consultants, is a Chilean economic consultant and representative of his country at the Meetings of the Parties of the Protocol. His individual leadership in global economy and technology cooperation supported the Latin American countries in completing their countries programs (baseline studies) and assisting with their institutional strengthening plans in Bolivia, Chile, Costa Rica, Cuba, Dominican Republic, Guatemala, Panama, and Uruguay. He also provided support for the implementation of programs in Argentina and Mexico with the implementing agencies of UNEP, United Nations Development Programme (UDEP), and the World Bank. He is a member of the UNEP Economics Options Committee and the UNEP Methyl Bromide TOC.





**K. Madhava Sarma, UNEP**  
(Award 1996)

K. Madhava Sarma, UNEP, has been the head of the UNEP Secretariat for the Vienna Convention and Montreal Protocol since 1991, provided counsel to the UNEP TEAP, and facilitated contact and meaningful interaction with various international groups vital to the efforts to reduce ODS use. He has made UNEP's programs more effective and managed the participation of over 162 countries, including more than 110 developing countries as parties. From 1986 to 1991 he served in the Ministry of Environment and Forests, Government of India, dealing with global environmental issues. At that time, many developing countries realized that protection of the ozone layer could only succeed if all countries phased out their consumption of ODSs; however, they felt that the problem of ozone depletion had been caused by the high consumption of industrialized countries, and many developing countries considered the Protocol of 1987 inadequate, particularly with respect to the provisions for technology transfer and financial assistance. In 1989 and 1990 Mr. Sarma worked to amend the Protocol at London to include the concept of a Multilateral Fund with management by an executive committee with balanced developed and developing country members.

**Stephen Seidel, Council for Environmental Quality**  
(Award 1996)

Stephen Seidel, Council for Environmental Quality, has visualized the strategy for global protection of the ozone layer, extracted relevant scientific findings that have influenced public policy, empowered regulatory staff, encouraged innovative approaches to industry cooperation, defended the Stratospheric Protection Division against political intervention, and created an environment where seemingly impossible tasks were accomplished. As a global negotiator, he cultivated science-based approaches to regulatory solutions, performance-based global ODS phaseout with national regulatory autonomy, trade provisions in environmental treaties, and financing the technology cooperation.

**Steven Shimberg, Staff Director and Chief Counsel, U.S. Senate Committee on Environment and Public Works**  
(Award 1994)

Steven Shimberg, Staff Director and Chief Counsel, U.S. Senate Committee on Environment and Public Works, played a critical role in shaping congressional support for both the Montreal Protocol and the 1990 Amendments to the Clean Air Act on ozone layer protection. He participated as part of the U.S. delegation in the negotiations leading up to the original Protocol, providing valuable insights and guidance throughout this early and difficult period. He helped to galvanize congressional support for the strongest possible agreements and helped push for a comprehensive approach to protecting the ozone layer within the United States to ensure that adequate measures would be taken to protect this vital resource.

**Dennis Tober, Florida Department of Environmental Regulation**  
(Award 1991)

Dennis Tober, Florida Department of Environmental Regulation, developed innovative state regulatory, voluntary, and leadership approaches to ozone layer protection.

**Dr. Mostafa Tolba, International Centre for Environment and Development, Cairo**  
(Award 1993)

Dr. Mostafa Tolba, International Centre for Environment and Development, Cairo, as the second executive director of UNEP, provided leadership, strong personality, inspiration, negotiation strategy, and diplomacy that was essential to the acceptance of the Vienna Convention and Montreal Protocol. Dr. Tolba received his Ph.D. in plant pathology from Imperial College, London University. From 1949 until 1971 he held various positions including professor of Botany and Microbiology, Secretary General of the Supreme Science Council of Egypt, Cultural Counselor and Director of the Egyptian Education Bureau,



Undersecretary of State for Higher Education of Egypt, Minister of Youth, and President of the Egyptian Academy of Scientific Research and Technology. In 1972 he led the Egyptian delegation to the **Stockholm Conference on the Human Environment**, which led to the establishment of UNEP in 1973. From 1976 until 1992 he was the executive director of UNEP with the rank of Undersecretary General of the United Nations. He was elected by the **United Nations General Assembly** for four consecutive four-year terms. After the Protocol was approved in 1987, Dr. Tolba continued to work tirelessly on every aspect of its operation including the assessments, solicitation of new signatories, management of trade controls and data reporting, and all aspects of implementation. He was particularly involved in translating the scientific and technical findings into policy options suitable for decision. His "informal meetings" brought together key experts and influential negotiators to find areas of agreement and to craft approaches that satisfied every perspective. As the executive director of UNEP, Dr. Tolba was also successful in international treaties for the trans-shipment of hazardous waste, the trade in endangered species, and biodiversity.cvgAlmost everyone agrees that without Dr. Mostafa Tolba, stratospheric ozone protection would have begun years later, and may possibly have been too late.

**F. A. (Tony) Vogelsberg,**  
DuPont  
(Award 1993)

F. A. (Tony) Vogelsberg, DuPont, acted as a global CFC phaseout ambassador, conducting meetings worldwide with customers, foreign governments, and industry groups. He has served several years as management committee chairman of the **Program on Alternative Fluorocarbon Testing and AFEAS**, a \$37 million voluntary industry effort. Mr. Vogelsberg is particularly skilled at mastering and communicating science findings to business, government, and public stakeholders.

**George H. White II,**  
U.S. Customs Service,  
Department of the  
Treasury  
(Award 1995)

George H. White II, U.S. Customs Service, Department of the Treasury, made an extraordinary effort as a Special Agent with the U.S. Customs Service and has carried out investigations leading to five convictions against ODS smugglers. As a result of his efforts and these convictions, more than 455 metric tonnes of illegal ODSs have been confiscated. By 1996 nine people had been arrested and eight convicted. He also serves as the primary contact at U.S. Customs for ODS smuggling cases, helping other investigators around the country. Agent White helped form the "**Operation Cool Breeze**" **Enforcement Team** (Award 1996) with members from the U.S. Office of the Assistant U.S. Attorney, Customs Service, EPA Office of Investigations, Internal Revenue Service Criminal Investigation Division, and Customs Inspectors from the Miami River Enforcement Team and the Trade Enforcement Teams at the ports of Miami and Everglades.



## Methyl Bromide Champion Award Winners

Dr. Jonathan Banks,  
Commonwealth  
Scientific and Industrial  
Research Organization  
(Award 1996)

Dr. Jonathan Banks, Commonwealth Scientific and Industrial Research Organization (CSIRO) Division of Entomology, as the chairman of the Methyl Bromide TOC of the UNEP TEAP, put together the inaugural Methyl Bromide TOC and guided over 60 members in their efforts to compile data on the alternatives to methyl bromide. Under his leadership, this diverse committee produced the UNEP Methyl Bromide TOC 1995 report, a remarkable consensus document detailing the available or near-market alternatives to methyl bromide use. It was highly influential in the decisions by the parties to the Montreal Protocol in December 1995 to further control methyl bromide. The report is widely quoted and has improved awareness of methyl bromide-free ways to achieve production and storage of particular agricultural crops that currently depend on methyl bromide.

Lt. Commander Robert  
Gay, Defense Logistics  
Agency  
(Award 1995)

Lt. Commander Robert Gay, Defense Logistics Agency, developed an improved controlled atmosphere technique that can replace methyl bromide for transporting perishable commodities overseas. His technique reduces produce respiration, slows ethylene production, inhibits pathogen reproduction, and kills insects.

Dr. Melanie Miller,  
Consultant,  
New Zealand  
(Award 1996)

Dr. Melanie Miller, Consultant, New Zealand, has been a leader in identifying, documenting and demonstrating methyl bromide alternatives. She is a member of the UNEP Methyl Bromide TOC, and has published numerous case studies of national methyl bromide use and alternatives. Her dedication to this cause is commendable.

David Mueller,  
Fumigation Service and  
Supply  
(Award 1995)

David Mueller, Fumigation Service and Supply, has educated the pest control community about potential alternatives to methyl bromide pesticide use and hosted workshops to explain the advantages and necessary caution in combining phosphine, heat, and carbon dioxide as part of an integrated pest control strategy. He also published the newsletter "Fumigation & Pheromones" to keep clients abreast of technical developments. He first experimented with alternatives to methyl bromide in June 1992 and by 1995 had reduced methyl bromide to less than 60 percent of treatments.

Yasuomi Tanaka,  
Weyerhaeuser  
Timberlands Nursery  
Team  
(Award 1995)

Yasuomi Tanaka, Weyerhaeuser Timberlands Nursery Team, led efforts at Weyerhaeuser to formulate a strategy to identify potential alternatives to the use of methyl bromide. His efforts led to the selection of several alternative chemicals including Basamid, Telone, chloropicrin, and Metham Sodium as a partial replacement for methyl bromide in the short term. Soil pasteurization and solarization, cultural technologies, and biocontrol are being evaluated as potential long-term replacements.



