National Aeronautics and Space Administration

FY 1990 SAFETY PROGRAM STATUS REPORT

NASA Safety Division
Office of Safety and Mission Quality
Washington, D.C. 20546

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SAFETY PROGRAM OVERVIEW

The NASA Safety Division concentrated on several initiatives in FY 1990 to enhance the quality and productivity of its safety oversight function. The major areas affected were training, risk management, safety assurance, operational safety, and safety information systems.

The primary thrust of NASA's extensive safety training effort is to expose engineers and technicians to critical safety requirements and the system safety process. There were a number of accomplishments in FY 1990 at both the Agency and Center levels. The Safety Division initiated the establishment of a centralized, intra-agency safety training program. Of the several courses under development at Headquarters, three were completed in FY 1990 and are now being offered to field installation personnel. These courses provide safety training specifically oriented to new and existing safety managers. In addition, the Safety Division initiated the development of an automated Safety Training Catalog that will contain information on all safety-related courses available to NASA personnel.

Many new safety courses and innovative safety training activities were developed at the Centers in FY 1990. Courses are now available at the Ames Research Center (ARC) in the areas of Chemical Hazard Communication, Hearing Conservation, and Hazardous Waste Generator Training. The Hazardous Communication program at the Goddard Space Flight Center (GSFC) heightened employee awareness in hazard recognition and control. Some of the courses offered at the Johnson Space Center (JSC) newly established Safety Training Center were Fire Warden Training, Confined Space Entry Monitor certification, Hazard Communication training, and training in universal precautions to avoid transmission of bloodborne pathogens. A major effort at the Kennedy Space Center (KSC) dealt with the problem of asbestos abatement. Industrial hygienists were taught the Occupational Safety and Health Administration (OSHA) Reference Method for analysis of airborne asbestos fibers and how to analyze asbestos air samples using Phase Contrast Microscopy. An asbestos awareness training video was developed and presented to KSC asbestos abatement workers. One of the unique safety activities at the Langley Research Center (LaRC) is an annual Pressure Systems Week held to acquaint employees with the hazards associated with high pressure systems. Safety efforts at the Lewis Research Center (LeRC) included the development of an Environmental Programs newsletter to communicate environmental safety concerns to all employees. A program, open to all LeRC employees, was held to discuss environmental issues with Center management. Marshall Space Flight Center (MSFC) safety training efforts were aimed at all employees, with special emphasis on obtaining at least one training course applicable to the specific duties of each safety specialist. In addition, the MSFC Safety Coordinator and Monitor Collateral Duty Safety Course was presented to more than 300 employees in FY 1990. At the Stennis Space Center (SSC), management/supervisor safety committees were instituted to ensure training and awareness and a new employee safety orientation tape and booklet were developed.

In the area of risk management, a probabilistic risk assessment of the LaRC 10-foot wind tunnel was completed in FY 1990. Also, the model and data used in the 1989 independent risk assessment of the accident scenario probabilities associated with the Galileo Space Shuttle mission were refined and extended to provide a better characterization of the

Ulysses mission as well as subsequent Space Shuttle missions involving radioisotope thermoelectric generators. A Probabilistic Risk Analysis Workshop was held at LaRC with approximately 50 research, engineering, and safety professionals in attendance.

Independent safety assurance was provided for 5 Space Shuttle launches, 5 Expendable Launch Vehicles, and 92 payloads in FY 1990. Efforts in safety assurance continued to include a Mission Safety Evaluation (MSE) for each Space Shuttle launch. The MSE report contains a certified independent assessment and status of significant mission risks, including acceptance rationale. This effort will be expanded to include a MSE for unmanned launch vehicles.

A NASA Safety Directors Meeting was held on June 19 through 22, 1990, in Colorado Springs, Colorado. Representatives from all NASA Centers were in attendance to discuss overall NASA safety efforts and to gain insight into the total NASA safety program. Some of the major topics were the Senior Safety Steering Committee Charter, "Safety 2000" (the Safety Division's Total Quality Management initiative), safety motivational awards, and status of the Centers' safety programs.

NASA continued its initiatives directed towards controlling trends, major causes or sources of fatalities, and lost-time disabilities and lowering overall compensation costs. Using a formula developed in 1989, the Safety Division set FY 1990 lost time injury/illness frequency rate goals for each Center. The formula considers a number of parameters including previous performance as compared to the Center's own past record and the overall Agency rate, improvement desired, and projected worker hours. The Center Safety offices set additional goals for their various contractor organizations. Six out of the nine Centers met their FY 1990 goals. The excellent efforts of all NASA employees resulted in one of the lowest overall NASA lost time frequency rates in recent history.

The NASA Safety Division began an initiative to periodically meet with OSHA's Office of Federal Agency Programs. These meetings have helped to establish an excellent working relationship with OSHA. NASA has gained insight into present and pending OSHA safety and health requirements. The information exchange has proven beneficial to both agencies.

NASA participated in the Federal Seat Belt Usage initiative, "Buckle Up America." The NASA Safety Division reviewed Seat Belt Survivor stories submitted by installation personnel. The winning author was invited to the Secretary of Transportation's Breakfast in Washington, DC. All other participants received certificates from the National Highway Traffic Safety Administration (NHTSA).

NASA participated with the Department of Defense and other Government agencies as a member of the Chlorofluorocarbon (CFC) Advisory Committee. This committee was formed to address the revision of military specifications and standards on the use of CFCs and Halons. NASA is also a member of the Halon Alternatives Research Corporation. This joint industry/Government working group was established to develop uniform policies for reducing Halon usage and research alternatives to Halon. NASA was one of the first Government agencies to develop a Halon/CFC reduction policy in accordance with the Montreal Protocol. NASA's leadership in this area established a baseline for other agencies to follow.

It is NASA's goal to be at the forefront of safety-related technology. Typical research projects supported in FY 1990 that promise to enhance the safety of NASA programs and operations included on-orbit fire detection/suppression, hydrazine absorbers/neutralizers, and a joint NASA/Air Force pressure vessel burst test program.

During FY 1990, various new management instructions, handbooks, standards, and other documents were developed, validated, or revised by the Safety Division. A major effort to revise the NASA Basic Safety Manual continued. A revised NASA Safety Standard for Lifting Devices and Equipment was distributed to NASA field installations for review and comment. A cooperative effort with OSHA to develop an Alternate Standard for Suspended Load Crane Operations was completed. The Alternate Standard was formally submitted to OSHA for final approval. The development of a Hydrogen/Oxygen Safety Handbook was initiated, an Aviation Safety policy document and handbook were drafted and staffed, and an Underwater/Neutral Buoyancy Safety Handbook was developed.

The Headquarters Hazardous Substances Internal Coordinating Committee was established. The Committee's purpose is to provide a forum for interdisciplinary discussion among all Headquarters staff concerned with the safety, storage, and transportation of hazardous materials and the environmental exposure of the NASA workforce.

The Safety Division continued its development of the NASA Safety Information System (NSIS) with the addition of a prototype Lessons Learned Automated Database. An effort was initiated at MSFC to document lessons learned from previous and ongoing projects for inclusion in the Agencywide lessons learned database.

The NASA Safety Reporting System (NSRS) was expanded to include all programs and projects at all field installations. The NSRS is NASA's off-line, confidential, supplementary safety reporting system. The NSRS system is administered by an independent, neutral agent, the Battelle Memorial Institute in Columbus, OH, which processes all incoming reports and maintains the database.

The Safety Division continued to participate in the Headquarters SRM&QA Survey Program. All NASA field installations are being surveyed on a 2-year cycle. As part of this effort, the Safety Programs at JSC/WSTF, MSFC, SSC, JPL, and GSFC/WFF were reviewed in FY 1990. The Centers are required to take corrective action on all discrepancies found during the surveys. Lessons learned as a result of the surveys are distributed throughout the Agency so that all may benefit.

NASA will continue to strive for maximum safety awareness and excellence in all activities. The Field Installations and the Safety Division will continue to work together to maintain an emphasis on safety.

Charles W. Mertz
Director, Safety Division

FY 1990
NASA SAFETY STATISTICS

Fatalities	0
NASA Safety Reportable Injuries/Illnesses	
No Lost Time	195
Lost Time	81
Total Cases	276
Costs	
Lost Wages	$115,415
Chargeback Billing	$6,010,207
Material Losses	$8,930,238
Total Losses	$15,055,860

NASA OCCUPATIONAL INJURY/ILLNESS RECORD

Injuries and illness are divided into two classes, lost time cases and no-lost time cases. A lost time case is defined by OSHA as either a nonfatal, traumatic injury that causes loss of time from work or disability beyond the day or shift when the injury occurred, or a nonfatal illness/disease that causes loss of time from work or disability at any time. A no-lost time case is a nonfatal injury (traumatic) or illness/disease (nontraumatic) requiring medical treatment beyond first aid but does not result in lost time.

The injury/illness figures in this report were obtained from two sources. The Office of Worker's Compensation (OWCP) tracks the number of claims made on OSHA recordable (i.e., compensable) injuries and illnesses. (It is possible for more than one claim to be made as the result of a given injury or illness.) The NASA Safety Division tracks those injuries/illnesses for which preventive action or corrective action plans may be developed to prevent recurrence (NASA Safety reportable injuries/illnesses).

NASA determines injury/illness frequency rates according to the number of injuries/illnesses per 200,000 hours worked. OSHA calculates injury/illness incidence rates according to the number of injuries/illnesses per 100 employees. Several charts in this report reflect these formulas.

Table 1 shows the FY 1990 NASA Safety reportable injury/illness statistics for Federal employees at NASA Centers and for contractor employees at the Jet Propulsion Laboratory (JPL). (JPL is government owned and contractor operated for the purpose of research and development.) The overall Safety reportable lost time rate of 0.36 for NASA Federal employees is a 20% decrease from the FY 1989 rate of 0.45. The Safety reportable lost time rate of 1.05 for JPL contractor employees is a 9% decrease from the FY 1989 rate of 1.16.

TABLE 1. NASA SAFETY REPORTABLE INJURIES/ILLNESSES BY INSTALLATION - ANNUAL REPORT FY 1990

			Lost Time Cases			No Lost Time Incident w/ Injury Cases		Lost Time Rate vs. Goal '90	
	Average No. of Employees	Hours Worked	No. Days	No. Cases	Freq. Rate	No. Cases	Freq. Rate	YTD Rate	Goal
ARC/DFRF	2,341	4,771,295	95	12	0.50	2	0.08	0.50	0.51
GSFC/WFF	3,748	6,754,260	52	10	0.30	28	0.83	0.30	0.40
HQDB	1,981	3,587,291	156	18	1.00	15	0.84	1.00	0.35
JSC/WSTF	4,043	6,825,258	42	8	0.23	5	0.15	0.23	0.32
KSC	2,547	5,118,517	57	5	0.20	36	1.41	0.20	0.37
LARC	3,072	5,441,430	36	8	0.29	16	0.59	0.29	0.37
LERC	2,829	4,758,759	112	12	0.50	75	3.15	0.50	0.43
MSFC/MAF	3,602	6,717,999	93	7	0.21	18	0.54	0.21	0.31
SSC	208	423,468	10	1	0.47	0	0.00	0.47	0.00
NASA	24,371	44,398,277	653	81	0.36	195	0.88	0.36	0.40
1989	23,499	43,091,611	847	96	0.45	122	0.57	0.45	0.40
JPL	6,482	12,707,013	424	67	1.05	263	4.14	1.05	0.95
1989	6,339	12,461,963	532	72	1.16	274	4.40	1.16	1.30

1. Lost Time frequency rate = number of lost workday cases per 200,000 hours worked.
2. Incidents w/Injury do not include Lost Time or First Aid cases.
3. Incidents w/Injury frequency rate = number of injury cases per 200,000 hours worked.
4. The Jet Propulsion Laboratory (JPL) is a government owned, contractor operated facility.

