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Waste Minimization Assessment

Goldstone Deep Space Communications Complex

JPL
Jet Propulsion Laboratory
California Institute of Technology

NASA
National Aeronautics and
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ABSTRACT

The Goldstone Deep Space Communications Complex (GDSCC), located in the Mojave Desert about 64.5 km (40 mi) north of Barstow, California, and about 258 km (160 mi) northeast of Pasadena, California, is part of the National Aeronautics and Space Administration's (NASA's) Deep Space Network (DSN), the world's largest and most sensitive scientific telecommunications and radio navigation network. The Goldstone Complex is managed, technically directed, and operated for NASA by the Jet Propulsion Laboratory (JPL) of the California Institute of Technology in Pasadena, California.

At present, activities at the GDSCC support the operation of nine parabolic dish antennas situated at five separate locations known as sites. Four sites are named Mars, Echo, Apollo and Venus. The fifth site, as yet unnamed, recently has been acquired from the U.S. Army and has two parabolic dish antennas.

Each of the five sites at the GDSCC has one or more antennas. These antennas, along with their ancillary equipment and installations, are called Deep Space Stations (DSSs). In the course of operation of these DSSs, various hazardous and non-hazardous wastes are generated.

In 1992, JPL retained Kleinfelder, Inc., San Diego, California, to identify and quantify the various streams of hazardous and non-hazardous wastes generated at the GDSCC. In June 1992, Kleinfelder Inc. submitted a report to JPL entitled "Waste Minimization Assessment" that detailed the past, present and possible future waste-management programs at the GDSCC.

This present volume is a JPL-expanded version of the Kleinfelder Inc. report.

The "Waste Minimization Assessment" report did not find any deficiencies in the various waste-management programs now practiced at the GDSCC, and it found that these programs are being carried out in accordance with environmental rules and regulations.

GLOSSARY

BLM	U.S. Bureau of Land Management
CASN	Chemical Abstract Service Number
CEPA	California Environmental Protection Agency
CFR	Code of Federal Regulations
DSCC	Deep Space Communications Complex
DSN	Deep Space Network
DSS	Deep Space Station
EA	Environmental Assessment
FSN	Federal Stock Number
ft	foot (feet)
GCF	Ground Communications Facility
GDSCC	Goldstone DSCC
HEF	High-Efficiency (Antenna)
JPL	Jet Propulsion Laboratory, Pasadena, California
km	kilometer(s)
m	meter(s)
MBGA	M. B. Gilbert Associates, Long Beach, California
MBS	Mojave Base Site (Goldstone)
mi	mile(s)
MSDS	Material Safety Data Sheets
MTF	Microwave Test Facility
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NOCC	Network Operations Control Center
NTC	National Training Center (U.S. Army)
OSHA	Occupational Safety and Health Act
PCB	Polychlorinated Biphenyl
ppm	parts per million
R&D	Research and Development
SCAQMD	South Coast Air Quality Management District
SETI	Search for Extraterrestrial Intelligence
STS	Space Transportation System (Space Shuttle)
TCA	1,1,1-Trichloroethane
TDS	Total Dissolved Solids
TMOD	Telecommunications and Mission Operations Directorate (JPL). Formerly known as TDA, the Office of Telecommunications and Data Acquisition (JPL)
TSD	Treatment, Storage, and Disposal (Facilities)
UST	Underground Storage Tank
VLBI	Very Long Baseline Interferometry
WMA	Waste Management Assessment

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SECTION I

INTRODUCTION

A. BACKGROUND OF WASTE MINIMIZATION AT THE GDSCC

The Goldstone Deep Space Communications Complex (GDSCC), is located in the Mojave Desert about 64.5 km (40 miles) north of Barstow, California, and about 258 km (160 miles) northeast of Pasadena, California, where the Jet Propulsion Laboratory (JPL) of the California Institute of Technology (Caltech) is located.

The GDSCC is part of the National Aeronautics and Space Administration's (NASA's) Deep Space Network (DSN). The DSN is the world's largest and most sensitive scientific telecommunications and radio navigation network.

The GDSCC is managed, technically directed, and operated for NASA by JPL in Pasadena, California. A detailed description of the GDSCC is presented in Section II of this report.

At present, activities at the GDSCC support the operation of nine parabolic dish antennas situated at five separate locations known as sites. Four sites are named Mars, Echo, Apollo and Venus. The fifth site, as yet unnamed, recently has been acquired from the U.S. Army and has two parabolic dish antennas.

These antennas, along with their ancillary equipment and installations, are called Deep Space Stations (DSSs). There now are nine DSSs at the GDSCC: one each at the Echo and Venus Sites, two each at the Mars and the as yet unnamed Sites, and three at the Apollo Site.

A sixth site, known as the Mojave Base Site, while part of the GDSCC, is not part of the DSN. It was previously involved in activities of the National Oceanic and Atmospheric Administration (NOAA), but these activities have been terminated as of May 1993.

In addition to the GDSCC, an off-site facility at nearby Barstow, California, is responsible for the calibration and repair of station test equipment, for personnel administration, for support of antenna hydraulic systems, and for general logistical support.

Numerous diverse activities at the GDSCC and the Barstow facility are carried out in support of the operation of the nine parabolic dish antennas. Some of these activities result in the generation of continuous and non-continuous streams of both hazardous and non-hazardous wastes.

This report deals with the history of past waste-generation and disposal at the GDSCC, with present-day waste-reduction programs at the GDSCC, and with suggested waste-reduction strategies needed to minimize the generation of both hazardous and non-hazardous wastes in the future at the GDSCC.

B. HAZARDOUS AND NON-HAZARDOUS WASTES AT THE GDSCC

1. Hazardous Wastes

At present, the main sources of continuously generated hazardous wastes at the GDSCC and the Barstow facility are oil-soaked rags and discarded oil filters. The oil-soaked rags result from various cleaning operations of antenna gearing, and the discarded oil filters come from the operations of diesel electrical-generators and motorcar pools.

Other sources of hazardous wastes are liquid solvents such as 1,1,1-trichloroethane (TCA) used for large-scale cleaning operations, and a variety of flammable liquids including oil, paints, kerosene, gasoline, antifreeze and diverse solvents.

Lead-acid batteries are sources of continuously generated solid hazardous wastes.

Both polychlorinated biphenyls (PCBs) and friable asbestos have been totally removed from the GDSCC (see JPL Publication 87-4, *Environmental Projects: Volume 1, Polychlorinated Biphenyl (PCB) Abatement Program, Final Report*, Jet Propulsion Laboratory, Pasadena, California, March 15, 1987, and JPL Publication 87-4, *Environmental Projects: Volume 12, Friable Asbestos Abatement, GDSCC*, Jet Propulsion Laboratory, Pasadena, California, June 15, 1990.

The GDSCC does not operate any facilities that require a hazardous-waste permit.

Most of the small quantity of hazardous wastes, now generated at the GDSCC each year, is sent to off-site commercial facilities for reclamation and reuse. The remainder is transported to off-site commercial treatment centers or to environmentally acceptable disposal facilities within 90 days of generation.

The GDSCC now has two properly managed central storage facilities for hazardous materials: one is located at each of the Echo and Venus Sites. In addition, nine decentralized storage facilities for hazardous materials are located as follows: three facilities at Echo Site, four at Mars Site, and one each at the Apollo and Venus Sites. Details concerning the construction in 1989 of the two new storage facilities for hazardous materials at the Echo and Venus Sites are described in JPL Publication 87-4, *Environmental Projects: Volume 9, Construction of Hazardous Materials Storage Facilities*, Jet Propulsion Laboratory, Pasadena, California, November 15, 1989.

The nine decentralized storage facilities for hazardous materials were completed in 1990.

In accordance with its environmental management program, the GDSCC conducts all of its hazardous-waste management operations in strict compliance with environmental regulations, and in a manner consistent with safety and the protection of human health and the environment.

2. Non-Hazardous Wastes

The main sources of non-hazardous wastes generated at the GDSCC and the Barstow facility are scrap wood, scrap metal, scrap wiring and various forms of paper. Figure 1 shows the scrap wood accumulation area, while Figure 2 depicts the scrap metal accumulation area, both at the Echo Site.

At the Echo Site, the GDSCC operates its own 10-acre, Class III, solid-waste landfill. This facility only accepts non-hazardous solid wastes.

The GDSCC operates a successful program for the sale of scrap lumber, scrap metal, and various forms of paper to off-site private parties for recycling and reuse. In addition, numerous unusual and salvageable items occasionally are generated and are auctioned off to private bidders and provide revenue for the GDSCC. If the item itself cannot be salvaged and sold as a complete unit, components of the item are sold for scrap recycling.

The sale of waste paper for recycling, particularly from the Barstow facility, also provides a small additional source of revenue. Figure 3 depicts the containers for the collection of recyclable cardboard at the Mars Site, while Figure 4 shows the manner in which recyclable white paper and computer paper are collected at the Echo Site.

Figure 1. Echo Site: Scrap Wood Accumulation Area

Figure 2. Echo Site: Scrap Metal Accumulation Area

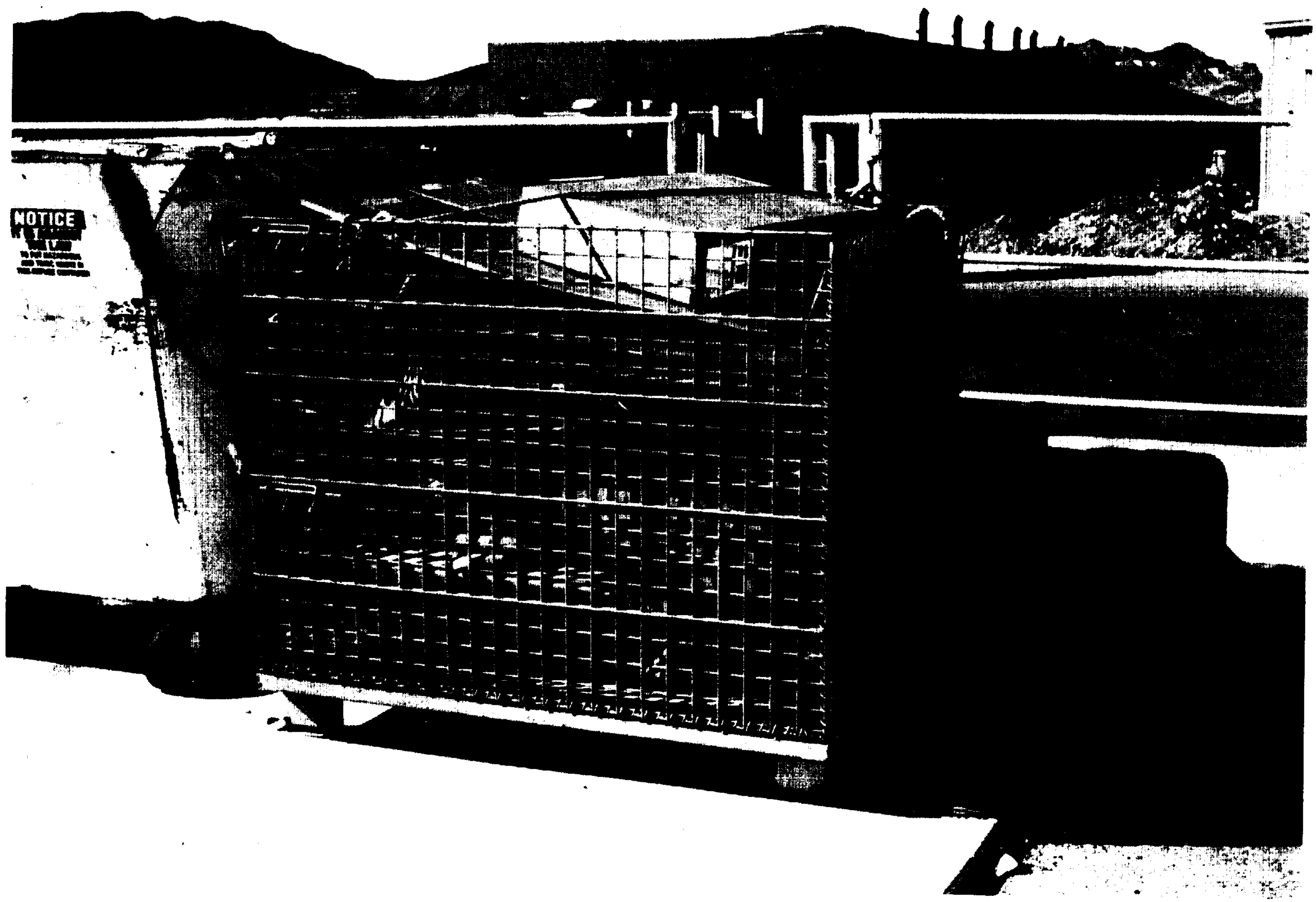


Figure 3. Mars Site: Container for the Collection of Recyclable Cardboard

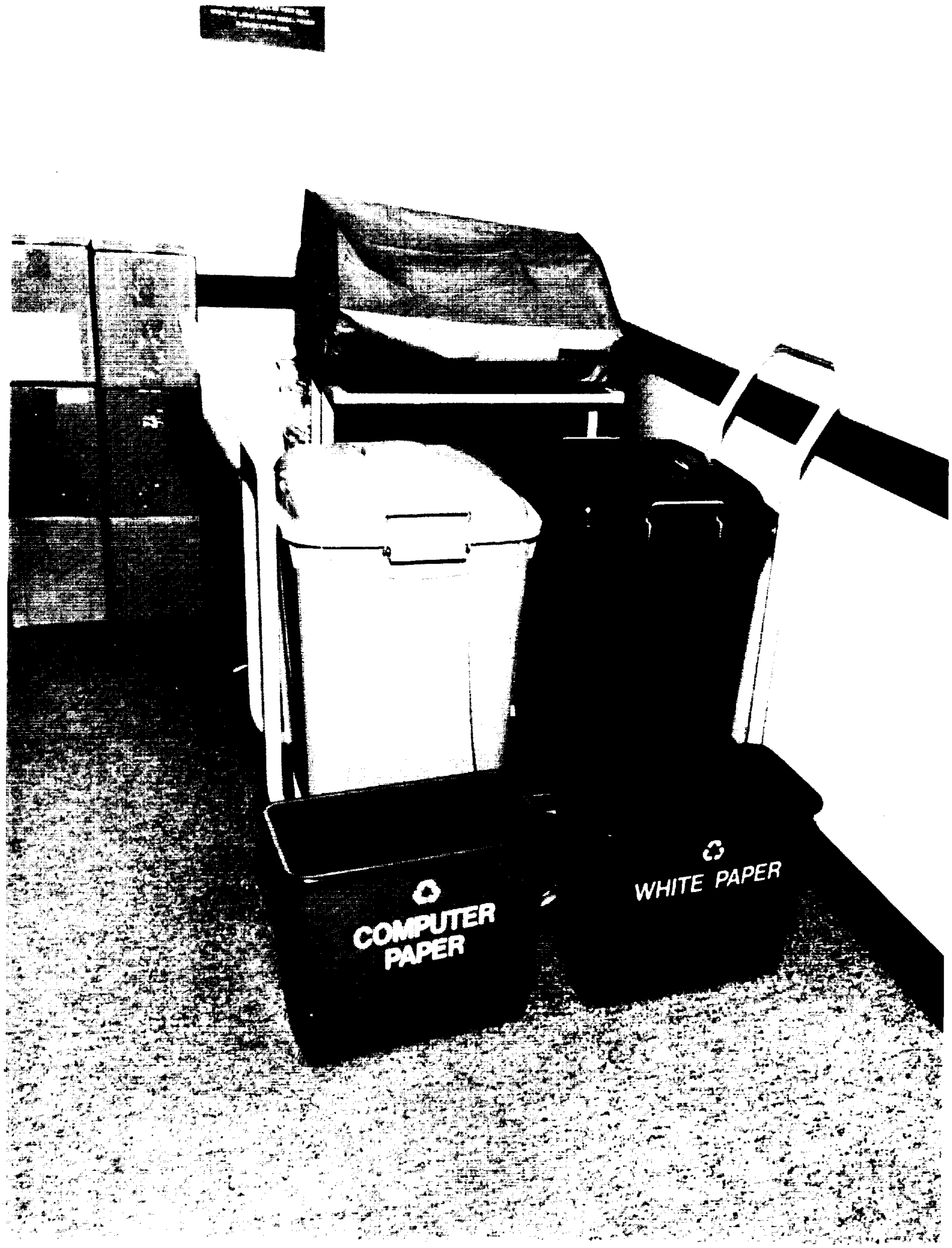


Figure 4. Echo Site: Collection of Both Computer Paper and White Paper

SECTION II

THE GOLDSTONE DEEP SPACE COMMUNICATIONS COMPLEX

A. LOCATION OF THE GOLDSTONE DEEP SPACE COMMUNICATIONS COMPLEX (GDSCC)

The GDSCC is located in southern California, in a natural, bowl-shaped depression area in the Mojave Desert, in San Bernardino County about 64.5 km (40 mi) north of Barstow, California, and about 258 km (160 mi) northeast of Pasadena, California, where JPL is located.

As indicated in Section I, the GDSCC is part of NASA's Deep Space Network (DSN), the world's largest and most sensitive scientific telecommunications and radio navigation network. The GDSCC is managed, technically directed, and operated for NASA by JPL.

The 135-km^2 (52-mi^2) GDSCC lies within the western part of the Fort Irwin Military Reservation (Figure 5). A Use Permit for the land was granted to NASA by the U.S. Army. The GDSCC is bordered by the Fort Irwin Military Reservation on the north, east, and southeast; the China Lake Naval Weapons Center on the northwest; and the State and Federal lands managed by the U.S. Bureau of Land Management (BLM) on the south.

B. FUNCTIONS OF THE GDSCC

After the Space Act of 1958 had accelerated U.S. plans and programs for space exploration, JPL initiated construction work at Goldstone to build the first tracking station of what is now known as the DSN. Thus, for almost four decades, the primary purpose of the DSN has been and continues today to be the support of the tracking of both manned and unmanned spacecraft missions and providing instrumentation for radio and radar astronomy in the exploration of the solar system and the universe.

Over the years, the DSN has become a world leader in the development of low-noise receivers; tracking, telemetry, and command systems; digital signal processing; and deep-space radio navigation.

The basic responsibilities of the DSN are to receive telemetry signals from spacecraft, to transmit commands that control the various spacecraft operations, and to generate the radio navigation data to locate and guide the spacecraft to its destination.

Because of its advanced technical ability to perform the above services, the DSN also is able to carry out the following functions: flight radio science, radio and radar astronomy, very long baseline interferometry (VLBI), and precise measurement of minute earth movements (geodynamics). Until October 1993, when the program was canceled, the DSN also participated in NASA's Search for Extraterrestrial Intelligence (SETI).

The GDSCC also is an R&D center both to extend the communication range and to increase the data acquisition capabilities of the DSN. It serves as a proving ground for new operational techniques. Prototypes of all new equipment are thoroughly tested at the GDSCC before they are duplicated for installation at overseas stations (see Section II.C).

