NASA National Aeronautics and Space Administration

# FY 1984 Safety Program Data Report

NASA Safety Division
Office of the Chief Engineer
Washington, D.C. 20546

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# SAFETY PROGRAM - FY 1984 OVERVIEW

NASA maintains an excellent Safety and Health record, evidence of management's commitment to the Safety Program. Total occupational injury and illness rates for NASA are well below those of the average of all other Federal agencies and many private sector manufacturing firms. The number of fires, motor vehicle accidents, and aircraft mishaps continues to decline.

The reduction of claims made to the Office of Workers' Compensation (OWCP) by employees in the Federal Government is an issue which has received much attention. On December 9, 1982, President Reagan asked the heads of all Federal agencies and departments to review existing safety and health programs and to take every step possible to reduce the number of occupational injuries and illnesses occurring in the Federal sector. He urged heads of agencies and departments to study their operations thoroughly to find more and better ways to reduce the injuries, illnesses, and associated costs in their jurisdictions. On October 11, 1983, the president established a goal of 3% per year for the reduction of workplace injuries. Having become effective at the start of FY 1984, that goal will remain in effect for five years and will cover both injury and occupational health claims.

NASA's FY 1984 OWCP claims represent a greater than 3% reduction.

Haggai Cohen
Deputy Chief Engineer

## SAFETY ACCOMPLISHMENTS AND INITIATIVES

Awareness and visibility of the NASA Safety Program received increased emphasis in 1984. Safety and systems safety officials joined occupational health personnel in sponsoring a three-day Directors' meeting and workshop at the National Space Technology Laboratories in October 1983. In April 1984, a follow-up Safety Directors' Workshop was held at the Lewis Research Center. In addition, an Aviation Safety Officers' Workshop was held at the Lewis Research Center.

Several centerwide "Safety and Health Awareness Programs" were initiated. A model program at the Ames Research Center was started with the full support of the Center Director and staff. The center's bimonthly newspaper, the ASTROGRAM, featured several articles about the program. In addition, personal invitations were extended to staff members to attend lectures on such topics as hearing conservation, use of seat belts, prevention of back injuries, life-saving measures during earthquakes, and other emergency response actions. Employees were encouraged to submit suggestions for improvements in safety. All serious suggestions were carefully evaluated, and the proposers were presented with token awards such as "Ames Aims for Safety" coffee cups, first aid kits, safety playing cards, safety "Buckle Up" key rings, and safety pen flashlights. Awards were also presented to attendees at safety lectures. This continuing program has succeeded in increasing awareness of safety at Ames.

Agency goals and a plan of action were established for 1984. A

Safety Program Plan was developed and sent to each center. This plan defined the major objectives and the milestones planned for the year. Quantitative goals to be used as safety program performance indicators for both NASA and contractor employee lost time rates, Type A and Type B mishaps, and monetary losses for each center were established. Agency managers were provided with the 1983 Safety Program Data Report which compared the safety program record of that year with the ten previous years to provide the necessary perspective and background. Status reports on the goals were distributed quarterly during 1984.

Summaries of NASA reports for 1968-1979 are now obtainable at NASA's Scientific and Technical Information Facility which is equipped with on-line computers. Copies of the reports are available off-line as microfiche and hard copy.

NASA is continuing with prompt mishap investigations, analyses, and corrective activities. A list of potential members of Mishap Investigation Boards, which included each person's previous board experience, training, and technical expertise, was distributed. Nine major Investigation Board reports were closed out by completing recommended actions and disseminating lessons learned. Memoranda of Agreement with the Air Force and the Army provided for an exchange of mishap data on common aircraft. The first phase in establishing a NASA-wide Automated Mishap Reporting and Corrective Action System was completed by implementing an operational pilot system at the Kennedy Space Center. All the centers are making greater use of the computer in performing rigorous causal factor analyses.

Increased emphasis was placed on safety engineering by our participation in reviews of major construction-of-facility projects to establish appropriate engineering abatement and operational controls early in the design phases. Hazard analyses, including subsystems and system hazard analyses and operating and support analyses, are being considered for applicability to high risk facilities. Safety engineering support was provided by reviewing modifications to such major research facility projects as the Aircraft Landing Dynamic Facility, the Transonic Dynamics Tunnel, a 20-inch Supersonic Wind Tunnel, an 8-foot High Temperature Tunnel, a 40 X 80 X 120-foot Wind Tunnel, and the Altitude Wind Tunnel. The design for a new operational facility, the "Cargo Hazardous Servicing Facility," was also reviewed. The Headquarters Safety Office appointed an advocate for facility safety projects to participate in the budget review process.

For the first time, a uniform assessment code was used to establish priorities for safety related projects. Also, a NASA-wide information system was established to communicate lessons learned from the NASA Pressure Systems Recertification effort.