Figure 1 illustrates the relative position of NASA's lost time injury/illness performance compared to other Federal agencies having more than 15,000 employees in FY 1989 and FY 1990. The incidence rates shown in the figure were calculated by OSHA based on OWCP data. Within this group of Federal agencies, NASA has ranked second since FY 1984.

Figure 2 compares NASA's lost time injury/illness performance for the last 11 years against that of other Federal agencies and select private sector industries. The incidence rates shown in the figure were calculated based on OWCP data. NASA's rates have been consistently lower than those of the Federal Government and the private sector. The most recent statistics available from the Department of Labor for the private sector are for FY 1989.

Figure 3 illustrates NASA's excellent overall injury/illness record over the last 11 years as compared to all other Federal agencies, the private sector, private sector manufacturing industry, and the private sector aerospace industry. The incidence rates shown in the figure were calculated based on OWCP data. The most recent statistics available from the Department of Labor for the private sector are for FY 1989.

Figure 4 shows how the FY 1990 NASA Safety reportable lost time injury/illness frequency rates for Federal employees at NASA Centers compare to the Centers' individual goals, the overall NASA goal of 0.40, and the overall FY 1990 NASA rate of 0.36.

Figure 5 plots the NASA Safety reportable lost time frequency rate, no lost time rate, and the total rate. FY 1988 was the first year that the number of Safety reportable lost time cases exceeded the number of no lost time cases. This trend was reversed in 1989 and 1990.

Figure 6 compares the FY 1990 NASA Safety reportable lost time frequency rates of NASA Federal employees at each Center with the previous year's rate and an average rate for the previous 3 years (FY 1987 - FY 1989).

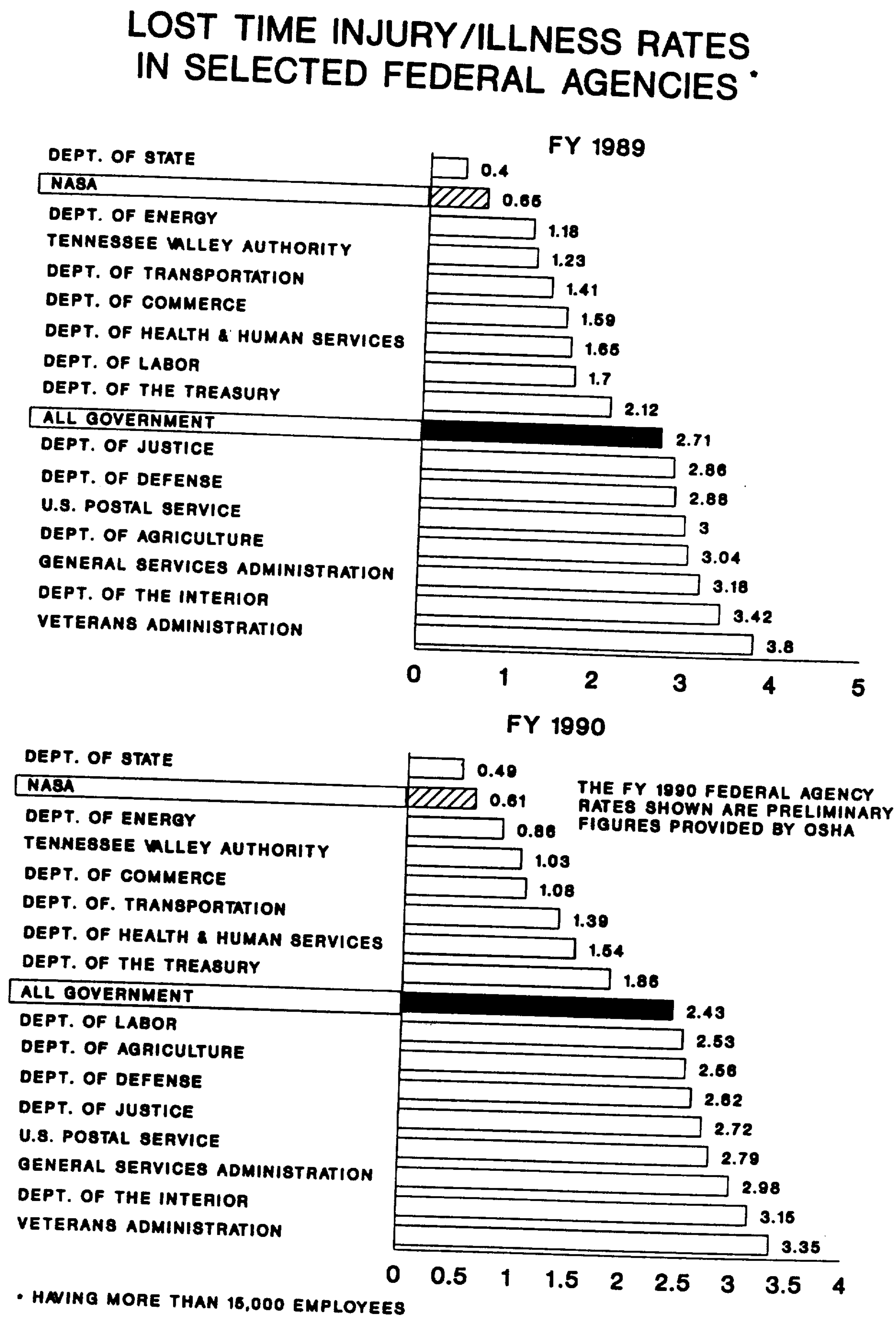

LOST TIME INJURY/ILLNESS RATES
IN SELECTED FEDERAL AGENCIES *
FY 1989
DEPT. OF STATE 0.4
NASA 0.65
DEPT. OF ENERGY 1.18
TENNESSEE VALLEY AUTHORITY 1.23
DEPT. OF TRANSPORTATION 1.41
DEPT. OF COMMERCE 1.59
DEPT. OF HEALTH & HUMAN SERVICES 1.65
DEPT. OF LABOR 1.7
DEPT. OF THE TREASURY 2.12
ALL GOVERNMENT 2.71
DEPT. OF JUSTICE 2.86
DEPT. OF DEFENSE 2.88
U.S. POSTAL SERVICE 3
DEPT. OF AGRICULTURE 3.04
GENERAL SERVICES ADMINISTRATION 3.18
DEPT. OF THE INTERIOR 3.42
VETERANS ADMINISTRATION 3.8
0 1 2 3 4 5
FY 1990
DEPT. OF STATE 0.49
NASA 0.61
DEPT. OF ENERGY 0.86
TENNESSEE VALLEY AUTHORITY 1.03
DEPT. OF COMMERCE 1.08
DEPT. OF. TRANSPORTATION 1.39
DEPT. OF HEALTH & HUMAN SERVICES 1.54
DEPT. OF THE TREASURY 1.86
ALL GOVERNMENT 2.43
DEPT. OF LABOR 2.53
DEPT. OF AGRICULTURE 2.56
DEPT. OF DEFENSE 2.62
DEPT. OF JUSTICE 2.72
U.S. POSTAL SERVICE 2.79
GENERAL SERVICES ADMINISTRATION 2.98
DEPT. OF THE INTERIOR 3.15
VETERANS ADMINISTRATION 3.35
THE FY 1990 FEDERAL AGENCY RATES SHOWN ARE PRELIMINARY FIGURES PROVIDED BY OSHA
0 0.5 1 1.5 2 2.5 3 3.5 4
* HAVING MORE THAN 15,000 EMPLOYEES

