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NATIONAL TOXICS CAMPAIGN
MILITARY TOXICS PROJECT
RR 1, BOX 2020
LITCHFIELD, MAINE 04350
(207)268-4071
FAX: (207)268-9258

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TO: Suzanne - Sen. Gore's office

FROM: Cathy Hinds

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OPERATION OZONE SHIELD:

The Pentagon's War on the Stratosphere

by Lenny Siegel

NATIONAL TOXICS CAMPAIGN FUND

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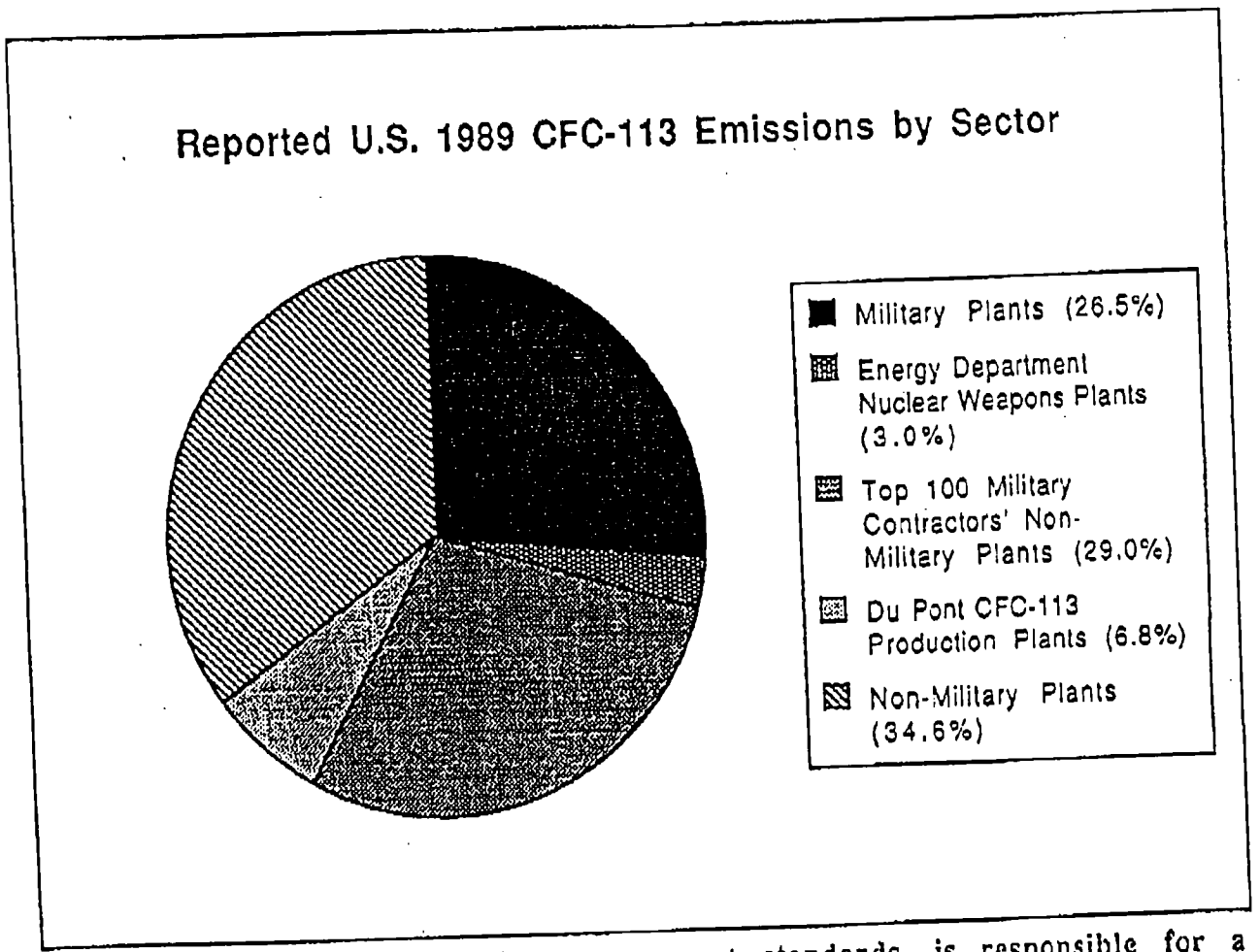

The U.S. military, through its procurement standards, is responsible for a substantial share of the ozone-depleting emissions of American industry. The above chart is based upon the 100 Plants reporting the greatest amount of CFC-113 air releases to the EPA in 1989. (See the Appendix on page 12 for details.)

February, 1992

OPERATION OZONE SHIELD:
The Pentagon's War on the Stratosphere

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SUMMARY

Scientists, U.S. policy-makers, and international law now agree: The long-term depletion of the stratospheric ozone layer poses a serious hazard to human health and the global environment. Emissions of chlorofluorocarbons (CFC's) and other forms of chlorine are catalyzing chemical reactions in the upper atmosphere, breaking down the Earth's shield of ozone and allowing an increased level of solar ultraviolet radiation to reach the Earth's surface. Increased ultraviolet exposure threatens crop yields and the viability of aquatic ecosystems. The Environmental Protection Agency (EPA) estimates that it could cause 200,000 additional skin cancer deaths in the United States over the next fifty years. The United Nations Environmental Programme (UNEP) projects that ozone depletion over the United States and comparable latitudes could reach ten percent by the end of the century, triggering millions of additional cases of skin cancer, blinding a million people, and weakening human and animal immune systems around the world.