**Dr. Joop van Haasteren,**  
the Netherlands  
Ministry of Housing,  
Planning, and the  
Environment  
(Award 1995)

Dr. Joop van Haasteren, the Netherlands Ministry of Housing, Planning, and the Environment, was instrumental in providing substantial technical materials on the Netherlands' successful phaseout of methyl bromide use in all but quarantine applications. In 1980 the Netherlands was one of Europe's largest users of methyl bromide, but during the decade between 1981 and 1991 Dr. Joop van Haasteren initiated and coordinated the complete elimination of methyl bromide in soil fumigation. When the UNEP TEAP began investigating alternatives to methyl bromide, Dr. van Haasteren and the Netherlands Ministry of Environment were instrumental in providing the specific verification of the technical and economic feasibility. He is a key member of the UNEP Methyl Bromide TOC.

## Scientific and Medical Uses Champion Award Winners

**Dr. Daniel Albritton,**  
NOAA, Aeronomy  
Laboratory  
(Award 1994)

Dr. Daniel Albritton, NOAA, Aeronomy Laboratory, and Dr. Robert Watson (Award 1994) have co-chaired the Montreal Protocol's Scientific Assessment Panel since 1988. These reports present the state of knowledge of atmospheric ozone and have provided a sound scientific basis for policy decisions. Both the integrity of the process he created and the worldwide acceptance of the assessment documents have been a fundamental driving force in the success of the Montreal Protocol. In addition to leadership in the assessment process, he effectively directed scientific research efforts toward improved understanding in key areas of uncertainty—from efforts to understand the causes of the Antarctic ozone hole, to the work of the ozone trends panel, to improvements in our understanding of the role of heterogeneous chemistry.

**Dr. John Grupenhoff,**  
National Association of  
Physicians for the  
Environment  
(Award 1995)

Dr. John Grupenhoff, as the executive vice president for the National Association of Physicians for the Environment, gathered support within the medical and environmental communities for the UV Index program. Through the networks this organization provides, EPA has been able to spread its message about sun protection through the health care community. He organized a coalition of nearly 30 national health care organizations in support of the UV Index and also proposed a resolution to the American Medical Association, which passed unanimously in support of the UV Index.

**Alvin Miller, National  
Weather Service  
(Award 1994)**

Alvin Miller, National Weather Service, provided the primary technical direction for the National Weather Service's Experimental UV Index program. He directs the overall collection of UV information from 58 U.S. cities daily and issues daily UV Index numbers to radio, television, and newspapers in each city.

**Dr. A.R. Ravishankara,**  
NOAA, Aeronomy  
Laboratory  
(Award 1995)

Dr. A.R. Ravishankara, NOAA, Aeronomy Laboratory, contributed both to the understanding and the solution of the problem of stratospheric ozone depletion. His research has influenced industry's development of viable replacement compounds by identifying those proposed alternatives that are "ozone-friendly" and by determining their effects on the Earth's climate.



Dr. F. Sherwood Rowland, University of California, Irvine  
(Award 1993)

Dr. F. Sherwood Rowland, University of California, Irvine, in 1974 proposed, with Dr. Mario Molina, the theory that CFCs deplete the ozone layer. He was a persistent developer of atmospheric models, inventive collector of data, and strong advocate of ozone layer protection.

Dr. Susan Solomon, NOAA, Aeronomy Laboratory  
(Award 1996)

Dr. Susan Solomon, NOAA, Aeronomy Laboratory, made major contributions to understanding ozone depletion and to the search for solutions. In 1985, she pointed out that polar stratospheric clouds could be the key to the special chemistry leading to the Antarctic ozone hole. She was then chosen by her international colleagues to be the leader of the pivotal National Ozone Expeditions including the first expedition to Antarctica in 1986, which provided experimental evidence for the chemistry of polar stratospheric clouds. She also provided improved scientific understanding of the meaning of ODPs and has been a leader in quantifying the ozone-depleting and climate-relevant roles of an array of substitute gases. In major field campaigns, she and her colleagues gathered evidence that proved her polar stratospheric clouds theory to be correct.

Dr. Robert Watson, World Bank  
(Award 1994)

Dr. Robert Watson, World Bank, and Dr. Daniel L. Albritton have co-chaired the Montreal Protocol's Scientific Assessment Panel since the assessment process was initiated in 1988. These reports present the state-of-the-science of atmospheric ozone and have provided a strong basis for policy decisions. Both the integrity of the process he has created and the worldwide acceptance of the assessment documents have been a fundamental driving force in the success of the Montreal Protocol. In addition to leadership in the assessment process, he effectively directed scientific research efforts toward improved understanding in key areas of uncertainty, such as the causes of the Antarctic ozone hole, the ozone trends panel, and the role of heterogeneous chemistry.

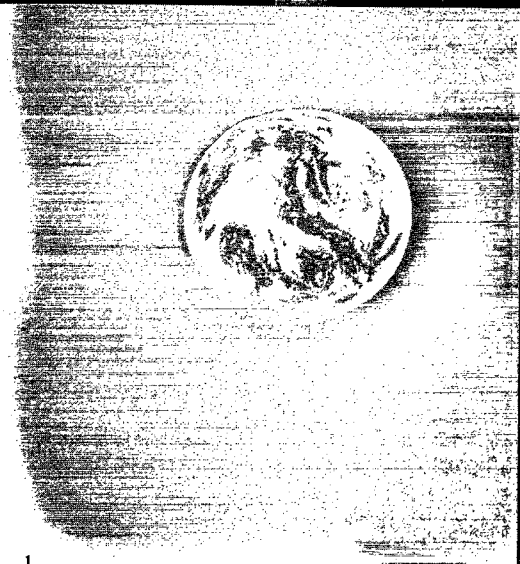
Dr. Peyton Weary, University of Virginia, Department of Dermatology  
(Award 1995)

Dr. Peyton Weary, University of Virginia, Department of Dermatology, was instrumental as the president of the American Academy of Dermatology in convincing many other medical organizations to support the UV Index. Additionally, he organized the Melanoma/Skin Cancer Screening Program in Virginia in the 1960s, which, supported by the Academy, has since been expanded nationwide.





# Conclusion: A Look at Tomorrow



**I**n working together to save the world's ozone layer, industry, government, and NGOs proved that necessity brings about innovative solutions. Through dedication, sacrifice, hard work, and compromise, these winners have succeeded in eliminating the need for most ODSs.

Following the success of the phaseout of ODSs in developed countries, it would be easy simply to congratulate the past winners and to stop at that point. But the lines of communication opened by all of these champions are too valuable to lose—and must be maintained to solve future environmental problems.

As efforts to eliminate ODSs have shown, solutions must be acceptable to all interests in order to succeed. Industrial leaders must cooperate among themselves and with governments and NGOs to find such solutions. This process has proven itself in the fight to save the ozone layer, and it will continue to demonstrate successes in the future.

Congratulations, winners—the champions of the stratospheric ozone success story. Thank you for clearing the way for even more cooperation and problem-solving as the turn of the century approaches and new challenges appear.

"EPA's voluntary 'Green Lights' and 'Energy Star' programs have their roots in the pioneering cooperative work with industry started by Dr. Stephen O. Andersen. Business and government worked together to find profitable ways to protect the environment. The opportunities are there but we all need each other to get the job done."

*John Hoffman (Award 1994)  
Director, Atmospheric Pollution Prevention Division, EPA*



"Seiko Epson's campaign to protect the stratospheric ozone layer showed us just how important it is to set the highest possible targets and charge ahead toward those targets as a team. We found that top management's strong commitment is very important to make a project successful. If you attract different types of people to a project who all share the same determination to make things happen, you can generate new ideas that under normal circumstances would never come out.

"We think the kind of global technical cooperation experienced during the ozone layer protection movement can serve as a valuable model for climate change activities in the future.

"Our ODS elimination campaign has emphasized solutions to global issues through cooperation rather than competition. We therefore chose to share our experience and technology as widely as possible and to open the technologies we have developed to the public.

"We plan to use this experience in future environmental activities to address the various problems that confront us."

*Kaichi Hasegawa (Award 1996)*  
*Seiko Epson*





# APPENDIX A

## Stratospheric Ozone Protection Award Winners, 1990-1996

### 1990

#### *Corporate Awards*

Digital Equipment Corporation  
Dolco Packaging  
DuPont Company

#### *Association Awards*

National Fire Protection Association  
Foodservice & Packaging Institute  
The Institute for Interconnecting and Packaging  
Electronic Circuits  
The Alliance for Responsible CFC Policy  
Mobile Air-Conditioning Society

#### *Laboratory Award*

Underwriters Laboratories

#### *Individual Awards*

Ward Atkinson, Sun Test Engineering\*  
James A. Baker, General Motors\*  
Jay Baker, Ford Electronics\*  
David Bergman, IPC  
James R. Beyreis, Underwriters Laboratories  
David Chittick, AT&T  
Joe Felty, Texas Instruments\*  
Art FitzGerald, Nortel/Northern Telecom\*  
Donald Grob, Underwriters Laboratories  
Leslie Guth, AT&T\*  
Kathi Johnson, China Lake Navy Weapons Center  
Electronics Manufacturing Productivity Facility  
Dr. William Kenyon, Global Centre for Process Change\*  
Dr. Margaret Kerr, Nortel/Northern Telecom  
Simon Oulouhojian, MACS\*  
Robin Sellers, Naval Avionics Center  
Gary Taylor, Taylor/Wagner\*

\*Member UNEP TEAP or its TOCs, Working Groups, or Task Forces.

