National Aeronautics and
Space Administration

FY 1992 SAFETY PROGRAM STATUS REPORT

NASA Safety and Risk Management Division
Office of Safety and Mission Assurance
Washington, D.C. 20546

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SAFETY PROGRAM OVERVIEW

In FY 1992, the NASA Safety Division continued efforts to enhance the quality and productivity of its safety oversight function. Initiatives set forth in areas such as training, risk management, safety assurance, operational safety, and safety information systems have matured into viable programs contributing to the safety and success of activities throughout the Agency.

FY 1992 saw continued success of the NASA Safety Training Center (NSTC) at the Johnson Space Center (JSC). Establishment of the NSTC is a major part of NASA's effort to develop a centralized intra-agency safety training program. The objective is to provide quality safety training for personnel at all NASA installations. Courses developed by the NSTC are presented at various NASA locations to minimize travel and reach the greatest number of people at the least cost. The NSTC conducted over 19,500 student classroom hours of training in FY 1992 on a broad range of safety-related topics.

As part of ongoing efforts to enhance the total quality of NASA's safety workforce, the NSTC presented the Certified Safety Professional Review Course to over 275 students at all NASA Centers in FY 1992 via the NASA Video Teleconference System. This course provided a comprehensive review of the skills and knowledge that well-rounded safety professionals must possess to qualify for professional certification. Several people from each NASA Center went on to take the certification tests given by the Board of Certified Safety Professionals.

Major safety training course development efforts in FY 1992 included the Occupational Safety and Health Administration (OSHA) 501 Course, "A Guide to Voluntary Compliance." This course provides instruction on general industry safety and health topics. Those who attend all 30 hours of instruction will receive recognition of completion of OSHA's Voluntary Compliance Outreach Program and will be qualified to take additional OSHA courses. FY 1993 will see the OSHA 501 course presented to personnel at all installations via the NASA Video Teleconference System. Another course developed in FY 1992 was the Payload Safety Training Course. This course is designed to enhance understanding of payload safety requirements and ultimately ensure the safety of workers during payload preflight processing and astronauts on orbit. The Safety Division sponsored the development of a NASA Management Oversight and Risk Tree Analysis Accident Investigation course. This course was presented at a number of NASA Centers during FY 1992.

The Safety Division conducted or sponsored a number of safety related research and development activities in FY 1992. There were significant efforts to improve and expand NASA's assurance information systems. An upgrade to the NASA Mishap Reporting/ Corrective Action System (MR/CAS) making it a multiuser system was implemented at the beginning of FY 1992. This Agencywide computer data base system provides the Field Centers and Headquarters with the ability to report mishaps and track corrective actions. It also acts as a repository for historical mishap data to be used in trend analyses and mishap prevention efforts. An upgraded prototype of the NASA Safety Training Catalog was completed and tested in FY 1992. This automated data base will provide NASA and contractor personnel instant access to information on safety-related courses available throughout the Agency. Version 1.0 of the Lessons Learned Information System was released in FY 1992. The system is available throughout NASA for use by safety personnel, program managers, and engineers to help avoid costly mistakes by allowing easy access to information on the experiences of others. The Safety Division continued sponsoring the Stennis Space Center's development of a NASA lifting device data base. Work on this project was initiated in FY 1991. The intent is to establish a method of tracking and retaining pertinent data relating to the safe operation of lifting devices. The data base will be used by safety and engineering personnel throughout NASA for historical and trend analysis purposes to determine equipment reliability and establish preventive maintenance requirements.

The Safety Division is sponsoring a joint NASA/Air Force test and evaluation program for graphite/epoxy composite overwrapped pressure vessels. This relatively new technology is becoming more widely used in the aerospace industry due to the potential for weight savings. There are a number of unique safety concerns for personnel working with and around these vessels. The purpose of the research program is to better define the design requirements and handling procedures necessary to use these vessels safely. A research program at the Kennedy Space Center (KSC) to develop effective fire protection for high bay structures also was sponsored in FY 1992.

NASA continued its initiatives to control trends, major causes or sources of fatalities, and lost time disabilities, and to lower overall compensation costs. The Safety Division sets annual lost time injury/illness frequency rate goals for each Center. The goals are based on a number of parameters including previous performance as compared to the Center's own past record and to the overall Agency rate, improvement desired, and projected worker hours. This effort is part of an overall safety motivation program that strives to continually reduce injuries in the workplace.

The Safety Division continued its excellent working relationship with OSHA. Numerous meetings were held with various OSHA offices. Topics covered during these meetings included early notification of pending new OSHA safety and health requirements, continued effort on a proposed memorandum of understanding establishing protocols for the abatement of cited deficiencies, and successful negotiation of an agreement that allows OSHA Training Institute courses to be presented by the NSTC. This includes a "Train the Trainer" program for NSTC instructors and the transfer of 10 OSHA courses and associated materials to the NSTC.

A major OSHA-related accomplishment for FY 1992 was completion of the suspended load crane operation abatement plan at KSC. The extensive documentation required by the NASA Alternate Standard for Suspended Load Operations (approved by the Assistant Secretary for Occupational Safety and Health in 1991) was completed. Lists of the operations, equipment involved, and analysis/approval documents were provided to OSHA as required by the Alternate Standard.

NASA continued to participate in the National Highway Traffic Safety Administration Drunk and Drugged Driver Awareness Campaign and the "70% Plus Federal Employees Safety Belt Use" program under Executive Order 12566.

During FY 1992, various new management issuances policies, handbooks, standards, and other documents were developed, validated, or revised by NASA Safety. A major effort to revise the NASA Safety Policy and Requirements Document (NASA Basic Safety Manual) continued. The document was distributed for final Headquarters review and is scheduled to be published in 1993. Effort continued on the Hydrogen Safety Standard and the Oxygen Safety Standard. A field installation review of the first drafts was completed, revisions were made, and the documents were prepared for a final review. A final review of the NASA Explosive Safety Standard was completed. The document is scheduled to be published in 1993. Plans include submitting the Explosive Safety Standard to OSHA for approval as an alternate/supplementary standard. A field installation review of the draft NASA Safety and Health Program Management Instruction was completed. The NASA Emergency Preparedness Plan was published. This document outlines NASA's implementation of the Federal Emergency Management Agency's Federal Response Plan. A final draft of the NASA Safety Standard for Fire Protection was distributed to the field installations for review and comment. A research and design effort was initiated to develop a NASA Facility System Safety Manual containing Agencywide guidelines.

The Headquarters Hazardous Substances Internal Coordinating Committee continued to provide a forum for interdisciplinary discussion among all Headquarters staff concerned with the health, safety, storage, and transportation of hazardous materials, and the environmental exposure of the NASA workforce. The committee was active in screening and assessing the impact of new and proposed regulatory requirements and the need for related training.

Independent safety assurance was provided for 7 Space Shuttle launches, 4 Expendable Launch Vehicles, and 105 payloads. Safety assurance efforts 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. In FY 1992, MSE activity was expanded to include Expendable Launch Vehicles.

A NASA Safety Steering Committee Meeting was held on December 10 through 12, 1991, in Washington, DC. Representatives from all NASA Centers were in attendance to discuss overall NASA safety efforts and problems and to assist in ensuring proper direction on the NASA safety program. Some of the major topics were the NASA Safety Policy and Requirements Document, safety training, survey trends, and safety program organizational changes.

NASA Safety also sponsored a Fire Protection Meeting in New Orleans on May 20 through 22, 1992, in conjunction with the National Fire Protection Association's Annual Meeting. The primary topic of the meeting was development of the NASA Safety Standard for Fire Protection. The document is scheduled to be published in 1993 and will define a comprehensive Agencywide fire protection program.

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 program at KSC was reviewed in FY 1992. 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. Off year self inspections are performed by the Centers and the results are forwarded to Headquarters.

NASA will continue to strive for maximum safety awareness and excellence in all activities. The field installations and Headquarters will continue to work together to maintain an emphasis on safety.

James D. Lloyd
Acting Director, Safety and Risk Management Division

FY 1992 NASA SAFETY STATISTICS

Fatalities	1
NASA Safety Reportable Lost Time Injuries/Illnesses	112
Costs	
Lost Wages	$167,948
Chargeback Billing	$6,398,334
Material Losses	$8,016,469
Total Losses	$14,582,751

Information on injuries/illnesses and material losses was obtained from the NASA Mishap Reporting/Corrective Action System (MR/CAS). Lost wages and chargeback billing figures are from the Office of Workers' Compensation Programs (OWCP).

NASA OCCUPATIONAL INJURY/ILLNESS RECORD

As defined by OSHA, a recordable (i.e., compensable) lost time case is a work-related incident that results in 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. NASA Safety organizations adhere to the OSHA reporting guidelines with some exceptions. For example, NASA Safety does not consider restricted duty or time taken for medical treatment to be lost time. Also, instances of injuries sustained during recreational activities or in parking lots during non-work-related activities are not included in the MR/CAS.

Table 1 shows the FY 1992 NASA Safety reportable injury/illness statistics for Federal employees at NASA Centers. (Note: This data, taken from MR/CAS, was validated via correspondence with the Centers.) The NASA Safety and Risk Management Division calculates injury/illness frequency rates based on the actual hours worked by each employee. The overall lost time frequency rate of 0.48 for NASA Federal employees is a 14% increase from the FY 1991 rate of 0.42.