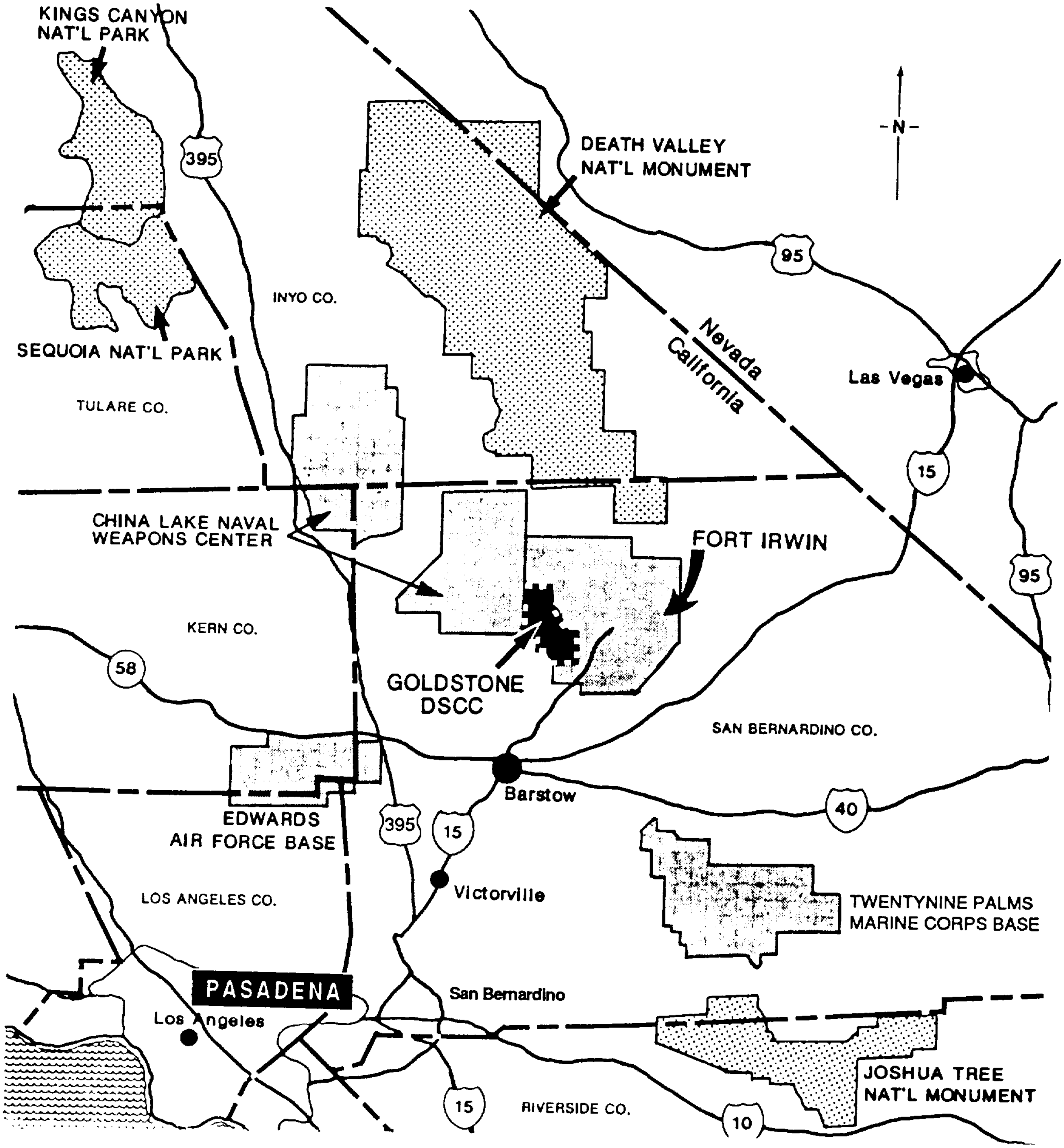


Figure 5. Geographic Relationship of the Goldstone Deep Space Communications Complex (GDSCC) to JPL in Pasadena, California

C. FACILITIES AT THE GDSCC

The GDSCC is a self-sufficient, working community with its own roads, airstrip, cafeteria, electrical power, and telephone systems, and it is equipped to conduct all necessary maintenance, repairs, and domestic support services. Facilities at the GDSCC include about 100 buildings and structures that were constructed during a 30-year period from the 1950s through the present. The construction of additional buildings and structures continues today as the GDSCC increases its activities and operations.

Goldstone is one of three Deep Space Communications Complexes (DSCCs) operated by NASA. The three DSCCs are located on three continents: at Goldstone in southern California's Mojave Desert; in Spain, about 60 km (37 mi) west of Madrid at Robledo de Chavela; and in Australia, near the Tidbinbilla Nature Reserve, about 40 km (25 mi) southwest of Canberra. Because these three DSCCs are approximately 120 deg apart in longitude, a spacecraft is nearly always in view of one of the DSCCs as the Earth rotates on its axis (Figure 6).

Activities at the GDSCC support nine parabolic dish antennas, and their ancillary equipment and installations, at five separate sites called Deep Space Stations (DSSs): Four sites are operational for space missions, while one is devoted to R&D activities. There also are four, similar, operational sites with four DSSs each in Spain and in Australia. Thus, the NASA DSN consists of a worldwide network of 12 operational DSSs.

The GDSCC also includes one antenna (DSS 13) at the Venus Site for research and development (R&D). The Mojave Base Site, with one parabolic dish antenna, was operated by the National Oceanic and Atmospheric Administration (NOAA), but its activity was terminated in May 1993.

A Network Operations Control Center (NOCC), located at JPL in Pasadena, controls and monitors the DSN. A Ground Communications Facility (GCF) of the DSN operates to link together the NOCC at JPL with the three DSCCs at Goldstone, Spain, and Australia.

A 26-m (85-ft) antenna, located at the Pioneer Site, was deactivated in 1981. In 1985, the Pioneer antenna (DSS 11) was designated a National Historic Landmark by the U.S. Department of Interior, and the Pioneer Site was returned to the U.S. Army. Each of the Goldstone sites is briefly described below.

Total NASA/JPL facilities at the GDSCC (Figure 7) include the nine DSN parabolic dish antennas, an airport, a microwave test facility, miscellaneous support buildings, and a remote support facility in Barstow, California, located about 64.5 km (40 mi) south of the GDSCC. The GDSCC support staff consists of about 260 personnel on-site and at the Barstow facility. Table 1 summarizes the major facilities, buildings (number and square footage), and antennas (construction date and size). Four sites within the GDSCC have antennas (referred to as stations) devoted to NASA DSN operations: Echo Station at the Echo Site, Mars and Uranus Stations at the Mars Site, and three antennas at the Apollo Site. The Venus Station, the antenna contained at the Venus Site, is devoted to R&D. A fifth site, as yet unnamed, has two antennas recently acquired from the U.S. Army. The unnamed site contains the two antennas, DSS 27 and DSS 28, and is located before the approach to the Venus Site.

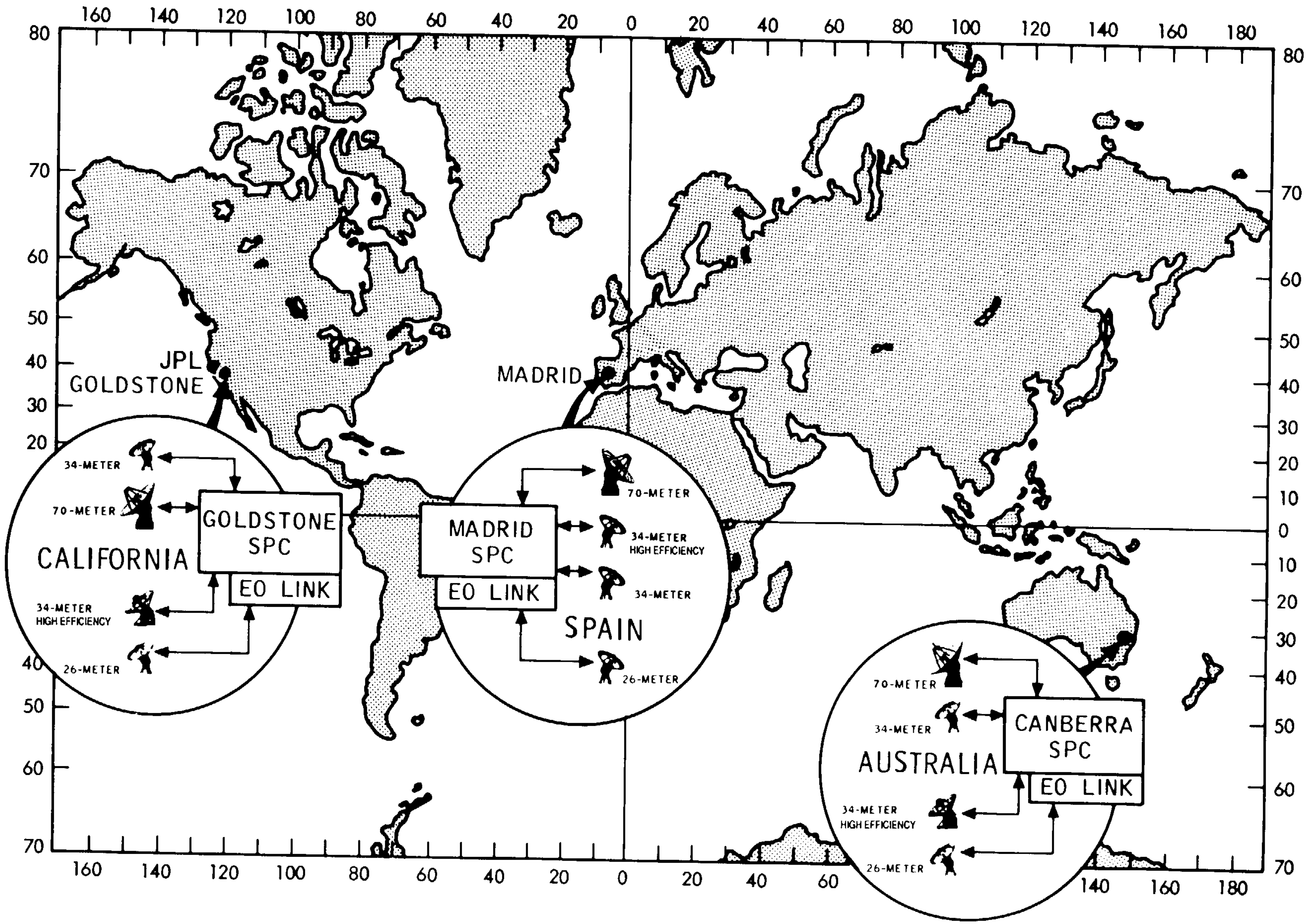


Figure 6. The Three-Continent NASA Deep Space Network as It Exists in 1994

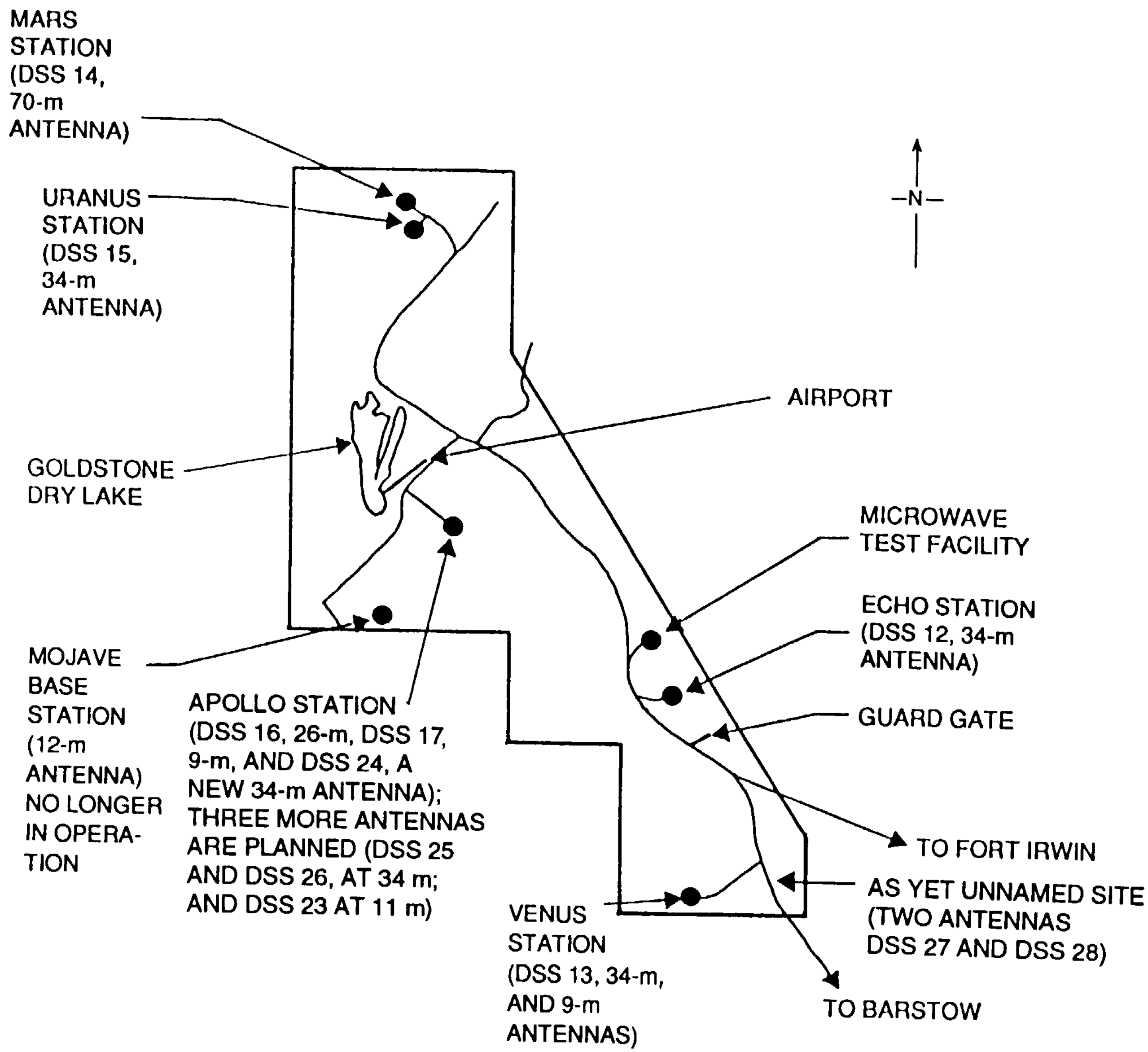


Figure 7. Schematic Map of the GDSCC Showing Locations of the Nine NASA Deep Space Stations (DSSs) and the Mojave Base Station, Once Operated by NOAA

Table 1. Major Facilities at the GDSCC

Site	Station Number	Buildings: Number	Buildings: (ft²)[a]	Antennas: Date of Construction	Antennas: Size (meters)
Echo Site	—	25	79,208	—	—
	DSS 12	—	—	1961[b]	34[c]
Venus Site	—	15	12,589[d]	—	—
	DSS 13 (new)	—	—	1991	34
	DSS 13 (old; no longer used)	—	—	1962[e]	26
	Existing antenna (no number assigned and no longer used)	—	—	—	9
Mars Site	—	14	41,754	—	—
	DSS 14	—	—	1966/1988	70[f]
	DSS 15	—	—	1984	34
Apollo Site	—	21	43,978	—	—
	DSS 16	—	—	1965[g]	26
	DSS 17	—	—	—	9
	DSS 24[h]	—	—	1994	34
Mojave Site	—	5	11,850	1964	12[i]
Airport[j]	—	3	4,848	1963/1970	—
Microwave Test Facility	MTF	1	2,880	1963	—
Miscellaneous	—	3	1,430	—	—
Barstow Facility[k]	—	1	28,343	—	—
Unnamed Site[l]	DSS 27	—	—	1994	34
	DSS 28	—	—	1994	34

[a] To convert square feet into square meters, multiply by 0.09290.

[b] The original antenna, built in 1959, was moved to the Venus Site in 1962. A 26-m antenna, built in 1961, was extended to 34 m in 1978.

[c] This antenna is to be dismantled and removed after the planned DSS-24 antenna at the Apollo Site becomes operational.

[d] This square footage does not include the two newly constructed facilities for Hazardous Materials Storage and for Acid Wash.

[e] This antenna was constructed at the Echo Site in 1959 and moved to the Venus Site in 1962. It no longer is being used and is being offered to any party willing to remove it from the GDSCC.

[f] Originally constructed as a 64-m antenna in 1966; enlarged to a 70-m antenna in 1988.

[g] This antenna originally was constructed for the NASA Goddard Space Tracking and Data Network. JPL/GDSCC/DSN operation of the antenna began in October 1984.

[h] This DSS-24 antenna previously was designated as DSS 18. Three new antennas are now planned for the Apollo Site: DSS 23, 11 m; and DSS 25 and DSS 26, each at 34 m.

[i] This antenna was operated by the National Oceanic and Atmospheric Administration (NOAA).

[j] The airport is located at the Goldstone Dry Lake.

[k] This site, a leased facility, is located in Barstow, California, about 64.5 km (40 mi) southwest of the GDSCC.

[l] JPL recently acquired these two antennas from the U.S. Army. The unnamed site is located before the approach to the Venus Site.

Source: *Directory of Goldstone DSCC Buildings and Supporting Facilities (Gold) Book*, JPL Document 880-165, internal document, Jet Propulsion Laboratory, Pasadena, California, October 1989 (revised edition).

D. ANTENNA STATIONS AT THE GDSCC

1. Echo Site DSS (DSS 12)

The Echo Site, as the administration center and operations headquarters of the GDSCC, is the most extensively developed site on the complex. It has one 34-m (111.5-ft) antenna and 24 support buildings, with a combined area of 7,358 m^2 (79,208 ft^2). Support buildings include administration and engineering offices, cafeteria, dormitory, transportation and maintenance facilities, storage areas, and warehouses. The Echo Station originally was built in 1959 as a 26-m (85-ft) antenna. The antenna was first used in 1960 to support the Echo Project, an experiment to transmit voice communications coast-to-coast by bouncing radio signals off the reflective Mylar surface of a passive balloon-type satellite. In 1962, this original 26-m antenna was moved to the Venus Site. In anticipation of this move, a newer 26-m antenna had been built at the Echo Site in 1961. In 1978, this antenna was enlarged to 34 m (111.5 ft). The present antenna is approximately 35 m (113 ft) high and weighs about 270,000 kg (300 tons). Eventually, its functions are to be replaced by the new beam-waveguide DSS-24 34-m antenna that has been constructed at the Apollo Site.