Many people within the U.S. government are working hard to limit that danger, but the Federal procurement bureaucracy, centered within the Department of Defense (DOD), still requires that government contractors use ozone-depleting substances, such as CFC-113 (Freon), in their work. Military specifications, ("mil-specs") set the standard, not only for weapons production and maintenance, but for the rest of industry. As a result, emissions of ozone-depleting chemicals continue, despite international agreements to phase out such substances.

- In 1989, the 100 U.S. industrial plants reporting the largest quantities of CFC-113 emissions included 26 major Defense contractor plants and 3 nuclear weapons plants. Those military plants were responsible for 7.35 million pounds of CFC-113 releases, equal to 29.5% of the top 100 releasers' emissions.
- The Pentagon itself reports using over 5.75 million pounds more of CFC-113 in 1989, primarily as a solvent for cleaning electronics equipment and metal parts. DOD is scheduled to provide new summary data to Congress, but its individual facilities are not required to report releases of ozone-depleting chemicals. We estimate that the armed services and weapons plants are responsible for about 37% of America's reported CFC-113 emissions.
- The non-military plants of the top 100 military contractors released an additional 7.24 million pounds of CFC-113, or 29.0% of the top 100 releasers' emissions. Though not required to follow military specifications, many of these facilities rely upon military standards. Thus, this value serves as a rough

indicator of the influence that military specifications have over the aerospace, weapons, and electronics industries.

- Over the last few years, the Department of Defense has issued a series of reports and directives designed to reduce the military sector's use and release of ozone-depleting compounds. For example, a recent report to Congress recommended that DOD "identify an individual office" to coordinate the campaign against ozone-depleting chemicals. Though it's moving in the right direction, the effort is slow and bureaucratic. In particular, DOD's schedule for eliminating the release, procurement, and use of ozone-depleting compounds includes no timetable for revising military specifications.
- Both the Air Force Titan 4 expendable launch vehicle and NASA's Space Shuttle, often used for military missions, directly deliver vast amounts of ozone-depleting chlorine to the upper atmosphere. Each launch does as much to deplete the ozone layer as the annual release of CFC-113 from most individual industrial plants. Recurring problems with the Titan Solid Rocket Motor Upgrade (SRMU)—including accidents at both ground tests—provide an opportunity to develop a more environmentally sensitive booster.

We applaud the progress DOD has made. We thank the many individuals within the U.S. military who are working to solve the problem. We recognize that eliminating all ozone-depleting releases may be complex, difficult, and costly. Nevertheless, we think that the Department of Defense, as an agency devoted to protecting the American people, should intensify and accelerate its program to stop destroying the ozone shield. We recommend the following:

1. All specifications requiring the use of CFC-113 should be withdrawn or overridden by January 1, 1993. The Pentagon should establish a timetable for eliminating requirements for other ozone-depleting compounds from Federal standardization documents, technical data packages, and engineering drawings.
2. Instead of a coordinating office, the Pentagon should establish a "CFC Command," with sufficient funding, personnel, and authority to launch a high priority campaign to protect, not destroy, the ozone layer: an "Operation Ozone Shield."
3. Each military base should report its releases of ozone-depleting substances through the EPA's Toxics Release Inventory.
4. The Air Force should choose an environmentally sound technology for Titan 4 boosters and subsequent launch systems.

Everybody's Shield

Few environmental issues have caught the attention of the American people, from eight-year olds to astronauts, as the degradation of the ozone shield. The ozone layer, actually a concentration of triatomic oxygen (O_3) in the stratosphere, from about 15 to 50 kilometers above the Earth, absorbs harmful ultraviolet radiation from the Sun. Throughout history and before, natural processes have continually created and broken down stratospheric ozone molecules.

Starting about two decades ago, however, humans started releasing large quantities of chlorine-containing pollutants into the upper atmosphere. As a consequence, ozone concentrations are declining measurably, creating at times the "ozone hole" over Antarctica, an actual gap in the ozone layer. In April, 1991 the Environmental Protection Agency announced that the ozone shield directly above the continental United States—and other countries at the same latitude—has degraded as much as five percent over the last decade, twice the depletion that scientists had anticipated. In October, 1991 the United Nations Environmental Programme projected, "With the increases in chlorine and bromine that are estimated for the year 2000, the additional ozone losses during the 1990's are expected to be comparable to those already observed for the 1980's."[1] That is, ozone depletion at middle latitudes may reach ten percent by the century's end.

As the ozone layer degrades, the level of ultraviolet radiation reaching Earth rises much faster than most life forms can adapt. Ultraviolet radiation at the upper end of the ultraviolet spectrum (UV-B) poses a threat to all living organisms because it can damage DNA, the substance containing the genetic code of all living cells. Increased exposure to UV-B can damage aquatic ecosystems, crops and trees, and the immune systems of humans and other animals.

Increased UV-B radiation triggers skin cancer, including deadly melanomas and the more prevalent non-melanoma cancers. EPA projects that the depletion of the ozone layer could "increase the number of skin cancer deaths in the United States over the next fifty years by about 200,000 as well as create other severe health problems."[2] A UNEP panel estimates, "If future ozone losses reach ten percent and are sustained at that level, non-melanoma skin cancer is expected to increase by 26 percent. This would mean an increase of 300,000 new skin cancer cases each year worldwide."[3]

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[1]United Nations Environment Programme/World Meteorological Organization, "Executive Summary: Scientific Assessment of Stratospheric Ozone, 1991," October 22, 1991, p. 3.