Figure 1

LOST TIME
OCCUPATIONAL INJURY/ILLNESS RATES
PRIVATE SECTOR-ALL FED. AGENCIES-NASA

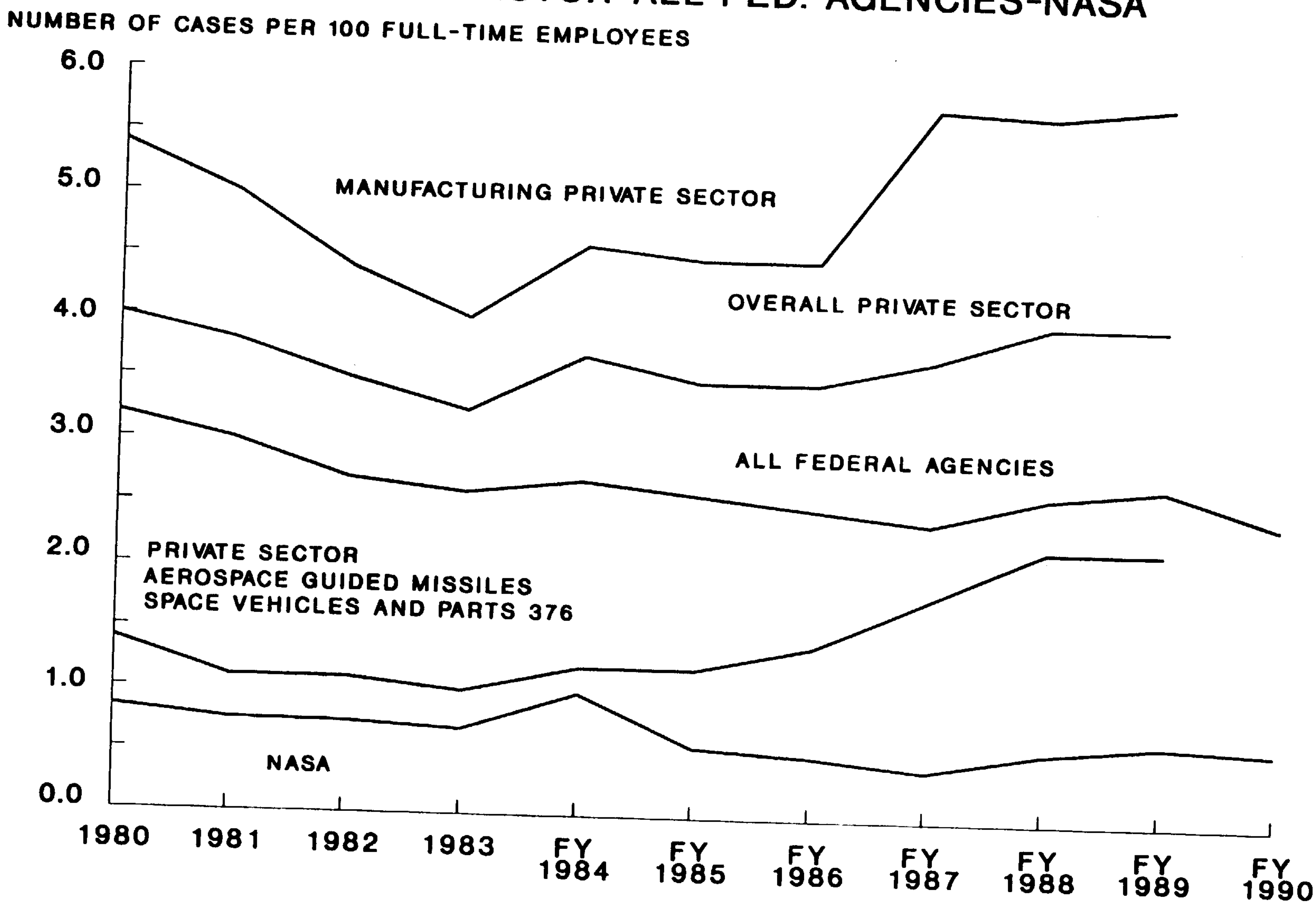


Figure 2

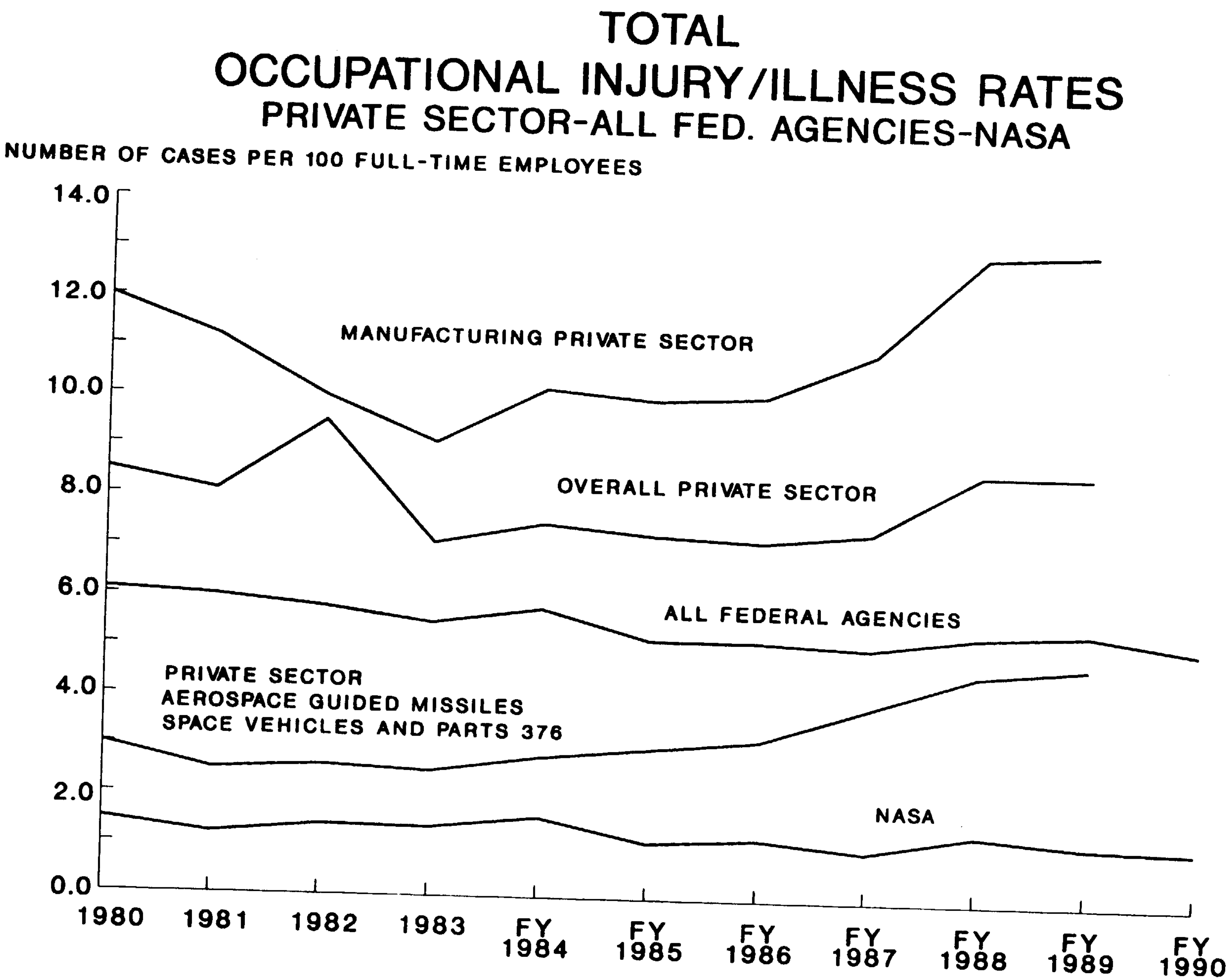

TOTAL
OCCUPATIONAL INJURY/ILLNESS RATES
PRIVATE SECTOR-ALL FED. AGENCIES-NASA
NUMBER OF CASES PER 100 FULL-TIME EMPLOYEES
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
MANUFACTURING PRIVATE SECTOR
OVERALL PRIVATE SECTOR
ALL FEDERAL AGENCIES
PRIVATE SECTOR
AEROSPACE GUIDED MISSILES
SPACE VEHICLES AND PARTS 376
NASA
1980
1981
1982
1983
FY 1984
FY 1985
FY 1986
FY 1987
FY 1988
FY 1989
FY 1990

Figure 3

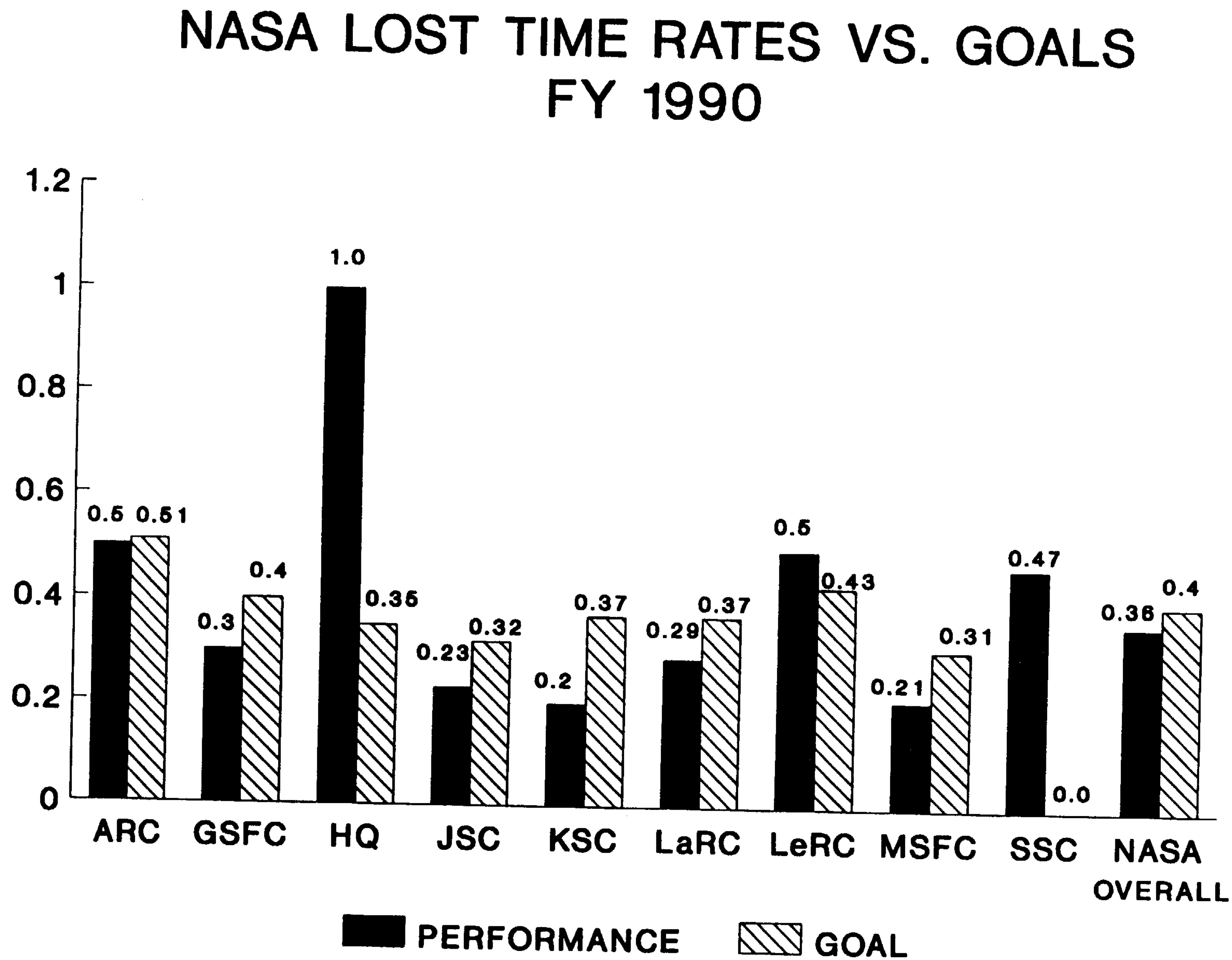

NASA LOST TIME RATES VS. GOALS
FY 1990
1.2
1
0.8
0.6
0.4
0.2
0
0.5 0.51
0.3 0.4
1.0 0.35
0.23 0.32
0.2 0.37
0.29 0.37
0.5 0.43
0.21 0.31
0.47 0.0
0.36 0.4
ARC
GSFC
HQ
JSC
KSC
LaRC
LeRC
MSFC
SSC
NASA OVERALL
PERFORMANCE
GOAL