\*\*Member of UNEP Science Assessment Panel.



# 1991

## *Corporate Awards*

Hitachi

Motorola

Nissan Motor Company

Nortel/Northern Telecom

TEAM Aer Lingus

3M

## *Association Awards*

Air-Conditioning and Refrigeration Institute

The Industry Cooperative for Ozone Layer Protection

The Japan Electrical Manufacturers' Association

Secretaria de Desarrollo Urbano y Ecologia

## *Individual Awards*

Elizabeth Cook, Friends of the Earth\*

Jorge Corona, Camara Nacional de la Industria  
de la Transformacion\*

Thomas E. Daum, U.S. Defense Reutilization  
& Marketing Service

David Doniger, Natural Resources Defense Council\*

William Kopko, York International\*

Colin Lea, U.K. National Physical Laboratory

Major E. Thomas Morehouse, Jr., U.S. Air Force\*

Richard Nusbaum, Pennsylvania Engineering\*

Robert C. Pfahl, Motorola

Dr. Richard Stolarski, NASA Goddard Space Flight Center\*\*

Dennis Tober, Florida Department of Environmental  
Regulation

Kjell Wetterlin, Astra II-Draco



## *Corporate Awards*

AT&T

The Boeing Company

British Aerospace Airbus

Chrysler Corporation

Ford Motor

General Dynamics

Space Systems Division

Fort Worth Division

IBM

Endicott, New York

Rochester, Minnesota

ICI Chemicals and Polymers

McQuay International

Mercedes-Benz

Naval Air Warfare Center Aircraft Division Lakehurst

RECTICEL International

Seiko Epson

The Trane Company

York International

## *Association Awards*

Camara Nacional de la Industria de la Transformacion

Halon Alternative Research Corporation

Halon Essential Use Panel—EPA, Victoria, Australia

The Swedish Institute of Production Engineering

Research (IVF)

Royal Norwegian Navy Materiel Command

U.S. Army Acquisition Pollution Prevention  
Support Office

## *Individual Awards*

Bryan H. Baxter, British Aerospace\*

Philip J. DiNenno, Hughes Associates\*

Stephen Peter Evanoff III, General Dynamics\*

Yoshiyuki Ishii, Hitachi\*

Colin Lewis, U.K. Ministry of Defence

Milton Lubraico, Ford Motor\*

Shigeo Matsui, Toshiba\*

Alan S. Miller, Center for Global Change\*

Geno Nardini, Instituto Mexicano del Aerosol\*

Tony L. Phillips, General Dynamics

Dr. Laura J. Turbini, Georgia Institute of Technology

Henry J. Weltman, General Dynamics

\*Member UNEP TEAP or its TOCs, Working Groups, or Task Forces.

\*\*Member of UNEP Science Assessment Panel.



## *Corporate Awards*

AlliedSignal  
Boeing Commercial Airplane Group  
Cadbury  
Charles County Board of Education  
The Coca-Cola Company  
Compaq Computer  
Copeland  
Defense Electronics Supply Center  
Defense Logistics Agency  
Department of the Navy—U.S. Chief of Naval Operations  
GEC-Marconi, Hirst Research Centre  
General Services Administration  
Hill AFB  
Hughes Aircraft  
IBM—Austin, Texas  
Kelly AFB, Texas  
Lufthansa German Airlines  
Martin Marietta Astronautics  
Matsushita Electric Industrial  
Minebea Group Companies in Thailand and Japan  
Motorola—Malaysian Project  
National Refrigerants  
Naval Aviation Depot, Cherry Point  
Naval Aviation Depot, Norfolk  
New York State Energy Research and Development  
Authority—HFC Supermarket Refrigeration  
Demonstration Team  
Nippondenso  
Rockwell International/U.S. Army Air-To-Ground  
Missile Systems Project Office  
J. Sainsbury  
Shaw's Supermarkets

Texas Instruments, Missile Systems Division  
Thioko, Space Operations  
Union Carbide/EKCO Housewares/Nordson  
Unitor Ships Service  
U.S. Air Force, Air Base Fire Protection and  
Crash Rescue Systems Branch  
Volvo Cars of North America  
Woolworths Limited (Australia)

## *Association Awards*

Center for Emissions Control  
Heating, Refrigerating and Air- Conditioning Institute  
of Canada  
ICOLP/ICEL  
Japan Industrial Conference for Ozone Layer Protection  
Polyisocyanurate Insulation Manufacturers' Association

## *Individual Awards*

Robert Carter, Waste Reduction Resource Center  
for the Southeast  
Nicholas T. Castellucci, Northrop Grumman  
David V. Catchpole, BP Exploration (Alaska)\*  
Eileen Claussen, U.S. Department of State  
Timothy Crawford, EMPF  
Michael Earl Dillon, Dillon Consulting Engineers  
Carl Eckersley, Compaq Computer  
Carole K. Ellenberger, Texas Instruments  
Kevin Fay, The Alliance for Responsible CFC Policy\*  
John Fischer, Naval Air Warfare Center  
Yuichi Fujimoto, Japan Electrical Manufacturers'  
Association\*  
Dr. Michael Hayes, Petroferm



Andrea Hinwood, Environmental Protection Authority  
(Australia)\*

Arthur G. Hobbs, Jr., Four Seasons Division of  
Standard Motor Products

Dr. Mike Jeffs, ICI Polyurethanes\*

Nancy Ketcham-Colwill, EPA Office of General Counsel

Dr. Lambert Kuijpers, UNEP Technology  
and Economic Assessment Panel\*

Steve Lee-Bapty, UK Department of the Environment\*

Kenneth W. Manz, Robinair Division, SPX\*

Thomas J. Mathews, Hannaford Brothers

Yasuo Mitsugi, Seiko Epson

Tsuneya Nakamura, Seiko Epson

Sergio Oxman, KIEN Consultants, Chile\*

Cynthia Pruett, IBM Asia Pacific\*

F. Sherwood Rowland, University of California, Irvine\*\*

Terry Schaumberg, San Antonio Air Logistics Center

Angie Criser Schurig, Texas Instruments

Yoshihide Shibano, S&C

Dr. John R. Stemniski, The Charles Stark  
Draper Laboratory\*

Dr. Robert E. Tapscott, New Mexico Engineering  
Research Institute \*

Steven D. Taylor, BP Exploration (Alaska)

Dr. Mostafa Tolba, International Centre for  
Environment and Development, Cairo and Second  
Executive Director of UNEP

Gary D. Vest, Principal Assistant Deputy  
Undersecretary of Defense (Environmental Security)

Clare Vinton, National Center for Manufacturing Sciences

F.A. (Tony) Vogelsberg, DuPont\*

Carmen C. Waschek, The Coca-Cola Company

Udo G. Wenning, Bosch-Siemens

Dr. Masaaki Yamabe, Asahi Glass\*

\*Member UNEP TEAP or its TOCs, Working Groups, or Task Forces.  
\*\*Member of UNEP Science Assessment Panel.



## *Corporate Awards*

Aeronautical Systems Center, Wright Laboratory, Aircraft  
Halon Replacement Team, Wright-Patterson AFB

The Aerospace Guidance and Metrology Center, Newark  
AFB, Ohio

U.S. Army Communications-Electronics Command/  
Tobyhanna Depot

Asahi Glass

Carrier

Falcon Halon Team, Wright-Patterson AFB

Ford Motor

General Motors

Hewlett-Packard

Honeywell

Hussmann

ICI Polyurethanes

Lockheed

Martin Marietta

Mitsubishi Electric

Norsk Forsvarsteknologi

Northrop Grumman

Saab-Scania

Separation Technologists

Tecumseh Products

Toyota Motor

## *Association Awards*

Alternative Refrigerants Evaluation Program, ARI

National Association of Fire Equipment Distributors

## *Individual Awards*

Dr. Daniel Albritton, National Oceanographic and  
Atmospheric Administration \* \*\*

Dr. Walter Brunner, envico\*

Brian Ellis, Protonique\*

Lt. General James A. Fain, Jr., Aeronautical Systems  
Center, Wright-Patterson AFB