[2]General Accounting Office (GAO), "Ozone-Depleting Chemicals: Increased Priority Needed if DOD Is To Eliminate Their Use," GAO/NSIAD-92-21, November, 1991, p. 8.

[3]United Nations Environmen: Programme, "Environmental Effects of Ozone Depletion: 1991 Update—Introduction, Executive Summary," November, 1991, as summarized in David Doniger, Liz Cook, and Michael Oppenheimer,

UV-B radiation also plays a role in the formation of cataracts, the clouding of eye lenses that often leads to blindness: "With a sustained ten percent ozone loss, there would be an additional one million blind people in the world."[4]

As indicated by the unexpectedly high level of ozone depletion over the U.S., scientists do not yet fully understand the chemical processes that destroy atmospheric ozone. It is generally agreed, however, that each ion of chlorine and bromine in the upper atmosphere triggers a series of chemical reactions in which hundreds of ozone molecules are broken down. Chlorofluorocarbon (CFC) gases such as CFC-113, sold by Du Pont under the trade name Freon, are released at the Earth's surface and move through the atmosphere for years. Eventually they reach the stratosphere, break down, and catalyze ozone depletion. Some sources of chloride ions, such as hydrogen chloride from solid rocket motor exhaust, only threaten the ozone layer when they are released directly in the stratosphere.

In the U.S., CFC's are used in aerosol propellants, in the manufacture of plastic foam and insulation, in refrigeration and air conditioning equipment, and in the sterilization of medical instruments. Halons, similar compounds that also include bromine, are used in fire extinguishing equipment in areas containing sensitive electronic devices. CFC-113 is used to clean metal and electronic components and assemblies.

Americans have been aware of the threat of ozone depletion since the late 1970's, when warnings about releases of CFC's—then known merely as fluorocarbons—from aerosol cans led to consumer boycotts and the prohibition of that use and the development of more ozone-friendly substitutes. Today thousands, perhaps millions of people avoid buying foam cups, CFC-based insulation, and car air conditioners, doing their part to protect the ozone shield.[5]

Part of the Problem

Meanwhile, the U.S. Department of Defense (DOD), an agency charged with responsibility for protecting Americans against external threats, remains a key part of the problem. Though DOD officially recognized its role in ozone depletion more than three years ago, its efforts to shape up have been woefully inadequate.

Following the ban of CFC aerosol sprays, the Reagan Administration abandoned plans to further regulate CFC's, and Du Pont sought new markets for

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"Petition for Acceleration of the Phase-Out Schedule for Ozone-Depleting Chemicals and Related Actions," Natural Resources Defense Council, Friends of the Earth, Environmental Defense Fund, December 3, 1991, p. 15.

[4] *ibid.*

[5] See, for example, Penny Mintz, "CFC's: Just Say No," *The Amicus Journal*, Natural Resources Defense Council, Summer, 1991, p. 29.

the compounds. The electronics and aerospace industries, in the process of phasing down their use of cancer-causing solvents such as trichloroethylene, adopted CFC-113 as an effective alternative.[6] By 1985, CFC-113 accounted for 12 percent of CFC's used in the US, and its use was growing 1.5 times as fast as other major CFC's.[7] The Department of Defense adopted CFC-113 as well, writing it into its procurement specifications, or "milspecs." Today "there are approximately 500 military and Federal specifications that directly require chlorinated solvents, CFC's and Halons. Additionally, approximately 9,000 milspecs have been identified that do not directly require these substances but cannot be met without the use of [ozone-depleting compounds]."[8]

In 1986, according to DOD itself, the "Armed Forces and companies supplying equipment to them accounted for nearly half" the nation's CFC-113 use.[9] We believe ~~that figure may understate the Pentagon's role in the current~~ CFC-113 market. The National Toxics Campaign Fund (NTCF) estimates that *direct* consumption by the military and military plants accounts for 37% of the CFC's emitted in the U.S. each year, and that military specifications account for as much as 31% more.

Earlier studies have shown that military contractors are among the top releasers of CFC-113 in California and Florida.[10] To determine the military role nationally, NTCF has identified military plants among the top 100 releasers of CFC-113 in 1989, as reported to the EPA's Toxics Release Inventory (TRI). Those top 100, accounting for nearly 40% of releases by all reporting firms, provide a good representation of the entire CFC-113 market.

In 1989, military and nuclear weapons plants released 29.5% of the top 100 total. (See Appendix on page 12 for details.) Since the releases of Du Pont's CFC-113 production plants—which sell to the military sector—are properly allocated between military and non-military CFC-113 users, we find that military factories are responsible for 31.6% of the CFC-113 emissions by the top 100 CFC-113 reporting facilities in the U.S.

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[6]Dennis Hayes, "Highest Disregard," *Mother Jones*, December, 1989, p. 35 argues that the electronics industry ignored ozone-depletion warnings and failed to use water- and terpene-based cleaning technologies.

[7]GAO, "Stratospheric Ozone: EPA's Safety Assessment of Substitutes for Ozone-Depleting Chemicals," GAO/RCED-89-49, February, 1989, p. 54. These figures take into account the ozone-depleting potential of each substance, which is based upon the percentage of the molecular weight represented by chlorine.