Figure 4

NASA INJURY/ILLNESS* RATES **
1980-1990

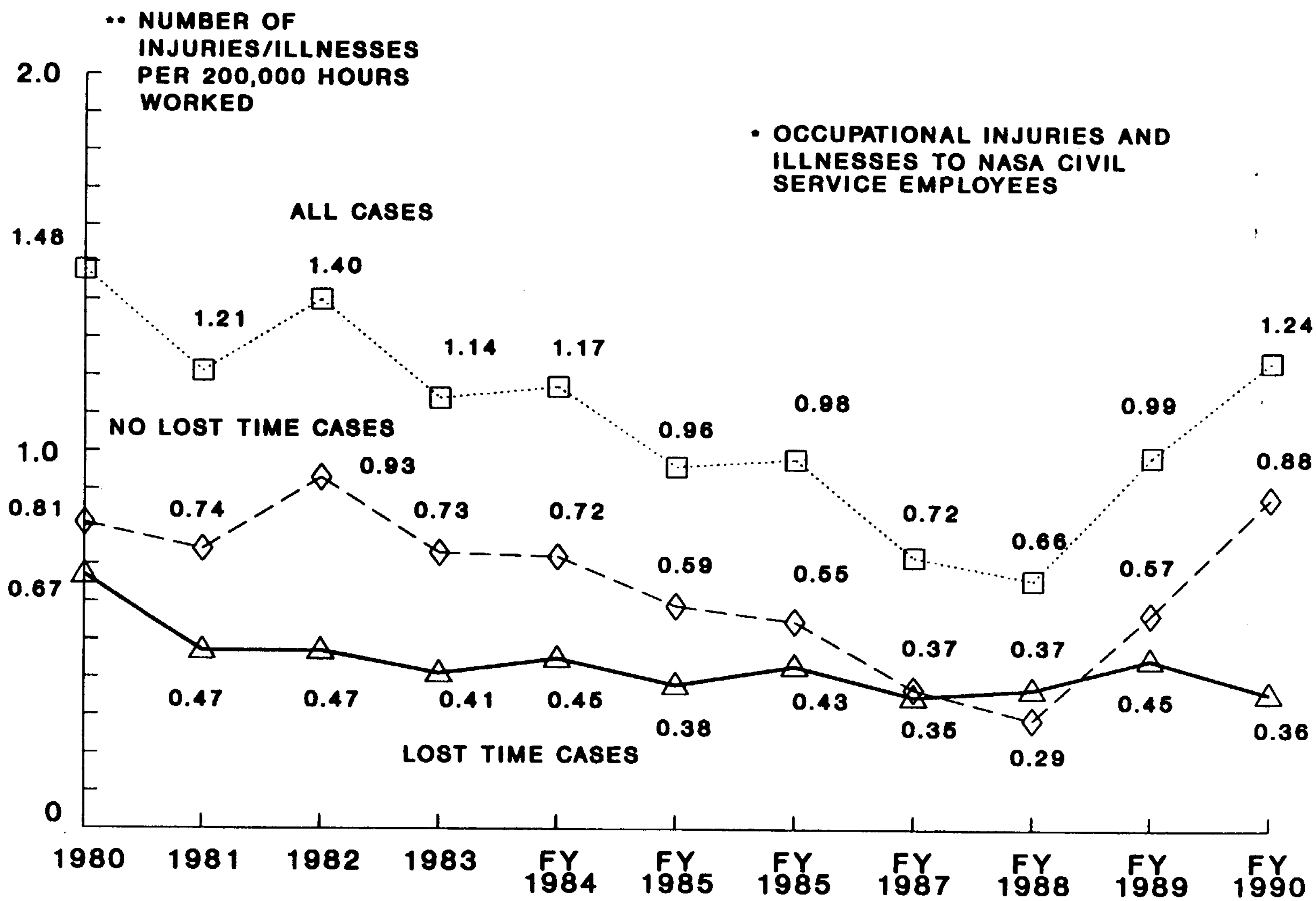


Figure 5

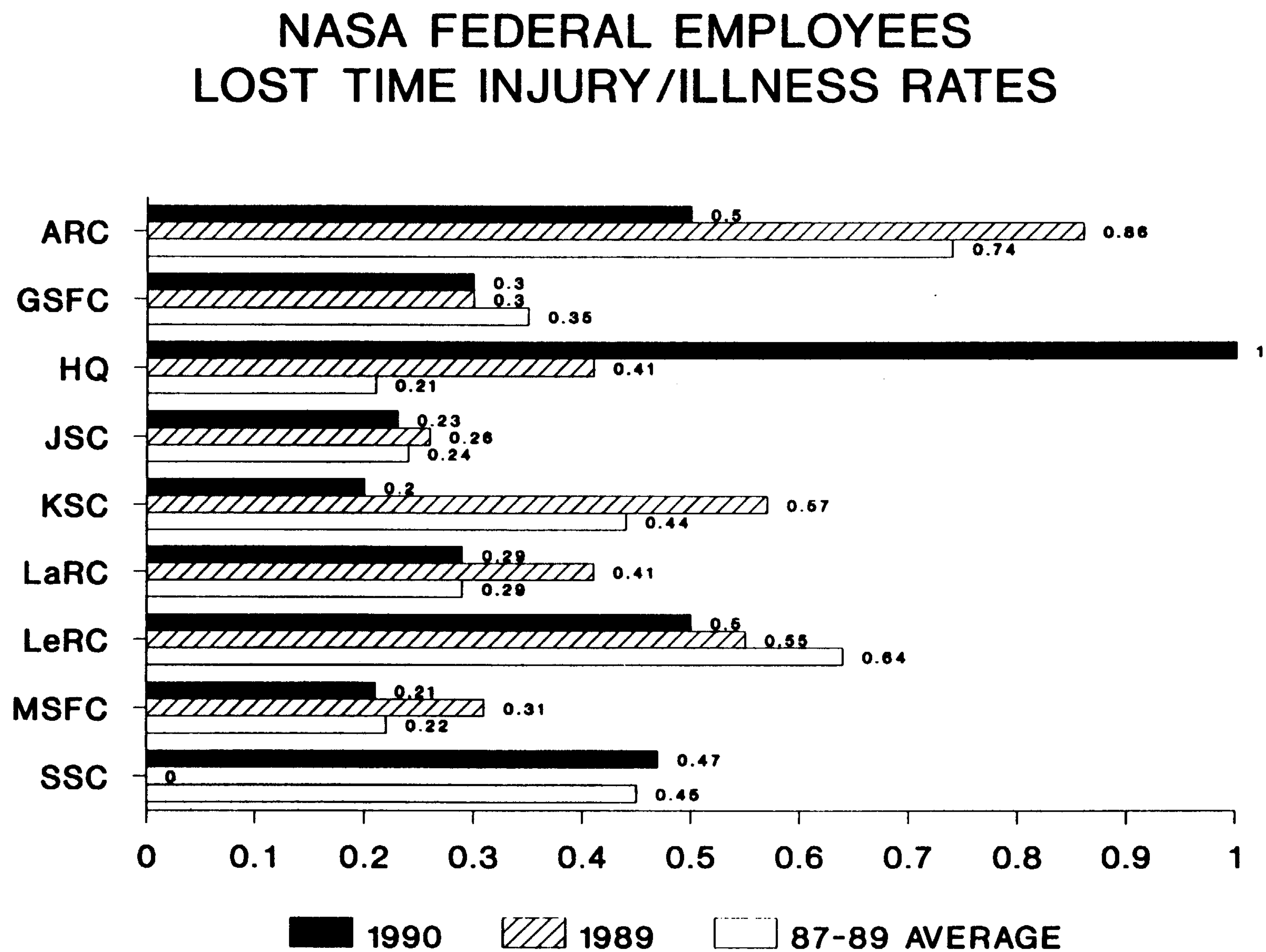

NASA FEDERAL EMPLOYEES
LOST TIME INJURY/ILLNESS RATES
ARC
GSFC
HQ
JSC
KSC
LaRC
LeRC
MSFC
SSC
0.5
0.86
0.74
0.3
0.3
0.35
1
0.41
0.21
0.23
0.26
0.24
0.2
0.57
0.44
0.29
0.41
0.29
0.5
0.55
0.64
0.21
0.31
0.22
0.47
0
0.45
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
1990
1989
87-89 AVERAGE

Figure 6

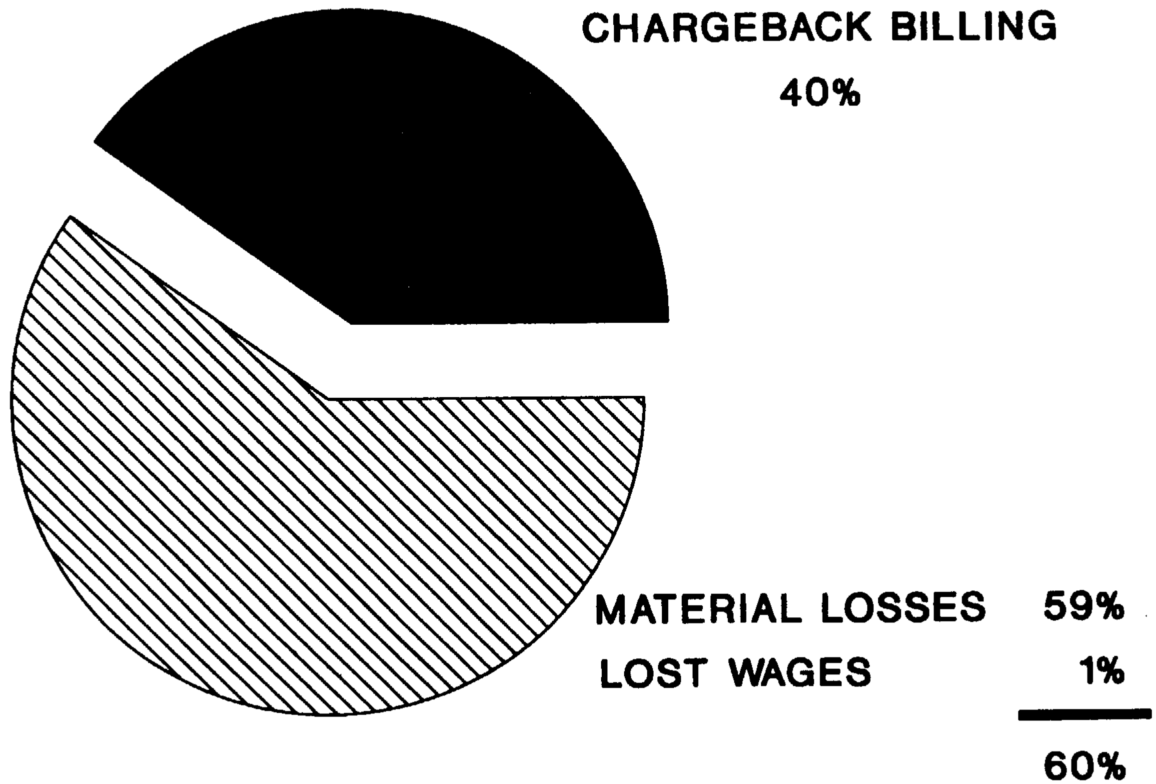
CHARGEBACK BILLING

Chargeback is defined by OSHA as a system under which the U.S. Department of Labor pays compensation and medical costs attributed to injuries that occurred after December 1, 1960, and then bills the agency that employed the individual who received compensation or benefits. In any given year, most of the chargeback billing is a result of illnesses and injuries that occurred in previous years. Only 4.8%, or $285,982, of the chargeback billing costs paid in FY 1990 were for injuries that actually occurred during that year.

Figure 7 illustrates the relationship between chargeback billing and all other mishap and injury related costs. These costs include lost wages (continuation of pay) as well as damage to or loss of NASA property in excess of $499. Of the $15.1 million total loss for FY 1990, $6.0 million, or 40%, was paid out in chargeback billing costs.

Figure 8 illustrates the trend of chargeback billing in the Federal Government and in NASA for the last 11 years. The Federal Government's chargeback billing costs have continued to increase each year. NASA's stabilized at around $5 million annually through 1989 but increased to $6.0 million in FY 1990.