Headquarters continued in its oversight role through inspections of center operations at Ames Research Center/Dryden Flight Research Facility, Kennedy Space Center, Marshall Space Flight Center, and the National Space Technology Laboratories. In addition, a program review that included a walk-through inspection and management review of the safety program implemented at the three Headquarters buildings was performed. Flight operations, including aviation safety, were reviewed at six centers by the Intercenter Aircraft Operations Panel. Also, an independent aviation safety review of flight operations at Kennedy Space Center was completed. The centers maintained an annual schedule of OSHA-type facility inspections with daily on-site visits to construction sites.

Resources were allocated for the conduct of independent fire risk assessments by Factory Mutual, Inc. at the Langley Research Center and at the Jet Propulsion Laboratory. At the Goddard Space Flight Center/Wallops Flight Facility, specially allocated resources were used to assess the fire risk for mission critical electronic systems. One safety research project to evaluate a nuclei fire detector was completed.

The Life Safety Code Equivalency System Development is continuing with the National Bureau of Standards tasked to develop a viable system for determining building life safety equivalency options for the agency.

Headquarters-sponsored safety training included Systems Safety Principles of Ergonomics, National Fire Prevention Association Life Safety Code, and Accident Investigation. The centers sponsored a wide variety of courses of particular value to their own employees. Kennedy Space Center, for example, offered 72 courses in fire and safety. At all centers all employees must receive safety access training for their respective work areas. Because individual employees at KSC may be required to support the Shuttle Transportation System from launch through landing, their training has become quite extensive. At this time, training is presented in several ways: formal lectures, walk-down familiarization, slide presentations, and video presentations. An earnest attempt is being made to stream-line the training program and bring it to the employee at his/her work station. During 1984, 63,515 hours of classroom training were offered for 43,809 attendees at KSC. At Langley Research Center 6,105 hours of training were provided for 2,295 attendees. The safety awareness programs at the centers also included an earthquake preparedness study, the development of a safety library, a hazardous waste management plan, hazardous waste response team training, a plan for disposal of used PCB transformers, environmental sample analyses, and environmental assessments.

Safety is considered an integral part of the agency's new initiative to enhance quality and to improve productivity. Any effort to improve quality at NASA is an effort to improve safety. The employee suggestion program and quality circle approach to problem identification and correction are being used to increase employee participation in center safety programs. At Goddard Space Flight Center, for example, actions were taken to reinforce employee and supervisory involvement in the safety program through small groups of management level employees who had demonstrated leadership in promoting safety. Meetings were held with employee representatives to encourage a free exchange of information in assessing asbestos hazards.

We are also pleased to report that our first safety intern from the Department of the Army's safety program at Red River Depot, Texarkana, Texas, completed his one-year program and is on the job at the Lewis Research Center.

## NASA OCCUPATIONAL INJURY/ILLNESS
## FY 1984 STATISTICS

| | |
|---|---|
| Fatalities | 0 |
| Non lost-time workday injuries | 147 |
| Lost workday injuries | 93 |
| Lost wages | $165,479 |
| Chargeback billing | $5,445,987 |

For reporting purposes, illnesses and injuries to personnel are divided into two classes: lost-time and non lost-time. Lost-time injuries/illnesses are defined by OSHA as work-related injuries/illnesses which involve days away from work, or days of restricted activity, or both. The number of days away from work or days of restricted work activity does not include the day of injury or onset of illness, or any days on which the employee would not have worked even though able to work.

## LOST-TIME INJURIES

The number of lost-time injuries/illnesses per 200,000 hours is a gross figure which gives an indication of how many lost-time incidents were reported in relation to the number of hours worked. This rate had been steadily declining, but a slight increase to 0.45 from 0.41 in 1983 was experienced. Table 1 shows injury/illness statistics for all centers during 1984.