Mary Beth Fennell, Naval Aviation Depot, Cherry Point

Tetsuro Fukushima, Hitachi, Environmental Policy Office

Victor Gatt, Malta Department of Industry

Charles Hancock, MDT\*

John Hathaway, Arizona Department of  
Environmental Quality

John Hoffman, U.S. EPA\*

Robert Holcomb, Motorola

Joel Krinsky, U.S. Navy

Dr. Barbara Kucnerowicz-Polak, State Fire Service  
Headquarters, Poland\*

Eduardo Lopez, FONDOIN

Dr. Mohinder Malik, Deutsche Lufthansa\*

Marion McQuaide, U.K. Ministry of Defence\*

Alvin Miller, National Weather Service

Tsutomu Odagiri, Japan Industrial Conference for  
Ozone Layer Protection

Steven Rasmussen, Hill AFB

Dr. Wallace Rubin, Multicore

Franklin Sheppard, Jr., Office of the Chief of Naval  
Operations, U.S. Navy

Steven Shimberg, U.S. Senate Committee on  
Environment and Public Works

Ronald Sibley, Defense Logistics Agency\*

Jack Swindle, Texas Instruments

James Vincent, U.S. Army Aviation and Troop Command

Dr. Robert Watson, NASA\* \*\*

Hideaki Yasukawa, Seiko Epson



# 1995

## *Corporate Awards*

Aberdeen Test Center, U.S. Army  
Advanced Cruise Missile DSO, U.S. Air Force  
AGM-130 Systems Program Office, U.S. Air Force  
Annapolis Detachment, Carderock Division, Naval  
Surface Warfare Center, U.S. Navy  
Australian Department of Administrative Services  
Centre for Environmental Management  
Beverage-Air  
Defence Institute of Fire Research, India  
Dixie-Narco  
Electrical & Mechanical Services Department,  
Hong Kong Government  
Epson Hong Kong Group  
GEO-CENTERS  
H.B. Fuller  
Low-Residue Soldering Task Force  
Navy Technology Center for Safety & Survivability,  
U.S. Naval Research Laboratory  
Ontario Hydro  
SANYO Electric  
Sea-Land Service  
Sharp  
Singapore Productivity and Standards Board—  
formerly named the Singapore Institute of  
Standards and Industrial Research  
Texas Instruments  
Titan IV Program ODS Reduction Team  
Toshiba  
USBI  
Xerox

## *Association Awards*

Air-Conditioning & Refrigeration Institute  
CFC Destruction Plasma Project, Clean Japan Center  
Industrial Technology Research Institute, Taiwan  
Industry Technician Certification Team  
Refrigerant Reclaim Australia  
Singapore Institute of Standards and  
Industrial Research

## *Individual Awards*

Neil Antin, U.S. Naval Sea Systems Command  
Craig Barkhouse, Foamex Canada\*  
David Breslin, U.S. Naval Sea Systems Command  
Robert V. Burress, SEHO USA  
Denis Clodic, Ecole des Mines de Paris, Centre  
d'Energetique\*  
Bjorn Egeland, Consolve A.S.  
Lt. Commander Robert Gay, U.S. Defense  
Logistics Agency  
Herbert T. Gilkey, Engineering Consultants\*  
Casey Grant, National Fire Protection Association  
Michael C. Grieco, ICBM Systems Program Office,  
U.S. Air Force  
Dr. John Grupenhoff, National association of Physicians  
for the Environment  
Dr. Joop Van Haasteren, Ministry of Housing, Spatial  
Planning and the Environment\*  
Masatoshi Kinoshita, Japan Industrial Conference  
on Cleaning  
Hiroshi Kurita, Japan Association for Hygiene  
of Chlorinated Solvents\*  
Michael J. Leake, Texas Instruments  
Captain Cynthia Lingg, U.S. Air Force  
Hitoshi Mamiya, Honda Motors  
C.K. Marfatia, Real Value Appliances  
James A. Mertens, Dow Chemical\*

\*Member UNEP TEAP or its TOCs, Working Groups, or Task Forces.

\*\*Member of UNEP Science Assessment Panel.



John Minsker, The Dow Chemical\*  
David Mueller, Fumigation Service and Supply\*  
Goro Ogino, Minebea  
Douglas O. Pauls, Contamination Studies Laboratories  
Jose Pons Pons, Spray Quimica\*  
Dr. A.R. Ravishankara, National Oceanic and  
Atmospheric Administration—Aeronomy Laboratory\*\*  
Yasuomi Tanaka, Weyerhaeuser, Timberlands  
Nursery Team  
Dr. Daniel P. Verdonik, Hughes Associates\*  
Dr. Hans U. Wäckerlig, Swiss Institute for the  
Promotion of Safety & Security  
Dr. Peyton Weary, University of Virginia  
George H. White, Special Agent, U.S. Customs Service,  
Miami, Florida  
James Wolf, American Standard





## *Corporate Awards*

Advanced Amphibious Assault Vehicle, U.S. Marine Corps  
 AlliedSignal/Carrier  
 Baxter Limited  
 Center for Technical Excellence for ODC Solvents  
 Draper Laboratory  
 F/A-18 Program Office and V-22 Program Office,  
 U.S. Navy  
 Tank-Automotive Research, Development, Engineering  
 Center, Survivability Technology Area, Halon  
 Replacement Team, U.S. Army  
 ICBM System Program Office, U.S. Air Force  
 International Institute of Refrigeration/Institut  
 International Du Froid  
 Lockheed Martin Aeronautical Systems  
 Lockheed Martin Skunk Works  
 Ministry of Science, Technology, and the  
 Environment, Malaysia  
 The Nikkan Kogyo Shimbun  
 Operation Cool Breeze Enforcement Team  
 Philadelphia Detachment of the Carderock Division of  
 the Naval Warfare Center, HFC Shipboard  
 Conversion Team, U.S. Navy  
 Sanden  
 3M Pharmaceuticals  
 Tyler Refrigeration

## *Association Awards*

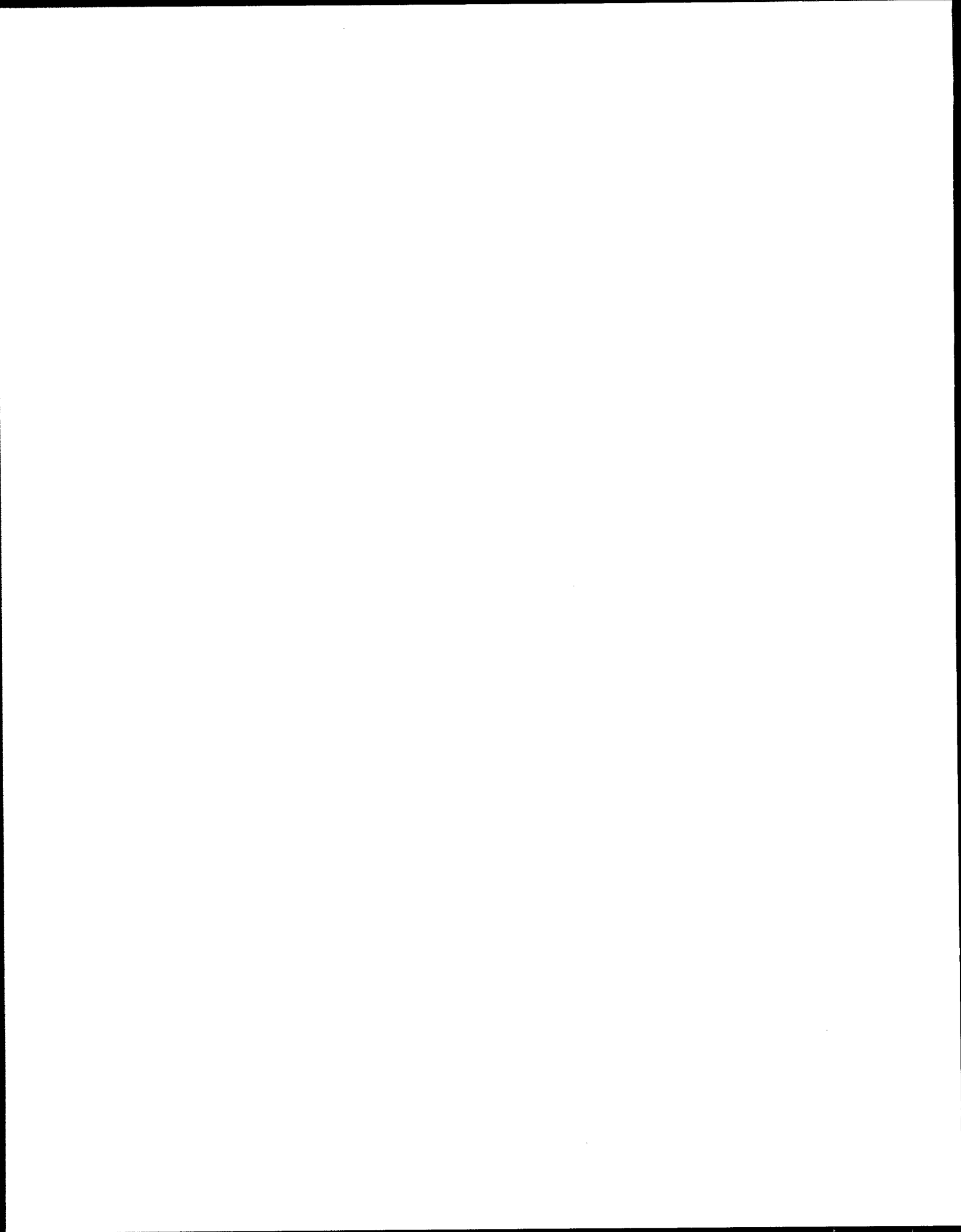
Association of Fluorocarbon Consumers and  
 Manufacturers of Australia  
 Halon Recycling & Banking Support Committee, Japan  
 International Institute of Refrigeration  
 International Mobile Air Conditioning Association  
 Japan Industrial Conference on Cleaning  
 The Refrigerant Import Committee of the Alliance for  
 Responsible Atmospheric Policy  
 Swedish Refrigeration Foundation