2. Venus Site (DSS-13)

The Venus Site consists of three antennas: DSS 13, a new 34-m (111.5-ft) antenna, a 26-m (85-ft) antenna, and a 9-m (29.5-ft) antenna. The smaller antenna is no longer used. There are 15 buildings with a combined area of 1,170 m^2 (12,589 ft^2). The support buildings provide space for operations control, laboratories, offices, security, workshops, warehouses, and mechanical equipment. The 26-m antenna, which was originally located at the Echo Site, was moved to the Venus Site in 1962. The antenna was used for a radar astronomy study of the planet Venus. Currently, it no longer is in use and is being offered to any party willing to remove it from the GDSCC. The primary functions of the new DSS 13 are R&D and performance and reliability testing of high-power radio-frequency transmitters and new systems and equipment prior to their introduction into the DSN.

The newly constructed DSS-13 antenna, a 34-m (111.5-ft) antenna similar in size and structure to DSS 15 (see below), began operation with R&D activities in 1991. It is to functionally replace the older 26-m antenna. An Environmental Assessment concerning this new DSS-13 antenna is the subject of JPL Publication 87-4, *Environmental Projects, Volume 6, Environmental Assessment: New 34-Meter Antenna at Venus Site*, Jet Propulsion Laboratory, Pasadena, California, June 15, 1988.

3. Mars Site (DSS 14 and DSS 15)

The Mars Site consists of two antennas at two stations (the Mars and Uranus stations) and 14 buildings, with a combined area of 3,879 m^2 (41,754 ft^2). The support buildings provide facilities for operations control, offices, training, mechanical equipment, storage, and security. The Mars Site now provides the logistics to operate every DSS at the GDSCC. In May 1989, M. B. Gilbert Associates (MBGA), Long Beach, California, submitted an Environmental Assessment to JPL concerning the construction work needed for a proposed building extension to the Operations Building (Bldg. G-86) at the Mars Site. The building extension was completed in 1992.

JPL Publication 87-4, *Environmental Projects: Volume 11, Environmental Assessment: Addition to Operations Building, Mars Site*, Jet Propulsion Laboratory, Pasadena, California, February 15, 1990, is an expanded JPL version of the Environmental Assessment document submitted to JPL by MBGA in May 1989.

The Mars Station Antenna (DSS 14), at 70 m (230 ft) in diameter, is one of the larger antennas of its kind in the world (see front cover). In 1991, the antenna celebrated its 25th anniversary of operation. The antenna, which originally was constructed as a 64-m antenna in 1966 and was enlarged to a 70-m antenna in 1988, is 7.25 times more powerful and sensitive than a 26-m antenna, extending the range of deep space communications by 2.7 times. It can maintain communications with spacecraft to the edge of the solar system. Standing more than 235 ft high, this antenna is one of the more striking features to be seen in the GDSCC geographic area. The 70-m antenna was used in August 1989 for the Voyager 2 spacecraft's encounter with the planet Neptune. The latter is located at a distance of 4.5 billion km (2.8 billion miles) from Earth.

The Uranus Station Antenna (DSS 15) has a 34-m (111.5-ft) high-efficiency (HEF), precision-shaped antenna, located approximately 488 m (1,600 ft) southeast of the Mars Station antenna. Built in 1984, this antenna at the GDSCC first was used in January 1986 to support the encounter of the Voyager 2 spacecraft with the planet Uranus. The latter is located at a distance of more than 3 billion km (1.8 billion miles) from Earth. The newly constructed 34-m, precision-shaped antenna at the Venus Site (see above) and the newly constructed DSS-24 antenna at the Apollo Site (see below), are similar in size and structure to this Uranus Station antenna.

4. Apollo Site (DSS 16, DSS 17, and DSS 24)

The Apollo Site has a 26-m (85-ft) antenna (DSS 16), a 9-m (29.5-ft) antenna (DSS 17), and 21 buildings, with a combined total area of 4,086 m^2 (43,978 ft^2). The buildings provide space for operations, equipment, storage, and warehousing. The 26-m antenna originally was constructed in 1965 by NASA's Goddard Space Tracking and Data Network to support the manned Apollo missions to the Moon. Operation of this antenna under JPL management began in October 1984. Both the 26-m and the 9-m antennas now are used to support the missions of the Space Shuttle [Space Transportation System (STS)] and satellites in both low and high Earth orbits. In May 1989, M. B. Gilbert Associates, Long Beach, California, submitted an Environmental Assessment to JPL concerning the construction work needed for a planned new 34-m (111.5-ft) antenna (DSS 24) at the Apollo Site[1]. The details of this Environmental Assessment are described in JPL Publication 87-4, *Environmental Projects: Volume 10, Environmental Assessment: New 34-Meter Antenna at Apollo Site*, Jet Propulsion Laboratory, Pasadena, California, January 15, 1990. Construction of this new DSS 24 antenna now has been completed. Three more antennas are being constructed at the Apollo Site: DSS 23 at 11 m, and DSS 25 and DSS 26, each at 34 m.

5. Mojave Base Site

The Mojave Base Site has one antenna and five buildings, with a combined area of 1,100 m^2 (11,850 ft^2). At one time, these buildings provided support facilities for operations, equipment, and maintenance. These buildings now are not in use.

[1] The newly constructed DSS-24 antenna previously was designated as DSS 18.

The Mojave Base Site has a 12-m (40-ft) antenna that until May 1993 had been operated by NOAA. The antenna was involved in several programs, including monitoring of shifts in the Earth's tectonic plates, monitoring weather changes, and retrieving information from very low-orbiting Earth satellites. In May 1993, all NOAA activities ceased at the Mojave Base Site.

E. SUPPORT FACILITIES AT THE GDSCC

1. Goldstone Dry Lake Airport

The airport consists of an approximately 1,829-m × 31-m (6,000-ft × 100-ft) paved runway. There are two buildings at the airport site neither of which is presently in use. An open hangar is used to provide shelter for a single aircraft. For its personnel, NASA operates three scheduled shuttle flights per week to the GDSCC that originate from the Van Nuys Airport. In addition, the Goldstone airport is used infrequently by administrative U.S. Army flights. Both NASA and the U.S. Army use propeller-driven aircraft.

2. Microwave Test Facility and Fire-Training Area

The Microwave Test Facility (MTF) and Fire-Training Area consist of a single building of 268 m^2 (2,880 ft^2) along with areas identified for fire fighting. The MTF is used for R&D testing of antenna microwave equipment. Fire training includes procedures for the quenching of fires.

3. Miscellaneous Buildings in the GDSCC Area

Three buildings and structures at the GDSCC that fall into this category include the main gate house, pump house, and radio spectrum monitor. The total area of these three buildings/structures is 133 m^2 (1,430 ft^2).

4. Off-Site Facility at Barstow, California

In addition to the above-mentioned on-site facilities, the GDSCC leases an office and warehouse support facility. The facility is a single-story, 2,633-m^2 (28,343-ft^2) structure located at 850 Main Street, in the nearby city of Barstow. The Barstow facility is responsible for the calibration and repair of station test equipment, for personnel administration, for support of antenna hydraulic systems, and for general logistic support.

F. NONSTRUCTURAL SUPPORT FACILITIES AT THE GDSCC

1. Transportation Network

The major roadways in the area are shown in Figure 8. The only surface public transportation route to the GDSCC is by the Fort Irwin Road that leads to Fort Irwin. The NASA Road cutoff from Fort Irwin Road leads into the GDSCC. The NASA Road merges with Goldstone Road, which is the only north-south paved access road within the complex. Both the NASA and Goldstone Roads are paved two-lane roads and are maintained by the Fort Irwin Post Engineer. Two-lane paved access roads also lead to each of the sites and major facilities.

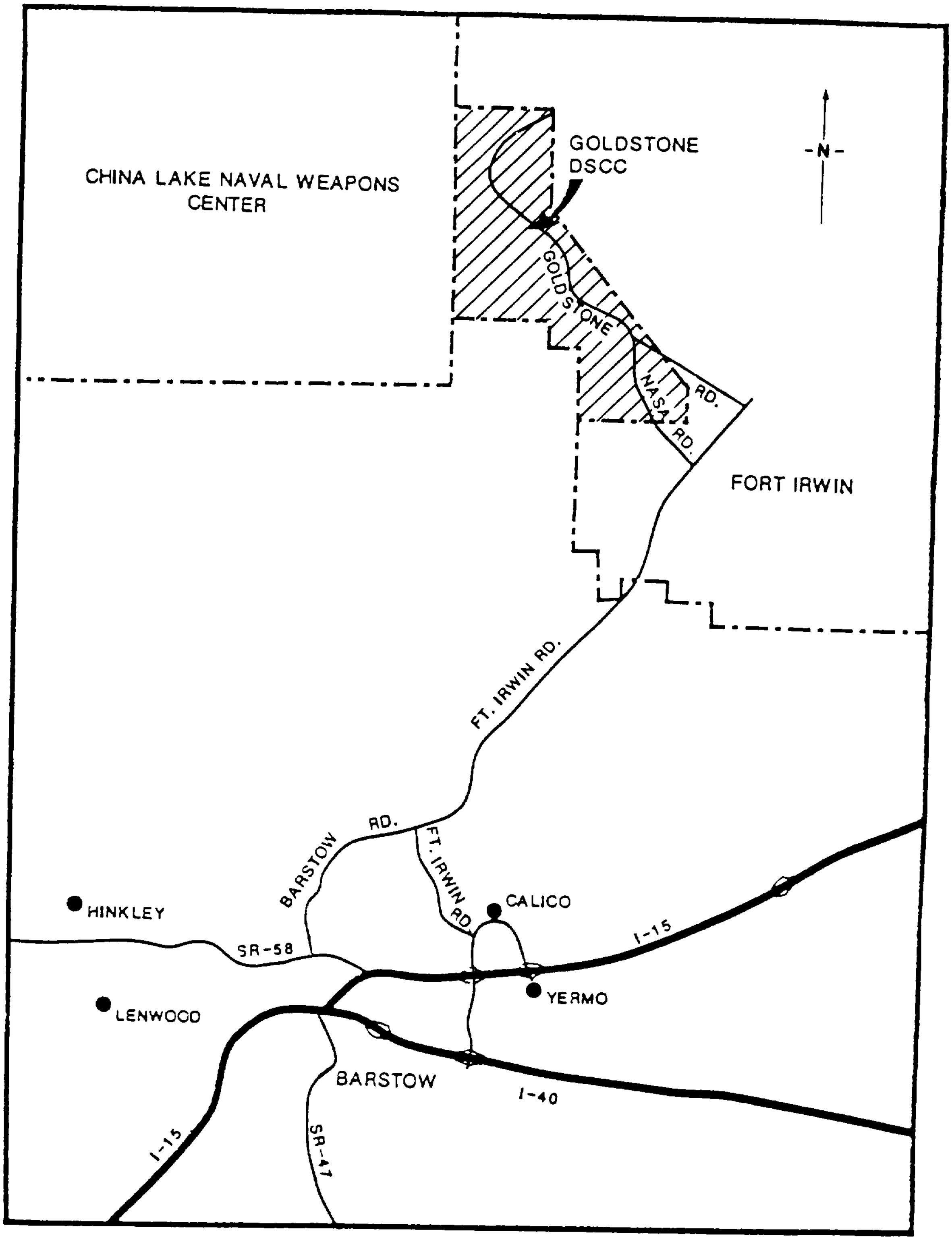


Figure 8. Major Roads Leading to and at the GDSCC

2. Utilities and Services

The Southern California Edison Company provides electricity for the Goldstone Complex. The GDSCC provides its own backup diesel-engine generators to ensure operations during emergencies and continuity of electrical service for prescheduled periods of time. Gasoline, diesel oil, and hydraulic oil are stored in double-walled underground storage tanks (USTs) fitted with sensors between the walls to detect leaks. Water is supplied by Fort Irwin from groundwater basin wells. Sanitary sewage is discharged through septic tank systems to leaching fields. The Echo and Mars Sites discharge wastewater to evaporation ponds (see JPL Publication 87-4, *Environmental Projects: Volume 8, Modifications of Wastewater Evaporation Ponds*, Jet Propulsion Laboratory, Pasadena, California, October 15, 1989).

G. SOLID-WASTE MANAGEMENT FACILITIES AT THE GDSCC

At the Echo Site, the GDSCC operates its own 4.05-hectare (10-acre), Class III landfill. This facility accepts only nonhazardous, solid wastes.

Most of a small quantity of hazardous waste, generated at the GDSCC each year, is sent to off-site commercial facilities for reclamation and eventual reuse. The remainder is transported to off-site commercial treatment or disposal facilities within 90 days of generation. The GDSCC now has two new centralized storage facilities for hazardous materials and wastes: one is located at the Echo Site, the other at the Venus Site. In addition, nine decentralized storage facilities for hazardous materials are located as follows: three facilities at the Echo Site, four at the Mars Site, and one each at the Apollo and Venus Sites. The GDSCC does not operate any facilities that require a hazardous waste permit. Details concerning the construction of the two new centralized storage facilities for hazardous materials and wastes at the Echo and Venus Sites are described in JPL Publication 87-4, *Environmental Projects: Volume 9, Construction of Hazardous Materials Storage Facilities*, Jet Propulsion Laboratory, Pasadena, California, November 15, 1989. The nine decentralized storage facilities for hazardous materials and wastes were completed in 1990. In accordance with its environmental management program, the GDSCC conducts all of its waste-management operations in strict compliance with environmental regulations, in a manner consistent with protection of human health and the environment.

H. WASTEWATER MANAGEMENT FACILITIES AT THE GDSCC

Four functioning sewage evaporation ponds, one pair at the Echo Site and another pair at the Mars Site, are designed to receive effluent from an upstream septic tank system. Extensive work was completed in the spring of 1989 to repair and reshape the previously eroded embankments of the wastewater evaporation ponds. Details of this construction work are recorded in JPL Publication 87-4, *Environmental Projects: Volume 8, Modifications of Wastewater Evaporation Ponds*, Jet Propulsion Laboratory, Pasadena, California, October 15, 1989. Since this report was written, another pair of sewage evaporation ponds has been constructed at the Mars Site. All sewage evaporation ponds now are lined with concrete banks.

I. UNDERGROUND STORAGE TANKS (USTs) AT THE GDSCC

As a large-scale facility located in a remote, isolated desert region, the GDSCC operations to support the various DSS antennas require numerous on-site storage facilities for gasoline, diesel oil, hydraulic oil, and waste oil. The most environmentally safe and economical way to store large quantities of these liquids is in double-walled, steel shells with outer fiberglass coating for corrosion protection, and a monitoring system in the annular space between the inner and outer shells to detect any leaks from either shell.

The installation of 13 new USTs with the above-described, environmentally safe properties (7 at the Echo Site, 5 at the Mars Site, and 1 at the Mojave Base Site) is discussed in detail in JPL Publication 87-4, *Environmental Projects: Volume 13, Underground Storage Tanks: Removal and Replacement*, Jet Propulsion Laboratory, Pasadena, California, February 15, 1991.

The removal of soil that had been contaminated by leakage from some of the old USTs is discussed in detail in JPL Publication 87-4, *Environmental Projects: Volume 14, Removal of Contaminated Soil and Debris*, Jet Propulsion Laboratory, Pasadena, California, March 1992.

J. OPERATIONAL RELATIONSHIPS BETWEEN THE GDSCC AND FORT IRWIN

Because the GDSCC is located within the Fort Irwin property, the two installations potentially can affect each other's roles and missions. Fort Irwin is a U.S. Army installation serving as the U.S. Army National Training Center (NTC). The remote desert environment allows military task forces to practice large-scale training maneuvers that could affect natural, historic, and cultural resources at the GDSCC. This especially is true when the maneuvers involve the movement of heavy equipment (tanks, large trucks) within the GDSCC. Most maneuvers occur at the eastern border of the GDSCC, and every effort is made by both the GDSCC and Fort Irwin personnel to avoid the use of sensitive areas for such maneuvers.

K. NATURAL ENVIRONMENTAL ASPECTS OF THE GDSCC

1. Geology

The GDSCC is located in the North Central section of the Mojave Desert Province. Typically, the Mojave Desert Province consists of broad, flat plains separated by low mountains [305 to 610 m (1,000 to 2,000 ft) of topographic relief]. The GDSCC is situated within one of these low mountain areas.

The GDSCC is located in a naturally occurring bowl-shaped depression area bounded on three sides by geological faults. The Garlock Fault lies to the north, while the Blackwater and Calico Faults lie, respectively, to the west and south. The GDSCC is bounded on the east by the Tiefort Mountains. Each antenna site at the GDSCC is located on natural alluvial material, ranging in thickness from 4.6 m (15 ft) at the Venus Site to more than 21.3 m (70 ft) at the Echo Site. The alluvium is derived from the surrounding hills.

2. Hydrology

Groundwater in the Goldstone area is generally confined and is found at depths ranging from 51.8 m (170 ft) near the Minitrack Site to approximately 305 m (1,000 ft) below the Echo Site. Chemical analyses of the groundwater have yielded total dissolved solids (TDS) values in excess of 1,000 ppm, indicating that the groundwater is brackish. The Goldstone Complex currently obtains potable water from a group of wells located at Fort Irwin, approximately 16.09 km (10 mi) to the southeast.

3. Climatic Conditions

The GDSCC lies within the U.S. Naval Weather Service's Southwest Desert, Climatic Area A. Mean annual temperatures for the area range from 10 to 26.7°C (50 to 80°F). Temperatures can climb as high as 45.5°C (114°F) during the summer months, and drop as low as -11.7°C (11°F) during the winter months. Mean annual precipitation for the area is approximately 6.35 cm (2.5 in.); most precipitation falls between November and February.

SECTION III

WASTE-MANAGEMENT PROGRAMS AT THE GDSCC

A. BACKGROUND OF WASTE MANAGEMENT AT THE GDSCC

In general, recent land bans, closures and use restrictions, concerning facilities for the treatment, storage and disposal (TSD) of hazardous wastes, have raised concern over the future of TSD facilities and the increasing costs associated with their use.

Furthermore, in particular, recently passed California legislation mandates the reduction and treatment of hazardous wastes and strictly specifies which treatment methods are acceptable. These recent laws, coupled with shrinking space for landfills in California, have heightened the responsibilities and have accelerated the efforts of installations that generate both hazardous and non-hazardous wastes to create strategies to reduce the generation of wastes.

Faced by the above-mentioned environmental concerns, and determined to provide more cost-effective alternatives, the GDSCC voluntarily has implemented a program both to manage wastes effectively, and to provide strategies to minimize the generation of wastes.

In June 1992, Kleinfelder, Inc., San Diego, California, was retained by JPL to assist with the development of a Waste Management Assessment (WMA) for both the GDSCC and the Barstow support facility. The result of the Kleinfelder, Inc. work was the publication of a report entitled "Waste Minimization Assessment." The report documents the waste-reduction programs used at the GDSCC and the Barstow support facility to minimize the generation of both hazardous and non-hazardous wastes.

The Kleinfelder, Inc. report deals with the volumes of wastes generated in the past, with a comparison of both the past and present generation of waste and the techniques used to reduce them, and with suggestions to reduce and treat wastes generated in the future both at the GDSCC and the Barstow facility.