TABLE 1. NASA INJURY/ILLNESS DATA BY INSTALLATION -- FY 1984

| | | | TOTAL INJURY/ ILLNESS DATA | | | LOST-TIME INJURY/ILLNESS DATA | | | | | LOST-TIME RATE OBJECTIVE FOR 1984 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NO. OF EMPLOYEES | HOURS WORKED IN K | NO. CASES | FREQ. 1983 | RATE 1984 | NO. CASES | NO. DAYS | FREQ. 1983 | RATE 1984 | SEVERITY RATE | CUM. RATE | TARGET RATE |
| ARC | 2,207 | 4,294 | 10 | 0.74 | 0.47 | 6 | 28 | 0.32 | 0.28 | 1.30 | 0.28 | 0.30 |
| GSFC | 3,804 | 7,015 | 35 | 0.93 | 1.00 | 20 | 238 | 0.46 | 0.57 | 6.78 | 0.57 | 0.45 |
| HQ | 1,620 | 2,930 | 19 | 1.60 | 1.30 | 5 | 70 | 0.53 | 0.34 | 4.78 | 0.34 | 0.50 |
| JSC | 3,540 | 6,026 | 30 | 2.33 | 1.00 | 9 | 104 | 0.39 | 0.30 | 3.45 | 0.30 | 0.30 |
| KSC | 2,204 | 4,716 | 10 | 0.49 | 0.42 | 6 | 84 | 0.29 | 0.25 | 3.56 | 0.25 | 0.30 |
| LaRC | 2,997 | 5,347 | 48 | 0.60 | 1.80 | 4 | 73 | 0.26 | 0.15 | 2.73 | 0.15 | 0.30 |
| LeRC | 2,682 | 4,848 | 69 | 2.27 | 2.85 | 39 | 318 | 0.84 | 1.61 | 13.12 | 1.61 | 0.60 |
| MSFC | 3,272 | 6,082 | 19 | 0.41 | 0.62 | 4 | 151 | 0.22 | 0.13 | 4.97 | 0.13 | 0.30 |
| NSTL | 128 | 263 | 0 | 0.76 | 0 | 0 | 0 | 0.76 | 0 | 0 | 0 | 0.30 |
| TOTAL | 22,454 | 41,521 | 240 | 1.14 | 1.15 | 93 | 1066 | 0.41 | 0.45 | 5.13 | 0.45 | |
| LAST YEAR | 22,576 | 42,360 | 242 | 1.14 | --- | 86 | 1249 | 0.41 | --- | 5.90 | 0.41 | |