FY 1990 COST OF NASA MISHAPS/INJURIES
TOTAL LOSS = $15,055,860



DOES NOT INCLUDE
COST OF MISSION FAILURES
OR TEST OPERATIONS LOSSES

Figure 7

HISTORY OF CHARGEBACK BILLING COSTS FOR ALL FEDERAL AGENCIES AND NASA (IN MILLIONS OF DOLLARS)

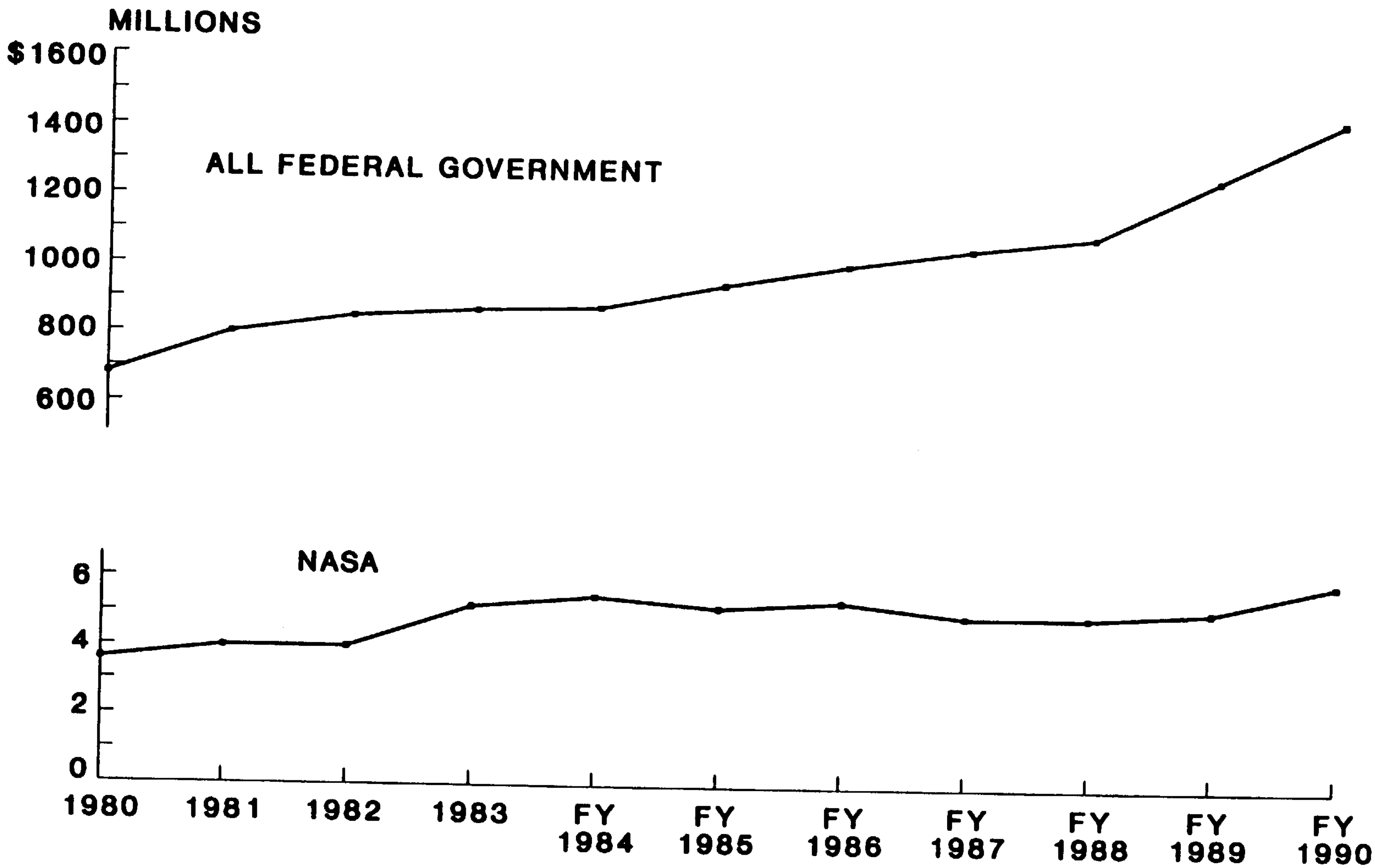


Figure 8

MATERIAL LOSSES

Tables 2A and 2B list the statistics for NASA material losses during FY 1990. Rescheduling and equipment replacement costs from major mission failures are not included in these statistics. Table 2A provides the number of equipment/property damage cases by equipment classification for each installation. Table 2B provides the cost of equipment/property damage cases by equipment classification for each installation.

Figure 9 illustrates the total costs of material losses over the last 11 years.

Figure 10 provides a percentage breakdown of equipment/property costs for FY 1990. Facility, flight hardware, and ground support equipment losses were the major contributors.

Figure 11 compares FY 1990 equipment/property costs with FY 1989 results. A significant decrease in aircraft losses (NASA lost an F-18 in FY 1989) resulted in a 35% decrease in the total cost of material losses between FY 1989 and FY 1990.

TABLE 2A. EQUIPMENT/PROPERTY DAMAGE BY INSTALLATION - ANNUAL REPORT FY 1990
NUMBER OF CASES BY EQUIPMENT CLASSIFICATION

	Flight Hardware	Ground Support Equip.	Facility	Pressure Vessel	Motor Vehicle	Aircraft	Other	Total Cases
ARC/DFRF	1	0	3	0	0	0	2	6
GSFC/WFF	0	1	1	0	0	0	2	4
HQDB	0	0	0	0	0	0	0	0
JPL	0	1	0	0	1	0	0	2
JSC/WSTF	0	1	3	1	2	1	8	16
KSC	20	5	8	1	10	0	3	47
LARC	1	0	4	0	0	0	0	5
LERC	0	0	6	0	0	0	2	8
MSFC	13	1	5	0	3	1	10	33
SSC	0	0	0	0	0	0	3	3
TOTAL	35	9	30	2	16	2	30	124
1989	38	16	30	2	64	5	43	198

TABLE 2B. EQUIPMENT/PROPERTY COSTS BY INSTALLATION - ANNUAL REPORT FY 1990
COST OF CASES BY EQUIPMENT CLASSIFICATION

	Flight Hardware	Ground Support Equip.	Facility	Pressure Vessel	Motor Vehicle	Aircraft	Other	Total Costs
ARC/DFRF	80,000	0	2,649,000	0	0	0	351,000	3,080,000
GSFC/WFF	0	10,000	246,000	0	0	0	21,800	277,800
HQDB	0	0	0	0	0	0	0	0
JPL	0	200,000	0	0	1,200	0	0	201,200
JSC/WSTF	0	50,000	51,500	25,000	3,405	36,220	24,627	190,752
KSC	3,745,138	229,410	209,192	1,000	28,335	0	20,601	4,233,676
LARC	12,000	0	35,800	0	0	0	0	47,800
LERC	0	0	207,962	0	0	0	7,000	214,962
MSFC	334,097	9,000	19,482	0	4,092	3,725	302,502	672,898
SSC	0	0	0	0	0	0	11,150	11,150
TOTAL	4,171,235	498,410	3,418,936	26,000	37,032	39,945	738,680	8,930,238
1989	3,105,798	233,789	4,272,326	12,500	63,127	5,186,386	811,762	13,685,688