This present volume is a JPL-expanded version of the Kleinfelder Inc. report.

B. WASTE-MANAGEMENT TRAINING PROGRAMS FOR PERSONNEL AT THE GDSCC

All environmental and safety personnel at the GDSCC and the Barstow facility are certified in accordance with Section 1910.12 of the Code of Federal Regulations (CFR 29). This certification involves a 40-hour training period that is required by the Occupational Safety and Health Act (OSHA) for all personnel who may be involved in the handling of hazardous materials and wastes.

1. Orientation Sessions for New Employees at the GDSCC

New employees at the GDSCC are required to attend an orientation session conducted one-on-one with personnel from the GDSCC environmental office. Participants are required to watch two 15-minute films that deal with how to read the labels of hazardous materials, and with the use and interpretation of Material Safety Data Sheets (MSDS).

Specific information also is provided that deals with the particular shop and operations to which the new employee has been assigned. Detailed information concerning the specific materials used in that shop's operation, as well as any other information available about specific, potentially dangerous workshop procedures, is provided and discussed.

At the end of the orientation session, each participant completes a quiz based upon the information that had been provided. The employee also is given a label-sequence card that defines the various terms the employee is likely to find printed on the labels of hazardous materials. Following his attendance at the orientation session, the employee receives further shop information from his shop supervisor.

Within each shop are MSDS stations that contain an appropriate MSDS index to booklets that provide general and specific information on the proper handling of hazardous materials. The MSDS stations also contain a form that has been developed at the GDSCC that describes general safety procedures.

2. Weekly and Monthly Discussion Sessions for Employees at the GDSCC

All personnel who work with hazardous materials at the GDSCC are required to attend weekly informal sessions led by a designated shop-safety officer or a shop supervisor. The purposes of these weekly sessions are to acquaint GDSCC personnel with any new materials in the workplace and their associated MSDSs, and to allow for discussion of any shop-specific concerns that may have arisen.

In addition, monthly sessions are held that are led by safety and environmental personnel. These sessions allow for the discussion of any problems that may have developed and also permit the review of any general concerns with regard to safety, health or the environment.

These various training programs and sessions are essential to sustain the knowledge of GDSCC personnel with respect to current safety, health and environmental issues.

3. Training for Control and Prevention of Spills of Hazardous Materials

Training in the control and prevention of spills of hazardous materials instructs personnel in the use of spill kits that are provided at each shop in the event of an accident. After the occurrence of any spill of a hazardous material, the events that led up to the spill are investigated by safety and environmental personnel to assess the events that resulted in the spill and to provide information on how to prevent spills in the future.

The GDSCC also maintains an Emergency Spill Response Team made up of employees who also serve as voluntary firemen. All members of this team have received the 40-hour OSHA-training procedure and they also serve as volunteer firemen for the town of Barstow.

4. Material Safety Data Sheets (MSDSs)

All materials used at the GDSCC are described by Material Safety Data Sheets (MSDSs). The complete MSDS index not only contains the usually recognized names of the materials, but also all of the synonyms that have ever been used to describe that material.

Since 1989, the number of entries in the MSDS index at the GDSCC has climbed from 224 to 507. Entries are indexed according to the following categories: Product name, a facility-assigned MSDS number, Federal Stock Number (FSN), and Chemical Abstracts Service Number (CASN).

Although the Environmental Office at the GDSCC has a complete MSDS index that contains all of the available MSDS volumes, each specific shop at the GDSCC retains an MSDS index that contains only the MSDSs that are pertinent to the specific materials used at that shop.

All materials arriving for use at the GDSCC are labeled by an Environmental Inspector who is responsible for seeing that the label carries all pertinent safety and health information concerning that material. The Environmental Inspector also assigns a GDSCC-specific MSDS number that corresponds to the number of that material in the MSDS index.

Audits are conducted to ensure that no new materials enter the GDSCC without being labeled with an MSDS reference number. Monthly audits by both environmental and safety personnel are conducted in every shop and building at the GDSCC.

All GDSCC shop personnel are instructed not to use either familiar or unfamiliar materials unless there is an MSDS associated with that material. If an MSDS cannot be found for a material, the personnel are instructed to bring the material to either the environmental or the safety office at the GDSCC for further investigation and instruction.

5. Quantification of Hazardous and Non-Hazardous Waste Streams at the GDSCC

Hazardous waste streams at the GDSCC were quantified by examining the waste-manifest data for each year from 1986 through 1991. The results are presented in a series of tables (Table 2 to Table 7). In addition, Table 8 is a summary that represents a direct comparison of all of the six years of data considered. Summarized results for each year also are graphically depicted in a series of figures (Figure 9 to Figure 14). The figures show dramatic improvement in the handling and disposal of hazardous wastes at the GDSCC for the period 1986 to 1991.

Non-hazardous solid-waste streams at the GDSCC were quantified by examining sales information provided for the period 1979 to 1991 by personnel at the Barstow facility. The strong commitment to look upon the continuously generated non-hazardous waste streams as "excess" materials that can be recycled or reused has led to a successful program for the sale of these materials to off-site private parties.

Table 2. Quantitative Data for Hazardous Wastes at the GDSCC (1986).

Waste Stream	Quantity	Total	Date of Record
PCB	3895 lbs		03/27
	8800 lbs	12,695 lbs	10/18
Waste Flammable Liquids			
Waste Oil Mixture	825 gal		
	110 gal		
	1320 gal		
Paint Related Materials	110 gal	2365 gal	
Waste Solvent			
1,1,1 TCA (Trichloroethane)	385 gal		
Ethylene Glycol	165 gal	550 gal	
Resins	110 gal		
	110 gal	220 gal	

Table 3. Quantitative Data for Hazardous Wastes at the GDSCC (1987).

Waste Stream	Quantity	Total	Date of Record
PCBs	600 lbs		12/21
	1500 lbs		02/26
	135 lbs	1635 lbs	02/26
Waste Flammable Liquids	50 gal		09/30
	50 gal		05/11
Kerosene	50 gal		09/30
18% Diesel/18% oil/63% water	4000 gal		01/27
40% ethylene glycol/55% water	150 gal		05/14
75% Waste Oil/25% Diesel	975 gal	5275 gal	11/20
Waste Corrosive Solid	10 gal	10 gal	09/30
Hazardous Waste Solid	0.55 cu yd		09/30
	0.25 cu yd		05/11
	9600 lbs	9600 lbs	12/01
	4.75 cu yd	5.55 cu yd	01/20
Waste Corrosive Liquid			
Batteries (wet, filled with acid)	0.15 cu yd[a]	0.15 cu yd	05/11
Hazardous Waste Liquid	220 gal	220 gal	05/11
Batteries			
Wet, corrosive material	206 lbs		05/14
	400 lbs		05/11
	300 lbs		05/11
Ni-Cd	30 lbs		05/11
Dry Cell	20 lbs	956 lbs	05/11
Asbestos	24 lbs		09/30
	9 lbs		05/11
	9 lbs	42 lbs	05/19
Waste Solvents			
1,1,1 TCA (Trichloroethane)	200 gal		09/30
	100 gal		05/11
Trichlorotrifluoroethane (Freon 113)	80 gal	380 gal	09/30

[a]This particular Corrosive Liquid Waste is measured in cubic yards because it involves cracked and leaking Lead/Acid batteries. These batteries are specially packed in containers that then are measured in cubic yards.

Table 4. Quantitative Data for Hazardous Wastes at the GDSCC (1988).

Waste Stream	Quantity	Total	Date of Record
Oily Rags and Filters	2220 lbs		11/04
	840 lbs		07/19
	1400 lbs		04/15
	300 lbs	4760 lbs	01/18
Batteries			
Ni-Cd Batteries	25 lbs		
	100 lbs		01/18
Zinc-Carbon Batteries	1 ea		
Gel Cell Batteries	200 lbs	325 lbs	07/19
Waste Solvent			
1,1,1 TCA (Trichloroethane)	300 gal		11/04
	100 gal		07/19
	200 gal		04/15
	220 gal		01/18
Trichlorotrifluoroethane	30 gal		11/04
(Freon 113)	25 gal		07/19
	50 gal		04/15
	55 gal	980 gal	01/18
Waste Flammable Liquids			
Gasoline	30 gal		11/04
	25 gal		04/15
Paint Related Material	55 gal		07/25
	25 gal		07/25
	55 gal		07/19
	165 gal	355 gal	
Waste Corrosive Liquid			
Chromic Acid	110 gal		07/19
Sulfuric Acid & Lime	150 lbs		
PCBs	25 lbs		02/26
Asbestos	327 lbs		
Mercury Filled Switches	30 lbs		07/19

Table 5. Quantitative Data for Hazardous Wastes at the GDSCC (1989).

Waste Stream	Quantity	Total	Date of Record
Oily Rags and Filters	1500 lbs		09/08
	2359 lbs	3859 lbs	05/24
Ni-Cd Batteries	61 lbs		10/10
Waste Solvent			
1,1,1 TCA (Trichloroethane)	275 gal		08/21
	275 gal		07/20
Trichlorotrifluoroethane	55 gal		09/08
(Freon 113)	55 gal	660 gal	05/24
Grease	20 gal		
Waste Flammable Liquids			
Waste Oil	110 gal		09/08
	55 gal		
Paint Related Material	55 gal		05/24
	55 gal	275 gal	
Waste Corrosive Liquids			
Phosphoric Acid	6 gal	6 gal	10/10
PCBs	120 lbs		08/21
	120 lbs	240 lbs	07/20
Asbestos	3060 lbs		04/07
	2480 lbs	5540 lbs	04/07
Steam Cleaning Waste Water	1200 gal		04/18
	1000 gal		04/21
	1375 gal		02/17
	4000 gal		01/18
	4000 gal	11,575 gal	01/20

Table 6. Quantitative Data for Hazardous Wastes at the GDSCC (1990).

Waste Stream	Quantity	Total	Date of Record
Oily Rags and Filters	85 lbs		11/08
	1520 lbs		11/08
	1450 lbs		07/02
	90 lbs		07/02
	305 lbs		02/07
	120 lbs	3570 lbs	02/07
Ni-Cd Batteries	400 lbs		11/15
	700 lbs		11/08
	120 lbs		
	125 lbs	1345 lbs	07/02
Waste Solvent			
1,1,1 TCA (Trichloroethane)	440 gal		11/15
	110 gal		07/02
	165 gal		02/07
	220 gal		02/13
Trichlorotrifluoroethane	55 gal		07/02
(Freon 113)	10 gal	1000 gal	02/07
Grease	60 lbs		07/02
Waste Flammable Liquids			
Waste Oil	55 gal		11/15
	55 gal		11/15
	165 gal		07/02
Paint Related Material	110 gal		11/15
	165 gal	550 gal	
Ammonium Hydroxide	5 gal		
Sodium Dichromate	30 lbs		02/07
Waste Cyanide	20 gal		
Asbestos	170 lbs		06/01
	15,000 lbs		03/21
	300 lbs		02/07
	290 lbs	15,760 lbs	02/07
Resins	10 gal		02/07
Contaminated Soil	32 cu yd		06/13
	32 cu yd		06/14
	32 cu yd	96 cu yd	06/15

Table 7. Quantitative Data for Hazardous Wastes at the GDSCC (1991).

Waste Stream	Quantity	Total	Date of Record
Oily Rags	2650 lbs		08/15
Waste Flammable Liquids			
	18 gal		05/20
	5 gal		02/15
Waste Paint	55 gal		08/15
	55 gal		02/15
	55 gal		02/15
Waste Oil	55 gal		08/15
	220 gal		02/15
with chlorinated solvent	275 gal	738 gal	05/20
Waste Flammable Solids	25 lbs	25 lbs	02/15
Waste Flammable Gas	64 lbs		05/20
	30 lbs	94 lbs	02/15
Waste Oxidizer	10 lbs		05/20
Waste Corrosive Liquid	10 gal		08/15
	47 lbs		05/20
Batteries			
Ni-Cd	30 lbs		08/15
Wet, Corrosive Material	275 lbs	305 lbs	06/21
Asbestos	900 lbs		04/17
Waste Solvents			
1,1,1 TCA (Trichloroethane)	165 gal		08/15
	55 gal		02/15
Mixed chlorinated solvent	110 gal		05/20
lab chemicals	55 gal	385 gal	05/20

Table 8. Summary of Quantitative Data for Hazardous Wastes at the GDSCC (1986-1991).

Waste Stream	1986	1987	1988	1989	1990	1991
Oily Rags & Filters			4760 lbs	3859 lbs	3570 lbs	2650 lbs
Flammable Liquids						
Total	2365 gal	5275 gal	355 gal	275 gal	550 gal	738 gal
waste paint-related materials	110 gal		300 gal	110 gal	275 gal	165 gal
waste oil	225 gal	975 gal		165 gal	275 gal	550 gal
kerosene		50 gal				
gasoline			55 gal			
other		4250 gal				23 gal
Flammable Solids						25 lbs
Flammable Gas						94 lbs
Corrosive Liquid		0.15 cu yd[a]	110 gal	6 gal		10 gal
batteries (wet, filled with acid)			150 lbs			47 lbs
Corrosive Solids		10 gal				
Solvents	550 gal	380 gal	980 gal	660 gal	1000 gal	385 gal
Soil					96 cu yd	
Wastewater				11,575 gal		
Oxidizer						10 lbs
Batteries		956 lbs	325 lbs	61 lbs	1345 lbs	305 lbs
Asbestos		42 lbs	327 lbs	5540 lbs	15,760 lbs	900 lbs
PCBs	12,695 lbs	34,568 lbs	25 lbs	240 lbs		
Miscellaneous						
resins	220 gal				10 gal	
mercury-filled switches			30 lbs			
grease				20 gal	60 lbs	
ammonium hydroxide					5 gal	
sodium dichromate					30 lbs	
cyanide					20 gal	

[a]See footnote to Table 3.

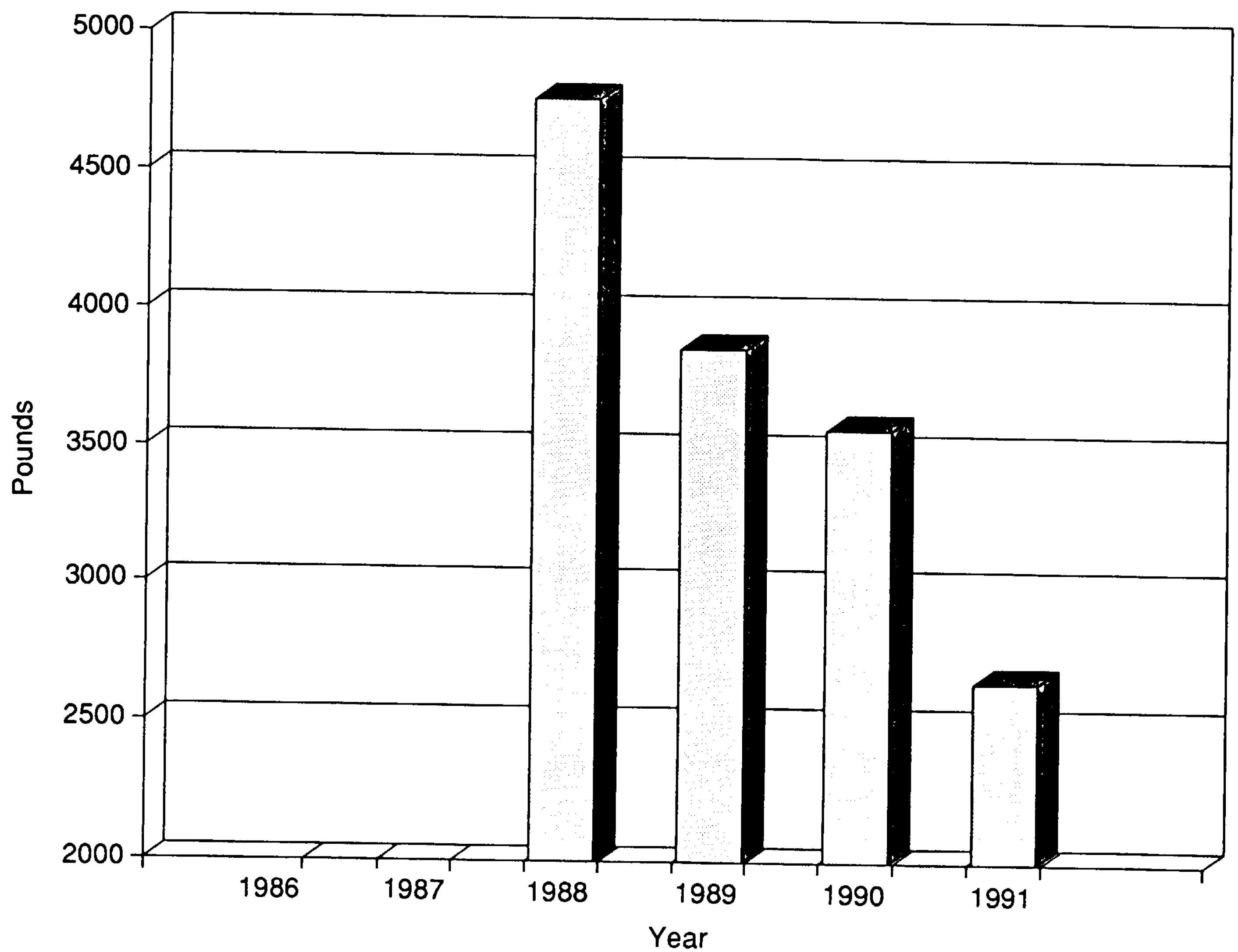


Figure 9. Summary of Annual Generation and Disposal of Hazardous-Waste Oil-Soaked Rags and Oil Filters at the GDSCC