1. Total injury/illness frequency rates = number of cases per 200,000 hours worked.

2. Lost time injury/illness frequency rate = number of lost workday cases per 200,000 hours worked.

3. Injury/illness severity rate = number of lost workdays per 200,000 hours worked.

Figure 1 illustrates the relative position of the NASA occupational injury rates compared to other Federal agencies for CY 1983. Within the Federal Government, NASA ranked fifth along with the Department of Education.

Figure 2 plots the NASA lost-time illness/injury rate for the last 11 years against other Federal agencies and selected private sector rates. NASA has consistently maintained a rate well below that of the Federal Government average and the average rate in the private sector.

Figure 3 compares the injury rates at the individual facilities to the all-NASA lost-time injury rate.

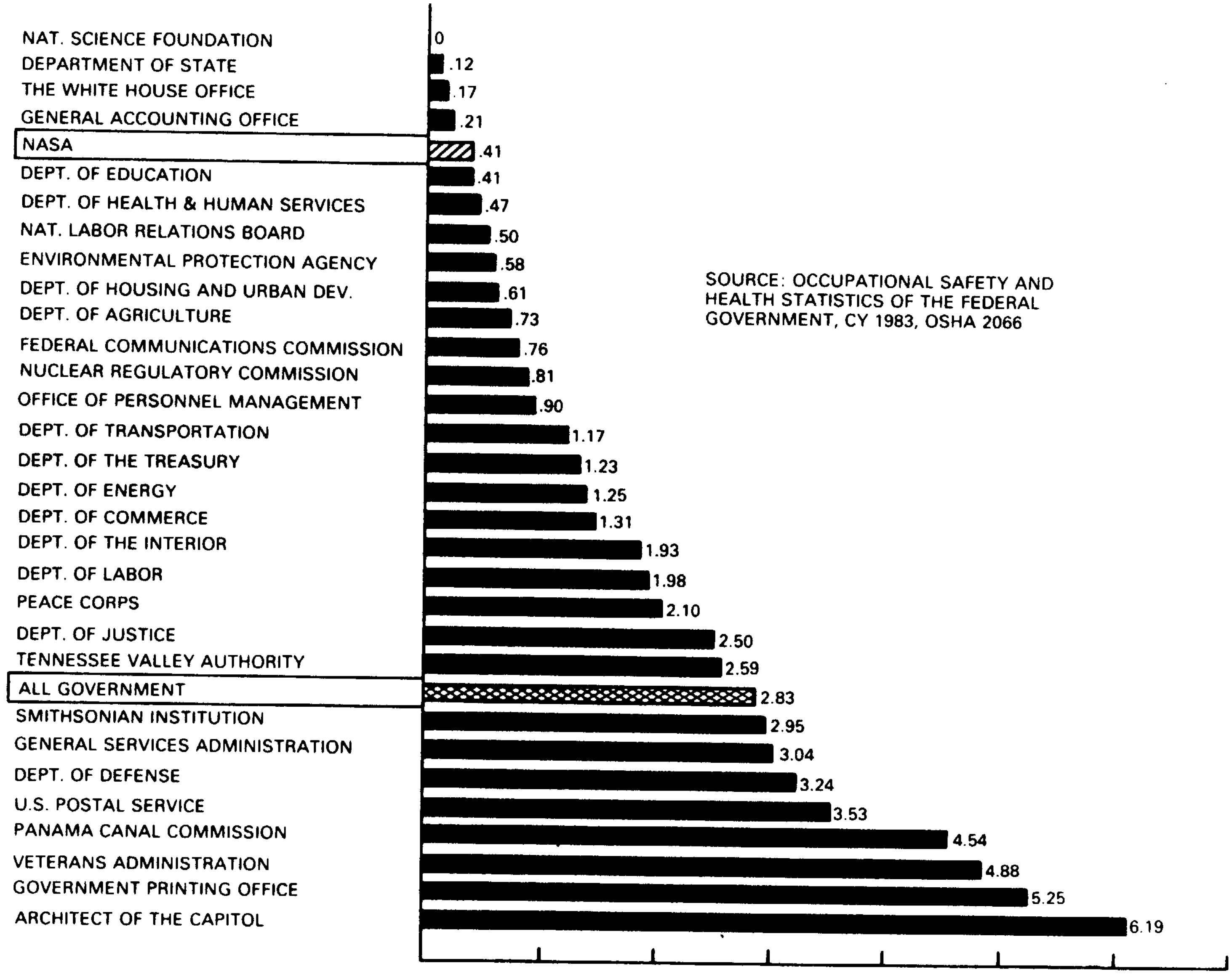
Figure 4 illustrates the injury severity rates at each of the NASA centers and at NASA overall. Since compensation for lost wages rather than medical costs constitutes the bulk of injury-related costs to NASA, this Figure is worthy of special note. The severity rate decreased slightly in 1984 to 5.13 from 5.81 days lost per 200,000 hours worked in 1983. Increased efforts to reduce the number of accidents and to decrease the number of days lost have offset the increases experienced in 1983.