## *Individual Awards*

Dr. Jonathan Banks, CSIRO Division of Entomology\*  
 Thomas A. Bush, U.S. Army  
 G. Victor Buxton, Environment Canada\*  
 Dr. Frank Cala, Church & Dwight  
 Dr. Suely M. Carvalho, Companhia de Tecnologia de  
 Saneamento Ambiental\*  
 Dr. Stephen DeCanio, University of California\*  
 Kaichi Hasegawa, Seiko Epson  
 Barbara Kanegsberg, BFK Solutions  
 Takeshi Kawano, Dai-Ichi Kogyo Seiyaku.  
 John King, U.S. Air Force  
 Jean M. Lupinacci, EPA\*  
 Trish MacQuarrie, Environment Canada\*  
 Dr. Melanie Miler, Consultant\*  
 Peter Mullenhard, U.S. Navy Clearinghouse  
 Larry Novak, Texas Instruments  
 John O'Sullivan, British Airways\*  
 K. Madhava Sarma, UNEP Montreal Protocol Secretariat\*  
 Stephen Seidel, U.S. Council for Environmental Quality\*  
 Dr. Ronald S. Sheinson, U.S. Naval Research Laboratory\*  
 Dr. Susan Solomon, National Oceanic and  
 Atmospheric Administration\*\*  
 Tsuyoshi Takaichi, Showa Denko  
 Yuji Yamazaki, Seiko Epson  
 Kiyoshige Yokoi, Matsushita

\*Member UNEP TEAP or its TOCs, Working Groups, or Task Forces.  
 \*\*Member of UNEP Science Assessment Panel.





# APPENDIX B

## Matrix of Award Winners' Affiliations

\*An organization is considered affiliated with an association if that organization has been a member of the association. An individual is considered affiliated with an association if the sponsor of the individual is a member of the association or if the individual was a contributor to a significant publication of that association. TEAP Sponsors are organizations that contributed experts to the TEAP, TOCs, Working Groups, or Task Forces.

Stratospheric Protection Award Winner	Year	Country	Government Affiliation	UNEP	Alliance*	ICEL ICOLP*	JEMA JICOP*	HARC*
<b>INDIVIDUALS</b>								
Albritton, Daniel L., National Oceanic and Atmospheric Administration (NOAA)— Aeronomy Laboratory	1994	USA	Science	MBTOC SAP				
Antin, Neil, U.S. Naval Sea Systems Command	1995	USA	Defense			Yes		
Atkinson, Ward, Sun Test Engineering	1990	USA		RTOC				
Baker, James A. General Motors Corporation	1990	USA		RTOC	Yes			
Baker, Jay, Ford Motor Company	1990	USA		STOC	Yes	Yes		
Banks, Jonathan, Commonwealth Scientific and Industrial Research Organization (CSIRO)	1996	Australia	Agriculture	MBTOC TEAP				
Barkhouse, Craig, Foamex Canada	1995	Canada		FTOC				
Baxter, Bryan H., British Aerospace	1992	UK		STOC		Yes		
Bergman, David, IPC	1990	USA				Yes		
Beyreis, James R., Underwriters Laboratories	1990	USA						
Breslin, David, U.S. Naval Sea Systems Command	1995	USA	Defense			Yes		



Stratospheric Protection Award Winner	Year	Country	Government Affiliation	UNEP	Alliance*	ICEL ICOLP*	JEMA JICOP*	HARC*
Brunner, Walter, Envico	1994	Switzerland		HTOC TEAP				
Burruss, Robert V., SEHO	1995	USA						
Bush, Thomas, U.S. Army ODS Elimination Program	1996	USA	Defense	HTOC		Yes		Yes
Buxton, Victor G., Environment Canada	1996	Canada	Environment	TEAP				
Cala, Frank, Church & Dwight	1996	USA						
Carter, Robert , Waste Reduction Resource Center for the Southeast	1993	USA						
Carvalho, Suely Maria Machado, San Paulo Environmental Agency Companhia de Tecnologia	1996	Brazil	Environment	RTF TEAP				
Castellucci, Nicholas T., Northrop Corporation	1993	USA						
Catchpole, David P, BP Exploration (Alaska)	1993	USA		HTOC	Yes			Yes
Chittick, David, AT&T	1990	USA			Yes	Yes		
Claussen, Eileen, Department of State	1993	USA	Foreign Service			Yes		
Clodic, Denis, Ecole des Mines de Paris, Centre d'Energitique	1995	France		RTOC				
Cook, Liz, Friends of the Earth	1991	USA		MBTOC				
Corona, Jorge, Camara Nacional de la Industria de la Transformacion	1991	Mexico		STOC TEAP				
Crawford, Timothy, Electronics Manufacturing Productivity Facility (EMPF)	1993	USA	Defense			Yes		
Daum, Thomas E., U.S. Defense Reutilization & Marketing Service	1991	USA	Defense			Yes		
DeCanio, Stephen, Economics Department, University of California	1996	USA	Education	EOC				
Dillon, Michael Earl, Dillon Consulting Engineers	1993	USA						
DiNenno, Philip J., Hughes Associates	1992	USA		HTOC				Yes
Doniger, David, Natural Resources Defense Council	1991	USA		MBTOC				



Stratospheric Protection Award Winner	Year	Country	Government Affiliation	UNEP	Alliance*	ICEL ICOLP*	JEMA JICOP*	HARC*
Eckersley, Carl, Compaq Computer	1993	USA				Yes		
Egeland, Bjorn, Consolve								
Ellenberger, Carole K., Texas Instruments	1993 1994	USA Switzerland		LAWG STOC		Yes Yes		
Ellis, Brian, Protonique	1995	Norway						
Evanoff, Stephen Peter III, General Dynamics	1992	USA		STOC		Yes		
Fain, Lt. General James A., Aeronautical Systems Center, Wright-Paterson AFB	1994	USA	Defense			Yes		
Fay, Kevin, The Alliance for Responsible CFC Policy	1993	USA		IAWG PAWG	Yes			
Felty, Joe, Texas Instruments	1990	USA		STOC		Yes		
Fennell, Mary Beth, Naval Aviation Depot	1994	USA	Defense			Yes		
Fischer, John, Naval Air Warfare Center	1993	USA	Defense			Yes		
FitzGerald, Arthur, Nortel Northern Telecom	1990	Canada		STOC		Yes		
Fujimoto, Yuichi, Japan Electrical Manufacturers' Association	1993	Japan		STOC TEAP		Yes	Yes	
Fukushima, Tetsuro, Environmental Policy Office, Hitachi	1994	Japan				Yes	Yes	
Gatt, Victor, Malta Department of Industry	1994	Malta	Environment					
Gay, Lt. Commander Robert, U.S. Defense Logistics Agency	1995	USA	Defense			Yes		
Gilkey, Herbert T., Engineering Consultants	1995	USA		RTOC				
Grant, Casey, National Fire Protection Association	1995	USA						Yes
Grieco, Michael C., ICBM Systems Program Office, U.S. Air Force	1995	USA	Defense			Yes		
Grob, Donald, Underwriters Laboratories	1990	USA						
Grupenhoff, John, National Association of Physicians for the Environment	1995	USA						
Guth, Leslie, AT&T	1990	USA		STOC	Yes	Yes		



Stratospheric Protection Award Winner	Year	Country	Government Affiliation	UNEP	Alliance*	ICBL ICOLP*	JEMA JICOP*	HARC*
Hancock, Charles, MDT	1994	USA		APTOC				
Corporation Hasegawa, Kaichi, Seiko Epson	1996	Japan				Yes	Yes	
Hathaway, John, Arizona Department of Environmental Quality	1994	USA	Environment	MBTOC				
Hayes, Michael, Petroferm	1993	USA						
Hinwood, Andrea, Environmental Protection Authority	1993	Australia	Environment	APTOC TEAP				
Hobbs, Arthur G., Jr., Four Seasons Division	1993	USA						
Hoffman, John, U.S. EPA	1994	USA	Environment	EOC		Yes		
Holcomb, Robert, Motorola	1994	USA				Yes		
Ishii, Yoshiyuki, Hitachi	1992	Japan		STOC		Yes	Yes	
Jeffs, Mike, ICI Polyurethanes	1993	UK		FTOC	Yes			
Johnson, Kathi, China Lake Navy Weapons Center, Electronics Manufacturing Production Facility (EMPF)	1990	USA	Defense			Yes		
Kanegsberg, Barbara, BFK Solutions	1996	USA						
Kawano, Takeshi, Dai-Ichi Kogyo Seiyaku	1996	Japan					Yes	
Kenyon, William, DuPont Company	1990	USA		STOC	Yes	Yes		
Kerr, Margaret, Nortel Northern Telecom	1990	Canada				Yes		
Ketcham-Colwill, Nancy, U.S. EPA Office of General Council	1993	USA	Environment			Yes		
King, John, Manager, ODS Removal Program, San Antonio Air Logistics Center, Texas	1996	USA	Defense			Yes		
Kinoshita, Masatoshi, Japan Industrial Conference on Cleaning (JICC)	1995	Japan			Yes	Yes		
Kopko, William, York International	1991	USA		RTOC	Yes			
Krinsky, Joel, U.S. Naval Sea Systems Command	1994	USA	Defense			Yes		
Kucnerowicz-Polak, Barbara, State Fire Service Headquarters	1994	Poland	Fire Service	HTOC TEAP				