[8]Emphasis added. "Recommendations for Eliminating the Use of Ozone Depleting Compounds in the Defense Sector," Department of Defense Chlorofluorocarbon (CFC) Advisory Committee Report of the U.S. Congress Committees on Armed Services, July 26, 1991, p. 36.

[9]"Department of Defense Seeks Alternatives for Ozone Depleting Chemicals," News Release No. 541-88, Office of Assistant Secretary of Defense (Public Affairs), November 2, 1988.

[10]"Deadly Rays, Fragile Shield," Citizens for a Better Environment (San Francisco), October, 1990; and "Florida Weapons Contractors Deplete Ozone Layer," News Release, Florida International University, November 8, 1990.

1989 Top 100 Reporting Air Releasers of CFC-113 in United States

Sector	Number of Plants	Releases (lbs)	% Releases	% Users' Releases[11]
Military Plants	26	6,601,765	26.5%	28.4%
Energy Department Nuclear Weapons Plants	3	750,816	3.0%	3.2%
Top 100 Military Contractors' Non-Military Plants	27	7,236,317	29.0%	31.2%
Non-Military Plants	39	8,621,538	34.6%	37.1%
Total, Plants *Using* CFC-113	95	23,210,436		100.0%
Du Pont CFC-113 Production Plants	5	1,705,256	6.8%	
TOTAL: Top 100 Releasers	100	24,915,692	100.0%	

Furthermore, the military itself is responsible for an enormous volume of ozone-depleting emissions. In 1989 it *used* 1,212 metric tons, or 2,672,000 pounds of halons and 4,255 metric tons (9,381,000 pounds) of CFC's, including 2,620 tons (5,776,000 pounds) of CFC-113. *If that use is roughly equivalent to CFC releases* by the armed services, then the military sector's direct share of reported U.S. CFC-113 releases rises to 37%.[12]

But no one knows exactly how much the military releases. GAO reports:

> DOD has neither identified nor tracked all of its ozone-depleting chemical usage quantitites, specific uses, and emissions. Consequently, the military departments are not fully aware of where and in what quantities all the regulated chemicals are used.[13]

The military is not currently required to report such emissions under the Toxics Release Inventory. Though Pentagon officials have promised to cooperate with the TRI, military-operated facilities squeeze through the loophole that exempts non-manufacturing facilities. Accurate, detailed, by-facility toxics releases reporting by the Pentagon is important not only for ozone-depleting substances, but for pollutants that cause more localized damage. For this reason, the General Accounting Office recommends that the Environmental Protection Agency (EPA) expand the TRI reporting base by including non-manufacturers and other exempt facilities, and that Congress enact legislation requiring Federal agencies to take part in the TRI program.[14] We agree: Each military base

[11]This column refers to the 95 of the top 100 facilities that do not manufacture CFC-113—all but Du Pont.
[12]We obtain this percentage by applying the military plants/nuclear weapons plant percentage to the total reported releases of CFC-113, and then adding the armed forces share (not in the TRI data base) to both the numerator (military) and denominator (all reporting facilities).
[13]GAO, "Ozone-Depleting Chemicals," p. 3.
[14]"Toxic Chemicals: EPA's Toxic Release Inventory Is Useful but Can Be Improved," U.S. General Accounting Office (GAO/RCED-91-121), June 1991, p. 31.

should report its release of ozone-depleting substances through the EPA's Toxics Release Inventory.

Department of Defense responsibility for the use and release of ozone-depleting substances does not stop with military plants and bases. Many non-military plants use CFC-113 either because they supply products indirectly to the military, or merely because military standards have been adopted in some non-military sectors.

In 1988, William Parker, at that time the Pentagon's top administrator for environmental affairs, explained the far-reaching impact of the Pentagon's requirements for the use of CFC-113:

> A shift away from CFC-113 is difficult, especially for the production of military equipment, because U.S. military specifications for soldering and cleaning as written discourage the use of alternative non-ozone depleting materials. These specifications have become the de facto world standard for electronic equipment manufacture for a variety of reasons: the military is a large customer and defense pacts with our allies internationalize standards; companies often produce their entire product line to qualify for possible military purchase; companies produce commercial electronics to these standards because they are assumed to be a mark of quality; and foreign standards cite military specifications even for civilian applications.[15]

A more recent DOD study agreed, "the commercial manufacturing sector generally considers DOD standards to be 'state of the art' technology, and a great deal of commercial manufacturing is done to military specifications, particularly where product reliability is an issue."[16] In 1991, a Bells Labs scientist figured that fifty percent of all electronics products are made "per military spec... because many companies do have have quality specifications of their own...."[17]

To serve as a *rough indicator* of wider DOD responsibility, we have included in our analysis a breakdown of the top 100 CFC-113 releasing plants that are owned by the nation's 100 largest military contractors, but which we did not identify as military plants. These military-influenced facilities account for 29% of the emissions of the top 100 releasers and 31.2% of the releases of the 95 CFC-using plants in the top 100 TRI list. To our knowledge, no one has

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[15]William H. Parker, III [Deputy Assistant Secretary of Defense (Environment)], "CFC's and Halon Use Reduction within the Department of Defense," paper presented to the United Nations Environmental Programme seminar on "Substitutes and Alternatives to Chlorofluorocarbons (CFC's) and Halons," October 20, 1988. p. 14.

[16]"Recommendations for Eliminating the Use of Ozone Depleting Compounds," p. 36.