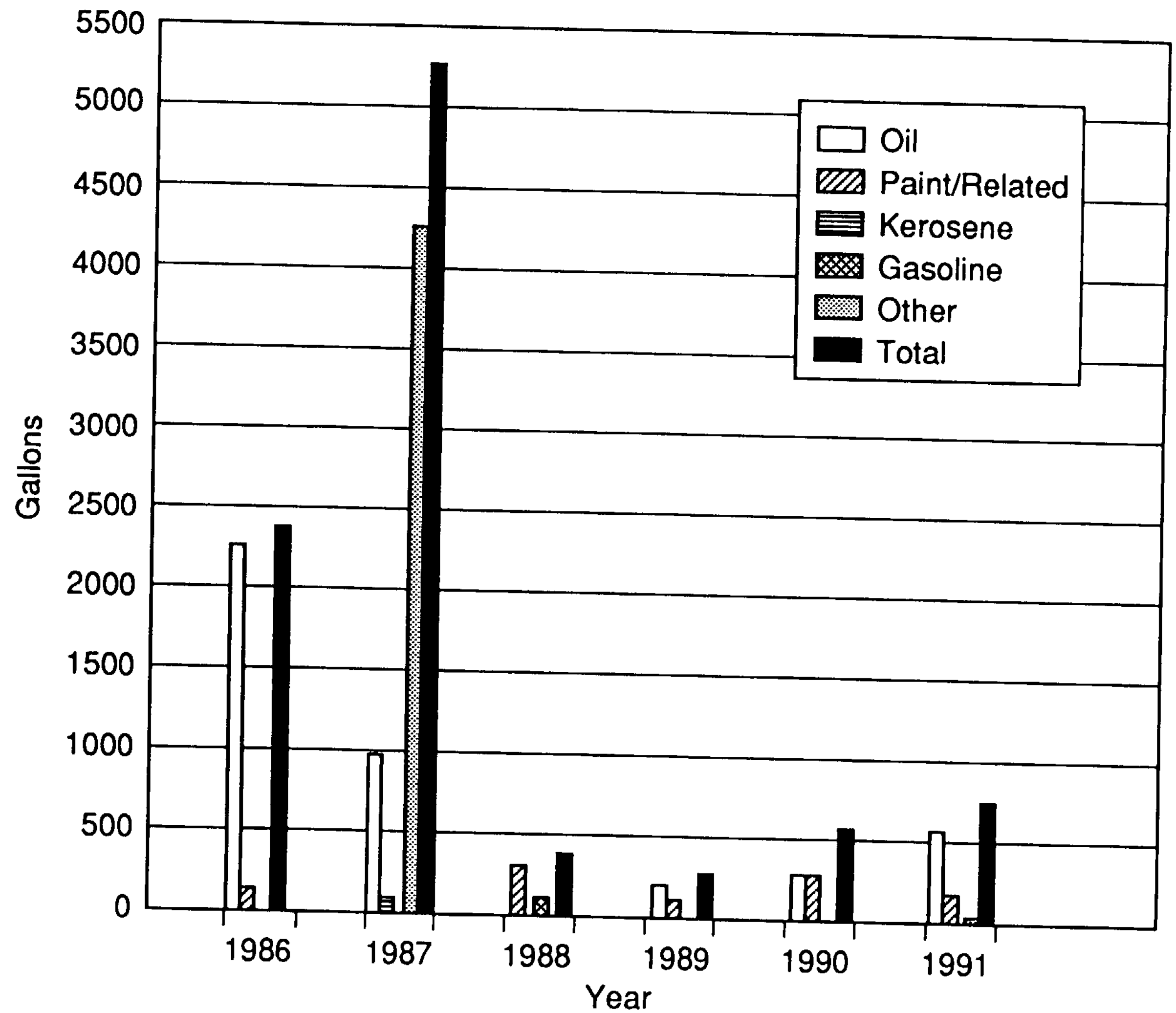


Figure 10. Summary of Annual Generation and Disposal of Hazardous-Waste Flammable Liquids at the GDSCC

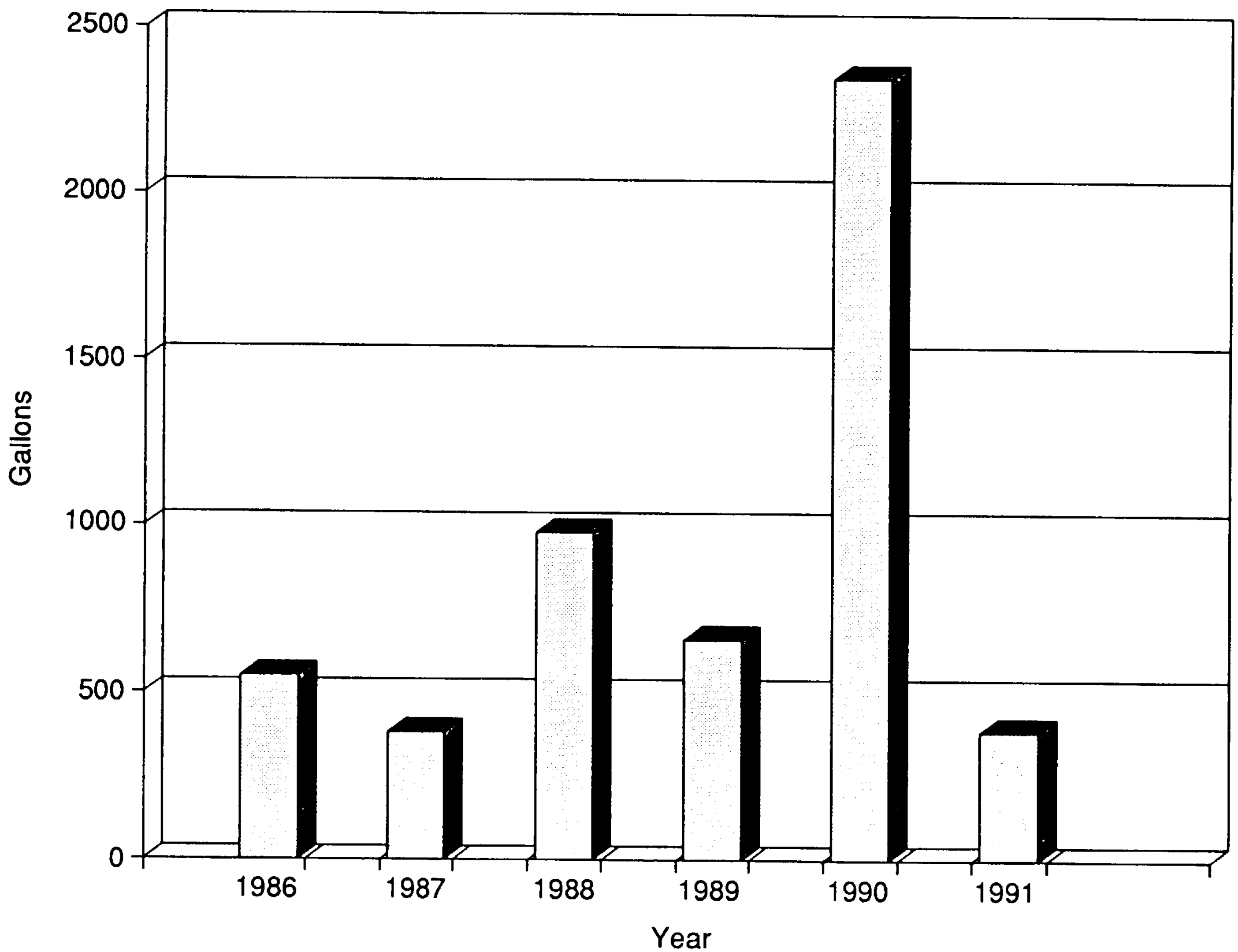


Figure 11. Summary of Annual Generation and Disposal of Hazardous-Waste Solvents at the GDSCC

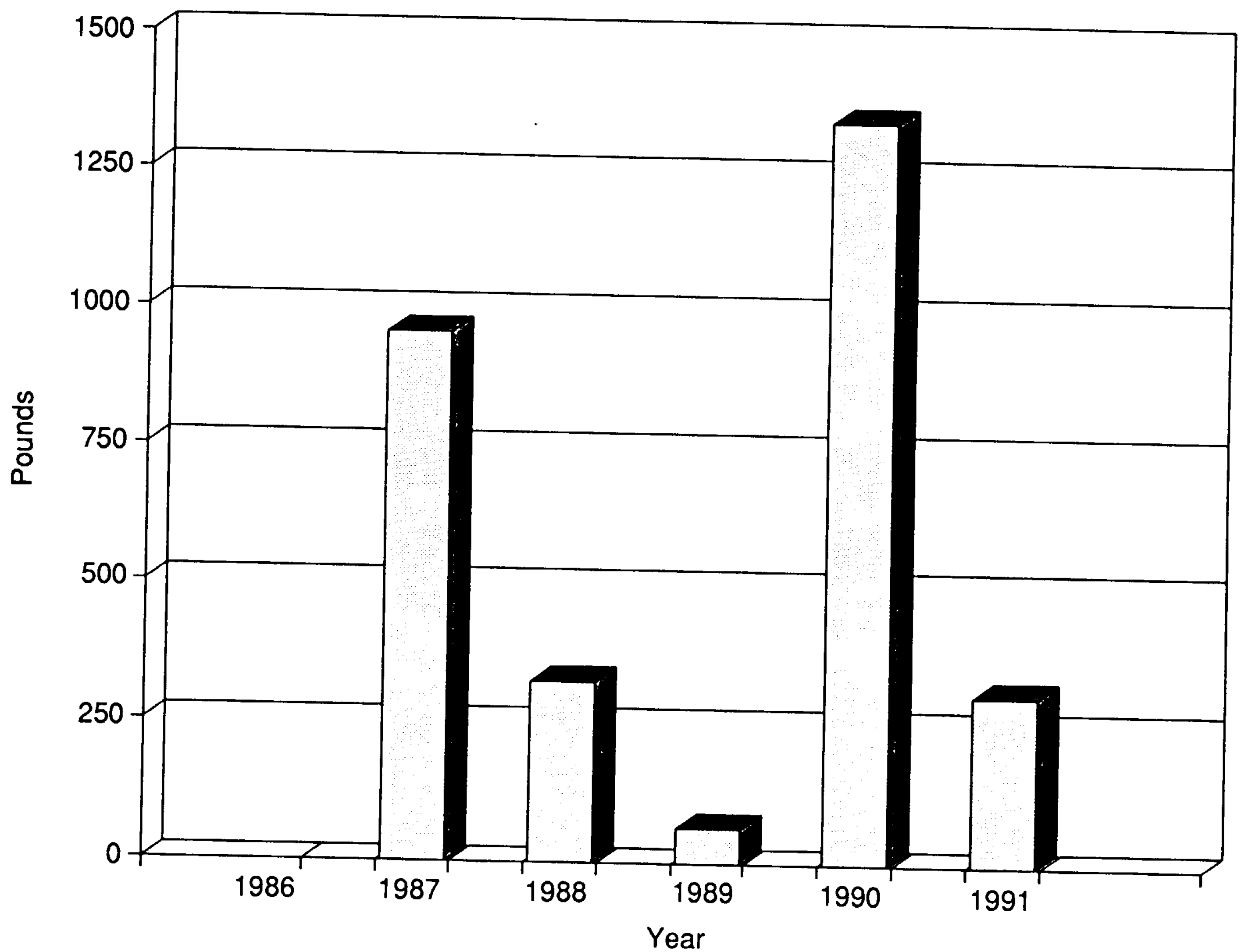


Figure 12. Summary of Annual Generation and Disposal of Hazardous-Waste Batteries at the GDSCC

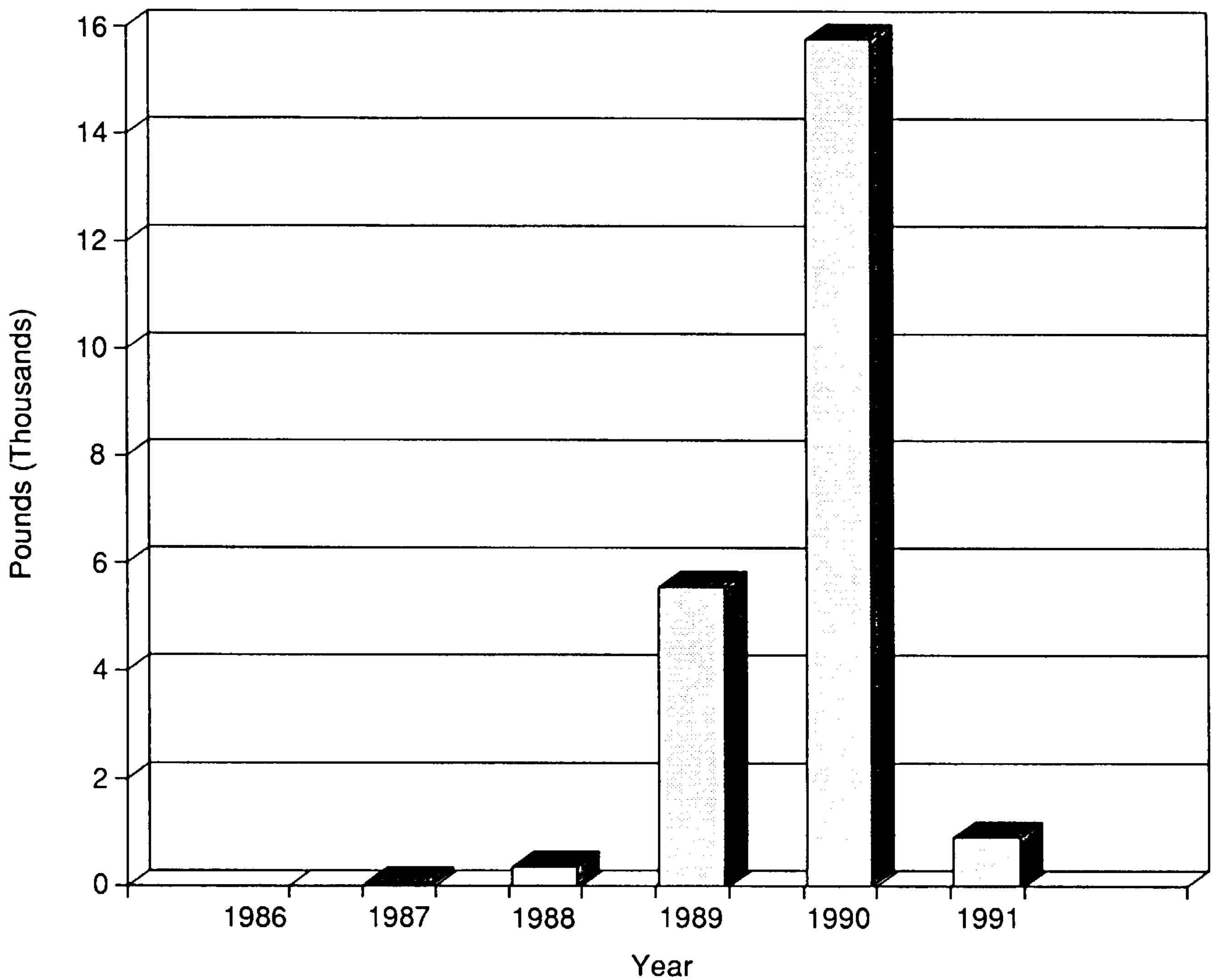


Figure 13. Summary of Annual Generation and Disposal of Hazardous-Waste Friable Asbestos at the GDSCC

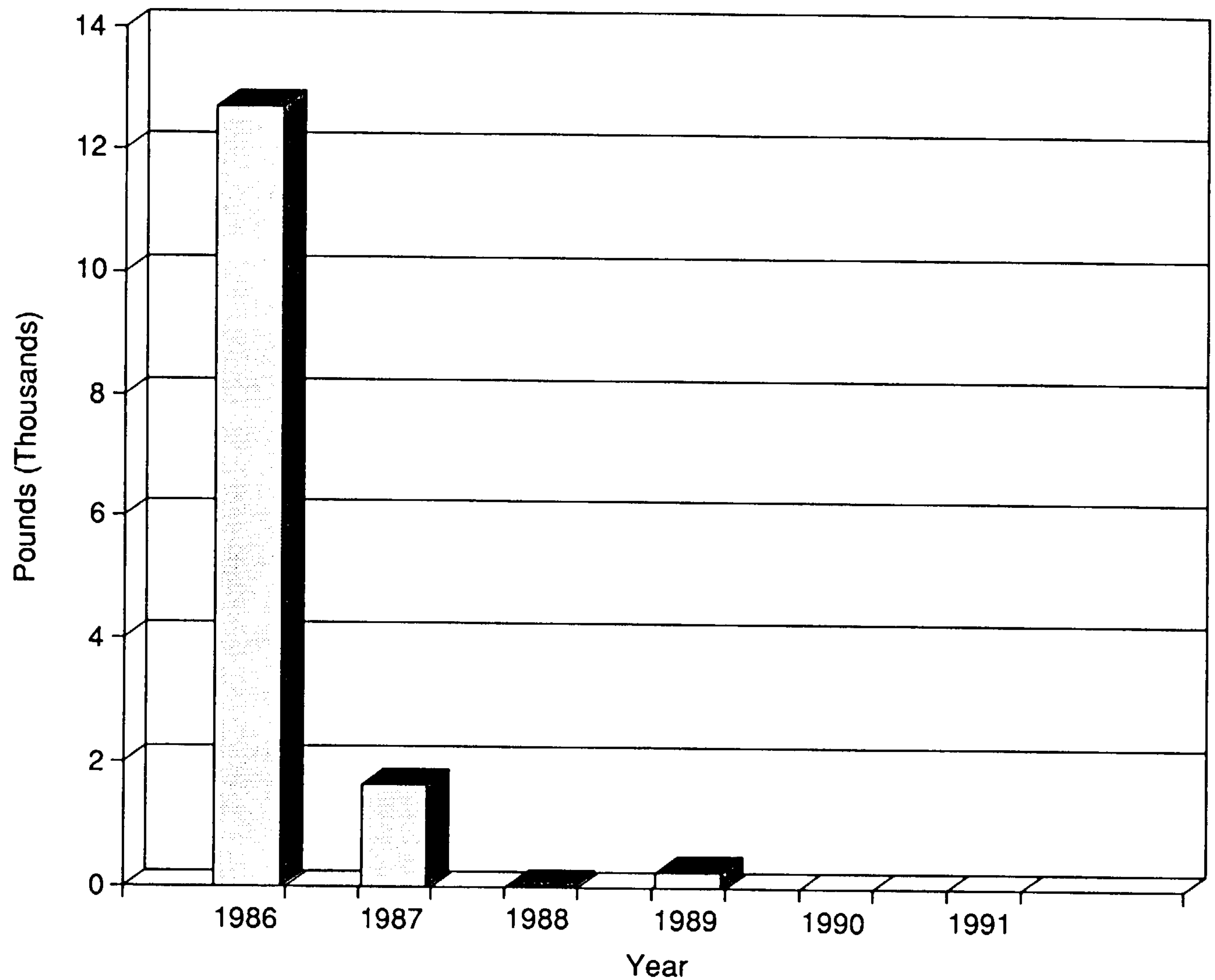


Figure 14. Summary of Annual Generation and Disposal of Hazardous-Waste Polychlorobiphenyls (PCBs) at the GDSCC

The sales results for non-hazardous wastes are listed in Table 9. In addition, Table 10 is a summary that provides data for a direct comparison of the 13 years of sales data considered. The summarized sales results for each year also are graphically shown in Figure 15 and Figure 16. The sales were made to recycle the non-hazardous wastes.

Figures 15 and 16 show that the sales of scrap lumber and scrap metal, respectively, have reached their highest points in the most recent years of the program (1989 through 1991).

Table 9. Sales of Non-Hazardous Wastes at the GDSCC (1979-1991).