Stratospheric Protection Award Winner	Year	Country	Government Affiliation	UNEP	Alliance*	ICEL ICOLP*	JEMA JICOP*	HARC*
Kuijpers, Lambert, UNEP Technology and Economic Assessment Panel	1993	Netherlands		CEITWG RTF RTOC TEAP				
Kurita, Hiroshi, Japan Association for Hygiene of Chlorinated Solvents (JAHCS)	1995	Japan		LAWG PAWG	STOC		Yes	Yes
Lea, Colin, U.K. National Physical Laboratory	1991	UK	Science					
Leake, Michael J., Texas Instruments	1995	USA				Yes		
Lee-Bapty, Steve, UK Department of the Environment	1993	UK	Environment	TEAP				
Lewis, Colin, United Kingdom Ministry of Defence	1992	UK	Defense			Yes		
Lingg, Captain Cynthia, U.S. Air Force	1995	USA	Defense			Yes		
Lopez, Eduardo, FONDOIN	1994	Venezuela	Environment					
Lubraico, Milton, Ford Motor Company	1992	Brazil		STOC	Yes	Yes		
Lupinacci, Jean, Atmospheric Pollution Prevention Division, U.S. EPA	1996	USA	Environment	FTOC TEAP		Yes		
MacQuarrie, P. Trish, Global Air Issues Branch, Environment Canada	1996	Canada	Environment	LAWG PAWG TEAP		Yes		
Malik, Mohinder, Deutsche Lufthansa	1994	Germany		STOC TEAP		Yes		
Mamiya, Hitoshi, Honda Motors	1995	Japan					Yes	
Manz, Kenneth W., Robinair Division, SPX Corporation	1993	USA		RTOC	Yes			
Marfatia, C. K., Real Value Appliances	1995	India						
Mathews, Thomas J., Hannaford Brothers	1993	USA						
Matsui, Shigeo, Toshiba	1992	Japan		STOC		Yes	Yes	
McQuaide, Marion, United Kingdom Ministry of Defense	1994	UK	Defense	HTOC				
Mertens, James A., Dow Environmental	1995	USA		STOC	Yes		Yes	
Miller, Alan S., Center for Global Change	1992	USA	Education	EOC MBTOC				
Miller, Alvin, National Weather Service	1994	USA	Science					



Stratospheric Protection Award Winner	Year	Country	Government Affiliation	UNEP	Alliance*	ICEL ICOLP*	JEMA JICOP*	HARC*
Miller, Melanie, Consultant	1996	New Zealand		EOC MBTOC				
Minsker, John, The Dow Chemical Company	1995	USA		FTOC	Yes			
Mitsugi, Yasuo, Seiko Epson	1993	Japan					Yes	
Morehouse, Major Edward T., U.S. Air Force	1991	USA	Defense	HTOC TEAP		Yes		Yes
Mueller, David, Fumigation Service and Supply	1995	USA		MBTOC				
Mullenhard, Peter, U.S. Navy's CFC & Halon Clearinghouse Team	1996	USA	Defense			Yes		Yes
Nakamura, Tsuneya, Seiko Epson	1993	Japan					Yes	
Nardini, Geno, Instituto Mexicano del Aerosol	1992	Mexico		APTOC				
Novak, Larry, Texas Instruments	1996	USA				Yes		
Nusbaum, Richard, Pennsylvania Engineering Company	1991	USA		APTOC				
O'Sullivan, John, British Airways	1996	UK		HTOC				Yes
Odagiri, Tsutomu, Japan Industrial Conference for Ozone Layer Protection (JICOP)	1994	Japan					Yes	
Ogino, Goro, Minebea	1995	Japan					Yes	
Oulouhojian, Simon, MACS	1990	USA			Yes			
Oxman, Sergio, KIEN Consultants	1993	Chile		EOC PATF RTF				
Pauls, Douglas O., Contamination Studies Laboratories	1995	USA						
Pfahl, Robert C., Motorola	1991	USA				Yes		
Phillips, Tony L., General Dynamics Corporation	1992	USA				Yes		
Pons Pons, Jose, Spray Quimica	1995	Venezuela		APTOC RTF TEAP				
Pruett, Cynthia, IBM Asia Pacific	1993	USA		STOC		Yes		
Rasmussen, Steven, Hill Air Force Base	1994	USA	Defense			Yes		





Stratospheric Protection Award Winner	Year	Country	Government Affiliation	UNEP	Alliance*	ICEL ICOLP*	JEMA JICOP*	HARC*
Ravishankara, A.R., National Oceanic and Atmospheric Administration— Aeronomy Laboratory	1995	USA	Science	SAP				
Rowland, F. Sherwood, University of California, Irvine	1993	USA	University	SAP				
Rubin, Wallace, Multicore	1994	UK						
Sarma, K. Madhava, UNEP Secretariat	1996	India		PAWG TEAP				
Schaumberg, Terry, U.S. Air Force, San Antonio Air Logistics Center	1993	USA	Defense			Yes		
Schurig, Angie Criser, Texas Instruments	1993	USA				Yes		
Seidel, Stephen, President's Council for Environmental Quality	1996	USA	Environment	MBTOC				
Sellers, Robin, Naval Avionics Center	1990	USA	Defense			Yes		
Sheinson, Ronald, U.S. Naval Research Laboratory	1996	USA	Defense	HTOC		Yes		Yes
Sheppard, Franklin Jr., U.S. Navy	1994	USA	Defense			Yes		Yes
Shibano, Yoshihide, S&C	1993	Japan					Yes	
Shimberg, Steven, U.S. Senate Committee on Environment and Public Works	1994	USA	Legislature					
Sibley, Ronald, Defense Logistics Agency	1994	USA	Defense	HTOC		Yes		Yes
Solomon, Susan, National Oceanic and Atmospheric Administration— Aeronomy Laboratory	1996	USA	Science	SAP				
Stemniski, John R., The Charles Stark Draper Laboratory	1993	USA		STOC		Yes		
Stolarski, Richard, NASA Goddard Space Flight Center	1991	USA	Science	SAP				
Swindle, Jack, Texas Instruments	1994	USA				Yes		
Takaichi, Tsuyoshi, Showa Denko	1996	Japan					Yes	
Tanaka, Yasuomi, Timberlands Nursery Team, Weyerhaeuser	1995	USA						



Stratospheric Protection Award Winner	Year	Country	Government Affiliation	UNEP	Alliance*	ICEL ICOLP*	JEMA JICOP*	HARC*
Tapscott, Robert E., New Mexico Engineering Research Institute (NMERI)	1993	USA		HTOC	Yes			Yes
Taylor, Gary, Taylor/Wagner	1990	Canada		HTOC ATF TEAP				Yes
Taylor, Steven D., BP Exploration (Alaska)	1993	USA			Yes			Yes
Tober, Dennis, Florida Department of Environmental Regulation	1991	USA	Environment					
Tolba, Mostafa, Second Executive Director of UNEP	1993	Egypt						
Turbini, Laura J., Georgia Institute of Technology	1992	USA	Education					
Van Haasteren, Joop, Ministry of Housing, Spatial Planning and the Environment	1995	Netherlands	Environment	MBTOC				
Verdonik, Daniel R., Hughes Associates	1995	USA		HTOC		Yes		Yes
Vest, Gary D., Deputy Assistant Secretary of the Air Force	1993	USA	Defense			Yes		Yes
Vincent, James, U.S. Army Aviation and Troop Command	1994	USA	Defense			Yes		
Vinton, Clare, National Center for Manufacturing Sciences	1993	USA						
Vogelsberg, Anthony, DuPont Company	1993	USA		PATF PAWG	Yes			
Wackerlig, Hans U., Swiss Institute for the Promotion of Safety & Security	1995	Switzerland						
Waschek, Carmen, The Coca-Cola Company	1993	USA						
Watson, Robert , NASA	1994	USA	Science	MBTOC SAP				
Weary, Peyton, University of Virginia	1995	USA	Education					
Weltman, Henry J., General Dynamics Corporation	1992	USA				Yes		
Wenning, Udo G., Bosch-Siemens	1993	Germany						
Wetterlin, Kjell, Astra II Draco	1991	Sweden						



Stratospheric Protection Award Winner	Year	Country	Government Affiliation	UNEP	Alliance*	ICEL ICOLP*	JEMA JICOP*	HARC*
White, George H., U.S. Customs Service	1995	USA	Law Enforcement					
Wolf, James, American Standard	1995	USA			Yes			
Yamabe, Masaaki, Asahi Glass	1993	Japan		STOC		Yes	Yes	
Yamazaki, Yuji, Seiko Epson	1996	Japan					Yes	
Yasukawa, Hideaki, Seiko Epson	1994	Japan					Yes	
Yokoi, Kiyoshige, Matsushita Refrigeration	1996	Japan					Yes	