[17]Jack Shandle, "Cutting Out Cleaning," *Electronics*, January, 1991, p. 41, citing Leslie Guth.

conducted the detailed site-by-site analysis of the reasons for CFC use that would be necessary to more accurately measure the military role.[18]

Part of the Solution?

In 1987, the international community officially recognized the environmental threat of CFC releases with the signing of the "Montreal Protocol on Substances that Deplete the Ozone Layer." The Montreal agreement originally called for a fifty percent cut in CFC use by 1998. Strengthened in 1990, it now bans CFC production by the year 2000. The U.S. Clean Air Act Amendments of 1990 of 1990 translated the Montreal goals into U.S. law, in cases setting more stringent intermediate standards.

While the Montreal Protocol and Clean Air Act represent a big step forward, they temper their protection of human health, accepting claims by industry that a more rapid phase-out of ozone-depleting compounds in technically infeasible or merely too expensive. Environmentalists believe that ozone depletion is a global disaster that will continue for years even if action is taken now to protect it, so we must act as quickly as we can. The use of CFC-113 as an industrial solvent, introduced within the last decade, can and should eliminated by the mid-1990's.

To further that goal, U.S. environmental groups have been using the Toxics Release Inventory to identify and pressure major users of CFC-113. In 1987, three IBM plants, topped by the company's San Jose, California complex—with nearly 1.5 million pounds—led the national list of CFC-113 emitters . Environmentalists, organized by the Silicon Valley Toxics Coalition, staged an Earth Day 1989 rally at the IBM facility, demanding a reduction in CFC use.

Facing immediate pressure and the recognition that they would eventually need to stop using CFC's, major commercially oriented electronics companies responded. By 1989, IBM San Jose had reduced its annual CFC-113 emissions to just 230,000 pounds, using technologies such as a water-based system for cleaning disk drive parts. Others, such as Digital Equipment, Northern Telecom, AT&T, and Apple, announced plans to eliminate CFC use as well.

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[18]Several of the facilities on the "Top 100 Military Contractors Non-Military Plants" list are likely influenced by military policy, since other arms of the same firms make similar products for the military—as in case of Boeing's 747 plant in Everett, Washington. A number may be subcontractors, supplying components and parts to military divisions of the same company or to other military contractors—Motorola and AT&T, for example.

On the other hand, some plants—such as GM-Harrison Radiator—may have no military connection, so by itself the military contractor list overstates the military role.

Still, there are facilities on the list of non-military plants that are likely subcontractors for the military sector, using military specifications to make those sales possible. In fact, the top non-military plant, SCI Systems, assembles electronic products for a variety of customers, so it is likely to rely on milspecs. Such plants compensate for cases such as GM-Harrison Radiator.

These points of non-ultraviolet light are encouraging, but CFC-113 use remains enormous. TRI participants reported CFC-113 air emissions totalling 63,232,772 in 1989, the most recent year for which data is available. The *New York Times* reports:

> Many smaller companies have not yet taken action, for lack of money or interest. Military contractors have not moved as fast as commercial computer and telephone companies, saying that regulations gave them less freedom to alter their production processes.[19]

Prodded by Congress, the public, and Defense Department insiders, the Pentagon now has a comprehensive program designed to phase out the use and release of ozone-depleting compounds and to identify, test, and use environmentally responsible substitutes. Despite a series of directives and studies, the Pentagon effort remains slow and bureaucratic.

DOD has established what it considers an "aggressive schedule" for eliminating the use of such compounds, staged to deal with "non-essential uses," "essential uses," and "mission-critical uses." For chlorofluorocarbons, including CFC-113, it sets the following schedule:

	Non-Essential	Essential	Mission-Critical
Institute plans to reduce unnecessary releases during operation, maintenance, and training	October, 1990	October, 1990	October, 1990
Institute plans to eliminate procurement and use	January, 1992	January, 1993	January, 1994
Step use in new procurements	January, 1993	January, 1994	January, 1995
Phase-out of current applications to 50 percent of 1986 levels	January, 1993	January, 1995	January, 1998
Reduce use in all applications to zero (except for recycled materials)	January, 1994	January, 1996	January, 2000
Percent of current DOD use of CFC's	21%	50%	29%

This schedule may enable DOD to meet the goals of the Clean Air Act and the Montreal Protocol, but it fails to treat ozone depletion as an environmental crisis. Non-essential uses, the category slated for the most rapid response, only account for 21% of the DOD use of CFC's! The definition of non-essential uses only mentions "comfort cooling in family housing and installation support activities" as examples. Mission-critical uses are supposed to be combat-related, but GAO finds that the Navy and Air Force use that category too loosely. It says that the Pentagon "has defined mission-critical uses so broadly that the military departments have significant latitude in identifying uses that can continue beyond the planned production phase-out."[20] While it may be difficult to replace fire-

[19] Andrew Pollack, "Moving Fast to Protect Ozone Layer," *New York Times*, May 15, 1991.

[20] GAO, "Ozone-Depleting Chemicals," p. 3.

fighting halons in electronically shielded command and control facilities, there are already proven substitutes for CFC-113 in many, if not most, solvent uses.

More important, this schedule for phasing out DOD CFC use makes no direct reference to military specifications, the set of DOD policies which have the greatest impact of ozone-depletion. These standards, which guide the chemical choices of a major portion of U.S. industry, influence much more than the environmental practices of armed services. Yet the Pentagon has announced no timetable for phasing out such milspecs. This is the greatest gap in the DOD strategy.