Year	Waste Stream	Est. Weight	Sale Number
1979	Air Conditioners	500 lbs	2673
	Concrete Utility Vaults	32 tons	2633
	Lumber-Salvage	2 tons	2518
1980	Scrap Metal, Batteries	9 tons	2762
	Radiators	2 tons	2632
	Reflector Panels	1 ton	2730
	Radiator	500 lbs	2706
1981	Trailer, Semi-Van	2 tons	9007
1982	Misc. Scrap Metal	2 tons	3228
	Scrap Lumber	2 tons	3250
1983	Trailer, Van	2 tons	9014
	Scrap Metal	8 tons	3816
	Generators	2 tons	3531
1984	Scrap Lumber	1 ton	3541
	Scrap Metal	3 tons	3441
	Distillation Unit	500 lbs	8918
	Truck Wrecker	10 tons	6028
	Generator Motor	4 tons	3616
	Trailer, Tanker	3 tons	9333
	Forklift	15,000 lb cap.	8893
	Radio Tower	3 tons	3143
	Generator	25 tons	3505
	Forklift	4 tons	3561
1985	Scrap Metal	8 tons	3940
	Scrap Lumber	0.5 ton	3883
	Load Bank	1 ton	3705
	Motor Generator	1000 lbs	3844
	Vehicles and Trailers	20 tons	3850
	Scrap Metal	8 tons	3816
1986	Portable Office	2 tons	4309
	Scrap Metal	5 tons	
1987	Welder, Tractor, Asphalt Machine, Trailers	20 tons	4052
	Scrap Metal, Air Conditioning Units, Towers, etc.	5 tons	4308
	Scrap Lumber	2 tons	4146
	Heat Exchanger	2 tons	4307
	Lathes	1000 lbs	4228

Table 9. Sales of Non-Hazardous Wastes at the GDSCC (1979-1991) (cont.).

Year	Waste Stream	Est. Weight	Sale Number
1988	Assorted Scrap Metal	5 tons	4562
	Clamshell	1 ton	4581
	Gas Pumps	500 lbs	4580
	Security Fence, Galvanized Steel	350 lbs	4561
1989	Scrap Ferrous/Non-Ferrous Metals	4 tons	4583
	Cafeteria Equipment	1 ton	4458
	Cafeteria Equipment	1 ton	4457
	Collimation Tower, Galvanized Steel	50 tons	4326
	Load Banks	3 tons	4706
	Trailer, Air Conditioning, Crane	80 tons	4619
1990	Scrap Metal	3 tons	4764
	Rotella Oil (lubricating oil for diesel engines)	2 drums	4838
	Load Bank	1 ton	4990
	Steam Cleaner	200 lbs	4847
	Steam Cleaner	250 lbs	4847
	Steam Cleaner	250 lbs	4848
	Scrap Metal Sale	25 tons	4949
1991	Assorted Scrap Metal and Cables	3 tons	5132
	Wood Storage Cabinet	400 lbs	5143
	Generator Set	1000 lbs	5058
	Tower, Scaffold	2 tons	5130
	Towers	30 tons	5084
	Generator Set	1 ton	5058
	Hydraulic Oil	8 drums	5131
	Scrap Lumber	4 tons	5102

Table 10. Summary of Sales of Non-Hazardous Wastes (Scrap Lumber and Metal) at the GDSCC (1979-1991).

Year	Scrap Lumber (Tons)	Scrap Metal (Tons)
1979	2	–
1980	–	9
1981	–	–
1982	2	2
1983	–	3
1984	1	3
1985	0.5	16
1986	–	5
1987	2	5
1988	–	5
1989	–	57
1990	–	28
1991	4	3
TOTAL	11.5	136

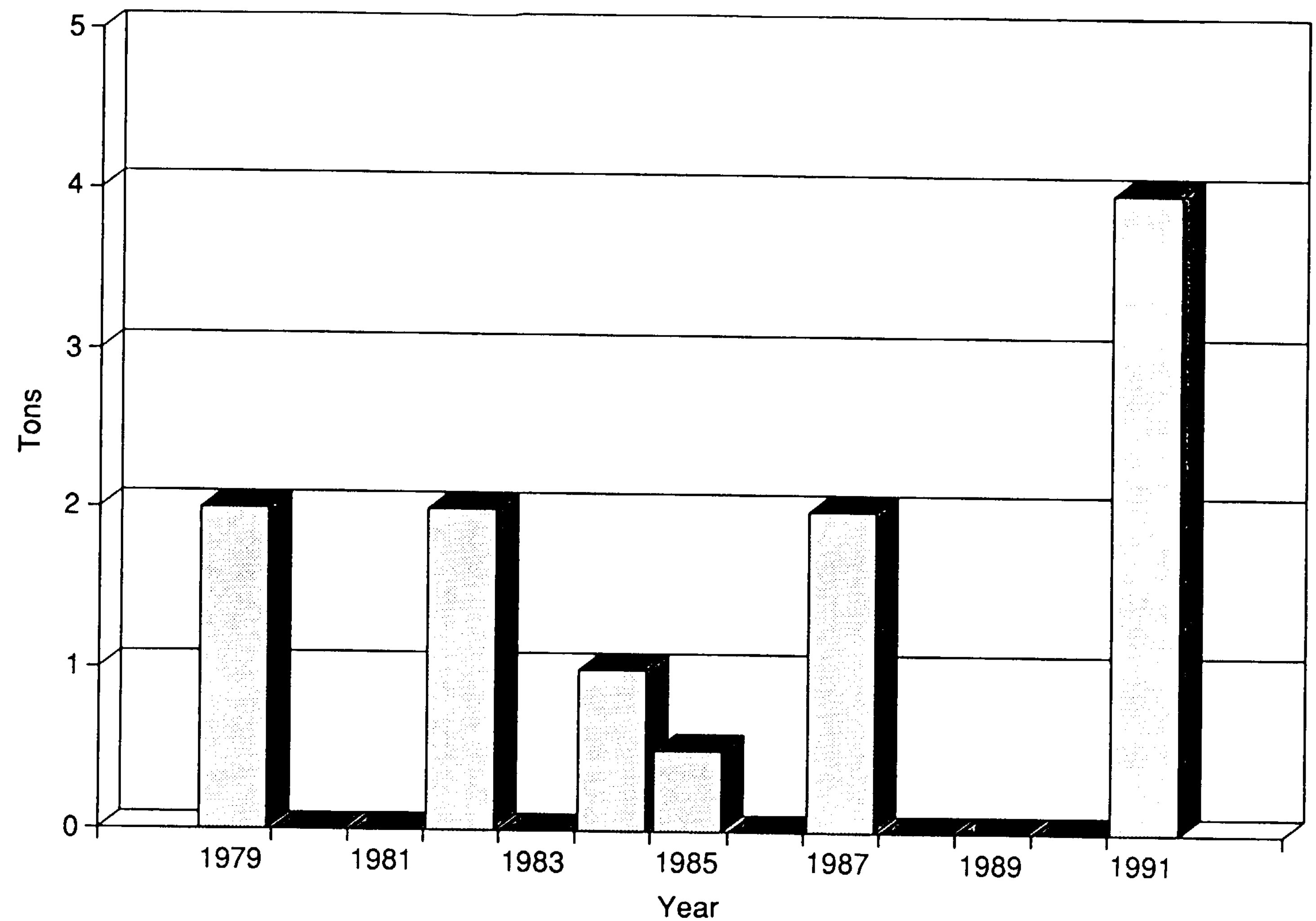


Figure 15. Summary of Annual Generation and Recycling of Non-Hazardous Scrap Lumber at the GDSCC

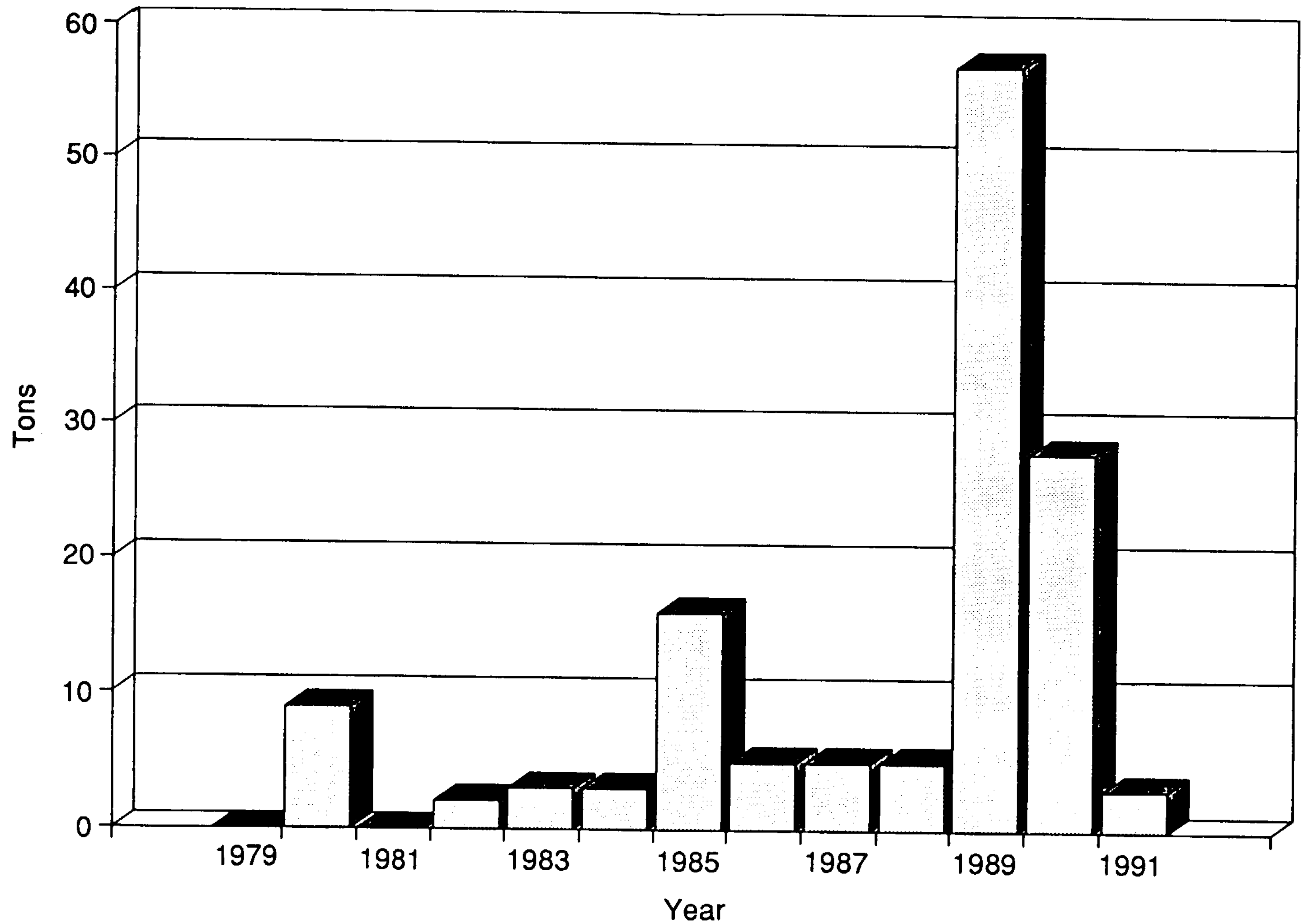


Figure 16. Summary of Annual Generation and Recycling of Non-Hazardous Scrap Metal at the GDSCC

SECTION IV

PAST, PRESENT AND FUTURE WASTE-MANAGEMENT PROGRAMS AT THE GDSCC

A. PAST WASTE-MANAGEMENT PRACTICES AT THE GDSCC

A yearly chronology of the past waste-treatment procedures at the GDSCC is presented as follows:

1. 1986

- In 1986, all liquid wastes at the GDSCC were solidified in rice-hull vermiculite or concrete and placed within a landfill.
- A program to recycle waste oil by using an off-site vendor was initiated.
- At that time, all metal drums that were used to contain wastes were rinsed, crushed and placed within a landfill. In 1986, however, procedures were changed for the cleaning of waste drums that were in good condition. The drums were triple-rinsed and scrubbed and then given to personnel at the NTC at Ft. Irwin for reuse. The drums that were in bad condition were rinsed and disposed of as scrap metal.

2. 1987

The GDSCC always knew it would be a generator of wastes, but it did not plan to be a recycling facility. Thus, using an outside vendor, the GDSCC began the full-scale recycling of waste solvents, paints, paint-related materials (turpentine, lacquer thinners), antifreeze, and lead-acid batteries at off-site locations.

3. 1988 and 1989

No changes in waste-treatment practices were instituted.

4. 1990

In 1990, a program was begun to send all 5-gallon and 55-gallon metal containers in good condition to the NTC at Ft. Irwin for rinsing and reuse. The cleaned containers, in good condition, were used by Ft. Irwin personnel for storage of waste oils at their motor pools. Containers in bad condition at the GDSCC were rinsed, crushed and disposed of as scrap metal.

Five-gallon containers that previously had contained a volatile compound, such as the refrigerant Freon, were crushed and disposed of in the on-site landfill. Each three months, about two 55-gallon drums of Freon were received at the GDSCC. Personnel at both the GDSCC and Ft. Irwin used the empty Freon-drums for the temporary storage of wastes destined to be removed off-site.

B. MAJOR ACCOMPLISHMENTS OF PAST WASTE-MANAGEMENT PROGRAMS AT THE GDSCC

1. PCBs

All polychlorinated biphenyls (PCBs) have been removed from the GDSCC. The GDSCC now is PCB-free.

2. Asbestos

All friable asbestos has been removed from the GDSCC. The GDSCC now is friable-asbestos free. Only non-friable asbestos remains.

3. Lead Abatement

All paint-coatings of building surfaces that were suspected of containing lead were wet-sandblasted and the removed samples were analyzed for lead content. Lead-contamination was found only in extremely low concentrations.

4. Paints

Only water-based paints now are used for painting buildings. Oil-based paints only are used for metal doors and antennas.

5. Tar

Since 1984, the use of hot-tar applications has been discontinued. Only cold-tar application methods are now used.

6. Oil Containment

Instead of using rags to absorb oil seepage from antenna gearing, absorbent booms now are used (see Figure 17). In addition, the usage of rags has been reduced by using strategically placed oil drip pans under and around hydraulic pumps (see Figure 18), and by the use of high powered vacuum equipment to scoop up collections of hydraulic oil (see Figure 19).

C. MAJOR ACCOMPLISHMENTS OF PRESENT-DAY WASTE-MANAGEMENT PROGRAMS AT THE GDSCC

1. Recycling of both Liquid and Solid Hazardous Wastes at the GDSCC

Beginning in 1987, a full-scale effort was initiated to recycle liquid hazardous wastes: waste solvents, antifreeze, paints, and paint-related materials such as turpentine and lacquer thinners. The success of this effort can be seen from the fact that the volume of disposal of hazardous flammable liquids in 1991 (oils, paints, turpentine, lacquer thinners, antifreeze, kerosene and gasoline) was only 10 percent of what the volume was in 1987. Most, but not all of these recycling efforts are conducted off-site by commercial vendors.

Figure 20 shows equipment at the Echo Site that is used to recycle antifreeze from motor vehicle pools, while Figure 21 depicts the use of non-ozone depleting recycled solvents in parts-washers at various shops at the Echo and Mars Sites.

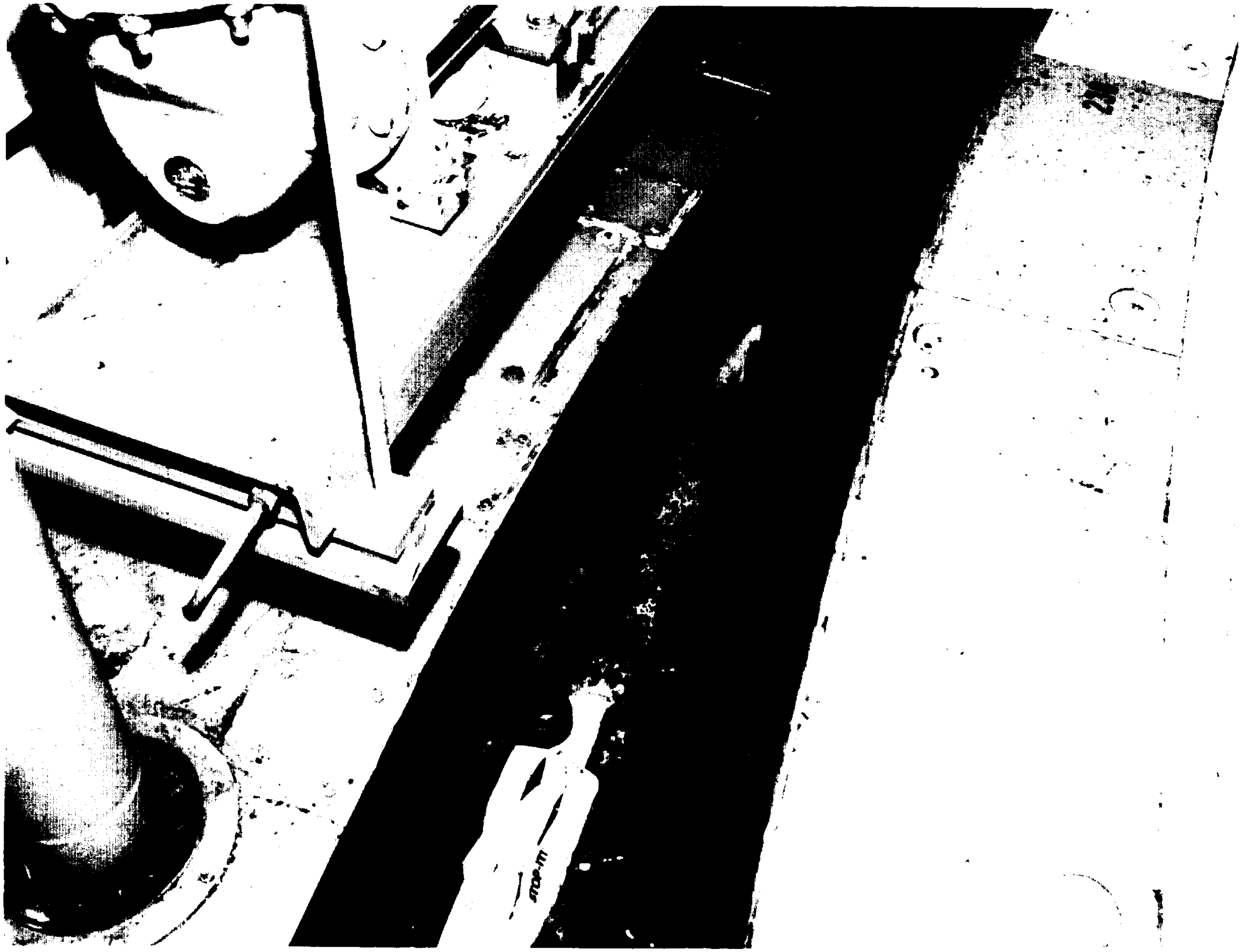


Figure 17. Mars Site: Use of Absorbent Booms at Antenna Gearing Has Cut Use of Rags to Absorb Oil by 50 Percent