Stratospheric Protection Award Winner	Year	Country	Government Affiliation	UNEP	Alliance*	ICEL ICOLP*	JEMA JICOP*	HARC*
<b>CORPORATIONS, MILITARY, GOVERNMENT</b>								
AlliedSignal	1993	USA		Sponsor	Yes			
AlliedSignal/Carrier	1996	USA		Sponsor	Yes			
AT&T	1992	USA		Sponsor	Yes	Yes		
Asahi Glass	1994	Japan		Sponsor	Yes	Yes	Yes	
Australian Department of Administrative Services Centre for Environmental Management DASCEM	1995	Australia	Environment					
Baxter Limited	1996	Malta						
Beverage-Air	1995	USA			Yes			
Boeing Commercial Airplane Group	1993	USA		Sponsor		Yes		Yes
Boeing Company	1992	USA		Sponsor		Yes		Yes
British Aerospace Airbus	1992	UK		Sponsor		Yes		
Cadbury	1993	UK						
Carrier	1994	USA		Sponsor	Yes			
Carrier/AlliedSignal	1996	USA		Sponsor	Yes			
Charles County Board of Education	1993	USA	Education					
Chrysler Corporation	1992	USA						
Coca-Cola Company	1993	USA						
Compaq Computer	1993	USA				Yes		
Copeland	1993	USA		Sponsor	Yes			
Defence Institute of Fire Research	1995	India	Defense Fire Service	Sponsor				
Digital Equipment Corporation	1990	USA		Sponsor		Yes		
Dixie-Narco	1995	USA						
Dolco Packaging	1990	USA						
Draper Laboratory	1996	USA		Sponsor		Yes		
DuPont Company	1990	USA		Sponsor	Yes			Yes
Electrical & Mechanical Services Department, Hong Kong Government	1995	Hong-Kong	Engineering					
Epson Hong Kong Group (EPH & EHK)	1995	Hong-Kong					Yes	
Ford Motor Company	1992	USA		Sponsor	Yes	Yes		



Stratospheric Protection Award Winner	Year	Country	Government Affiliation	UNEP	Alliance*	ICEL ICOLP*	JEMA JICOP*	HARC*
Ford Motor Company	1994	USA		Sponsor	Yes	Yes		
GEC-Marconi, Hirst Research Center	1993	UK		Sponsor				
General Motors Corporation	1994	USA		Sponsor	Yes			
General Services Administration	1993	USA	Operations					
General Dynamics Corporation -General Dynamics Space Systems Division -General Dynamics - Fort Worth Division	1992	USA		Sponsor		Yes		
GEO-CENTERS	1995	USA						
H. B. Fuller	1995	USA						
Hewlett-Packard	1994	USA				Yes		
Hitachi	1991	Japan		Sponsor		Yes	Yes	
Honeywell	1994	USA				Yes		
Hughes Aircraft	1993	USA				Yes		
Husmann	1994	USA			Yes			
IBM -IBM , Endicott, New York -IBM , Rochester, Minnesota	1992	USA		Sponsor		Yes		
IBM, Austin, Texas	1993	USA		Sponsor		Yes		
ICI Chemicals and Polymers	1992	UK		Sponsor	Yes			
ICI Polyurethanes	1994	UK		Sponsor	Yes		Yes	
Lockheed Corporation	1994	USA		Sponsor		Yes		
Lockheed Martin Aeronautical Systems	1996	USA		Sponsor		Yes		
Lockheed Martin Skunk Works	1996	USA				Yes		
Lufthansa German Airlines	1993	Germany		Sponsor				
Martin Marietta	1994	USA						
Martin Marietta Astronautics	1993	USA						
Matsushita Electric Industrial Company	1993	Japan		Sponsor		Yes	Yes	
McQuay International (formerly Snyder General Corporation)	1992	USA			Yes			
Mercedes-Benz	1992	Germany						
Minebea Group Companies in Thailand and Japan	1993	Thailand					Yes	
Ministry of Science, Technology and the Environment	1996	Malaysia	Environment					



Stratospheric Protection Award Winner	Year	Country	Government Affiliation	UNEP	Alliance*	ICEL ICOLP*	JEMA JICOP*	HARC*
Mitsubishi Electric	1994	Japan				Yes	Yes	
Motorola	1991	USA				Yes		
Motorola-Malaysian Project	1993	Malaysia				Yes		
National ChloroFluoro Carbons Enforcement Initiative, Operation Cool Breeze Enforcement Team	1996	USA	Law Enforcement					
National Refrigerants	1993	USA			Yes			
New York State Energy Research and Development Authority-HFC Supermarket Refrigeration Demonstration Team	1993	USA	Energy					
Nikkan Kogyo Shimbun	1996	Japan						
Nippondenso Company	1993	Japan					Yes	
Nissan Motor Company	1991	Japan					Yes	
Norsk Forsvarsteknologi (NORSK)	1994	Norway						
Nortel/Northern Telecom	1991	Canada		Sponsor		Yes		
Northrop-Grumman	1994	USA						
Ontario Hydro	1995	Canada				Yes		
RECTICEL International	1992	Belgium		Sponsor				
Rockwell International, U.S. Army Air-to-Ground Missile Systems Project Office	1993	USA	Defense					
Royal Norwegian Navy Materiel Command	1992	Norway	Defense					
Saab-Scania	1994	Sweden						Yes
Sainsbury	1993	UK						Yes
Sanden	1996	Japan					Yes	
SANYO Electric	1995	Japan		Sponsor			Yes	
Sea-Land Service	1995	USA						
Secretaria de Desarrollo Urbano y Ecologia (SEDUE)	1991	Mexico	Environment	Sponsor				
Seiko Epson	1992	Japan					Yes	
Separation Technologies	1994	USA						
Sharp	1995	Japan		Sponsor			Yes	
Shaw's Supermarkets	1993	Japan						
TEAM Aer Lingus	1991	Ireland						
Tecumseh Products	1994	USA		Sponsor	Yes			



Stratospheric Protection Award Winner	Year	Country	Government Affiliation	UNEP	Alliance*	ICEL ICOLP*	JEMA JICOP*	HARC*
Texas Instruments, Missile Systems Division	1993	USA		Sponsor		Yes		
Texas Instruments	1995	USA		Sponsor		Yes		
3M Company	1991	USA		Sponsor	Yes			Yes
3M Pharmaceuticals	1996	USA		Sponsor	Yes			
Thiokol Corporation, Space Operations	1993	USA				Yes		
Toshiba	1995	Japan		Sponsor		Yes	Yes	
Toyota Motor Corporation	1994	Japan					Yes	
Trane	1992	USA		Sponsor	Yes			
Tyler Refrigeration	1996	USA			Yes			
Underwriters Laboratories	1990	USA						
Union Carbide, EKCO Housewares, Nordson	1993	USA						
U. S. Air Force, Advanced Cruise Missile DSO	1995	USA	Defense			Yes		
U. S. Air Force, Aeronautical Systems Center, Wright Laboratory, Aircraft Halon Replacement Team, Wright-Patterson Air Force Base	1994	USA	Defense			Yes		
U. S. Air Force, Aerospace Guidance and Metrology Center, Newark Air Force Base, Ohio	1994	USA	Defense	Sponsor		Yes		
U.S. Air Force, AGM-130 System Program Office	1995	Defense				Yes		
U.S. Air Force, Air Base Fire Protection and Crash Rescue Systems Branch	1993	USA	Defense			Yes		
U. S. Air Force, Falcon Halon Team Wright-Paterson Air Force Base	1994	USA	Defense			Yes		
U. S. Air Force, Hill Air Force Base	1993	USA	Defense			Yes		
U. S. Air Force, ICBM System Program Office	1996	USA	Defense			Yes		
U. S. Air Force, Kelly Air Force Base	1993	USA	Defense			Yes		
U.S. Air Force, Titan IV ODS Reduction Team	1995	USA	Defense	Sponsor		Yes		
U S. Army, Aberdeen Test Center	1995	USA	Defense			Yes		



Stratospheric Protection Award Winner	Year	Country	Government Affiliation	UNEP	Alliance*	ICEL ICOLP*	JEMA JICOP*	HARC*
U.S. Army Acquisition Pollution Prevention Support Office	1992	USA	Defense	Sponsor		Yes		
U.S. Army Center for Technical Excellence for ODC Solvents	1996	USA						
U.S. Army Communications-Electronics Command (CECOM), Tobyhanna Depot	1994	USA	Defense	Sponsor		Yes		
U. S. Army, TACOM Survivability Technology Area-Halon Replacement Program	1996	USA	Defense			Yes		
U. S. Defense Electronics Supply Center	1993	USA	Defense			Yes		
U. S. Defense Logistics Agency	1993	USA	Defense	Sponsor		Yes		Yes
U. S. Department of Defense Low-Residue Soldering Task Force	1995	USA	Defense			Yes		
U. S. Marine Corps, Advanced Amphibious Assault Vehicle, Direct Reporting Program Manager	1996	USA	Defense			Yes		
U. S. Navy, Annapolis Detachment, Carderock Division, Naval Surface Warfare Center	1995	USA	Defense			Yes		
U. S. Navy, Chief of Naval Operations	1993	USA	Defense			Yes		
U. S. Navy F/A-18 Program Office and V-22 Program Office	1996	USA	Defense			Yes		
U. S. Navy, Naval Air Warfare Center Aircraft Division Lakehurst	1992	USA				Yes		
U. S. Navy, Naval Aviation Depot, Cherry Point	1993	USA	Defense			Yes		
U. S. Navy, Naval Aviation Depot, Norfolk	1993	USA	Defense			Yes		
U. S. Navy, Philadelphia Detachment of the Carderock Division of the Naval Warfare Center, HFC Shipboard Conversion Team	1996	USA	Defense			Yes		
U. S. Navy, Technology Center for Safety and Survivability, U.S. Naval Research Laboratory	1995	USA	Defense			Yes		