Figure 5 shows how NASA has compared with other Federal agencies and certain private sector organizations in terms of time lost due to occupational injuries and illnesses.

Figure 6 shows the number of NASA employees and the number of lost time injuries over the last 11 years.

# CY 1983 LOST TIME INJURY/ILLNESS RATES IN FEDERAL AGENCIES

OCCUPATIONAL INJURY AND ILLNESS INCIDENCE RATES FOR CIVILIAN PERSONNEL PER 200,000 MAN-HOURS WORKED




SOURCE: OCCUPATIONAL SAFETY AND HEALTH STATISTICS OF THE FEDERAL GOVERNMENT, CY 1983, OSHA 2066

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Figure 1

# LOST-TIME OCCUPATIONAL INJURY/ILLNESS RATES:

## PRIVATE SECTORS-ALL FEDERAL AGENCIES-NASA

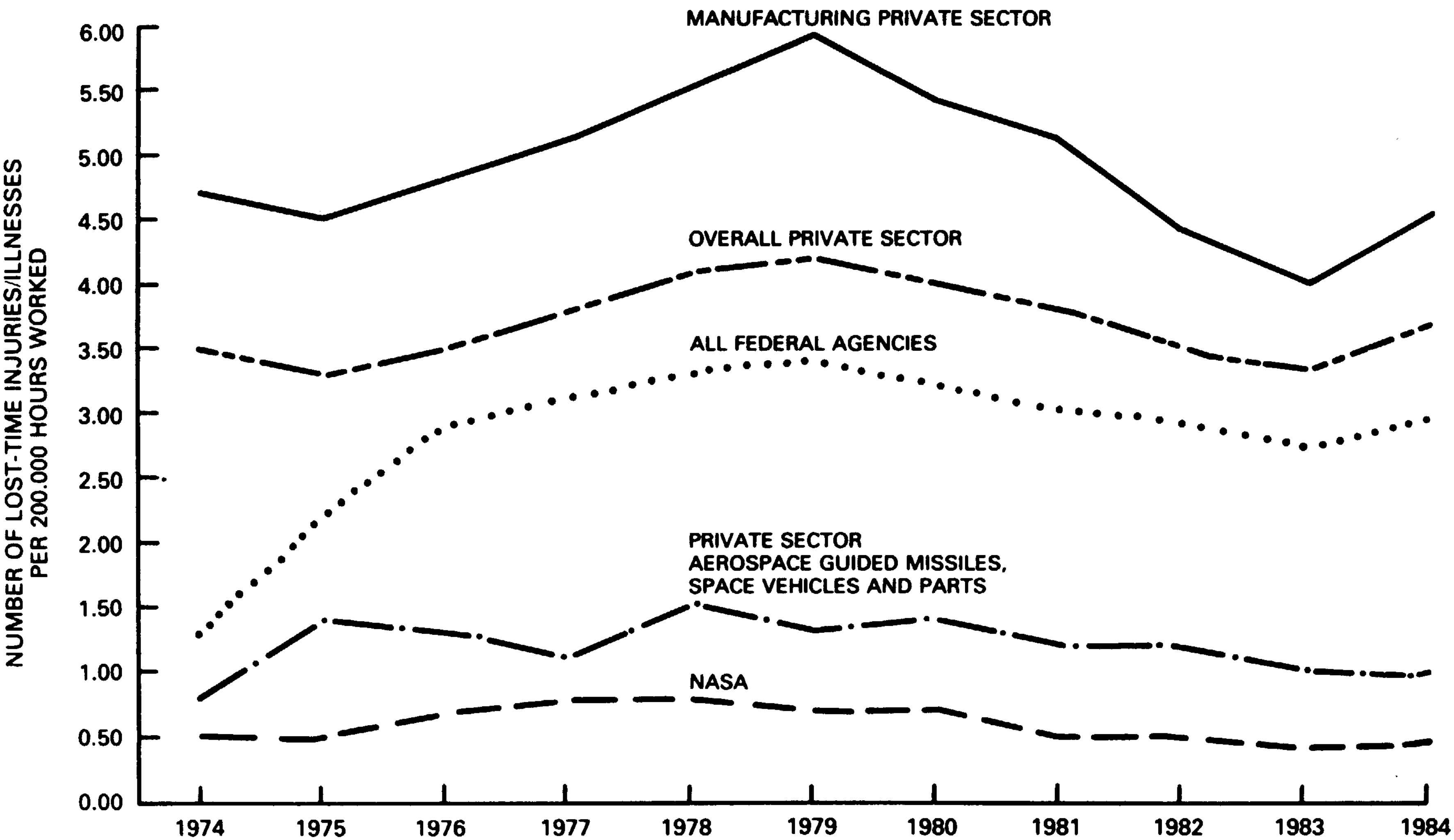


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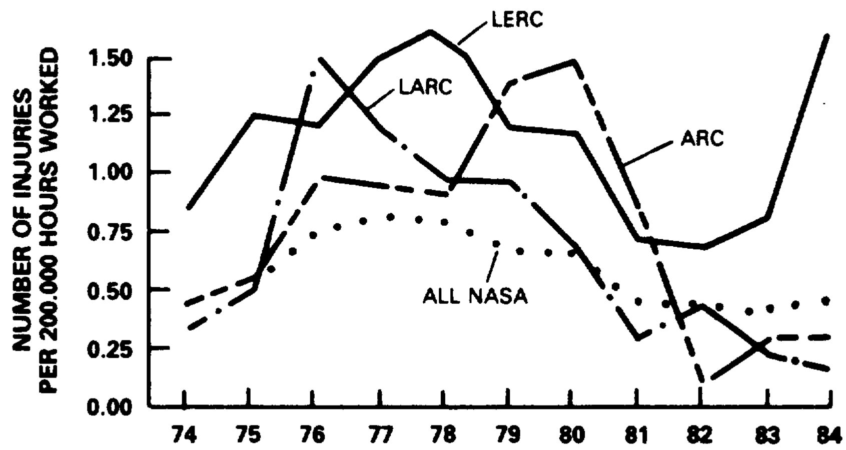
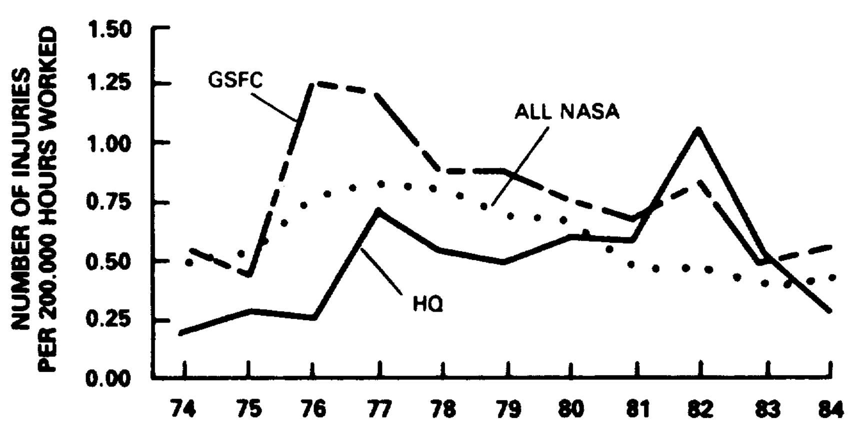
Figure 2
12