To its credit, the Department of Defense has begun to examine the thousands of milspecs that call for the use of ozone-depleting substances. This process has the support, at least on paper, of top policy-makers, and many Pentagon researchers and managers are taking the task seriously. Compared to major commercial firms, however, the Pentagon's progress is extremely slow. GAO reports, as of September, 1991, that the Pentagon had revised only one of 9,600 standards requiring its contractors to use ozone-depleting chemicals![21] It calls on the military to speed up the revision process.

In fact, the Pentagon appears to be resisting pressure from its contractors:

> Despite a mandate last May from the Assistant Secretary of Defense for Production and Logistics calling for switching to CFC alternatives, some in DOD are resisting. Others are reworking their specifications, but mainly to please nervous suppliers who expect to run out of CFC cleaning agents.... Front-line DOD specification officials are well aware of the [Defense electronics contractors'] initiative, but, said one specification official, "We've not gotten a lot of direction from DOD in terms of this issue—at least not me."[22]

To overcome inertia within the Department, high-level DOD officials must set a timetable for eliminating requirements for ozone-depleting compounds from Federal standardization documents, technical data packages, and engineering drawings. They should withdraw or override all milspecs requiring CFC-113 solvents by January 1, 1993. To back that up, they should dedicate sufficient funds and personnel to quickly revise more detailed documents to incorporate these changes.

DOD's CFC Advisory Committee, comprised of five members each from DOD, EPA, and industry, recommends that DOD identify an individual office to coordinate the effort to eliminate requirements for CFC's and other ozone-

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[21] *ibid.*, p. 4.

[22] "DOD Asked to Stop Requiring CFC Solvents," *Defense Cleanup*, March 1, 1991, pp. 1-2.

depleting compounds.[23] That's a good idea, but it doesn't go nearly far enough. DOD should create a "CFC Command" with the budget, personnel, and authority to force recalcitrant bureaucrats to move quickly. It should be headed by someone with sufficient rank to ensure cooperation from all military components.

Though the U.S. military has a well-deserved reputation for bureaucratic inefficiency, it recently proved its ability to respond to a crisis, moving hundreds of thousands of people and vast quantities of materiel to the Middle East. Ozone degradation poses a clear and immediate threat to the environmental security of the United States, and our Defense Department must shift from a destroyer of the ozone layer to a protector. We need an Operation Ozone Shield!

Rockets Attack the Ozone Layer, Too

Together, industrial and military users of CFC's represent the largest threat to the ozone layer, but Air Force and NASA space launches are among the largest individual sources of ozone-depleting chemicals. Large solid-fueled rocket boosters, used by the Air Force on the Titan 4 expendable launcher and by NASA on the Space Shuttle, generate hundreds of thousands of pounds of toxic exhaust every time they burn.[24] A major portion of that exhaust is hydrogen chloride. When released near the Earth's surface, hydrogen chloride combines with water in the atmosphere to form hydrochloric acid, creating acid rain or acid fog. When emitted in the stratosphere, hydrogen chloride quickly breaks down into chlorine and hydrogen. The chlorine, identical to chlorine from CFC's, triggers ozone-depletion reactions.

Each Shuttle launch, reports NASA, directly deposits 68,000 kilograms (150,000 pounds) of chlorine into the upper atmosphere. This is equivalent to the amount of chlorine in 263,000 pounds of CFC-113. In all of 1989, only one industrial plant in the United States—Du Pont's West Virginia facility—released enough CFC-113 to equal the ozone destruction caused by three shuttle launches—and NASA now fires several Shuttles each year. Only four other plants release as much as two launches. Only twenty-seven more equalled the ozone-depletion impact of a single launch.

With each launch, the Titan 4's solid-fueled boosters emit nearly half the hydrogen chloride as the current Shuttle boosters. The larger Titan's Solid Rocket Motor Upgrade (SRMU), now in development, is supposed to release nearly sixty percent the exhaust as the Shuttle. With three to eight launches

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[23]"Recommendations for Eliminating the Use of Ozone Depleting Compounds in the Defense Sector," p. ES-2.

[24]For a more detailed report on the toxic impact of U.S. rocket launches, see Lenny Siegel, "No Free Launch," National Toxics Campaign Fund, August, 1990.

planned each year, the Titan program ranks just behind the Shuttle on the list of the largest annual ozone depleters.

NASA argues that solid rocket launches represent a small part of the overall problem, but that is no reason to ignore them. If our government does nothing to eliminate sources of that size, then it will accomplish virtually nothing. In fact, it can set back the entire ozone-protection effort by example: Why should releasers of minuscule amounts of ozone-depleting chemicals, such as small businesses and individual consumers, make sacrifices to help maintain the ozone layer when well funded Federal agencies such as NASA and the Air Force ignore the largest sources?

We do not call for an immediate end to space-launch activities. Rather we call for a halt in the development of new solid rocket boosters—the Shuttle's Advanced Solid Rocket Motor and the Titan SRMU—before they are produced. Future launch programs, such as the National Launch System, should also use environmentally sound technologies.

There are several possible alternatives to solid boosters, each of which must be evaluated for cost, safety, thrust, and pollution. Among the candidates that appear, at least at first glance, to pose a lesser environmental threat are liquid hydrogen-oxygen engines, like the Shuttle's main engine; hybrid engines, which use a rubberized solid fuel in combination with liquid oxygen; and solid fuels with magnesium added to combine with chlorine products.