Stratospheric Protection Award Winner	Year	Country	Government Affiliation	UNEP	Alliance*	ICEL ICOLP*	JEMA JICOP*	HARC*
Unitor Service Ship	1993	Singapore		Sponsor	Yes			
USBI	1995	USA						
Volvo Cars of North America	1993	Sweden						
Woolworths (Australia)	1993	Australia						
Xerox	1995	USA						
York International	1992	USA		Sponsor	Yes			

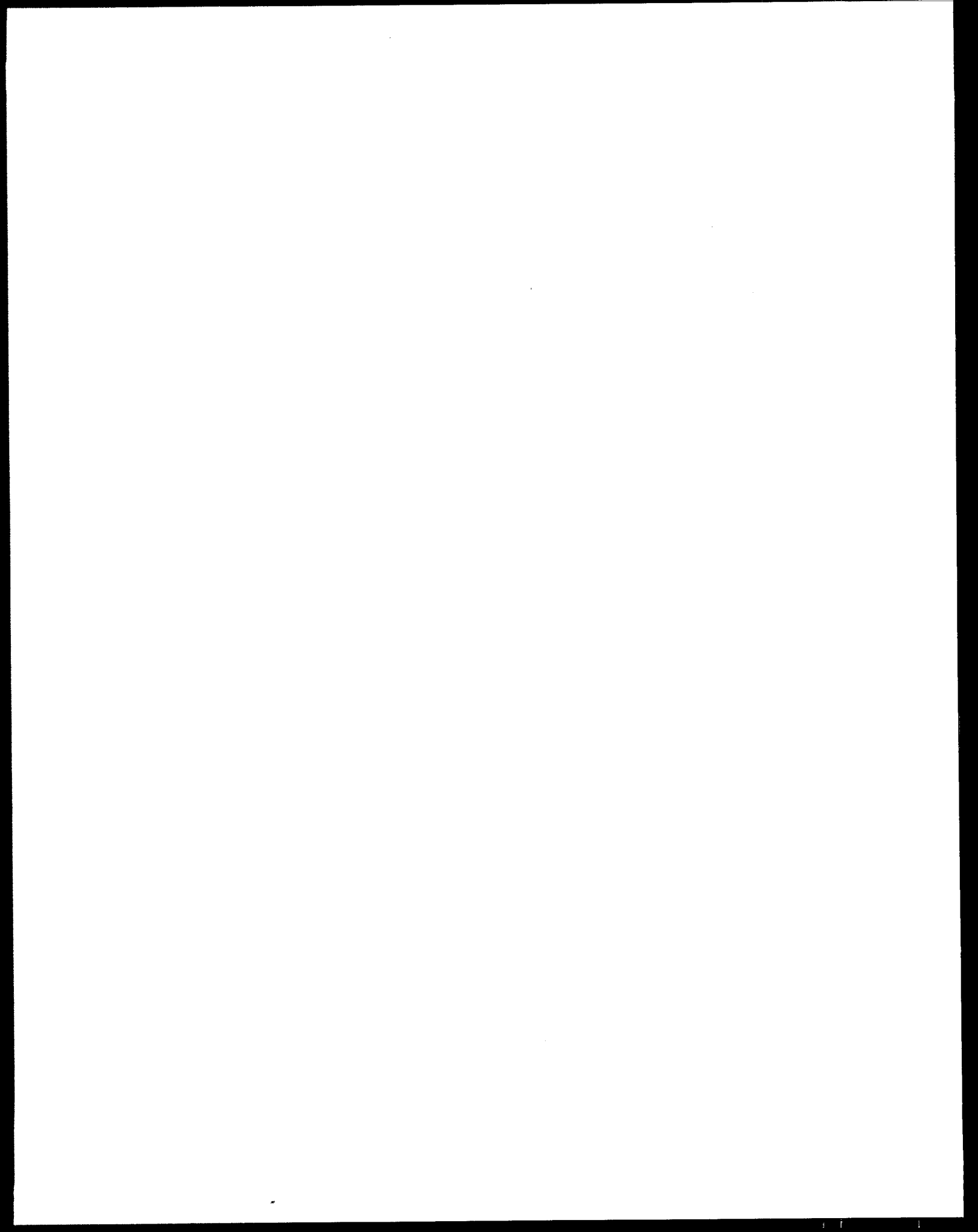


Stratospheric Protection Award Winner	Year	Country	Government Affiliation	UNEP	Alliance*	ICEL ICOLP*	JEMA JICOP*	HARC*
<b>ASSOCIATIONS</b>								
Association of Fluorocarbon Consumers and Manufacturers of Australia (AFCAM)	1996	Australia						
Air Conditioning & Refrigerant Institute (ARI)	1995	USA			Yes			
Air Conditioning & Refrigeration Institute (ARI)	1991	USA			Yes			
Alliance for Responsible CFC Policy	1990	USA		Sponsor	Yes			
Alternative Refrigerants Evaluation Program (AREP), ARI	1994	USA						
Camara Nacional de la Industria de la Transformacion	1992	Mexico		Sponsor				
Center for Emissions Control	1993	USA						
CFC Destruction r.f. Plasma Project, Clean Japan Center	1995	Japan					Yes	
Foodservice & Packaging Institute (FPI)	1990	USA						
Halon Alternatives Research Corporation, (HARC)	1992	International		Sponsor		Yes		Yes
Halon Essential Use Panel, EPA, Victoria	1992	Australia						
Halon Recycling & Banking Support Committee	1996	Japan					Yes	
Heating, Refrigerants and Air Conditioning Institute of Canada (HRAI)	1993	Canada						
Industrial Technology Research Institute (ITRI)	1995	Taiwan						
Industry Cooperative for Ozone Layer Protection (ICOLP/ICEL)	1991	International				Same		
Industry Cooperative for Ozone Layer Protection (ICOLP/ICEL)	1993	International				Same		
Industry Technician Certification Team	1995	USA						
International Institute of Refrigeration (IIR)/Institute International Du Froid (IIF)	1996	International						



Stratospheric Protection Award Winner	Year	Country	Government Affiliation	UNEP	Alliance*	ICEL ICOLP*	JEMA JICOP*	HARC*
Institute for Interconnecting and Packaging Electronic Circuits (IPC)	1990	International						
International Mobile Air Conditioning Association (IMACA)	1996	International			Yes			
Japan Electrical Manufacturers' Association (JEMA)	1991	Japan		Sponsor		Same	Yes	
Japan Industrial Conference on Cleaning (JICC)	1996	Japan				Yes	Yes	
Japan Industrial Conference for Ozone Layer Protection (JICOP)	1993	Japan		Sponsor		Same		
Mobile Air-Conditioning Society (MACS)	1990	USA		Sponsor	Yes			
National Association of Fire Equipment Distributors (NAFED)	1994	USA						Yes
National Fire Protection Association (NFFA)	1990	USA						Yes
Polyisocyanate Insulation Manufacturers Association (PIMA)	1993	USA		Sponsor	Yes			
Refrigerant Reclaim Australia	1995	Australia						
Refrigerants Import Committee of the Alliance for Responsible Atmospheric Policy	1996	USA			Yes			
Singapore Productivity and Standards Board (PSB) formerly Singapore Institute of Standards and Industrial Research (SISIR)	1995	Singapore		Sponsor				
The Swedish Institute of Production Engineering Research (IVF)	1992	Sweden						
Swedish Refrigeration Foundation	1996	Sweden						





# APPENDIX C

## EPA's Stratospheric Ozone Protection Team, 1985-1997

### Office of Atmospheric Programs & Antecedents

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Thomas Land  
Pat Lawson  
David Lee  
Jacqueline Levister  
Joel Levy  
Jeffrey Levy  
Barbara Lewis  
Jean Lupinacci-Rausch  
Bella Maranion  
Denise Mauzerall  
Gary McNeil  
Karen Metchis  
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Christine O'Donnell  
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Nilesh M. Patel  
Karla Perri  
Monica Peterson  
Sally Rand  
Ingrid Robinson  
Reva Rubenstein  
Kristin Saltonstall  
Mavis Sanders  
Stephen Seidel  
Nancy Smagin  
John O. Sparks  
Sue Stendebach  
Kathryn Sutton\*  
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Peter Voigt  
Tracy Ward  
Robert Waugh  
Carol Weisner  
Jeff Wells  
Lucille Williams\*  
Rosemary Workman  
Lillian Yates\*  
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\*Employed by the American Association for Retired People (AARP) under a grant from EPA.



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