TABLE 1. NASA SAFETY REPORTABLE LOST TIME INJURIES/ILLNESSES BY INSTALLATION
ANNUAL REPORT FY 1992

	Average No. of Employees	Hours Worked	Lost Time Cases No. Days	Lost Time Cases No. Cases	Freq.* Rate	1992 Goal
ARC/DFRF	2,613	4,775,106	114	15	0.63	0.54
GSFC/WFF	3,988	7,263,213	65	14	0.39	0.37
HQ	2,343	4,183,339	144	21	1.00	0.57
JSC/WSTF	4,074	7,244,694	171	14	0.39	0.34
KSC	2,693	4,883,114	46	8	0.33	0.38
LARC	3,141	5,678,236	78	9	0.32	0.37
LERC	2,871	5,541,674	148	15	0.54	0.43
MSFC/MAF	3,738	6,978,703	179	16	0.46	0.37
SSC	234	499,611	0	0	0	0.37
NASA	25,695	47,047,690	945	112	0.48	0.40
1991	24,763	44,627,896	1051	94	0.42	0.40

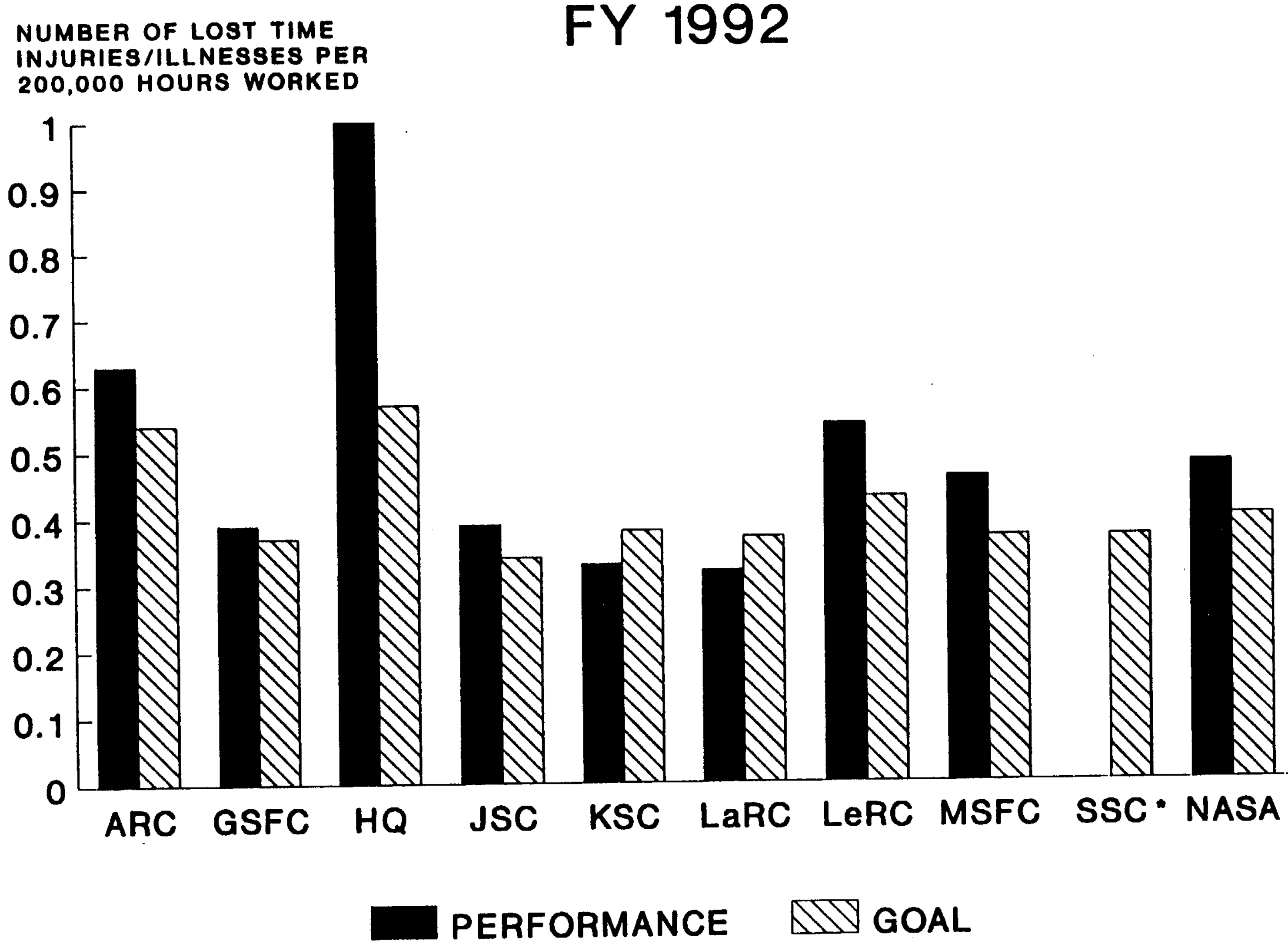
* Lost Time frequency rate = Number of lost workday cases per 200,000 hours worked.

Figure 1 shows how the FY 1992 NASA Safety reportable lost time injury/illness frequency rates for Federal employees at NASA Centers compare to the Centers' individual goals set by the Safety and Risk Management Division, the overall NASA goal of 0.40, and the overall FY 1992 NASA rate of 0.48. NASA did not meet its overall goal for FY 1992 and only 3 NASA Centers met their individual goals.

Figure 2 plots the NASA Safety reportable lost time frequency rates for the last 11 years. The plot shows a relatively narrow range of rates during this period, from 0.35 in 1987 to 0.48 in 1992. There has been a slight upward movement of the rates over the last 2 years. This is not considered a major trend at this time; however, it has been flagged as an area of concern and all NASA Centers have been asked to place extra emphasis on efforts to reduce lost time injuries and illnesses.

Figure 3 compares the FY 1992 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 1989 - FY 1991).