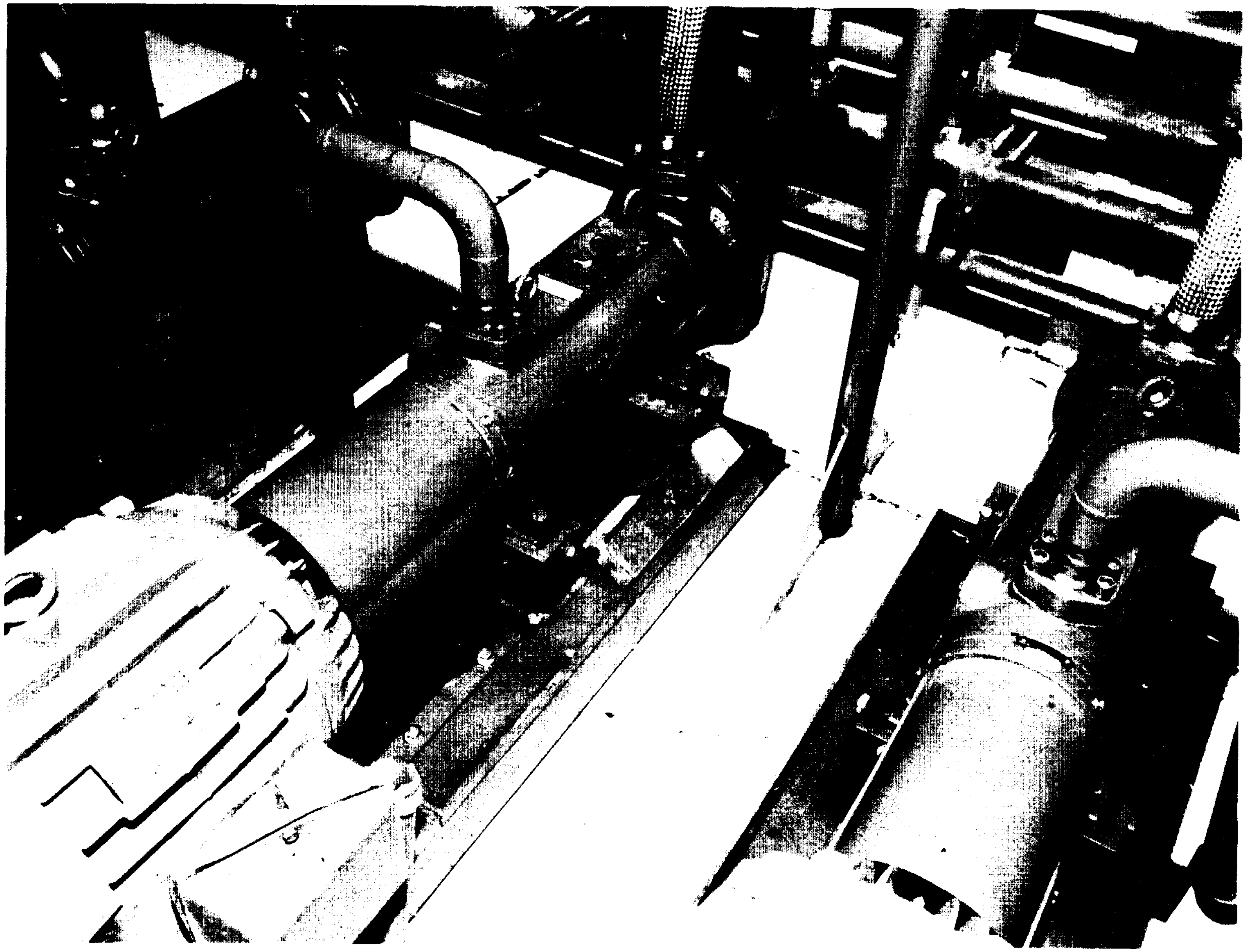


Figure 18. Mars Site: Strategically Placed Oil Drip Pans Under and Around Hydraulic Pumps Reduce the Need for Oil-Absorbing Rags

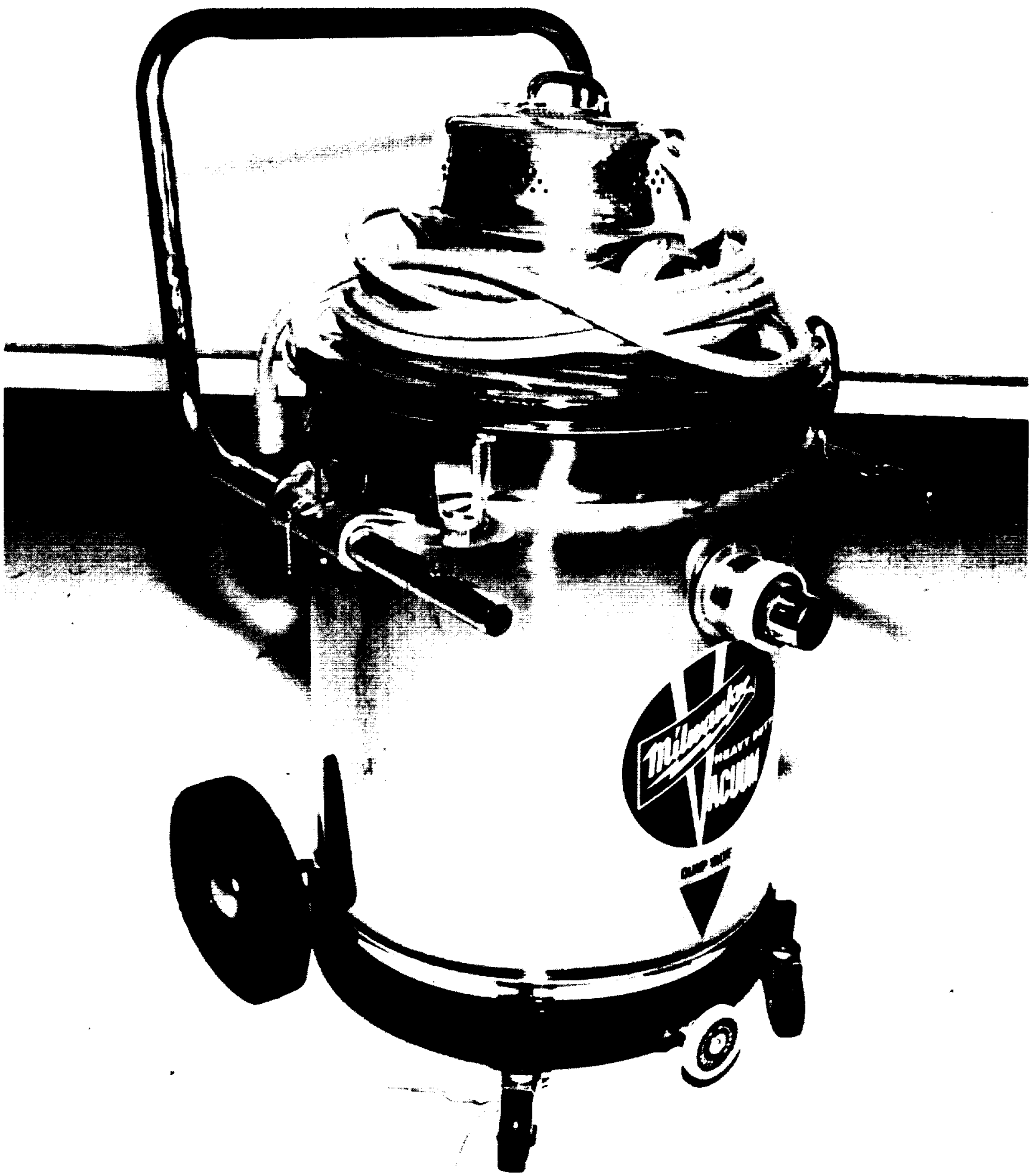


Figure 19. Mars Site: High-Powered Vacuum Equipment to Scoop Up Collections of Hydraulic Oil Reduces the Need for Oil-Absorbing Rags and/or Booms

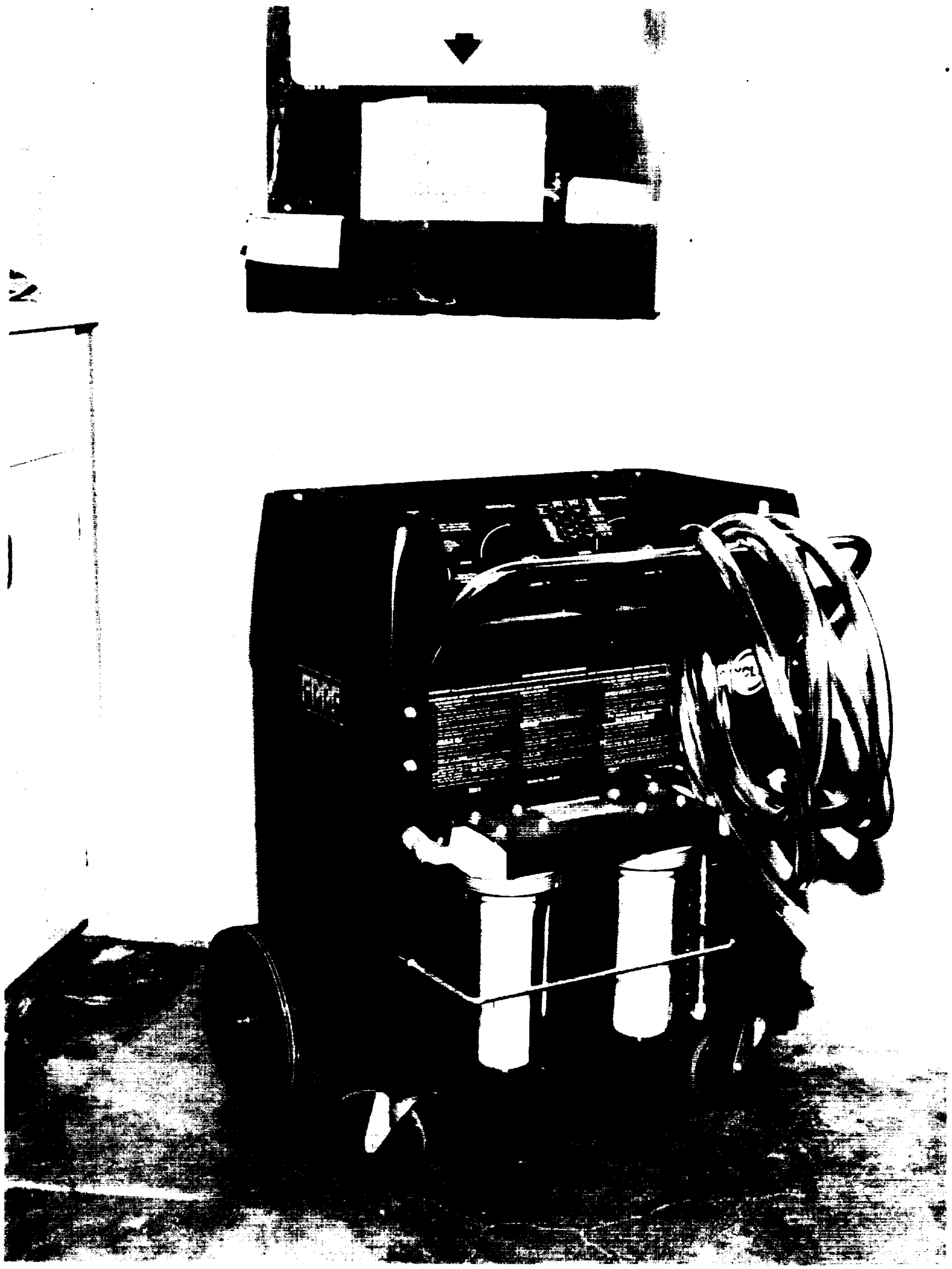


Figure 20. Echo Site: Equipment to Recycle Antifreeze From Vehicles

Figure 21. Echo and Mars Sites: Use of Recycled Non-Ozone Depleting Solvents in Parts-Washers in Workshops

Figure 22 shows equipment used at the Barstow facility to recycle solvents, while Figure 23 shows how the recycled solvents are used for parts-washing at the Barstow facility.

At the same time that the recycling of liquid hazardous wastes was begun, the recycling of lead-acid batteries, which are examples of solid hazardous wastes, also was begun.

2. Recycling of Paper: A Non-Hazardous Waste

Beginning in 1989, a paper-recycling program was initiated at both the GDSCC and the Barstow facility. Cardboard (see Fig. 3) and white office paper and computer pager (see Fig. 4), magazines and colored paper are the types of paper-products now being recycled.

The volume of recycled paper in 1991 was more than 100 percent greater than the volume recycled in 1990. This program serves not only as a space-saver, but also as a minor source of revenue for the GDSCC. Hard copies of various reference materials first are placed on microfilm before they are dispatched for recycling.

This commitment to the recycling of paper at the GDSCC and the Barstow facility is strong and is an excellent example of the GDSCC's improved efficiency in the reduction of wastes, and its overall concern for environmental compliance.

3. Recovery of Freon Refrigerant

The GDSCC has equipment to recycle Freon bled from both building air-conditioning units and from vehicle-cooling systems. This practice has eliminated the venting of Freon to the atmosphere.

Figure 24 depicts the equipment used to recover Freon from building air conditioning units, while Figure 25 shows the equipment at the Echo Site used to recover and recycle Freon from motor-vehicle cooling systems.

4. Replacement of 1,1,1-Trichloroethane (TCA) by an Alternative Solvent

The use of 1,1,1-trichloroethane (TCA) as a solvent to clean the bilge areas and bull gears of antennas has been eliminated by the use of an alternative solvent called "Multi-Solv." By helping to cut heavy grease in cleaning operations, "Multi-Solv" also has been helpful in cutting down the usage of wipe rags. This reduces the number of rags that have to be cleaned and then be either incinerated or sent off-site for disposal in an environmentally acceptable landfill. This use of an alternative solvent also helps the GDSCC decrease its dependence upon hazardous materials, in general.

5. Current General Reuse and Recycling Efforts at the GDSCC

The equipment-section records group at the GDSCC maintains files of all excess scrap materials at both the GDSCC and the Barstow facility. These scrap materials are collected and prepared for sale to the highest, off-site, private-party bidder for either reuse or recycling. This both reduces the volumes of wastes that previously were destined for a landfill, and also provides some revenue from the sale of the scrap-assets.