As the participants in the Montreal Protocol and the EPA start to look at the impact of rocket launches, the Air Force, at least, sees the handwriting on the wall. An Air Force environmental official told the *Los Angeles Times*, "The EPA has yet to develop precisely what their regulations will be, but we know it's coming."[25]

We think it should come sooner, rather than later, and the Titan SRMU may be the place to start. The SRMU project is already in trouble, suffering a lethal accident in September, 1990 and a failed test-firing in April, 1991. It is at least a year behind schedule and five percent above budget. As a result, the Air Force is seeking new booster options, including at least one proposal for a liquid-fueled booster. The Air Force should choose an environmentally sound technology for Titan 4 boosters.

[25]George Hatch, "Is Space Age Offing the Ozone?" *Los Angeles Times*, July 21, 1991, p. B5.

Appendix: Top 100 CFC-113 Air Releasers by Sector, 1989[26]

COMPANY	LOCAL NAME	LOCATION	CFC-113 Emissions (lbs)	% of Top 100
			6,601,765	26.5%
Military Plants[27]			500,000	2.0%
Air Force Plant No. 4	General Dynamics	Fort Worth, Texas	484,200	1.9%
IBM		Endicott, New York	417,422	1.7%
General Dynamics		East Camden, Arkansas	408,400	1.6%
Miss. Army Ammo. Plant	Mason & Hanger	Stennis Space Center, Miss.	378,000	1.5%
Honeywell		Clearwater, Florida	377,000	1.5%
Eastman Kodak		Rochester, New York	321,000	1.3%
United Technologies	Hamilton Standard	Windsor Locks, Connecticut	300,000	1.2%
Allied-Signal	AiRResearch	Torrance, California	293,537	1.2%
Honeywell		Albuquerque, New Mexico	275,275	1.1%
Moog		East Aurora, New York	253,780	1.0%
General Dynamics		Pomona, California	232,905	0.9%
Air Force Plant No. 44	Hughes Aircraft (GM)	Tucson, Arizona	231,334	0.9%
General Electric		Lynn, Massachusetts	225,000	0.9%
Bulova	Hamilton Technology	Lancaster, Pennsylvania	185,600	0.7%
Allied-Signal	Garrett Engine	Phoenix, Arizona	179,300	0.7%
Raytheon		Lowell, Massachusetts	170,000	0.7%
United Technologies	Pratt & Whitney	North Haven, Connecticut	168,895	0.7%
Pneumo Abex	NWL Control Systems	Kalamazoo, Michigan	161,510	0.6%
General Motors	Hughes Aircraft	Fullerton, California	160,000	0.6%
Unisys		Roseville, Minnesota	157,608	0.6%
Rockwell International		Richardson, Texas	157,600	0.6%
Honeywell		Minneapolis, Minnesota	149,380	0.6%
SCI Systems		Huntsville, Alabama	140,100	0.6%
Motorola		Scottsdale, Arizona	138,519	0.6%
Sequa	Atlantic Research	East Camden, Arkansas	135,400	0.5%
Boeing		Renton, Washington		

[26] All of the release figures here and in the Appendix are taken from an EPA printout, "Top 100 Facilities for CFC 113 Releases in 1989," August 1, 1989. Unfortunately, national 1990 data will not be available until the summer of 1992. EPA does not check the submissions of participating companies, and its data do not include all TRI releases by industry. Nevertheless, it is the best yardstick of CFC-113 and other hazardous releases available.

[27] In general, we counted as military plants those facilities reporting more than $5 million in DOD Prime Contract awards in fiscal year 1989. (See "Dollar Summary of Prime Contract Awards by State, County, Contractor, and Place," DOD Directorate for Information Operations and Reports, DIOR/ST25-89.) Consequently, we did not identify as military plants Storage Technology's Louisville, Colorado facility (with $3,869,000 in contracts) or the Compaq plant in Houston, Texas (with $3,425,000). On the other hand, we included factories such as Eastman Kodak in Rochester, New York, where $33,533,000 in DOD contracts represents a relatively small portion of sales. Based on anecdotal information, we included a United Technologies/Pratt & Whitney plant in North Haven, Connecticut and a Boeing facility in Renton, Washington, in the military group. We also counted the now "mothballed" Army-owned Mississippi Army Ammunition Plant, even though it did not show up in the 1989 contract statistics. Only one other plant on our military list, Moog's East Aurora, New York factory, registered below $16,000,000 in fiscal year 1989 contracts, with $8,772,000.