NASA LOST TIME RATES VS. GOALS FY 1992



* SSC HAD NO LOST TIME CASES DURING FY 1992

Figure 1

NASA LOST TIME INJURY/ILLNESS RATES
1982-1992

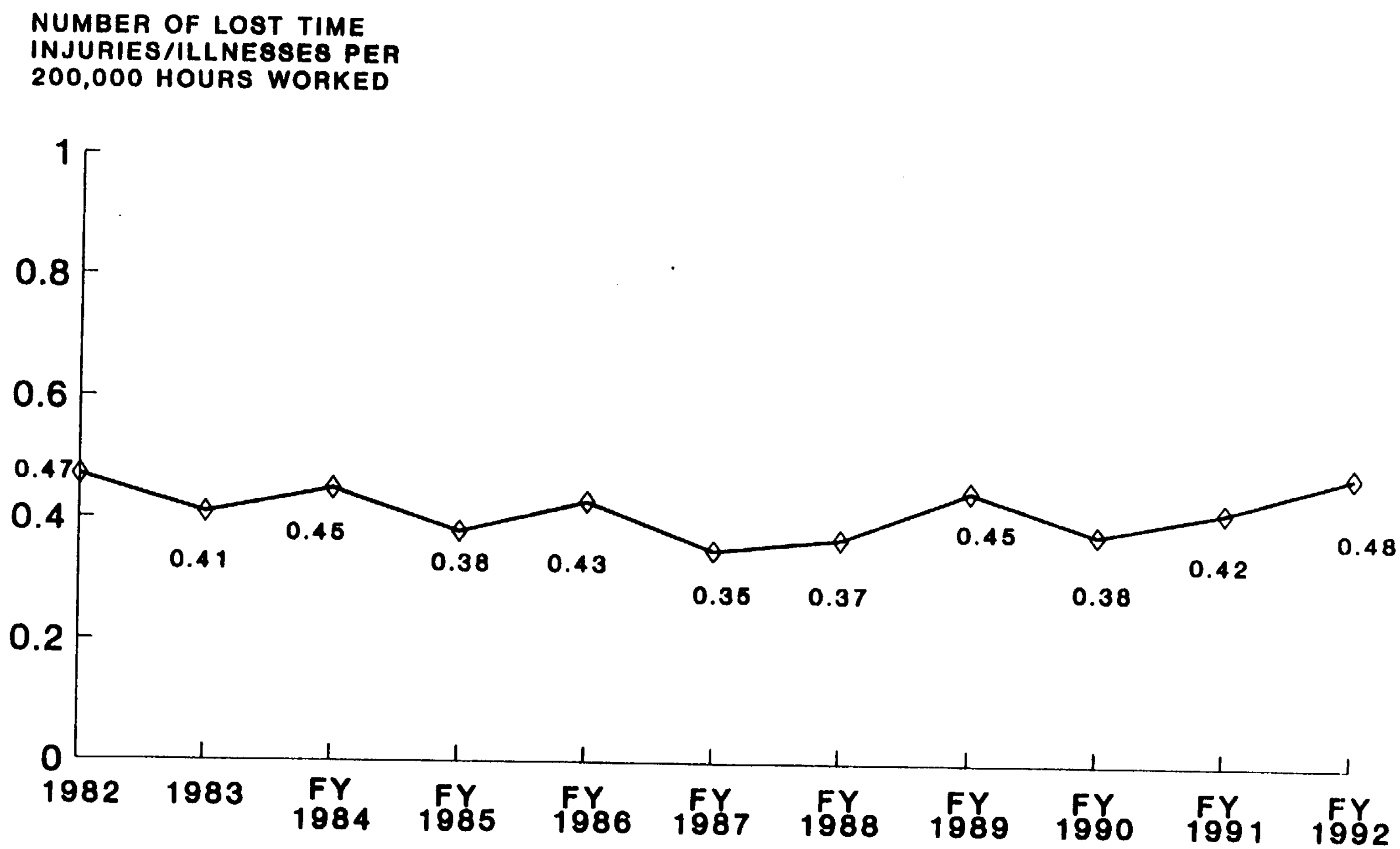


Figure 2

NASA FEDERAL EMPLOYEES LOST TIME INJURY/ILLNESS RATES

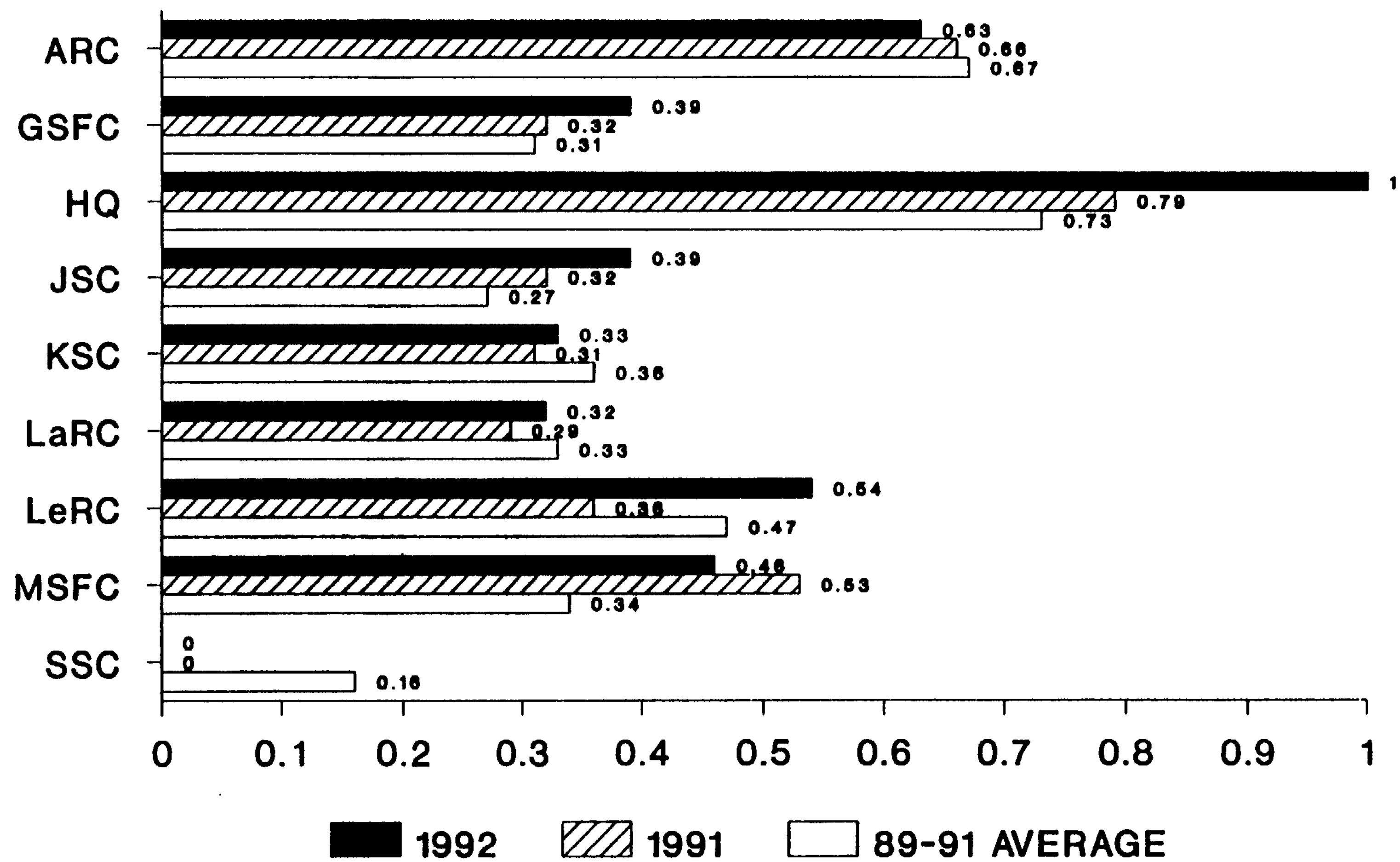


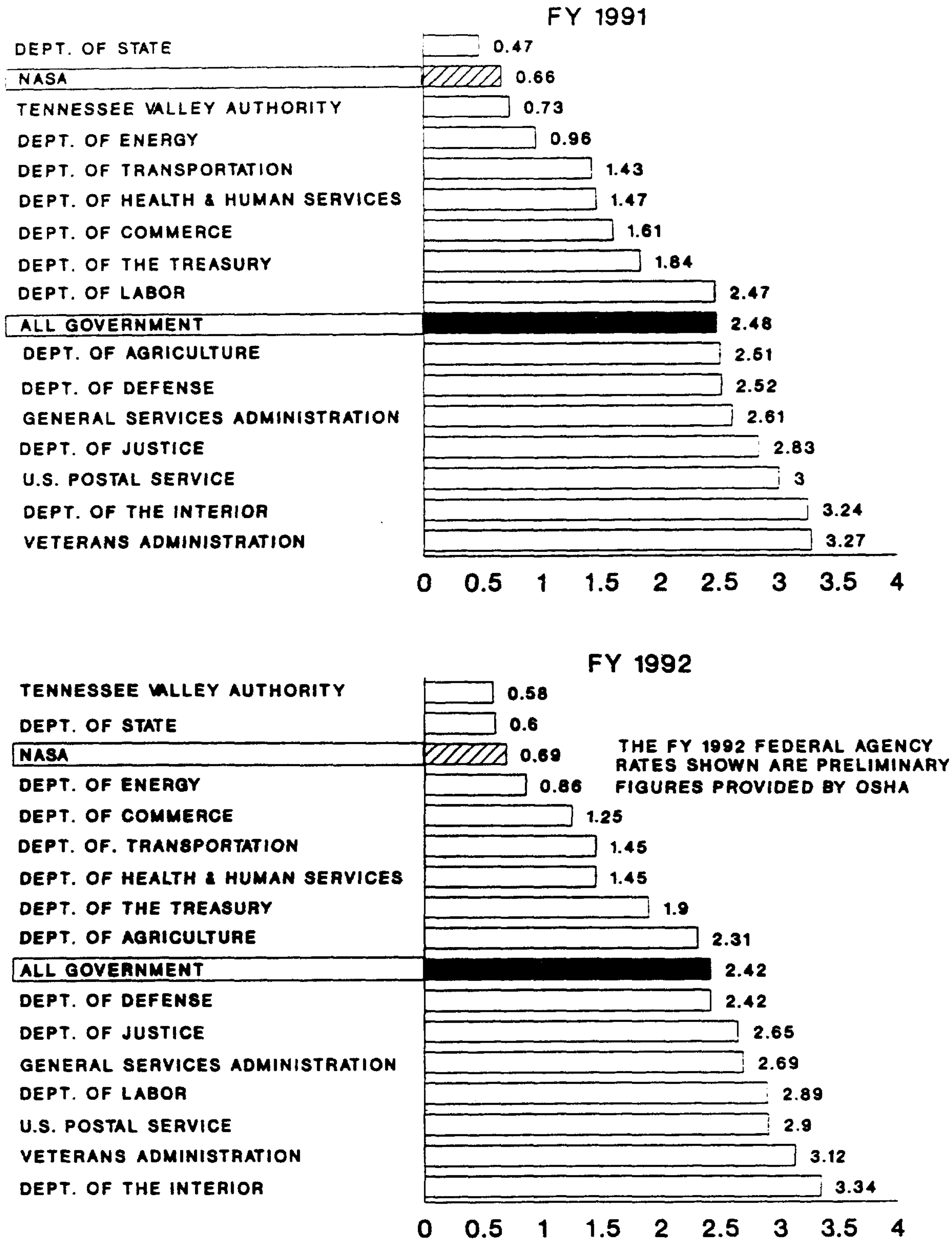
Figure 3

Comparison of NASA's injury/illness performance to that of other government agencies and private industries can be made using the injury/illness incidence rates published by the Department of Labor. Figures 4 and 5 reflect these rates which are based on OWCP data and determined according to the number of injury/illness cases per 100 employees. The incidence rate for NASA is usually slightly higher than the frequency rate calculated by the NASA Safety and Risk Management Division. This is due to inherent differences in the two formulas and variations in the OWCP data. (OWCP tracks the number of claims made on OSHA recordable injuries and illnesses. It is possible for more than one claim to be made as the result of a given injury or illness.)

Figure 4 illustrates the relative position of NASA's lost time injury/illness performance compared to that of other Federal agencies having more than 15,000 employees in FY 1991 and FY 1992. Within this group of Federal agencies, NASA ranked second from 1984 to 1991. A significant improvement by the Tennessee Valley Authority resulted in NASA slipping to third in FY 1992.

Figure 5 compares NASA's lost time injury/illness performance for the last 11 years against that of all Federal agencies and select private sector industries. 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 1991.

LOST TIME INJURY/ILLNESS RATES IN SELECTED FEDERAL AGENCIES *



* HAVING MORE THAN 15,000 EMPLOYEES.