1. Cost of Mission Failures is not included in mishap costs.

NASA MATERIAL LOSSES DUE TO MISHAPS (IN MILLIONS OF DOLLARS) 1980-1990

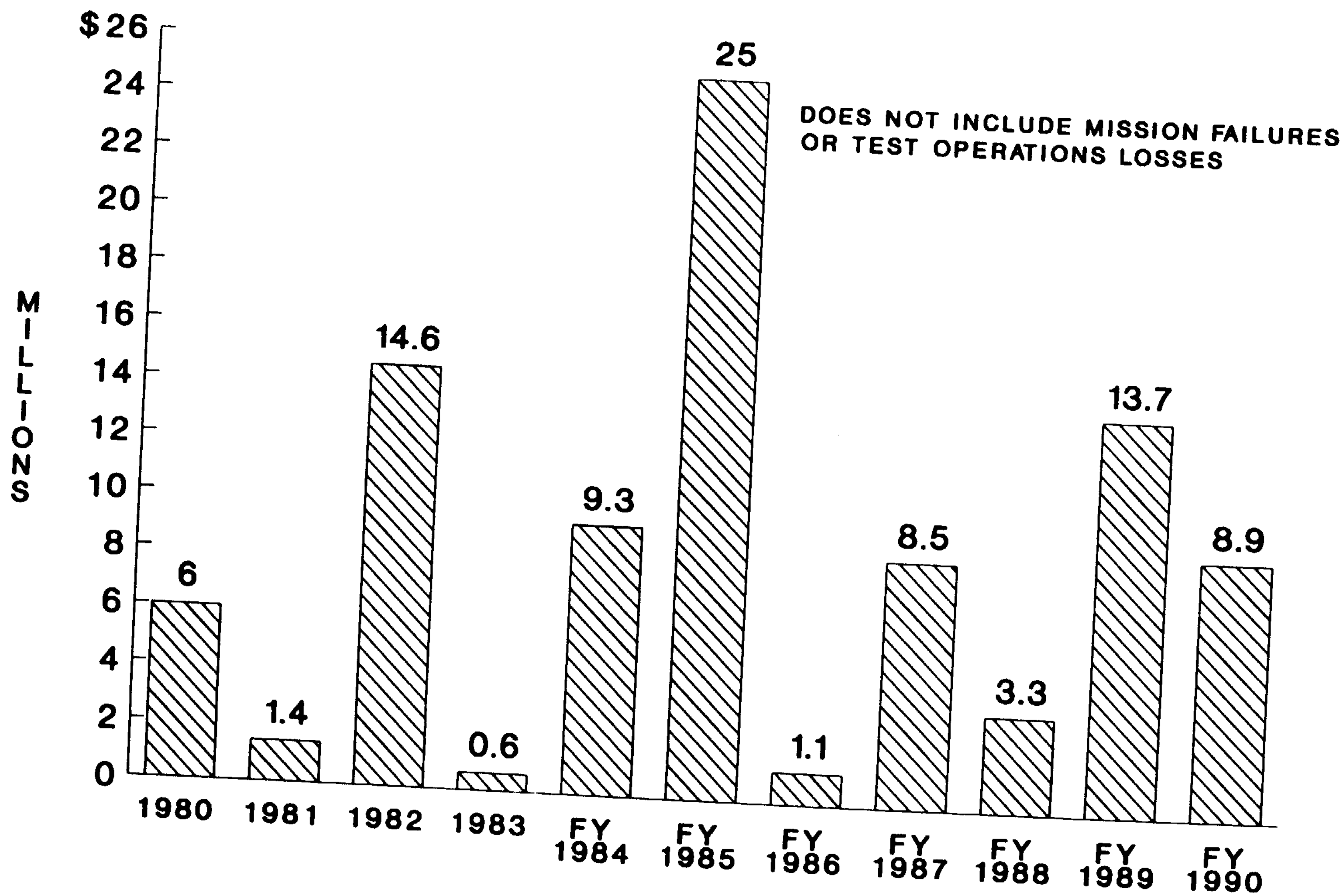


Figure 9

FY 1990 EQUIPMENT/PROPERTY COSTS
NASA TOTAL $8,930,238

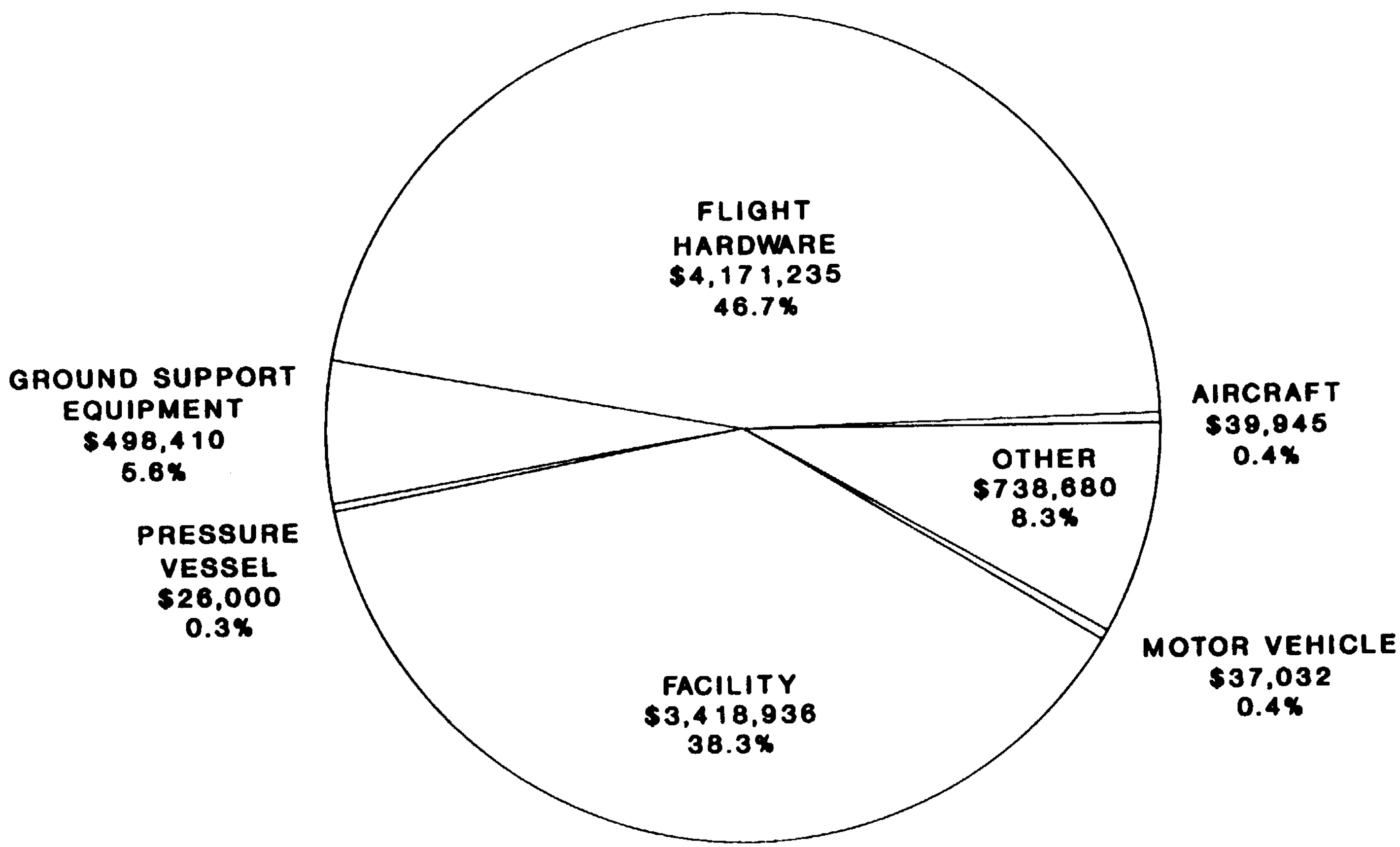


Figure 10

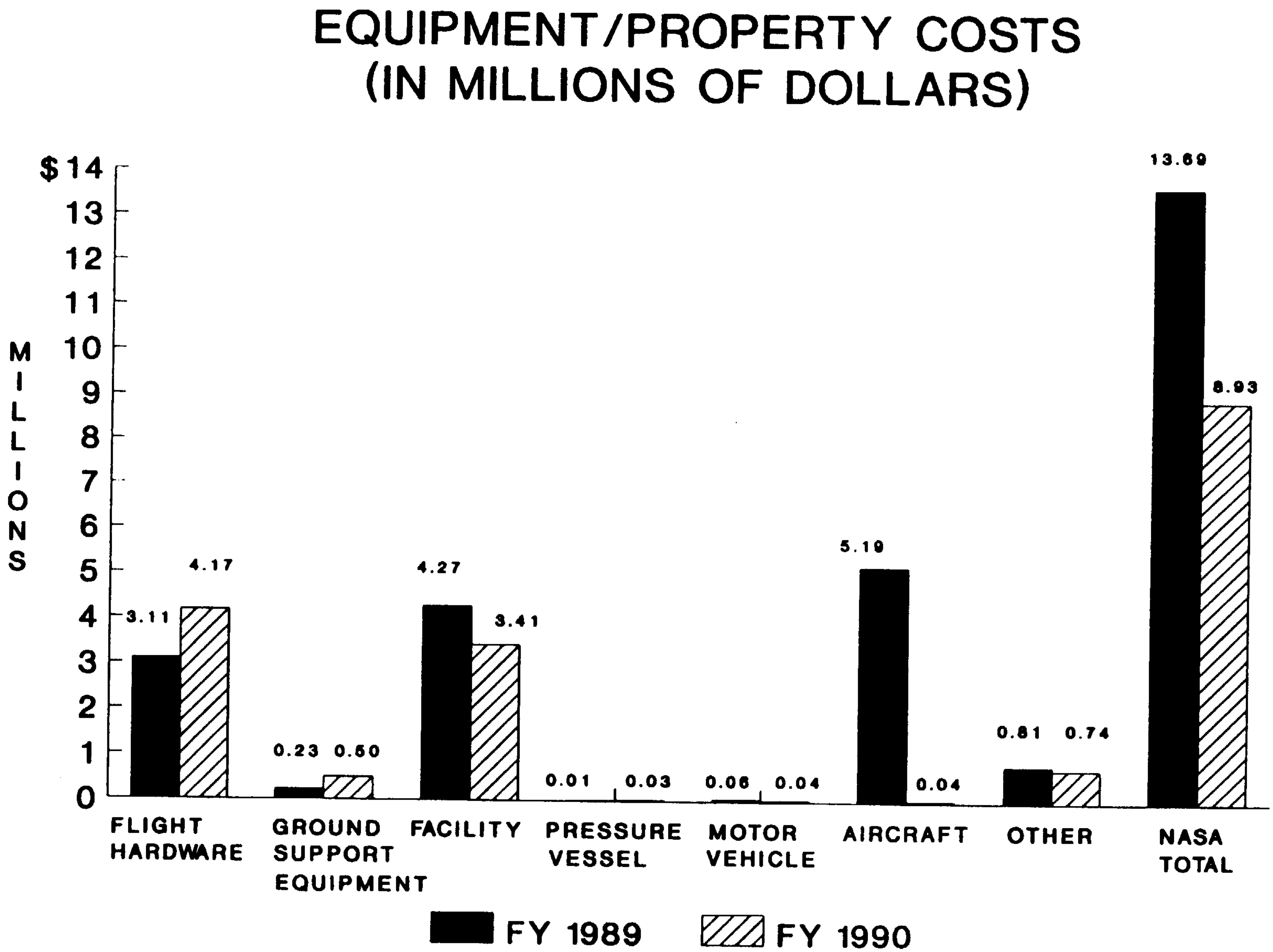

EQUIPMENT/PROPERTY COSTS
(IN MILLIONS OF DOLLARS)
$14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
MILLIONS
3.11
4.17
0.23
0.50
4.27
3.41
0.01
0.03
0.06
0.04
5.19
0.04
0.81
0.74
13.69
8.93
FLIGHT HARDWARE
GROUND SUPPORT EQUIPMENT
FACILITY
PRESSURE VESSEL
MOTOR VEHICLE
AIRCRAFT
OTHER
NASA TOTAL
FY 1989
FY 1990

Figure 11

NASA MISHAP DEFINITIONS

The revised NASA Management Instruction for Mishap Reporting and Investigation (NMI 8621.1E), dated September 6, 1988, contains updated NASA mishap definitions. All mishaps reported in FY 1990 were categorized according to these definitions as follows:

1. **NASA MISHAP:** Any unplanned occurrence, event, or anomaly that meets one of the definitions below. Injury to a member of the public while on NASA facilities also is defined as a NASA mishap.

   a. **TYPE A MISHAP:** A mishap causing death and/or damage to equipment or property equal to or greater than $1,000,000. Mishaps resulting in damage to aircraft or space hardware, i.e., flight and ground support hardware, meeting this criterion are included. This definition also applies to a test failure if the damage was unexpected or unanticipated or if the failure is likely to have significant program impact or visibility.

   b. **TYPE B MISHAP:** A mishap resulting in permanent disability to one or more persons, or hospitalization (for other that observation) of five or more persons, and/or damage to equipment or property equal to or greater than $250,000 but less than $1,000,000. Mishaps resulting in damage to aircraft or space hardware which meet this criterion are included, as are test failures where the damage was unexpected or unanticipated.

   c. **TYPE C MISHAP:** A mishap resulting in damage to equipment or property equal to or greater than $25,000 but less than $250,000, and/or causing occupational injury or illness that results in a lost workday case. Mishaps resulting in damage to aircraft or space hardware mishaps and test failures that meet these criteria are also included.

   d. **MISSION FAILURE:** Any mishap (event) of such a serious nature that it prevents accomplishment of the majority of the primary mission objectives. A mishap of whatever intrinsic severity that, in the judgment of the Program Associate Administrator, in coordination with the Associate Administrator for Safety and Mission Quality, prevents the achievement of primary mission objectives as described in the Mission Operations Report.

   e. **INCIDENT:** A mishap consisting of less than Type C severity of injury to personnel (more than first aid severity) and/or property damage equal to or greater than $500 but less than $25,000. Events which have small property loss, less than $500, should be reported as incidents if they have significantly greater potential or high visibility.

2. **NASA CONTRACTOR MISHAP:** Any mishaps as defined in paragraphs 1a through 1e that involve only NASA contractor personnel, equipment, or facilities in support of NASA operations.

3. **IMMEDIATELY REPORTABLE MISHAPS:** All mishaps that require immediate telephonic notification to local and Headquarters safety officials. Included in this category are those mishaps defined in paragraphs 1a through 1d and 2 with the exception of Type C injury/illness cases and incidents.

4. **CLOSE CALL:** An occurrence in which there is no injury, no property/equipment damage, and no significant interruption of productive work, but which possesses a high potential for any of the mishaps as defined in paragraphs 1a through 1e.

5. **OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) RECORDABLE MISHAP:** An occupational death, injury or illness that must be recorded subject to OSHA requirements in 29 CFR Part 1960 and Part 1910.

6. **COSTS:** Direct costs of repair, retest, program delays, replacement, or recovery of NASA materials including hours, material, and contract costs, but excluding indirect costs of cleanup, investigation (either by NASA, contractor, or consultant), injury, and by normal operational shutdown. Materials or equipment replaced by another organization at no cost to NASA will be calculated at "book" value. This includes those mishaps covered by insurance.

MISHAP STATISTICS

Tables 3 and 4 show the mishaps that were reported by the NASA field installations as having significance beyond the minor dollar losses or injury incident categories. These mishaps provide "lessons learned" for all NASA accident prevention programs.

Figure 12 presents an 11-year overview of all NASA Type A and B mishaps and Type C property damage mishaps. Type B and C personal injuries are reflected in Table 1. The dollar limits for each category have escalated over the years due to inflation and policy changes.

Figure 13 presents an 11-year history of NASA's total losses from chargeback billing costs, lost wages, and material losses due to mishaps.

Tables 5A and 5B provide a safety performance summary for FY 1990. Table 5A shows the incidents with injury rates for NASA employees at each Center and compares FY 1990 lost time injury/illness rates with each Center's goal and previous performance. Table 5B shows the number and type of mishaps and the cost of material losses for FY 1989 and FY 1990.