COMPANY	LOCAL NAME	LOCATION	CFC-113 Emissions (lbs)	% of Top 100
Department of Energy Nuclear Weapons Plants			**750,816**	**3.0%**
Savannah River Plant	Du Pont/Westinghouse	Aiken, South Carolina	400,000	1.6%
Bendix Plant	Allied-Signal	Kansas City, Missouri	176,300	0.7%
Oak Ridge Plant	Martin Marietta	Oak Ridge, Tennessee	174,516	0.7%
Non-Military Plants of Top 100 Military Contractors[28]			**7,236,317**	**29.0%**
General Motors	Harrison Radiator	Lockport, New York	660,250	2.6%
IBM		Rochester, Minnesota	624,000	2.5%
General Motors	Delco Electronics	Oak Creek, Wisconsin	540,100	2.2%
AT&T		Lee's Summit, Missouri	505,000	2.0%
Boeing		Everett, Washington	460,160	1.8%
Motorola		Arlington Heights, Illinois	350,000	1.4%
General Motors		Coopersville, Michigan	300,000	1.2%
AT&T		North Andover, Massachusetts	295,010	1.2%
Ford Motor	Ford Electronics	Lansdale, Pennsylvania	279,000	1.1%
Hewlett-Packard		Boise, Idaho	260,000	1.0%
Acustar	Chrysler	Dayton, Ohio	259,000	1.0%
Allied-Signal		Baton Rouge, Louisiana	235,290	0.9%
IBM		San Jose, California	230,000	0.9%
General Electric		Louisville, Kentucky	227,000	0.9%
Motorola		Seguin, Texas	190,000	0.8%
General Motors	Delco Electronics	Kokomo, Indiana	178,029	0.7%
GTE	AG Communications	Northlake, Illinois	173,000	0.7%
General Electric		Morrison, Illinois	166,100	0.7%
AT&T		Oklahoma City, Oklahoma	160,700	0.6%
Motorola		Plantation, Florida	155,000	0.6%
Motorola		Phoenix, Arizona	154,000	0.6%
Unisys		Clear Lake, Iowa	150,000	0.6%
IBM		Austin, Texas	150,000	0.6%
AT&T		Little Rock, Arkansas	143,000	0.6%
Rockwell International		Downers Grove, Illinois	135,868	0.5%
TRW	Technar	Irwindale, California	128,310	0.5%
AT&T		Allentown, Pennsylvania	127,500	0.5%

[28]From "100 Companies Receiving the Largest Dollar Volume of Prime Contract Awards, Fiscal Year 1989," DOD Directorate for Information Operations and Reports, DIOR/P01-89.

COMPANY	LOCAL NAME	LOCATION	CFC-113 Emissions (lbs)	% of Top 100
Non-Military Plants			**8,621,538**	**34.6%**
SCI Systems		Rapid City, South Dakota	534,556	2.1%
Robert Bosch		Charleston, South Carolina	510,000	2.0%
Baxter HealthCare		Mountain Home, Arkansas	450,000	1.8%
Seagate Technology	Imprimis Technology	Omaha, Nebraska	323,000	1.3%
Crain Industries		Elkhart, Indiana	309,000	1.2%
Nashua Corporation		Merrimack, New Hampshire	298,000	1.2%
Baxter HealthCare		Anasco, Puerto Rico	273,375	1.1%
Compaq Computer		Houston, Texas	270,000	1.1%
Northern Telecom		Chapel Hill, North Carolina	264,500	1.1%
Lennox International		Fort Worth, Texas	264,068	1.1%
WCI Holdings	Collins & Aikman	Farmville, North Carolina	262,805	1.1%
Storage Technology		Louisville, Colorado	251,545	1.0%
Inter-City Products	Heil-Quaker	Lewisburg, Tennessee	244,000	1.0%
Wacker Siltronic		Portland, Oregon	240,000	1.0%
Timken	MPB	Keene, New Hampshire	231,000	0.9%
Millipore		Cidra, Puerto Rico	200,000	0.8%
Sony Magnetic Products		Dothan, Alabama	198,246	0.8%
MEMC Electronic Materials		Moore, South Carolina	190,000	0.8%
Meramec Group	Fashion Shoe	Sullivan, Missouri	189,000	0.8%
Bristol-Myers Squibb	Zimmer	Warsaw, Indiana	188,862	0.8%
Becton-Dickinson		Columbus, Nebraska	188,630	0.8%
Gentex		Simpson, Pennsylvania	187,655	0.8%
Siemens-Bendix Automotive		Newport News, Virginia	182,746	0.7%
Pilkington Holdings	Sola Barnes Hind	San Diego, California	181,800	0.7%
C. R. Bard	Bard Cardiopulmonary	Las Piedras, Puerto Rico	160,000	0.6%
Bausch & Lomb		Rochester, New York	160,000	0.6%
Calsonic Manufacturing		Shelbyville, Tennessee	160,000	0.6%
Matsushita Electric		Franklin Park, Illinois	160,000	0.6%
Schering-Plough	Wesley-Jessen Corp.	Chicago, Illinois	159,920	0.6%
McDermott	Babcock & Wilcox	Lynchburg, Virginia	151,500	0.6%
Becton Dickinson	Vacutainer	Sumter, South Carolina	150,000	0.6%
Jepson Corp.	Signet Armorlite	San Marcos, California	148,165	0.6%
Stanley Electric		London, Ohio	140,000	0.6%
Becton Dickinson	Deseret Medical	Sandy, Utah	138,108	0.6%
NMB	New Hampshire Ball Bearings	Peterborough, New Hampshire	136,979	0.5%
Evcon Industries		Wichita, Kansas	135,240	0.5%
Electromedics		Englewood, Colorado	132,184	0.5%
CIMCO		Costa Mesa, California	129,000	0.5%
NMB	New Hampshire Ball Bearings	Chatsworth, California	127,654	0.5%
CFC-113 Production Plants			**1,705,256**	**6.8%**
Du Pont		Washington, West Virginia	800,000	3.2%
Du Pont		Clearfield, Pennsylvania	279,480	1.1%
Du Pont	Chambers Works	Deepwater, New Jersey	229,623	0.9%
Du Pont	Corpus Christi Plant	Ingleside, Texas	211,553	0.8%
Du Pont		Antioch, California	184,600	0.7%
TOTAL (INCLUDING CFC-113 PRODUCTION PLANTS)			24,915,692	100.0%