Figure 4

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

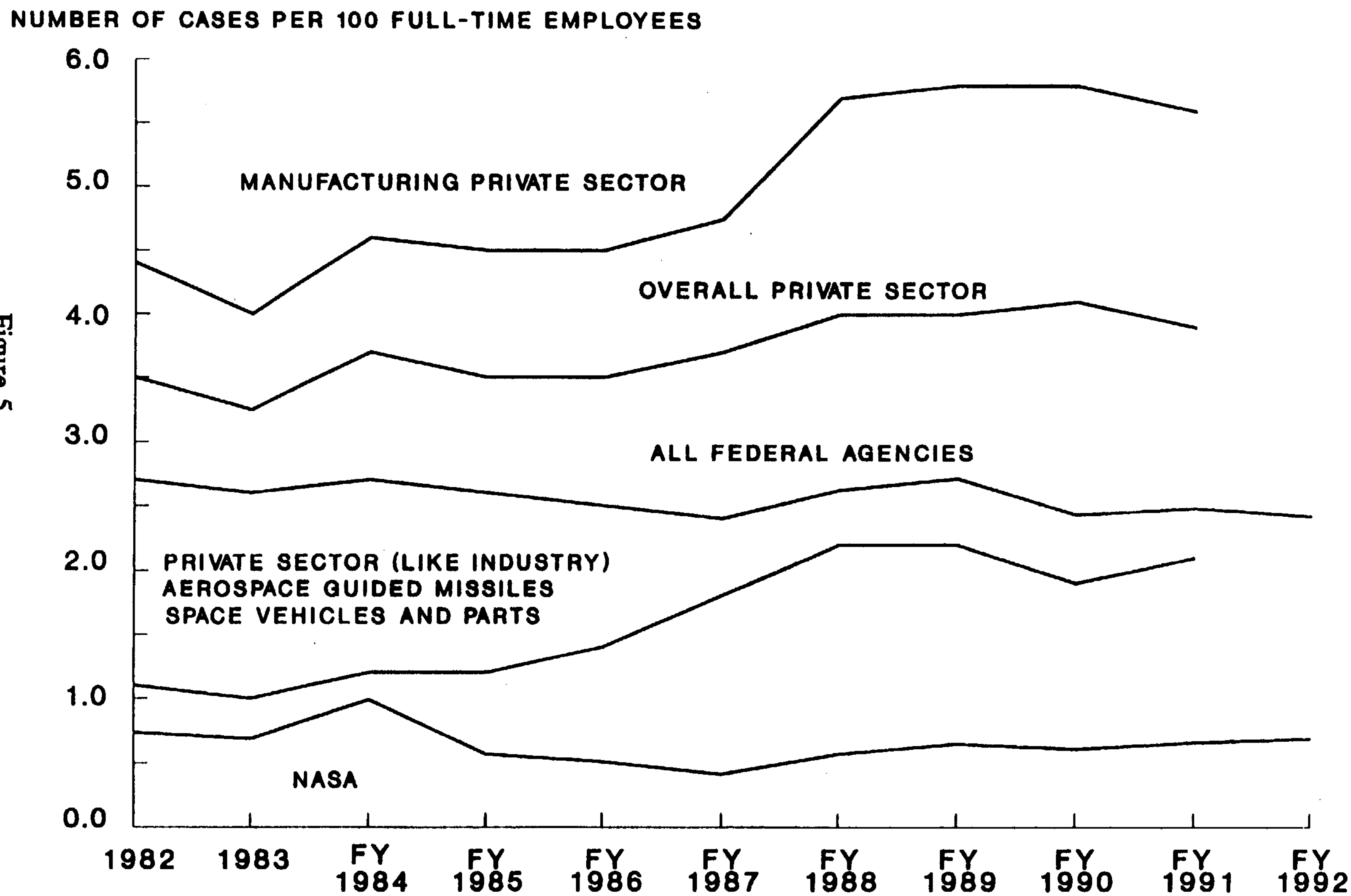


Figure 5

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. This is a direct loss to NASA's operating budget. In any given year, most of the chargeback billing is a result of illnesses and injuries that occurred in previous years.

Figure 6 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 $1000. Of the $14.6 million total loss for FY 1992, $6.4 million, or 44%, was paid out in chargeback billing costs.

Figure 7 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 rise each year with the sharpest increases occurring since 1988. From 1988 to 1992, the chargeback billing costs for all Federal Agencies increased by 52 percent from $1.1 billion to $1.67 billion. NASA's chargeback billing costs stabilized at around $5 million annually during the 1980's but has recently begun to increase as well. In comparison, NASA's chargeback billing costs rose 25 percent since 1988. In general, the spiraling cost of health care is considered to be one of the major factors in the rising trend of chargeback billing.

FY 1992 COST OF NASA MISHAPS/INJURIES
TOTAL LOSS = $14,582,751

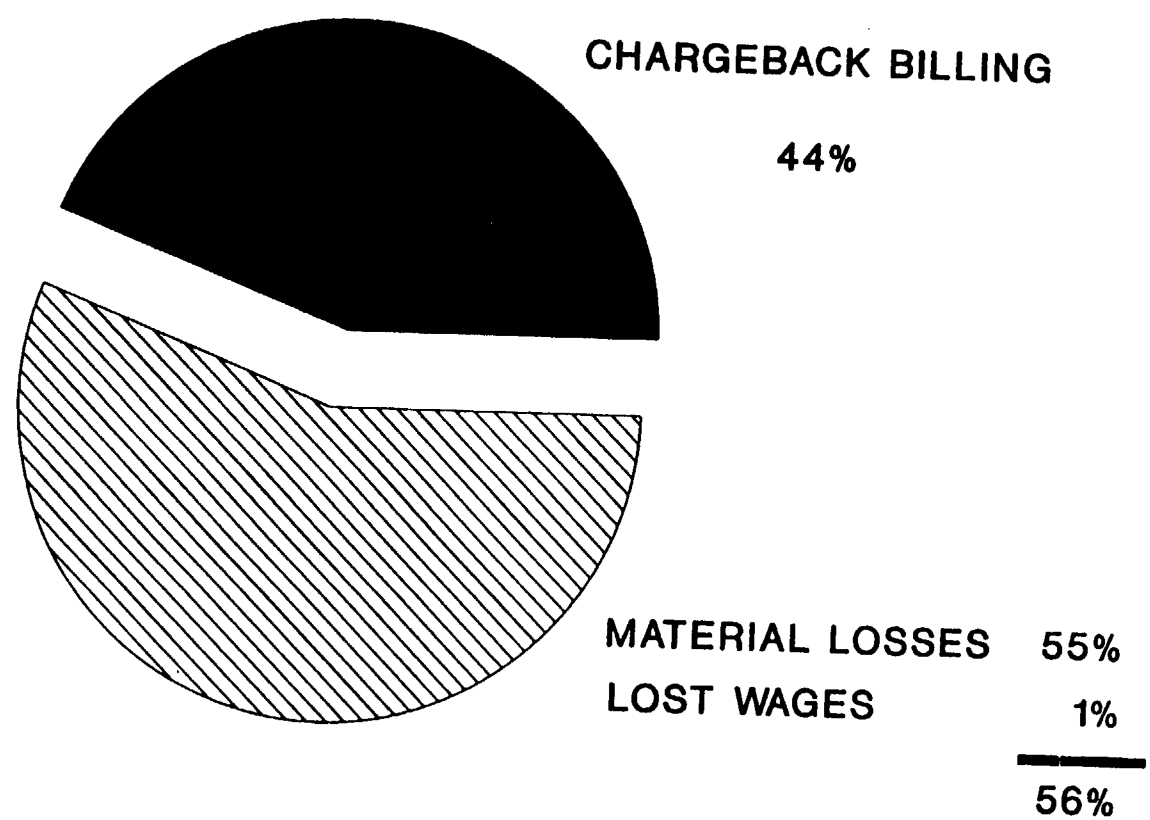


Figure 6

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

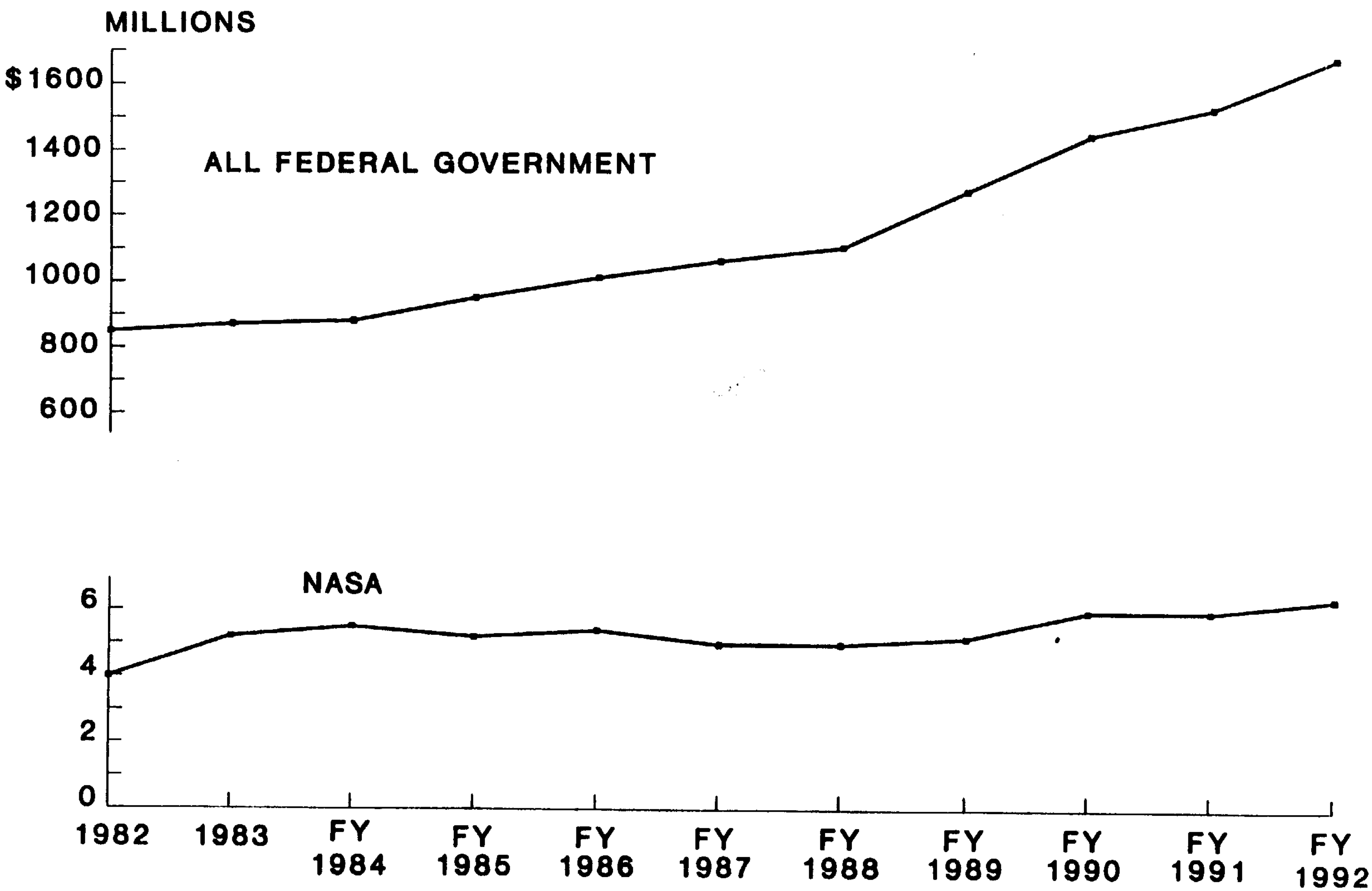


Figure 7

MATERIAL LOSSES

Tables 2A and 2B list the statistics for NASA material losses during FY 1992. Indirect costs associated with cleanup, investigation, injuries, or shutdown of operations 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 8 illustrates the total costs of material losses over the last 5 years.

Figure 9 provides a percentage breakdown of equipment/property costs for FY 1992. The major contributors were flight hardware related losses due to a handling mishap and a number of engine test failures.