TABLE 3. FATALITIES - ANNUAL REPORT FY 1990

	1986 N/ C/ O	1987 N/ C/ O	1988 N/ C/ O	1989 N/ C/ O	1990 N/ C/ O
ARC/DFRF	0/ 1/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0
GSFC/WFF	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0
HQDB	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0
JPL	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0
JSC/WSTF	3/ 2/ 3	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0
KSC	0/ 3/ 0	0/ 0/ 0	0/ 1/ 0	0/ 1/ 0	0/ 0/ 1
LARC	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0
LERC	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0
MSFC/MAF	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0
SSC	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0
TOTAL	3/ 6/ 3	0/ 0/ 0	0/ 1/ 0	0/ 1/ 0	0/ 0/ 1

1. N/ C/ O = NASA / Contractor / Other.

TABLE 4. NASA MAJOR MISHAPS BY INSTALLATION - ANNUAL REPORT FY 1990

	1986 A/ B/ C	1987 A/ B/ C	1988 A/ B/ C	1989 A/ B/ C	1990 A/ B/ C
ARC/DFRF	0/ 0/ 17	0/ 0/ 16	0/ 0/ 21	1/ 0/ 19	1/ 1/ 14
GSFC/WFF	0/ 0/ 9	0/ 0/ 16	0/ 0/ 13	0/ 0/ 8	0/ 0/ 11
HQDB	0/ 0/ 7	0/ 0/ 1	0/ 0/ 0	0/ 0/ 8	0/ 0/ 18
JPL	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 1/ 0	0/ 0/ 1
JSC/WSTF	0/ 0/ 13	0/ 2/ 8	0/ 0/ 7	0/ 2/ 14	0/ 0/ 12
KSC	1/ 1/ 10	1/ 0/ 6	0/ 2/ 14	0/ 2/ 18	1/ 0/ 12
LARC	0/ 0/ 5	0/ 0/ 5	0/ 0/ 10	1/ 0/ 16	0/ 0/ 8
LERC	0/ 0/ 24	0/ 0/ 20	0/ 0/ 12	0/ 1/ 16	0/ 0/ 13
MSFC/MAF	0/ 0/ 10	2/ 0/ 12	0/ 1/ 14	0/ 1/ 18	0/ 0/ 10
SSC	0/ 0/ 0	0/ 0/ 2	0/ 0/ 1	0/ 0/ 0	0/ 0/ 1
TOTAL	1/ 1/ 95	3/ 2/ 86	0/ 3/ 92	2/ 7/117	2/ 1/100

1. Includes NASA fatalities, permanent disabilities, hospitalization of 5 or more persons, lost time mishaps and Type A, B, & C property damage according to NMI 8621.1E.

NASA TYPE A, B, AND C MISHAPS
1980-1990

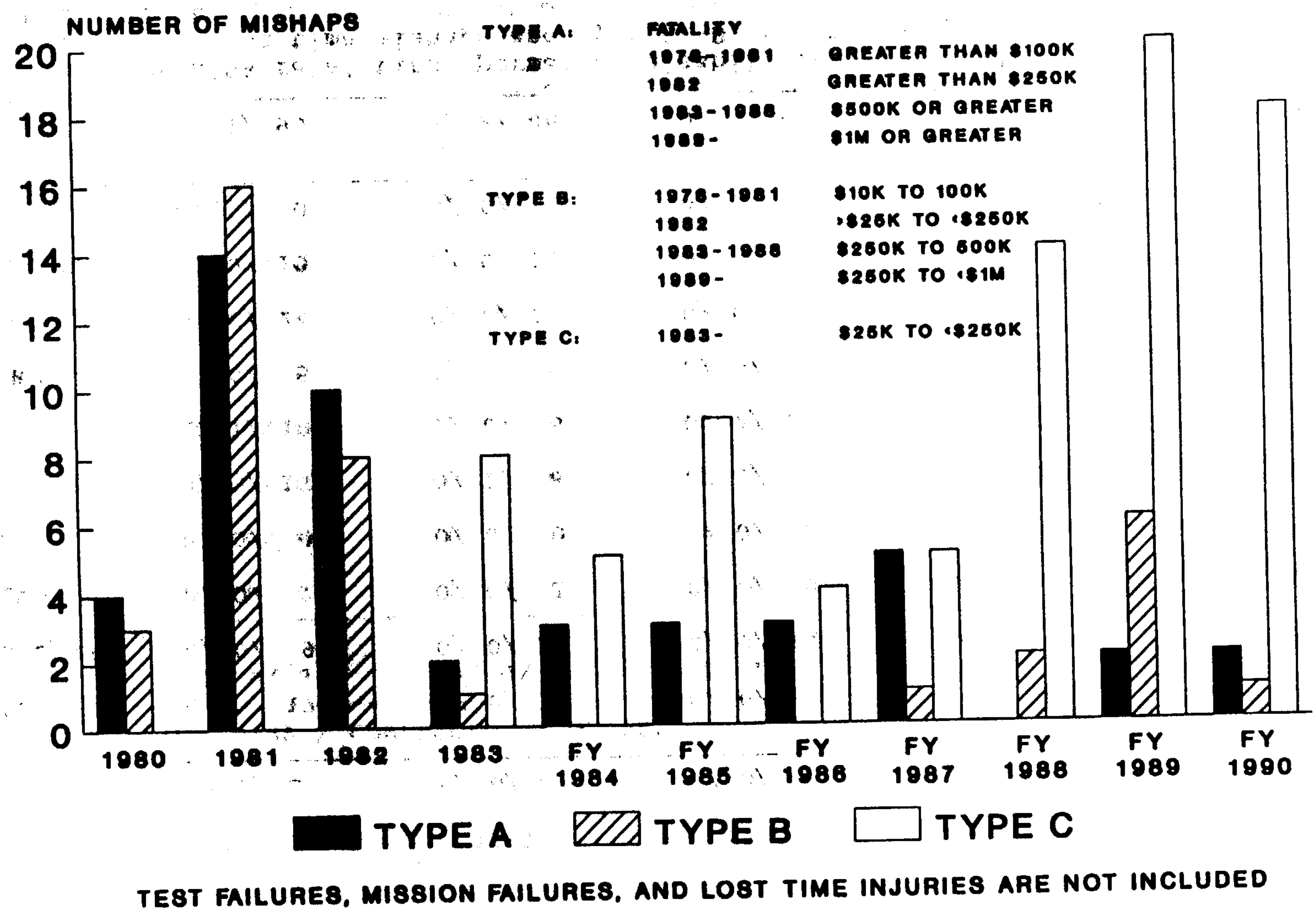


Figure 12

TOTAL COSTS TO NASA DUE TO MISHAPS (IN MILLIONS OF DOLLARS) 1980-1990

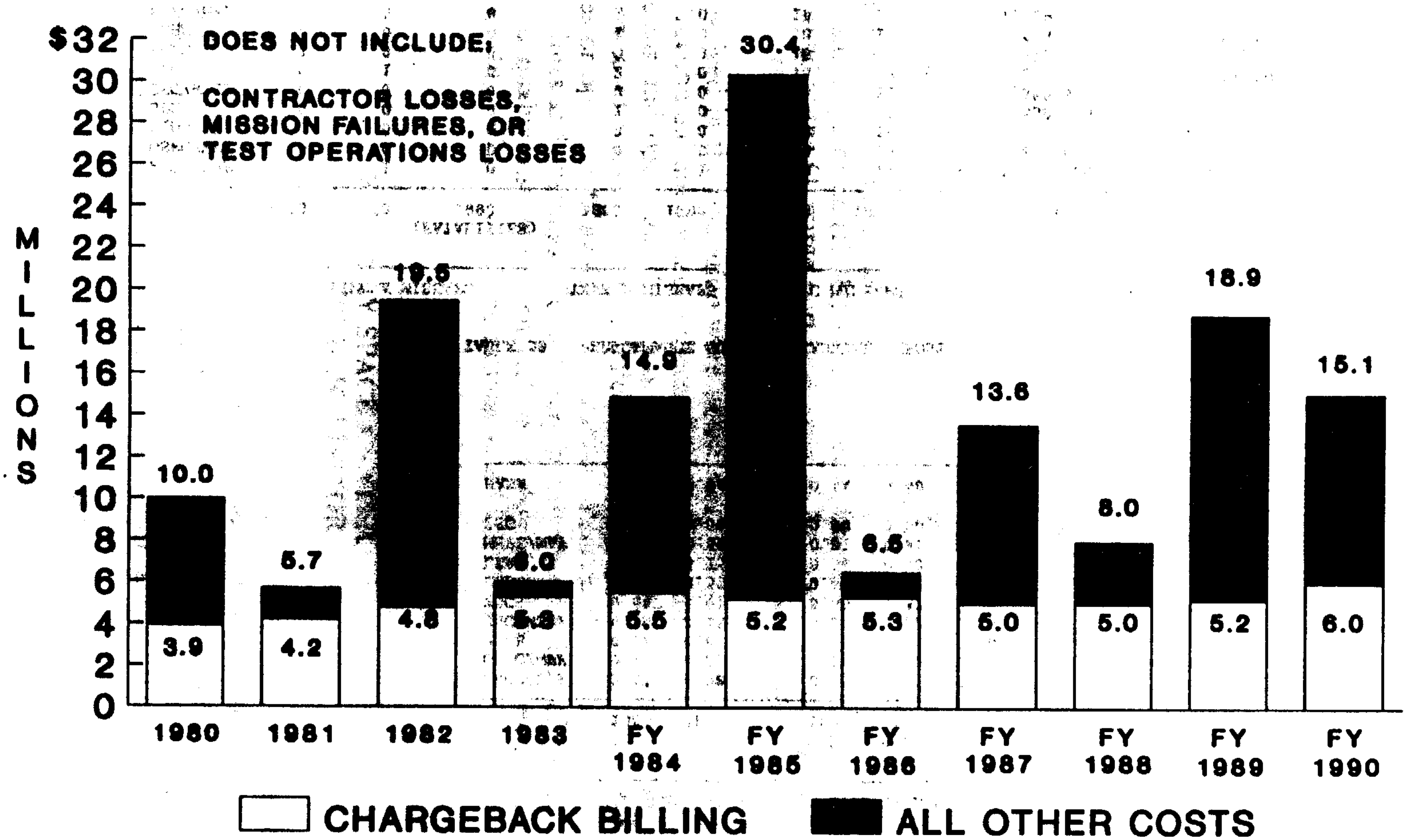


Figure 13

TABLE 5A. PERFORMANCE SUMMARY - ANNUAL REPORT FY 1990

	NASA NO LOST TIME INCIDENT W/INJURY RATES		NASA LOST TIME RATES		
	1989	1990	1989	GOAL 1990	1990
ARC/DFRF	0.17	0.08	0.85	0.51	0.50
GSFC/WFF	0.43	0.83	0.24	0.40	0.30
HQDB	0.17	0.84	0.52	0.35	1.00
JSC/WSTF	0.39	0.15	0.26	0.32	0.23
KSC	0.84	1.41	0.58	0.37	0.20
LARC	[illegible]	0.50	0.45	[illegible]	[illegible]
LERC	[illegible]	0.15	0.50	0.43	[illegible]
MSFC/MAF	[illegible]	0.54	0.31	0.31	[illegible]
SSC	[illegible]	0.00	0.00	0.00	[illegible]
NASA	[illegible]	0.88	0.44	0.40	[illegible]

TABLE 5B. PERFORMANCE SUMMARY - ANNUAL REPORT FY 90

	TYPE A MISHAPS			TYPE B MISHAPS		TYPE C MISHAPS		MATERIAL LOSSES	
	1989	1990	(FATALITIES) 1990	1989	1990	1989	1990	1989	1990
ARC/DFRF	1	1	0	0	1	[illegible]	14	5,025,400	3,080,000
GSFC/WFF	0	0	0	0	0	[illegible]	13	279,811	277,800
HQDB	0	0	0	0	0	[illegible]	18	1,000	0
JPL	0	0	0	1	0	[illegible]	1	559,323	201,200
JSC/WSTF	0	0	0	2	0	14	12	1,350,391	190,752
KSC	0	1	0	2	0	18	12	1,251,176	4,233,676
LARC	1	0	0	0	0	16	8	3,376,465	47,800
LERC	0	0	0	1	0	16	13	563,000	214,962
MSFC/MAF	0	0	0	1	0	18	10	1,269,122	672,898
SSC	0	0	0	0	0	0	1	10,000	11,150
TOTALS	2	2	0	7	1	117	102	13,685,688	8,930,238

MAJOR MISHAPS IN FY 1990

EARTHQUAKE
AMES RESEARCH CENTER
TYPE A

On October 17, 1989, several buildings at the Ames Research Center sustained damage due to an earthquake measuring 7.1 on the Richter scale. Cost of the widespread damage to the installation totaled $2,600,000.