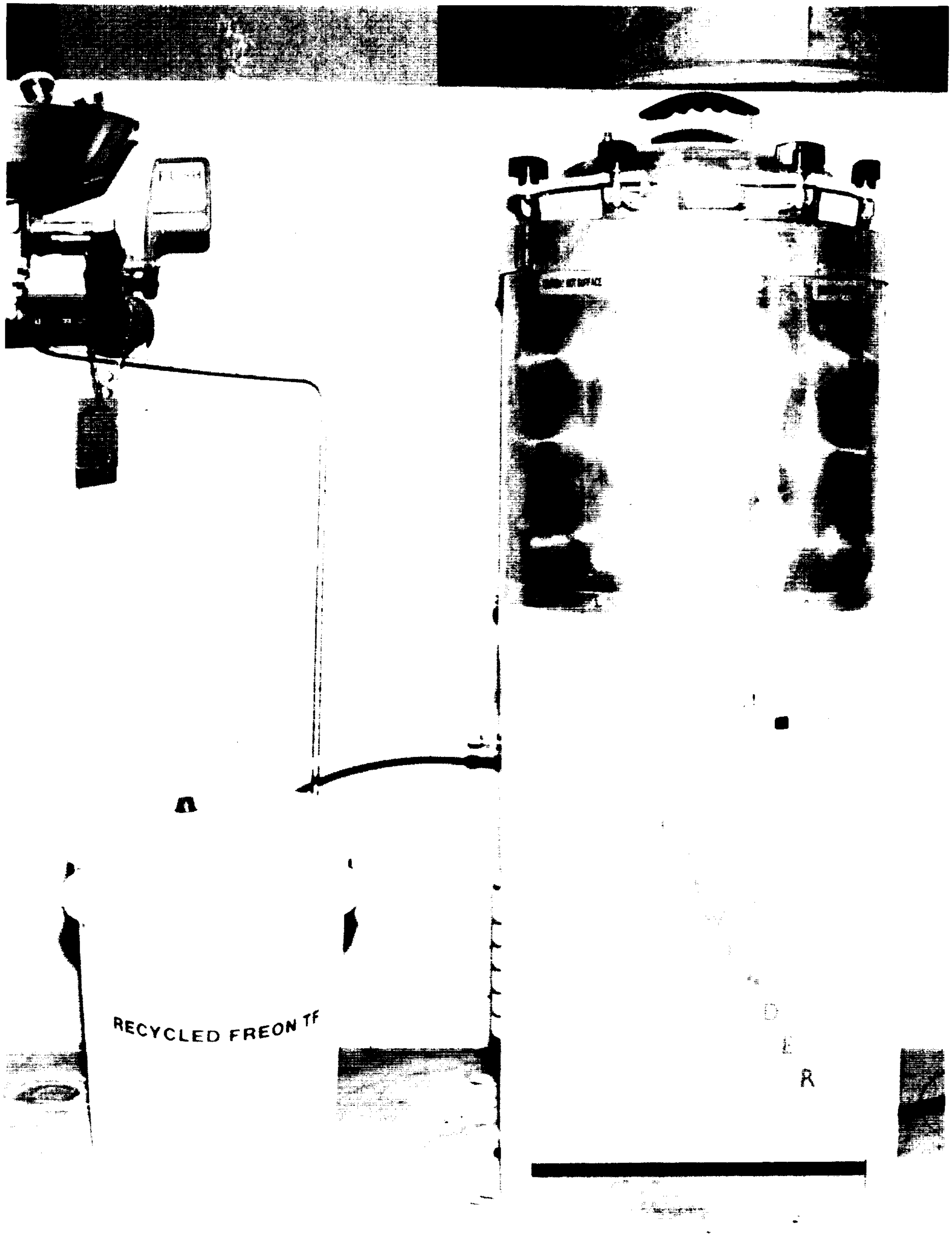


Figure 22. Barstow Facility: Equipment Used to Recycle and Contain Solvents

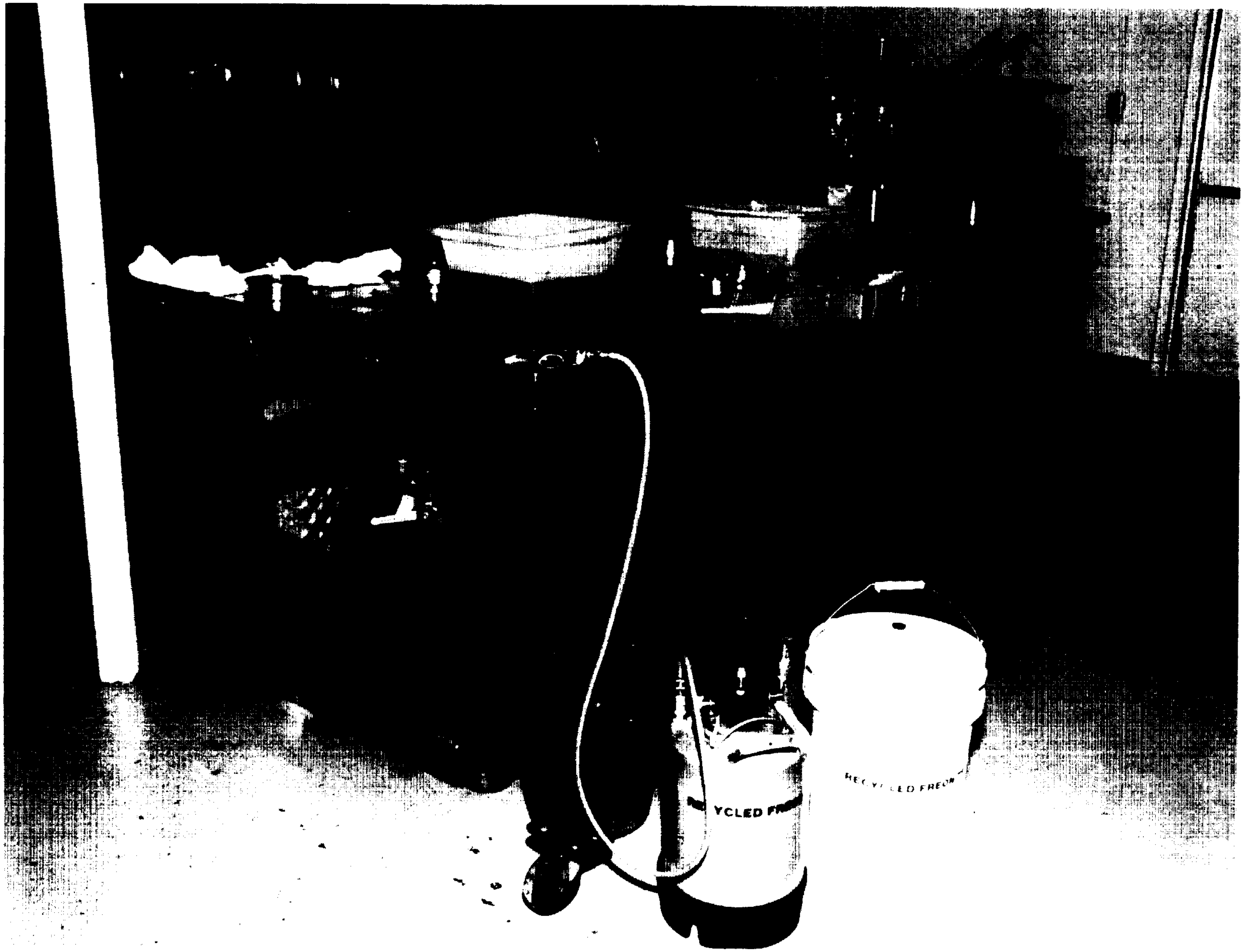


Figure 23. Barstow Facility: Use of Recycled Solvents in the Washing of Parts in a Workshop

Figure 24. Echo Site: Equipment Used to Recover Refrigerant From Building Air-Conditioning Units

Figure 25. Echo Site: Equipment Used to Recover Refrigerant From Motor-Vehicle Cooling Systems

D. FUTURE WASTE-MANAGEMENT PRACTICES AT THE GDSCC

It is significant that the Kleinfelder Inc. report entitled "Waste Minimization Assessment" and submitted to JPL in 1992, did not find any gross or minor deficiencies in the various waste-management programs now practiced at the GDSCC.

The report, however, does recommend the following "fine tuning" of some current waste-management practices at the GDSCC:

1. The Material Safety Data Sheet (MSDS) System

Although the current MSDS-tracking system at the GDSCC is quite comprehensive, it could be improved by the improvement of procurement measures, by the prevention of materials coming on-site from alternative procurement sources, and by the riddance of all outdated records.

Those materials that occasionally are brought on-site by non-GDSCC personnel cannot be tracked by normal means. Thus, it should be forbidden to bring materials on-site other than through traditional procurement means.

It is important to educate and to stress the importance to all GDSCC personnel about the risks of using any materials that do not have an associated MSDS.

2. The Federal Stock Number (FSN) System

At present, the procurement of materials at the GDSCC and the Barstow facility is based upon the use of the Federal Stock Number (FSN). This could lead to safety, health and environmental risks because the FSN only provides information about a material's performance rather than the physical and chemical characteristics of that material.

Thus, for example, if an operation at the GDSCC requires the use of a cleaning/stripping agent, the FSN will provide the information that the material functions as a cleaner/stripper, but it will not indicate the health and environmental characteristics of that material.

It is important, therefore, to match an MSDS to any material obtained through an FSN-procurement procedure.

3. Recycling of Used Oil Filters

As of 1991, the GDSCC used an off-site contractor to remove discarded oil filters and to incinerate them.

An alternative procedure to the incineration of oil filters is to "rehabilitate" them to form steel reinforcement bars. TAMCO, a steel mill located in Etiwanda, California, has the appropriate equipment and environmental permits and the approval from the South Coast Air Quality Management District (SCAQMD) and the California Environmental Protection Agency (CEPA, formerly the California Department of Health Services) to accept and recycle drained and crushed discarded oil filters.

TAMCO uses the waste oil-filters as ferrous scrap in its electric arc furnace to recycle them into steel reinforcement bars. The paper components of the filters, which are saturated with oil, serve to boost the heat output of the furnace.

Although TAMCO requires certain conditions to be met before discarded oil filters can be accepted for recycling, the TAMCO process provides an alternative technique for the disposal of discarded oil filters other than by incineration or by sending them to a landfill. The use of TAMCO by the GDSCC could help reduce the largest hazardous-waste stream at the DSN facility.

Details of the TAMCO requirements for the acceptance of discarded oil filters are presented in Appendix A.

APPENDIX A

ACCEPTANCE PROCEDURES FOR THE CONVERSION OF USED OIL FILTERS TO STEEL REINFORCEMENT BARS BY THE TAMCO STEEL MILL, ETIWANDA, CALIFORNIA

TAMCO

P.O BOX 325, ETIWANDA, CA 91739 (714) 987-2521, FAX (714) 899-1910

TO: INTERESTED PARTIES

FROM: Tamco

SUBJECT: Tamco ACCEPTANCE PROCEDURES FOR USED OIL FILTERS

Tamco is defined as a steel mill, whose sole product is various sizes of steel reinforcement bar for the construction industry. Our primary feed material is ferrous scrap. The ferrous scrap is melted in an electric arc furnace (EAF). Tamco will recycle more than 400,000 tons of ferrous scrap into steel reinforcement bar this year.

On March 27, 1991, the State of California Department of Health Services added Section 66828 to Chapter 30, Division 4, of Title 22 of the California Code of Regulations (CCR). This section is entitled "Management of Used Oil Filters". It is this section of the CCR that designates Used Oil Filters meeting certain conditions, as ferrous scrap; thus allowing Tamco to process them into steel reinforcement bar.

Tamco's electric arc furnace and air pollution control equipment (baghouse) are permitted by the South Coast Air Quality Management District (SCAQMD) to process ferrous scrap. In other words, now that the Used Oil Filters (again after certain conditions are met) are considered scrap, they (the filters) are now a candidate as a feed material in Tamco's steel making operation.

In Tamco's system, the three main parties are: the Supplier, the Transporter and the Receiving Facility (Tamco). The Supplier is the party or collection point that will send the filters directly to Tamco (the Receiving Facility).

Tamco will hold the Supplier accountable for conformity to the State Regulations and Tamco's receiving criteria. The Transporter is the hauler, or owner of the vehicle, that delivers the filters to Tamco.

In order for Tamco to accept Used Oil Filters for recycling, the following requirements must be met by potential suppliers:

- **All deliveries must be scheduled at least 48 hours in advance**
- **If supplier of the filters are from an E.P.A. Permitted Oil Recycler or TSD, a copy of the Facility's E.P.A. Permit must be on file at Tamco**
- **If supplier of filters is not a Permitted Oil Recycler, the name(s), location, and E.P.A. I.D. Numbers of the facility(s) where the used oil drained from the filter was or will be recycled**
- **Written certification that filters to be shipped to Tamco shall be oil filters <u>exclusively</u>**
- **Written certification that the used oil has been drained from the filters to be received by TAMCO and managed in accordance with Article 13, Chapter 6.5, Division 20 of the California Health and Safety Code**
- **Written certification that the filters shipped to Tamco contain at least 60% (by weight) ferrous metal**
- **A monthly forecast of approximate quantities (in pounds) of filters that Tamco can expect to receive from suppliers**
- **All filters must be crushed to be accepted**
- **Filters will be accepted only in shipments of 10,000 pounds or more**
- **Loads will be accepted in rail cars, covered dump trucks or covered roll-off boxes**

As specified in the State regulations, each load of Used Oil Filters received by Tamco must be on a Bill of Lading. <u>No shipments will be accepted on a Hazardous or Non-Hazardous Waste Manifest!!!</u>

The following must appear on each Bill of Lading:

- A receipt, or document number
- The month, day, and year of delivery to Tamco
- Name, address, and phone number of the supplier or collection point of the filters
- Tamco's name, address and telephone number as the receiving facility
- Transporter's name, address and telephone number
- Signature of the parties representing the supplier and transporter of filters
- The load must be identified as "DRAINED AND CRUSHED USED OIL FILTERS" on the Bill of Lading
- A space for Tamco personnel to enter gross, tare and net weights of load
- The control number issued by Tamco
- Facility where the used oil drained from the filter was or will be recycled

The following may be cause for Tamco to not accept shipments of Used Oil Filters:

- The presence of free-flowing oil or other liquid on and around the filters
- Filters that are not crushed
- Unscheduled deliveries
- Other scrap or materials mixed with filters or vice-versa
- Incorrect, incomplete or no Bill of Lading
- Loads arriving with Hazardous or Non-Hazardous Waste Manifests
- Loads arriving before 7 A.M. or after 3 P.M., or anytime on weekends and holidays
- Filters other than oil filters (i.e. gasoline, air)

All rejected loads will be reported to State and County Environmental Health agencies.

To schedule a load of Used Oil Filters into Tamco, please call for an appointment at (714) 987-2521, extension 275, at least 48 hours in advance. If there are any questions, please call (714) 987-2521, extension 203. Tamco will issue a Certificate of Recycling to the Supplier after processing the filters.

TAMCO
D BOX 325 ETIWANDA CA 91739 (714) 987-2521. FAX (714) 899-1910

CERTIFICATE OF RECYCLING

APRIL 12, 1991

SUPPLIER: PETROLEUM RECYCLING CORPORATION
13579 WHITTRAM AVENUE
FONTANA, CA 92335

TRANSPORTER: DALTON TRUCKING

THIS IS TO CERTIFY THAT
5,780 POUNDS
OF USED OIL FILTERS WERE RECEIVED BY TAMCO
ON DOCUMENT NUMBER 128742
ON APRIL 5, 1991
THIS MATERIAL HAS BEEN RECYCLED
INTO REINFORCEMENT BAR

FURTHERMORE, ALL OIL FILTERS RECEIVED ON THE ABOVE REFERENCE DOCUMENT HAVE BEEN RECYCLED PURSUANT TO THE PROVISIONS STATED IN SECTION 66828, CHAPTER 30, DIVISION 4, TITLE 22 OF THE CALIFORNIA CODE OF REGULATIONS (CCR).

THANK YOU FOR PARTICIPATING IN OUR ENDEAVOR TO BUILD AMERICA AND CLEAN UP THE ENVIRONMENT.

TAMCO

SECTION 66828 IS ADDED TO CHAPTER 30, DIVISION 4, OF TITLE 22 OF THE CALIFORNIA CODE OF REGULATIONS

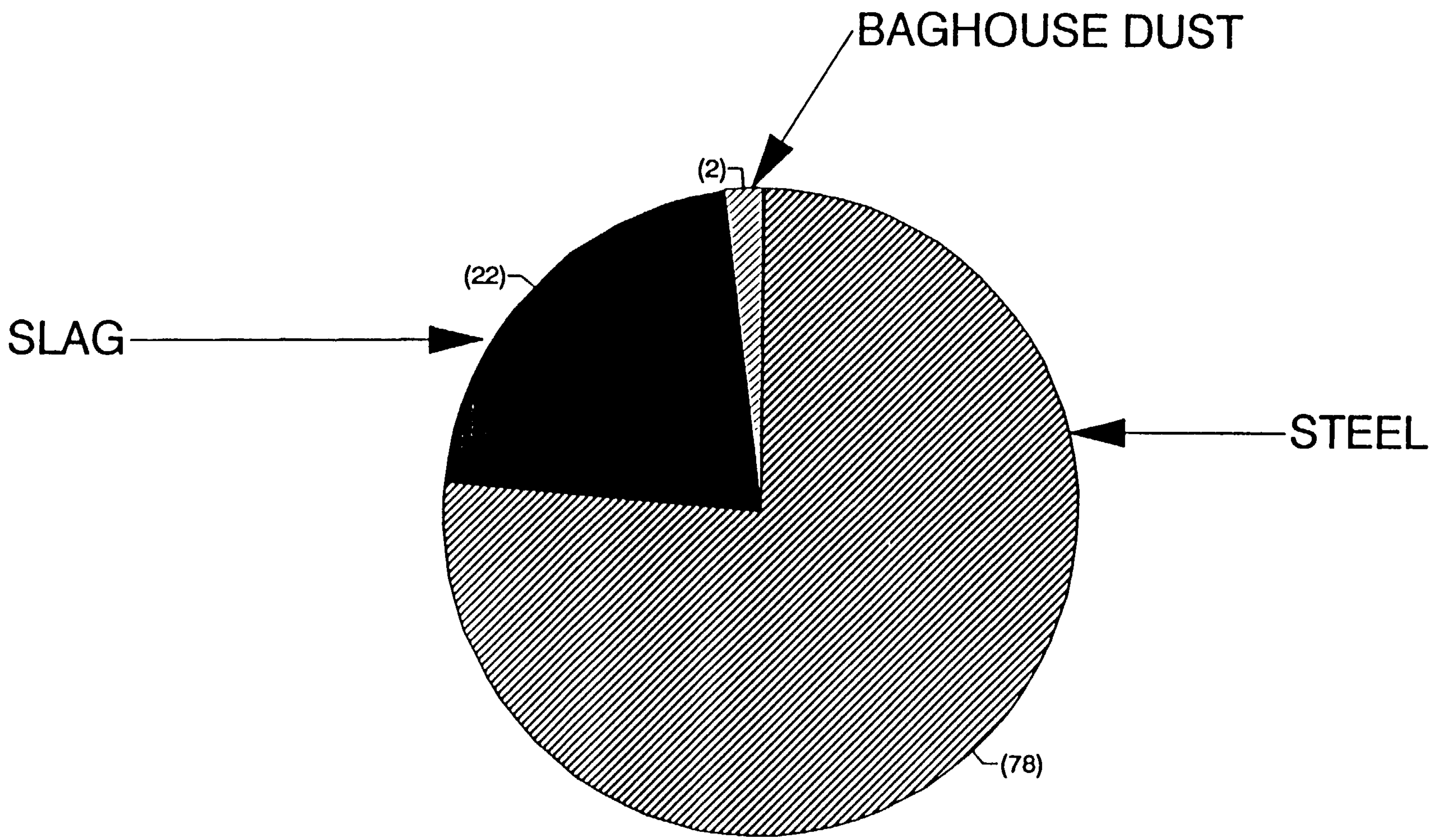
Section 66828. Management of Used Oil Filters.

(a) For the purposes of this section, "used oil filters" are defined as filters which contain a residue of used oil (as defined in Health and Safety Code Section 25250.1(a)) and which are exempt from regulation as a hazardous waste under federal law Section 261.6(a)(3)(iv), Title 40, Code of Federal Regulations.

(b) Used oil filters that are managed and recycled according to the following requirements shall not be regulated as hazardous waste.
(1) The filters are drained of free-flowing used oil.
(2) The drained used oil filters are transferred for the purposes of metal reclamation.
(3) The drained used oil filters are accumulated, stored, and transferred in a closed, rainproof container that is capable of containing any used oil that may separate from the filters placed inside. Containers shall be labelled as "drained used oil filters" (not as hazardous waste) and show initial date of accumulation and receipt.
(4) Storage of less than one ton of used oil filters shall be limited to one year. Storage of one ton or more used oil filters is limited to 90 days.
(5) Persons generating, transporting, or receiving used oil filters shall use a bill of lading to record the transfer of used oil filters. Bills of lading must indicate generator, transporter, and receiving company names, addresses, and telephone numbers, as well as the quantity of used oil filters transferred, and the date of transfer. A copy of each bill of lading must be kept on the premises of the generator, transporter, and receiving facility where the used oil filters were handled. Copies of bills of lading shall be kept for a period of three years.
(6) Used oil that is separated from the used oil filters shall be managed in accordance with Article 13, Chapter 6.5, Division 20 of the Health and Safety Code.

NOTE: Authority cited: Sections 208 and 25150, Health and Safety Code. Reference: Sections 25150, 25159.5, and 25175, Health and Safety Code.

OIL FILTER YIELD
PERCENT BY WEIGHT



OIL FILTER YIELD

```
                                  +------------>BAGHOUSE DUST
                                  |                  |
                                  |             ZINC PRODUCTS
                                  |                  |
                                  |             LEAD PRODUCTS
                                  |                  |
                                  |             IRON RICH
                                  |          CEMENT ADDITIVE
                                  |
OIL FILTER------------------------+-------------------->STEEL
                                  |                      |
                                  |                REINFORCING
                                  |                    BAR
                                  |
                                  +-------------------->SLAG
                                                         |
                                                   COMPACTION
                                                    MATERIAL
                                                         |
                                                   AGGREGATE
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15. Supplementary Notes

16. Abstract

The Goldstone Deep Space Communications Complex (GDSCC), located in the Mojave Desert, is part of the National Aeronautics and Space Administration's (NASA's) Deep Space Network (DSN), the world's largest and most sensitive scientific telecommunications and radio navigation network. The Goldstone Complex is operated for NASA by the Jet Propulsion Laboratory.

At present, activities at the GDSCC support the operation of nine parabolic dish antennas situated at five separate locations known as "sites."

Each of the five sites at the GDSCC has one or more antennas, called "Deep Space Stations (DSSs). In the course of operation of these DSSs, various hazardous and non-hazardous wastes are generated.

In 1992, JPL retained Kleinfelder, Inc., San Diego, California, to quantify the various streams of hazardous and non-hazardous wastes generated at the GDSCC. In June 1992, Kleinfelder, Inc., submitted a report to JPL entitled "Waste Minimization Assessment."

This present volume is a JPL-expanded version of the Kleinfelder, Inc. report.

The "Waste Minimization Assessment" report did not find any deficiencies in the various waste-management programs now practiced at the GDSCC, and it found that these programs are being carried out in accordance with environmental rules and regulations.

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