Figure 10 compares FY 1992 equipment/property costs with FY 1991 results. There was a significant decrease in equipment/property losses from $26.7 million in FY 1991 to $8 million in FY 1992. The difference is primarily due to the $20 million Space Shuttle Main Engine test failure late in FY 1991. (See the mishap summary on page 30.)

TABLE 2A. EQUIPMENT/PROPERTY DAMAGE BY INSTALLATION - ANNUAL REPORT FY 1992
NUMBER OF CASES BY EQUIPMENT CLASSIFICATION

	Flight Hardware	Ground Support Equip.	Facility	Pressure Vessel	Motor Vehicle	Aircraft	Other	Total Cases
ARC/DFRF	0	0	1	0	0	0	0	1
GSFC/WFF	0	1	0	0	0	0	0	1
HQ	0	0	0	0	1	0	0	1
JPL	1	2	2	0	0	0	2	7
JSC/WSTF	0	0	4	2	1	2	2	11
KSC	18	5	1	1	2	0	0	27
LARC	0	0	0	0	0	0	0	0
LERC	0	0	7	0	1	0	2	10
MSFC	17	0	9	0	1	0	6	33
SSC	0	0	1	0	0	0	1	2
TOTAL	36	8	25	3	6	2	13	93
1991	20	14	23	3	29	6	26	121

TABLE 2B. EQUIPMENT/PROPERTY COSTS BY INSTALLATION - ANNUAL REPORT FY 1992
COST OF CASES BY EQUIPMENT CLASSIFICATION

	Flight Hardware	Ground Support Equip.	Facility	Pressure Vessel	Motor Vehicle	Aircraft	Other	Total Costs
ARC/DFRF	0	0	189,234	0	0	0	0	189,234
GSFC/WFF	0	3,775	0	0	0	0	6,207	9,982
HQ	0	0	0	0	1,255	0	0	1,255
JPL	305,000	102,100	2,500	0	0	0	7,000	416,600
JSC/WSTF	0	0	7,642	4,500	236	45,497	9,012	66,887
KSC	208,387	27,822	10,000	1,262	6,054	0	0	253,525
LARC	0	0	0	0	0	0	0	0
LERC	0	0	47,942	0	1,000	0	67,023	115,965
MSFC	6,463,400	0	233,804	0	1,263	0	225,974	6,924,441
SSC	0	0	37,500	0	0	0	1,080	38,580
TOTAL	6,976,787	133,697	528,622	5,762	9,808	45,497	316,296	8,016,469
1991	23,756,352	141,558	1,640,762	115,020	82,696	290,204	657,558	26,684,150

NASA MATERIAL LOSSES DUE TO MISHAPS
(IN MILLIONS OF DOLLARS)
1988-1992

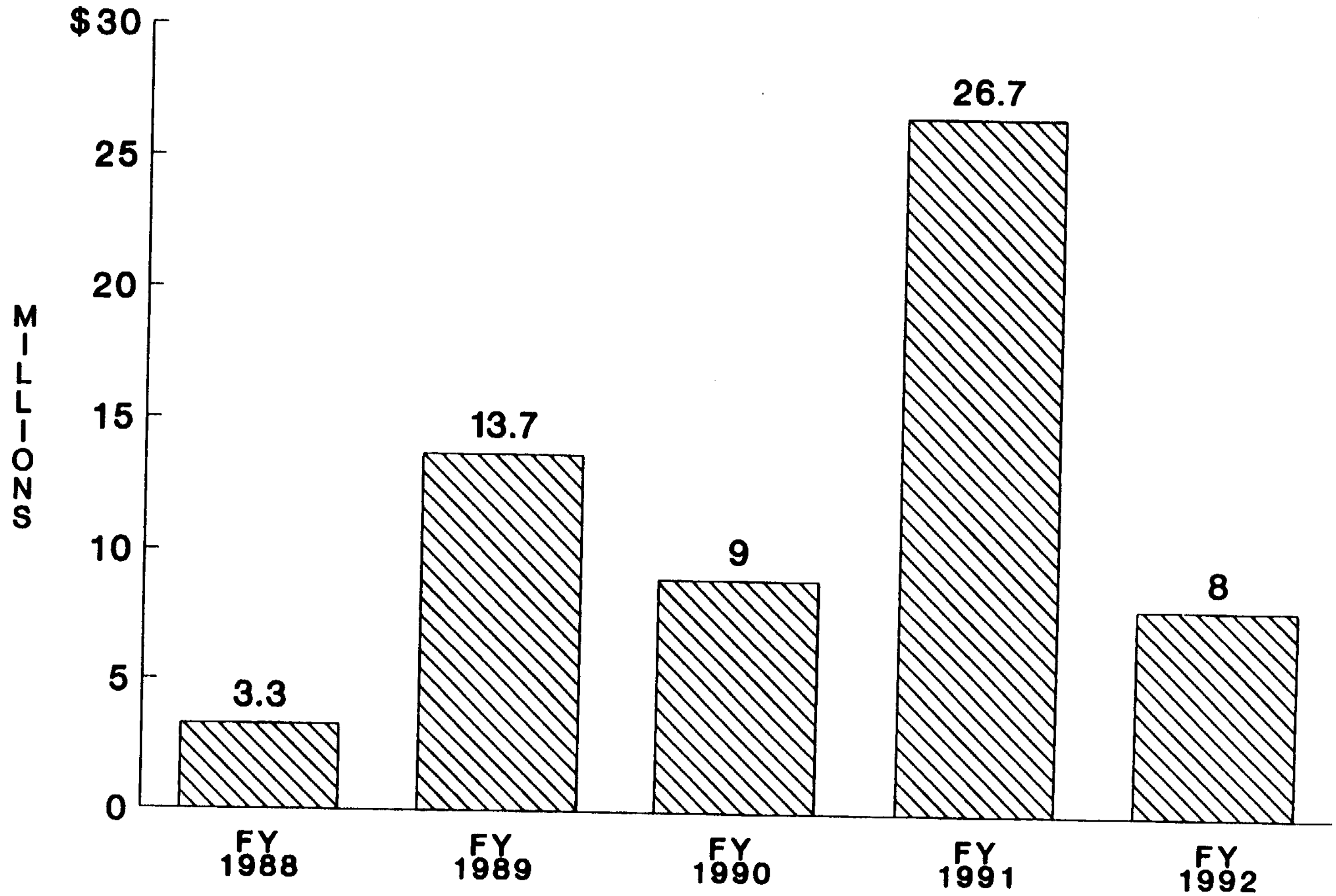


Figure 8

FY 1992 EQUIPMENT/PROPERTY COSTS
NASA TOTAL $8,016,469

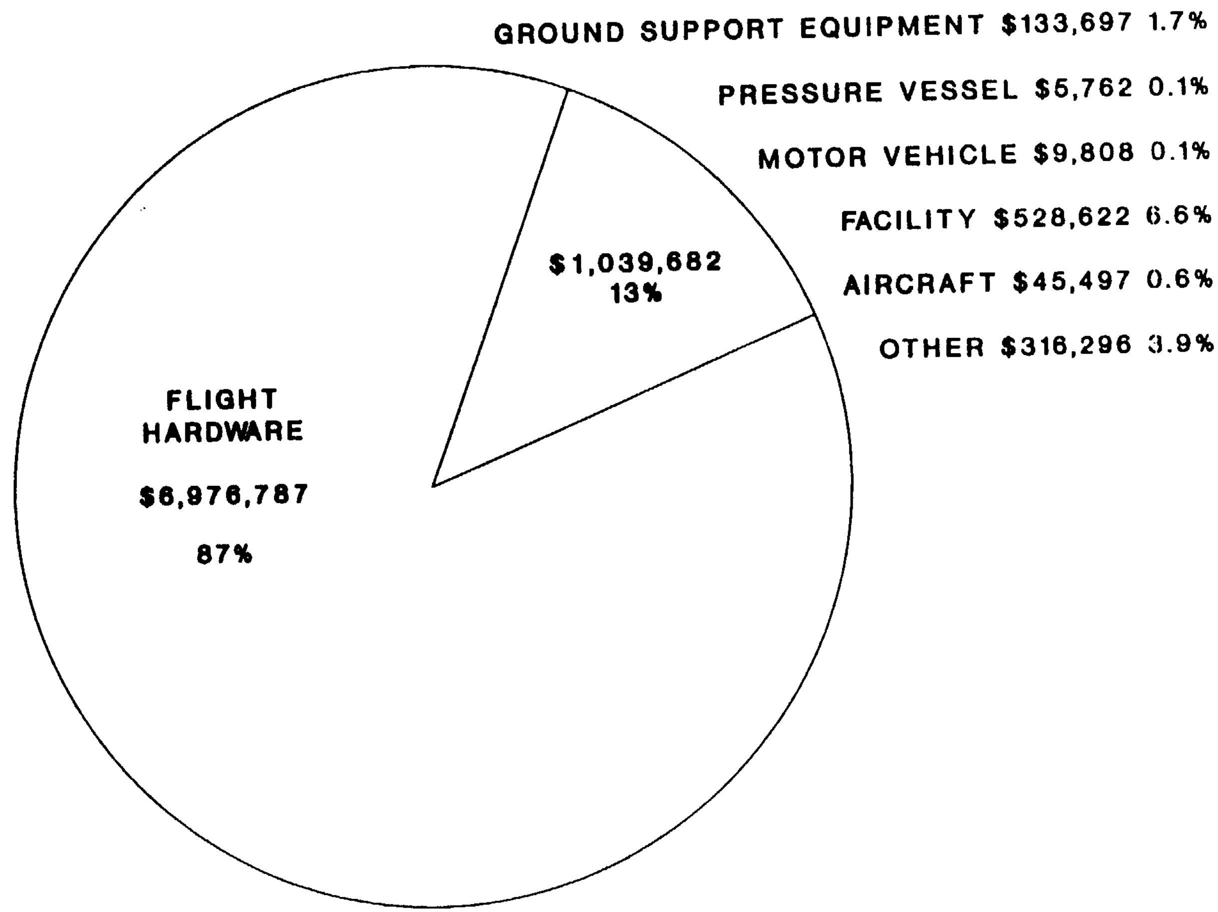


Figure 9

EQUIPMENT/PROPERTY COSTS (IN MILLIONS OF DOLLARS)