FUEL CELL MISHAP
KENNEDY SPACE CENTER
TYPE A

On April 4, 1990, a fuel cell installed in the Orbiter Atlantis, OV-104, was damaged while an attempt was being made to vent the fuel cell prior to its removal and replacement. Investigations revealed that the Orbiter hydrogen (H_2) purge vent port was capped. This allowed the H_2 pressure to exceed the oxygen (O_2) pressure in the fuel cell, causing the migration of potassium hydroxide (KOH) water solution throughout the O_2 side of the fuel cell. KOH was found at the O_2 purge port of the fuel cell. Due to the corrosive qualities of KOH, the 96 internal cells, the regulator, and the accumulator had to be replaced.

The personnel involved in the operation were unfamiliar with the task. The Operations Maintenance Instruction did not contain a precautionary note addressing the need to keep the purge port clear and open and there was no placard on the Orbiter. One of the significant shop practices stressed to all technicians working around the Orbiter is to cap disconnected lines or openings to avoid contamination. Personnel are therefore naturally conditioned to cap lines and openings. Contributing factors were the lack of system training for technicians and quality inspectors and lack of communication between engineering, technicians, and quality. Final cost of the mishap was $3,500,000.

FATALITY
KENNEDY SPACE CENTER
TYPE A/PUBLIC VISITOR

On June 9, 1990, a 7-year-old female public visitor to the Kennedy Athletic, Recreation, and Social Organization Park drowned in the park's swim lake. The child's death was caused by accidental drowning. There was no evidence to indicate that foul play, physical defect, or other factors caused the drowning. Contributing factors were: (1) the child was allowed to proceed into the deeper water outside the roped-off area without proper adult supervision; (2) the condition of the swim lake (i.e., reduced visibility caused by a large number of swimmers stirring up the sandy bottom in addition to the areas where grass was growing) made it difficult to observe a submerged body.

MODEL EFFECTS TEST MISHAP IN THE 80 X 120 WIND TUNNEL
AMES RESEARCH CENTER
TYPE B

On February 8, 1990, the Model Effects team was operating on swing shift, conducting the 16th of 50 scheduled runs in the 80 by 120 foot wind tunnel. At that time, the middle instrumentation hatch of a 968 Grumman VSTOL model opened into the air stream, separated from its hinge and cable support, traveled over the fuselage, and lodged in the intake of the starboard TF-34 jet engine. There was extensive damage to the jet inlet fan and jet engine core.

The investigation revealed that the fasteners intended to secure the middle instrumentation hatch and rear blower hatch of the model were not used. A change in the method of securing the hatches, initiated in 1986, was the primary cause of the mishap. At that time, the model was used to test the Outdoor Aerodynamic Research Facility (OARF). Crew changes and the nature of the testing requirements resulted in the absence of the fasteners. There were no adverse effects noted with the change in procedures during the 1986 OARF test.

Contributing factors to the mishap were: (1) inspections of the model did not identify the missing hatch fasteners; (2) training for model-specific inspection procedures used during the model preparation and test did not exist for engineers, mechanics and technicians; (3) the Gross Hazards analysis did not address all sources of engine foreign object damage; (4) adequate as-built documentation did not exist to properly review the hatch configuration of the 698 Model; (5) the design for fastening the hatches was deficient.

Final cost of the mishap totaled $350,000.

TYPE C MISHAPS
EQUIPMENT/PROPERTY DAMAGE

Ames Research Center
Building N-259 sustained damage due to a leak in the 3-inch, 3000 psi air line that runs under the building. A heavy rain sealed the ground around the building, allowing pressure to build, resulting in buckled floors and distorted structure. The primary cause of the mishap was equipment failure due to material defects. Cost of the mishap was estimated at $25,000.

On July, 11, 1990, a NASA C-130 propeller assembly was damaged while being shipped on a flatbed truck to a contractor overhaul facility. The propeller assembly disconnected from its mounting fixture, fell off the truck, hit the shoulder of the highway, and bounced off the roadway. The primary cause of the mishap was failure of the mounting fixture bolts due to fatigue resulting from improper maintenance and misuse. Lack of proper supervision when preparing the propeller assembly for shipping was a contributing factor. Final cost of the mishap was $80,000.

Goddard Space Flight Center
Four trailers making up the Geostationary Operational Environmental Satellite ground systems facility were damaged in a fire on the morning of January 27, 1990. The investigation board was unable to categorically determine the ignition source for the fire. It was likely one of the following: (1) a short circuit in the lighting equipment or one of the several electrical devices powered up at the time, (2) a malfunction in a lithium battery system, (3) the spontaneous ignition of one or more lithium batteries present in the trailers. Two of the trailers sustained severe heat, smoke, and fire damage. The other two trailers suffered heavy heat and smoke damage. Final cost of the mishap was $246,000.

Jet Propulsion Laboratory
The Near Infrared Mapping Spectrometer (NIMS) instrument engineering model electronics was destroyed while being stored in the Building 11 thermal/vacuum chamber. The most probable direct cause of the mishap was the accidental activation of the electronics platform heater switch by a heavy coiled cable resting on a swivel chair near the switch. Final cost of the mishap was $200,000.

Johnson Space Flight Center
A Hard Upper Torso (HUT) assembly, part of the Extravehicular Mobility Unit, was damaged during shipment from JSC to a contractor. Inspection of the HUT and its shipping case indicated the damage was caused by "high acceleration forces," i.e., dropping the shipping case. The primary cause of the mishap was a deviation from proper handling procedure. Cost of the mishap was estimated at $25,000.

Various pieces of electronic equipment were damaged due to a power outage. The outage occurred when an attempt was made to change the oil in an electric power generator engine while the engine was on line. The oil level was allowed to drop low enough to cause the governor to fail to the full open position, resulting in the engine and generator shutting down. The primary cause of the mishap was failure to follow proper procedure. Cost of the mishap was estimated at $50,000.

The east end high-bay door in Building B-10 was open approximately 8 feet when the upper sections of the door fell. The primary cause of the mishap was equipment failure due to design deficiency. Final cost of the mishap was $38,000.

An employee was hoisting the rear of a Rolls Royce Spey Engine mounted on a parking stand in Hangar 135 to exchange a support adapter when the engine fell forward and impacted the hanger floor. The primary cause of the mishap was lack of attention. Misjudgment of conditions was a contributing factor. Final cost of the mishap was $36,220.

Kennedy Space Center

A contractor was in the process of hoisting a 40,000-pound test weight from a payload canister to a flatbed truck with a 65-ton mobile crane when the boom of the crane slipped, falling toward the canister. The test weight contacted the inside of the canister doors and slid inside the canister, damaging the side of the canister. The primary cause of the mishap was malfunction of the boom hoist brake due to improper assembly and adjustment. Incorrect positioning of the crane relative to the test weight was a contributing factor. Final cost of the mishap was $200,000.

An Orbiter Orbital Maneuvering System/Reaction Control System (OMS/RCS) thruster was damaged while being prepared for a test. The technicians involved did not follow the sequence of installation called out in the Problem Report. They improperly installed the thruster into an unauthorized T-shaped mounting fixture clamped onto an access platform's kick plate. The technicians then left the area. While they were gone, the thruster fell striking a kick plate on a lower platform and continued falling, finally coming to rest on the OMS engine service platform. Factors contributing to this mishap were the lack of detailed instructions in the Problem Report on how or where to install the mounting fixture and the technicians' lack of training in the proper use of the fixture. Cost of the mishap was estimated at $100,000.

An employee painting the superstructure of the LC-39 central utilities plant inadvertently stepped on and broke, a 1-inch chilled water line that sprayed water on a 4160 VAC motor control center in the utility annex mechanical room. The controls shorted out, resulting in the shut down of all 4160 VAC in the utility annex. The primary cause of the mishap was equipment failure due to material failure. Human factors and a poor working environment contributed. Final cost of the mishap was $75,000.

An operator attempted to move the bridge bucket in High Bay 1 of the Orbiter Processing Facility and inadvertently left the bucket's payload bay door hooks attached to the Orbiter's open payload bay doors. Movement of the bridge placed extreme pressure on the winch and counter weights, causing the wire rope to move off a pulley wheel and fray. The primary cause of the mishap was lack off attention by the operator and failure to conduct proper checkout procedures. Cost of the mishap was estimated at $120,000.

Two chassis assemblies were overheated during a baking process due to an incorrectly set thermal meter. The meter (a replacement for one that failed earlier) was set to 140 degrees Celsius instead of 140 degrees Fahrenheit. The primary cause of the mishap was lack of attention. Contributing factors were an organization deficiency and lack of training. Final cost of the mishap was $36,804.

After dynatube leak checks, Shuttle thruster manifolds were vented to ambient pressure which allowed the thrusters to leak. The test cell was evacuated and hyperexhaust fans were activated when technicians noticed the vapor. The primary cause of the mishap was deviation from proper procedure. Lack of attention by personnel was a contributing factor. Final cost of the mishap was $65,000.

Lewis Research Center

Vacuum piping and second, third, and fourth stage mechanical vacuum pumps filled with water due to a leak in intercooler tube bundles, which circulate cooling tower water. The primary cause of the mishap was equipment failure due to material failure. Final cost of the mishap was $140,000.

Marshall Space Flight Center

A carbon dioxide removal subassembly, being received from the vendor, sustained damage when it fell off the delivery truck's hydraulic lift platform onto the ground (approximately 4 feet). The primary cause of the mishap was deviation from proper handling procedures. Contributing factors were poor task coordination and inadequate planning. Cost of the mishap was estimated at $220,000.

A rear diffuser was cracked during a practice disassembly. Liquid nitrogen was poured into the rear diffuser ducts to chill the parts and unload a retaining nut. A "popping" sound was noted coming from the unit shortly after the nitrogen was added. The primary cause of the mishap was equipment failure due to material failure. A contributing factor was procedure deficiency. Cost of the mishap was estimated at $45,000.

A liquid oxygen pump ball bearing test rig was damaged during a mission cycle durability test. While on cycle 89 of a planned 120-cycle test, vibrations suddenly increased, followed by a fire on the rig. The primary cause of the mishap was equipment failure due to material failure. Final cost of the mishap was $130,000.

* U.S. G.P.O. 1991-282-282:40028