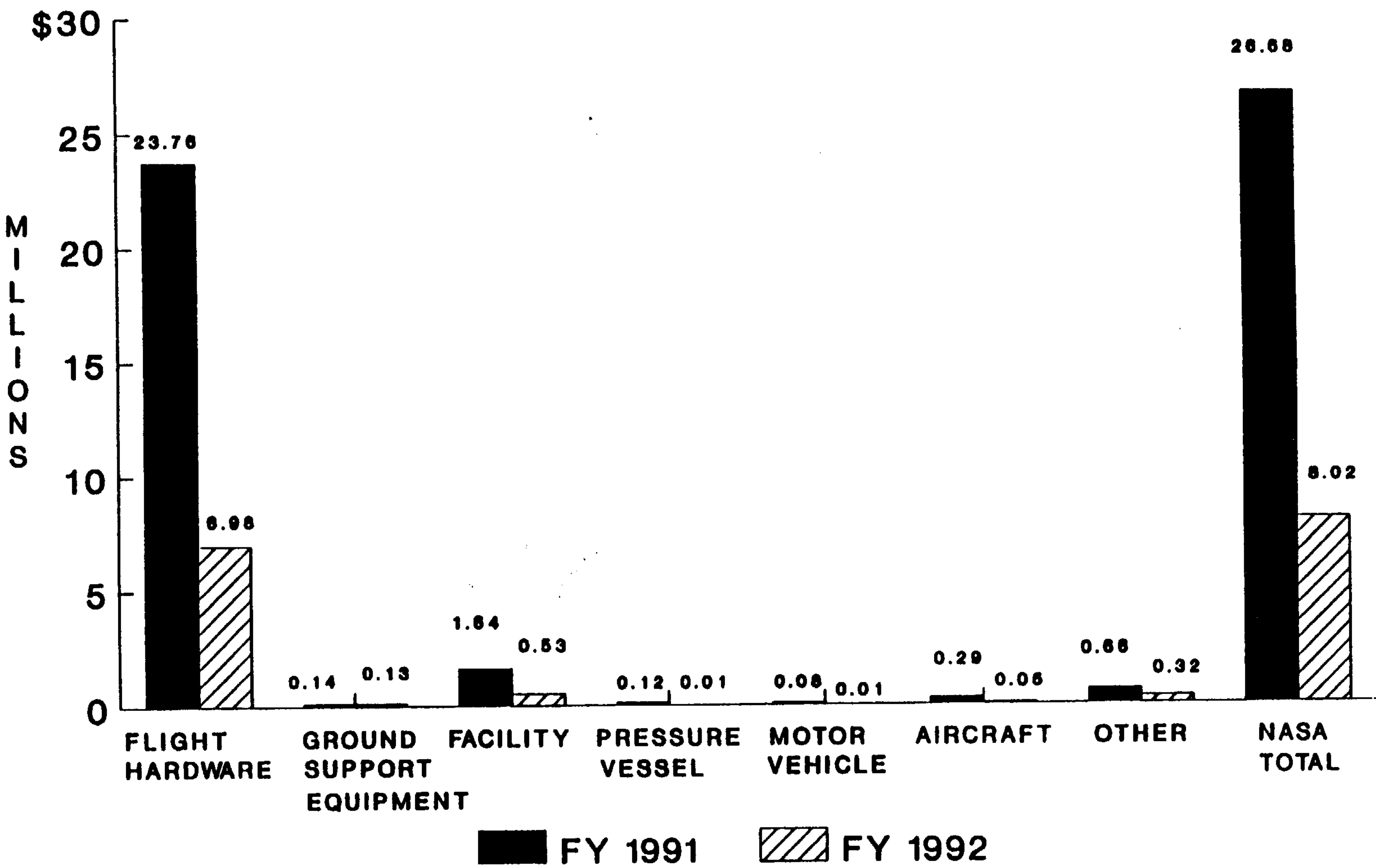


Figure 10

NASA MISHAP DEFINITIONS

The revised NASA Management Instruction for Mishap Reporting and Investigation (NMI 8621.1F), dated December 31, 1991, contains updated NASA mishap definitions. All mishaps reported in FY 1992 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 these criteria 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 these criteria 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 which meet these criteria are included, as are test failures where the damage was unexpected or unanticipated.

   d. **MISSION FAILURE:** Any mishap (event) of such a serious nature that it prevents accomplishment of a 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 (now Safety and Mission Assurance), prevents the achievement of primary mission objectives as described in the Mission Operations Report or equivalent document.

   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 $1,000 but less than $25,000.

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 significant equipment/property damage (less than $1,000), 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 Parts 1960 and 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 number of mishaps that were reported by the NASA field installations as having significance beyond the minor dollar losses or no-lost time injury category. These mishaps provide lessons learned for all NASA accident prevention programs.

Table 3 shows the number of fatalities experienced by NASA over the last 5 years categorized by Center.

Table 4 shows the number of Type A, B, and C mishaps over the last 5 years.

Figure 11 presents a 5-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 12 presents a 5-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 1992. Table 5A compares FY 1992 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 1991 and FY 1992.

TABLE 3. FATALITIES - ANNUAL REPORT FY 1992

	1988	1989	1990	1991	1992
	N/ C/ O	N/ C/ O	N/ C/ O	N/ C/ O	N/ C/ O
ARC/DFRF	0/ 0/ 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
HQ	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	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 1	0/ 0/ 0
KSC	0/ 1/ 0	0/ 1/ 0	0/ 0/ 1	0/ 0/ 0	0/ 0/ 0
LARC	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	1/ 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	0/ 1/ 0	0/ 1/ 0	0/ 0/ 1	0/ 0/ 1	1/ 0/ 0

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

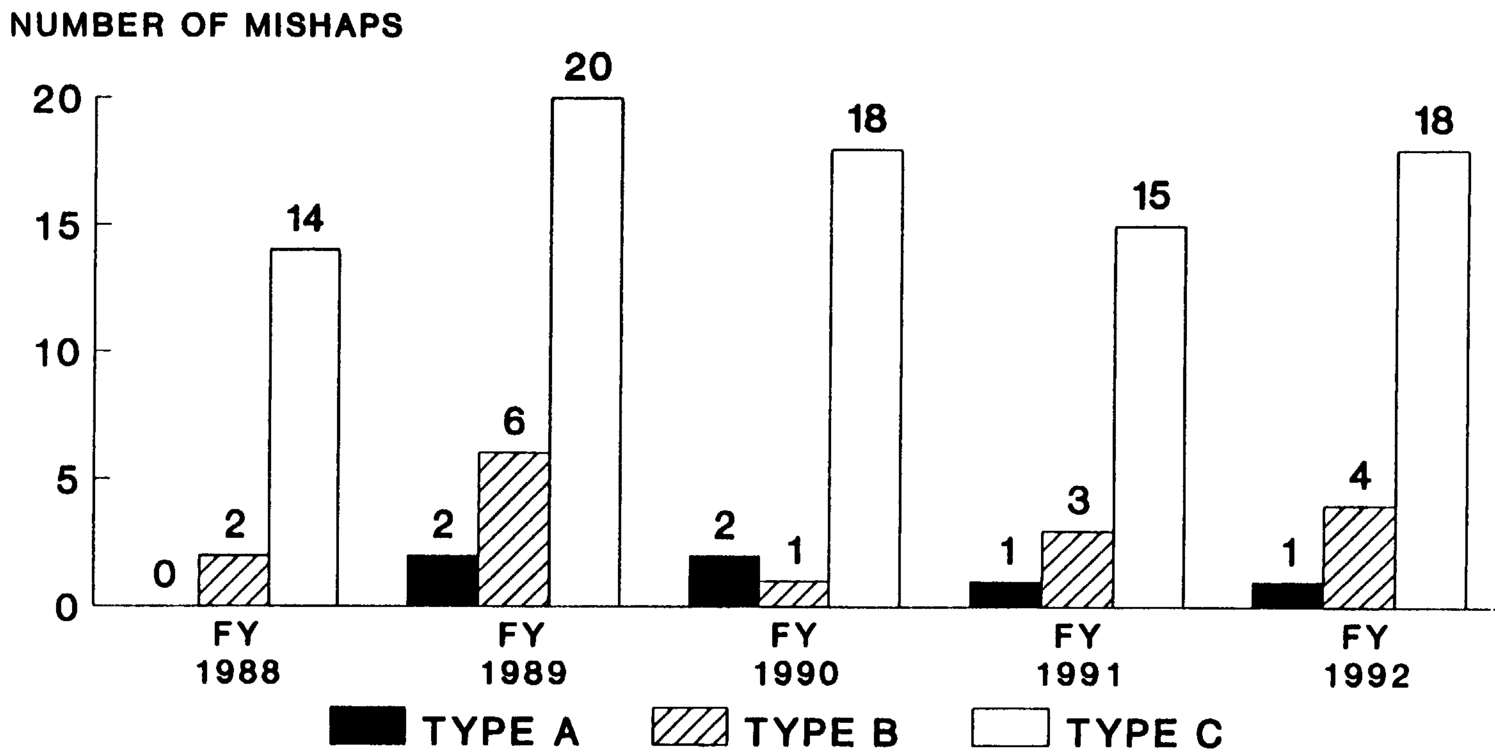
TABLE 4. NASA MAJOR MISHAPS BY INSTALLATION - ANNUAL REPORT FY 1992

	1988	1989	1990	1991	1992
	A/ B/ C	A/ B/ C	A/ B/ C	A/ B/ C	A/ B/ C
ARC/DFRF	0/ 0/ 21	1/ 0/ 19	1/ 1/ 14	1/ 2/ 12	0/ 0/ 16
GSFC/WFF	0/ 0/ 13	0/ 0/ 8	0/ 0/ 11	0/ 0/ 9	0/ 0/ 14
HQ	0/ 0/ 0	0/ 0/ 8	0/ 0/ 18	0/ 0/ 17	0/ 0/ 21
JPL	0/ 0/ 0	0/ 1/ 0	0/ 0/ 1	0/ 0/ 1	0/ 1/ 1
JSC/WSTF	0/ 0/ 7	0/ 2/ 12	0/ 0/ 12	0/ 1/ 13	0/ 0/ 15
KSC	0/ 2/ 13	0/ 1/ 17	1/ 0/ 11	1/ 0/ 8	0/ 0/ 11
LARC	0/ 0/ 10	1/ 0/ 16	0/ 0/ 8	0/ 0/ 8	0/ 0/ 9
LERC	0/ 0/ 12	0/ 1/ 16	0/ 0/ 13	0/ 0/ 11	0/ 0/ 16
MSFC/MAF	0/ 1/ 14	0/ 1/ 18	0/ 0/ 11	1/ 0/ 20	1/ 3/ 26
SSC	0/ 0/ 1	0/ 0/ 0	0/ 0/ 1	0/ 0/ 1	0/ 0/ 1
TOTAL	0/ 3/ 91	2/ 6/114	2/ 1/100	3/ 3/100	1/ 4/130

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

NASA TYPE A, B, AND C MISHAPS
1988-1992

TYPE A:	1983 - 1988	$500K OR GREATER
	1989 -	$1M OR GREATER
TYPE B:	1983 - 1988	LESS THAN $500K BUT GREATER THAN $250K
	1989 -	LESS THAN $1M BUT GREATER THAN $250K
TYPE C:		LESS THAN $250K BUT GREATER THAN 25K



LOST TIME INJURIES ARE NOT INCLUDED.

Figure 11

TOTAL COSTS TO NASA DUE TO MISHAPS
(IN MILLIONS OF DOLLARS)
1988-1992

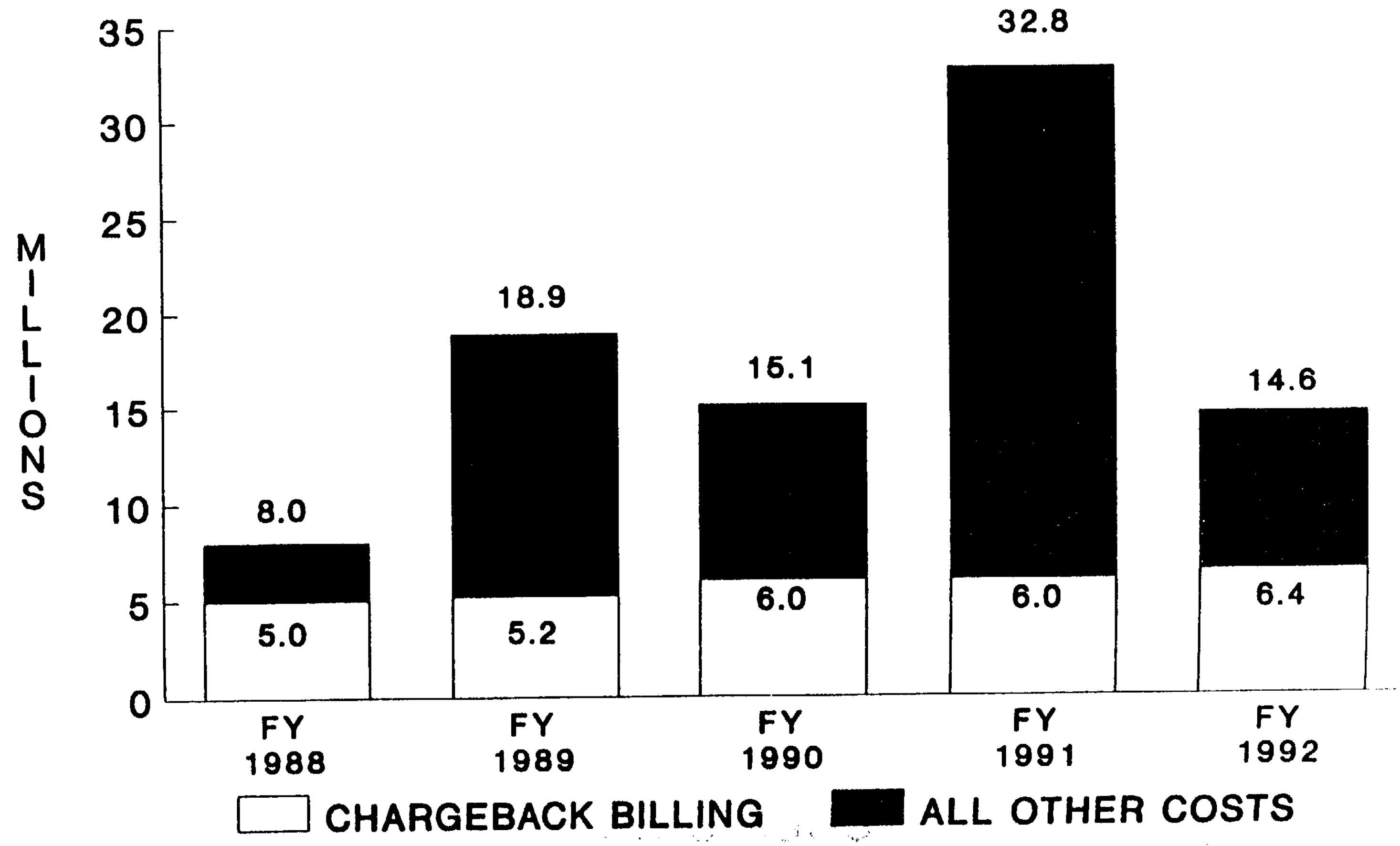


Figure 12

TABLE 5A. PERFORMANCE SUMMARY - ANNUAL REPORT FY 1992

NASA LOST TIME RATES

	1991	GOAL 1992	1992
ARC/DFRF	0.66	0.54	0.63
GSFC/WFF	0.32	0.37	0.39
HQ	0.79	0.57	1.00
JSC/WSTF	0.32	0.34	0.39
KSC	0.31	0.38	0.33
LARC	0.29	0.37	0.32
LERC	0.36	0.43	0.54
MSFC/MAF	0.50	0.37	0.46
SSC	0.00	0.37	0.00
NASA	0.42	0.40	0.48

TABLE 5B. PERFORMANCE SUMMARY - ANNUAL REPORT FY 1992

	TYPE A MISHAPS			TYPE B MISHAPS		TYPE C MISHAPS		MATERIAL LOSSES	
	1991	1992	(FATALITIES) 1992	1991	1992	1991	1992	1991	1992
ARC/DFRF	1	0	0	2	0	12	16	1,385,824	189,234
GSFC/WFF	0	0	0	0	0	9	14	30,251	9,982
HQ	0	0	0	0	0	17	21	0	1,255
JPL	0	0	0	0	1	1	1	171,500	416,600
JSC/WSTF	0	0	0	1	0	13	15	654,807	66,887
KSC	1	0	0	0	0	8	11	2,773,943	253,525
LARC	0	0	1	0	0	8	9	96,366	0
LERC	0	0	0	0	0	11	16	83,506	115,965
MSFC/MAF	1	1	0	0	3	20	26	21,400,933	6,924,441
SSC	0	0	0	0	0	1	1	87,020	38,580
TOTALS	3	1	1	3	4	100	130	26,684,150	8,016,469

MAJOR MISHAPS

FY 1991

SPACE SHUTTLE MAIN ENGINE TEST FAILURE
MARSHALL SPACE FLIGHT CENTER
TYPE A

NOTE: This mishap occurred relatively late in FY 1991. Due to the complexity of the mishap, investigation results and final cost figures were not available in time to be included in the Safety Program Status Report for FY 1991.

On July 24, 1991, at approximately 4:53 p.m. Central Daylight Time, a static test of Space Shuttle Main Engine Number 0215 was terminated by commands from the Command and Data Simulator (CADS) to the engine controller/software when the CADS detected that the controller had entered Electrical Lockup. This condition was prompted when both Main Combustion Chamber (MCC) pressure channel values fell below the lower qualification limit. Prior to the shutdown command, flashes were observed in the nozzle exhaust, followed by a fire in the area of the fuel preburner. On-site hardware evaluation revealed limited external damage in the region of a burnthrough of the hot gas manifold coolant duct elbow. The small fire observed in this area resulted in localized damage to two engine harnesses and the high pressure fuel turbopump. Further investigation revealed extensive internal damage to the main injector, MCC, and nozzle. There was no facility damage.

The principal cause of the mishap was the failure of a high pressure fuel turbine second stage blade. The failure was caused by the internal crack growth of a preexisting, subsurface flaw embrittled by hydrogen exposure. The embrittlement resulted from hydrogen exposure through microshrinkage porosity or diffusion as a result of long-term exposure. Final cost of the mishap was $20,000,000.

FY 1992

FATALITY
LANGLEY RESEARCH CENTER
TYPE A

A NASA employee at the Langley Research Center (LaRC) died of cancer on November 13, 1991. OWCP ruled that his death resulted from occupational exposure to asbestos which first occurred at LaRC in 1967.

TRANSFER ORBIT STAGE HANDLING MISHAP
MARSHALL SPACE FLIGHT CENTER
TYPE A

A Transfer Orbit Stage (TOS) Solid Rocket Motor (SRM) was damaged on January 2, 1992, at United Technologies, Chemical Systems Division, Coyote Canyon Facility while in the process of being lifted from a thermal conditioning chamber. An error during the lift caused the SRM to strike the chamber wall. In addition, specific instructions requiring the use of protective jacketing for the SRM during handling were disregarded. At the time of the mishap, the crane operator was expected to lift the SRM slightly and perform a " boom back" maneuver to recenter the SRM in the thermal chamber. The operator instead performed a "boom retract" maneuver which moved the SRM toward the crane and into the chamber wall. The damage was visually evident as a series of impact points, gouges, and scrapes of varying dimensions that covered less than one quadrant of the Kevlar epoxy composite motor case. The nature of the damage was permanent and the SRM was determined to be unsuitable for its intended use as the orbital transfer motor for the Advanced Communication Technology Satellite mission. Final cost of the mishap was $3,906,000.

TOPEX SPACECRAFT HANDLING MISHAP
JET PROPULSION LABORATORY
TYPE B

On March 8, 1992 a handing mishap occurred while the TOPEX spacecraft was being prepared for thermal vacuum testing (T/V) in building 10 at the Goddard Space Flight Center. As part of the procedure, the T/V Fixture Assembly, consisting of the spacecraft, thermal test shrouding and instrumentation mounted on the Spacecraft Horizontal Support Structure (SHSS) and suspended by four vertical cables from an H-frame spreader bar, was lifted and positioned above the T/V chamber. During final crane positioning maneuvers, the suspended assembly began a slow overturning rotation. The assembly rotated approximately 115 degrees before being halted by the entanglement of one of the four suspension cables with the SHSS. The primary cause of the mishap was a deficiency in the design of the handling fixture assembly. The T/V Fixture Assembly, as configured for TOPEX, was found to be unstable. Final cost of damage to the spacecraft and the test fixture was $305,000.

SPACE SHUTTLE MAIN ENGINE TEST FAILURE
MARSHALL SPACE FLIGHT CENTER
TYPE B

On November 6, 1991, a test firing of Space Shuttle Main Engine 2032 was terminated 3.72 seconds into a scheduled 400-second test by the Command and Data Simulator (CADS). Sensors indicated that the Low Pressure Fuel Pump (LPFP) discharge pressure exceeded its maximum qualification limit. The engine controller responded by issuing a Major Component Failure signal which initiated the CADS cutoff. Post-test inspections found no external engine or facility damage. Internal borescope inspections revealed heavy erosion of the High Pressure Fuel Turbopump first stage nozzle and turbine blades. The primary cause of the mishap was an error made during assembly of the engine. A coupler used to link the Chamber Coolant Valve Actuator to the Chamber Coolant Valve was inadvertently omitted. With the coupling component left out, actuator movement did not translate into actual valve movement. This resulted in additional fuel flow to the Main Combustion Chamber and Nozzle coolant circuit and reduced fuel flow to the preburners. The increased coolant flow resulted in an increased LPFP turbine flow which increased its speed and discharge pressure. This in turn exceeded the sensor qualification limit. Final cost of the mishap was $900,000.

TRANSFER ORBIT STAGE THRUST VECTOR CONTROL
ACTUATOR OVERTRAVEL/OVERTEMPRETURE
MARSHALL SPACE FLIGHT CENTER
TYPE B

On June 17, 1992, Thrust Vector Control (TVC) electronics and the yaw actuator on the Transfer Orbit Stage (TOS)/Mars Observer flight vehicle were damaged during test operations at the Kennedy Space Center Payload Hazardous Servicing Facility. During the powered flight portion of the mission test, the TVC yaw axis actuator drove the solid rocket motor nozzle mechanism into a mechanical stop called the gib ring. The yaw axis actuator motor, under the control of the flight control system software, was subjected to stall currents of 33 amperes for the duration of the powered flight (approximately 168 seconds). The stall currents resulted in an overtemperature condition in the yaw actuator and the electronic TVC controller that supplies control power to the actuator. Thermal analysis concluded that both components had been over stressed. The primary cause of the mishap was a problem with the flight software. A higher than specified effective gain between nozzle angle command and required controller voltage was coded into the software. As a result, the TVC nozzle was commanded to an angular deflection 20 percent greater than expected. In addition, the built-in software limit, intended to protect against an overcommand condition, was beyond the mechanical stop of the nozzle gib ring. Final cost of the mishap was $299,000.

SPACE SHUTTLE MAIN ENGINE TEST FAILURE
MARSHALL SPACE FLIGHT CENTER
TYPE B

Space Shuttle Main Engine 2107 sustained damage during a test firing on June 17, 1992 at the Stennis Space Center. The test was terminated after only 1.29 second when the Digital Computer Unit A (DCU-A) detected that DCU-B had halted. During the shutdown process, the Oxidizer Preburner Oxidizer Valve (OPOV) leaked after valve closure resulting in high liquid oxygen (LOX) pump speed and high LOX turbine discharge temperatures and pressures. Post-test inspections indicated no external or facility damage. Internal borescope inspection revealed heavy erosion of the High Pressure Oxidizer Turbopump (HPOTP) first stage nozzle and blades. The most probable cause of the OPOV leakage was found to be the combination of an ambient temperature Kel-F seal and high valve delta pressure at valve closure. These conditions typically exist for shutdowns between 0.8 and 1.5 seconds. The combination resulted in the seal binding with the bellows, leaving a leak gap between the seal and the bellows end cap. Reduced pressures and temperatures later in the shutdown permitted full OPOV closure. Final cost of the mishap was $900,000.

TYPE C MISHAPS
EQUIPMENT/PROPERTY DAMAGE

Ames Research Center
Main drive components on the ARC Unitary Plan Wind Tunnel sustained damage during drive start procedures on January 13, 1992. Several electrical breaker trips and problem signals were noted when the tunnel operator attempted the drive start. An inspection by the shift electrician revealed that a flash over had occurred on the slip rings between phase 2 and 3 of one of the main drive motors. The cost of the mishap was estimated at $189,234.

Jet Propulsion Laboratory
The sub-reflector and quad legs on an antenna were damaged while in the process of moving to track the Pioneer spacecraft when an earthquake measuring 7.4 on the Richter scale occurred. The cost of the damage was estimated at $100,000.

Johnson Space Center
The right wing tip of Shuttle Training Aircraft, NASA 944, struck a light-aircraft hangar during taxi operations. The primary cause of the mishap was misjudgment of conditions. Contributing factors were a procedure deficiency and improper illumination. Final cost of the mishap was $40,497.

Kennedy Space Center
A Space Shuttle Solid Rocket Booster aft skirt tilt hydraulic fluid reservoir was damaged due to overpressurization that occurred while attempting to bleed the rock actuator and reservoir. The primary cause of the mishap was inadequate operation procedures and requirements. Final cost of the mishap was $60,191.

A support strut on a Space Shuttle cryogenic tank was found to be cracked and had a visible "ding" where it had been struck with an unknown object. The mishap was attributed to human error due to lack of attention. Final cost of the mishap was $26,050.

A fire started in an asbestos abatement containment area while the abatement workers were on lunchbreak. A mobile light fell against the Visqueen-lined wall of the containment area causing the Visqueen to catch on fire. The cost of the mishap was estimated at $25,000.

Lewis Research Center
The safety valve on an air compressor lifted and blew 125 psig service air onto piping above. The force of the air knocked asbestos insulation loose from the piping and into the work area below. The primary cause of the mishap was a design deficiency. Final cost of the mishap was $52,000.

Marshall Space Flight Center

A test cell's vertical sliding door was being closed during cell checkout operations. As the door reached its full upward (closed) position, the six door panels progressively fell to the open position. All six panels remained in their respective guide channels after falling. The primary cause of the mishap was a drive mechanism failure due to a design deficiency. A misjudgment of conditions was a contributing factor. Final cost of the mishap was $117,668.

An overhead crane was damaged when its hook/block became wedged between the hoist drum and a support brace. The hook had just been cleared of a load and was being returned to a position near the bridge. The hook continued to ascend upon release of the ascend button. The operator attempted to engage the emergency stop button, but it failed to stop the hook from ascending. Final cost of the mishap was $40,506.

A Space Shuttle Main Engine High Pressure Fuel Turbopump main housing was damaged during a machining operation. The tool was positioned approximately 6 to 8 inches from the housing when the operator inadvertently engaged the vertical turret lathe feed to rapid jog. The lathe rapidly positioned the cutter into the housing damaging the inner liner strut covers and the outer pump end static surface. Final cost of the mishap was $100,000.

The pressure rupture disc on an autoclave failed during curing of 4 nozzle components. The rupture disk had been replaced as part of regular preventive maintenance and the nozzle curing process was the first pressure cycle the disk had experienced. The disk was found to have a lower rating than required. Final cost of the mishap was $155,900.

A Space Shuttle Main Engine High Pressure Oxidizer Turbopump disk/shaft was damaged during assembly of the disk/shaft into the main housing. The "crows feet" hold downs on the shaft table were inadvertently left in the locked position. As the load was applied to seat the shaft into the housing, six turbine inlet side disk tangs were torn from the disk. Final cost of the mishap was $74,000.

A Space Shuttle Main Engine High Pressure Oxidizer Turbopump turbine bellows and bellows heat shield were damaged during a test run when a low chamber pressure occurred. The primary cause of the mishap was equipment failure due to material failure. Final cost of the mishap was $67,400.

A servo-actuator body and tailstock assembly was damaged during proof load test. The investigation revealed that only 4 of 19 bolts attaching the tail stock and bearing assembly to the housing had been installed. Three of the bolts were stripped from the housing and one was bent. A processing step to install the additional 15 bolts had been omitted. The primary cause of the mishap was lack of attention and a procedural deficiency. Final cost of the mishap was $70,000.

Premature advance was experienced at 109.8 seconds into a 520-second Space Shuttle Main Engine test when the high pressure pump vibration exceeded the 10 "G" limit. Borescope inspection revealed a 1-inch by 2-inch piece of the turbine side inducer was missing. The primary cause of the mishap was equipment failure due to a design deficiency. Final cost of the mishap was $76,574.

An explosion and fire occurred in the liquid oxygen feed system to a 40k engine during test preparations. The test conductor was knocked down and received first and second degree burns. An assistant also was knocked down but was not injured. The primary cause of the mishap was equipment failure due to a design deficiency. Final cost of the mishap was $45,000.

A fuel service module was damaged during refurbishment when it was dropped. A holding fixture was being used to secure the module in the machining lathe. The module came loose from the fixture and dropped to the floor causing dents and scratches. The primary cause of the mishap was equipment failure due to a design deficiency. A misjudgment of conditions was a contributing factor. The cost of the mishap was estimated at $60,000.

<u>Stennis Space Center</u>
An air compressor was damaged when it caught on fire during normal operations. The primary cause of the mishap was equipment failure due to material failure. Final cost of the mishap was $37,500.