# INJURY FREQUENCY RATES



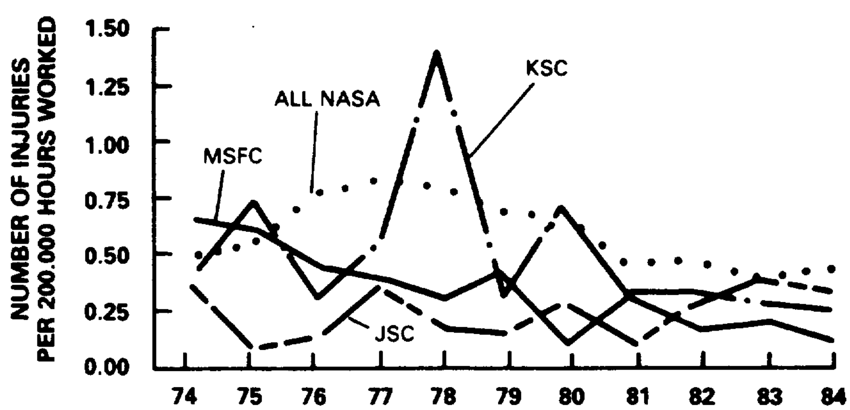




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Figure 3

# INJURY SEVERITY RATES

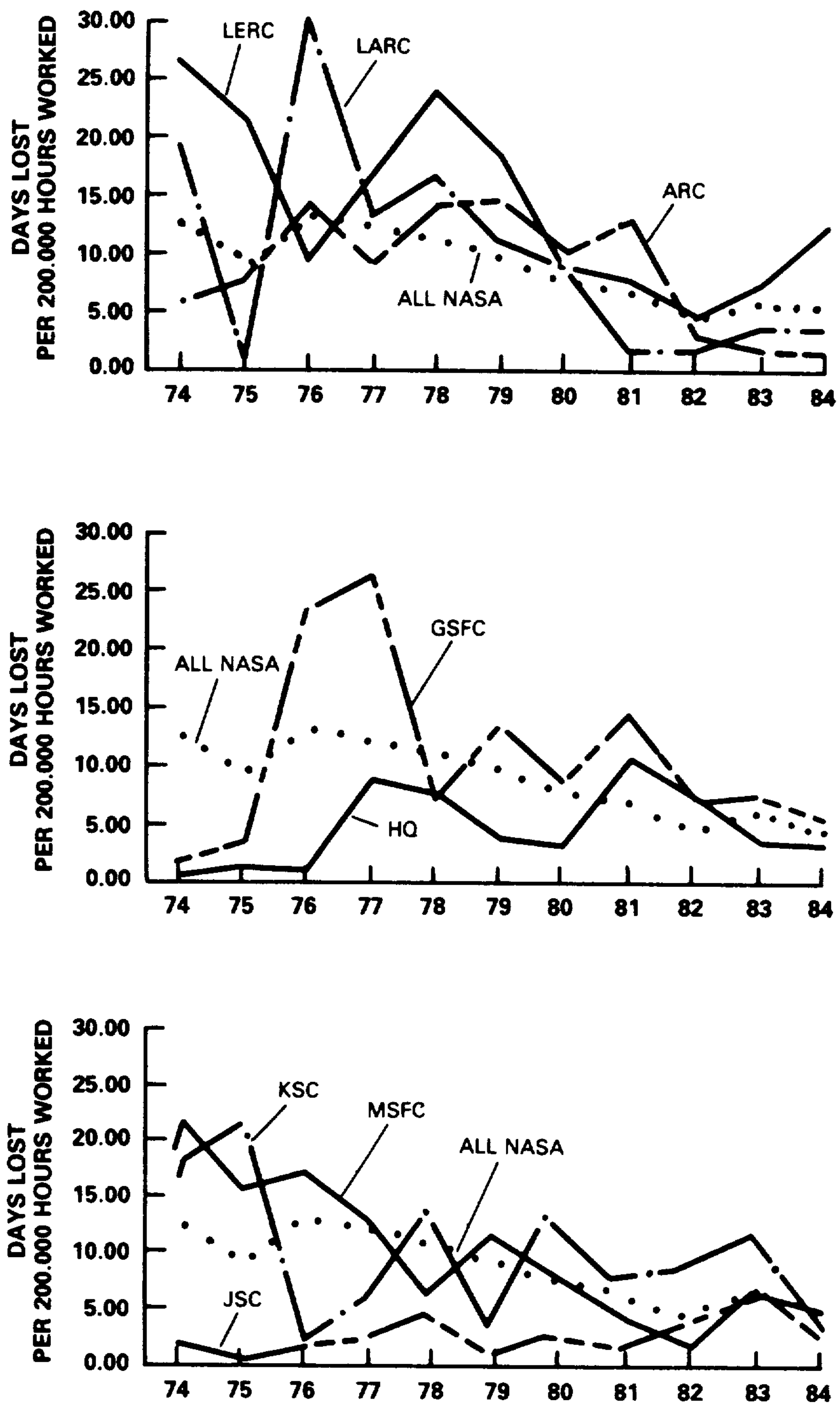


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Figure 4

# TIME-LOST OCCUPATIONAL INJURY/ILLNESS SEVERITY RATES

## PRIVATE SECTORS-SELECTED INDUSTRY-ALL FEDERAL AGENCIES

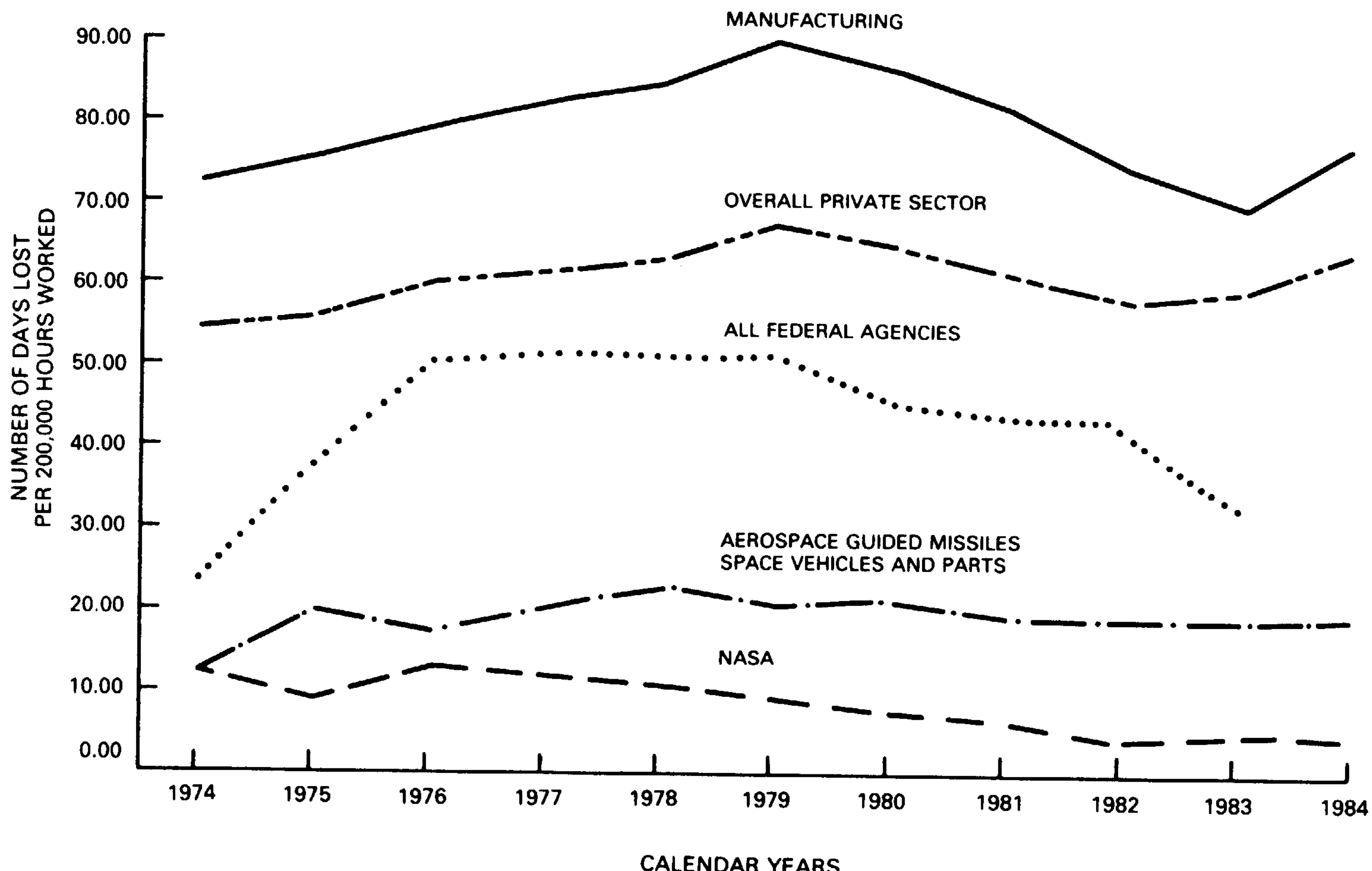


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Figure 5

# NUMBER OF NASA EMPLOYEES AND NUMBER OF LOST TIME INJURIES VS TIME

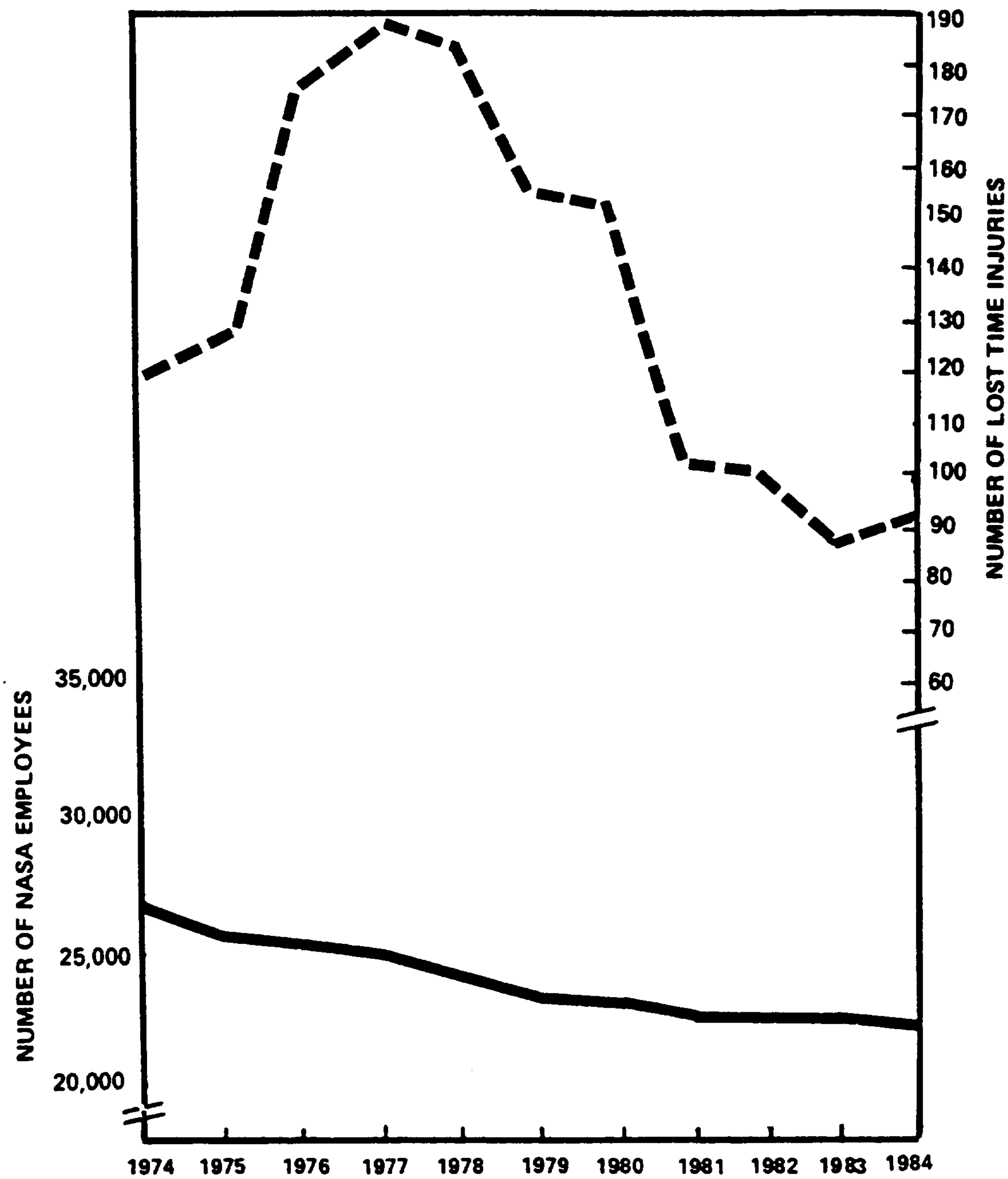


Figure 6

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## NON LOST-TIME INJURIES AND ILLNESSES

Non lost-time injuries and illnesses are defined as those which require medical treatment but do not result in days lost or in work restrictions beyond the day of the injury or onset of illness. If only first aid is required, the injury is not recordable and is not included in injury/illness statistics.

Figure 7 plots the lost-time rate, the non lost-time rate, and the total reportable rate per 200,000 hours worked. The total reportable rate of 1.17 in 1984 reflects a slight increase from 1.14 in 1983.

Table 2 compares the number and frequency rates of lost-time injuries and illnesses among NASA Federal employees at each of the centers with those among contractor employees. With the exception of the Lewis Research Center and Headquarters, NASA Federal employees suffered fewer lost-time illnesses and injuries in 1984 than did contractor employees.

Figure 8 illustrates NASA's excellent overall injury/illness record over the last 11 years compared with that of other Federal agencies and select private sector groups.

Figure 9 compares the number of illness/injury cases among NASA Federal employees and contractor employees for the last two years.

# NASA OCCUPATIONAL INJURY/ILLNESS* RATES**
# (1975-1984)

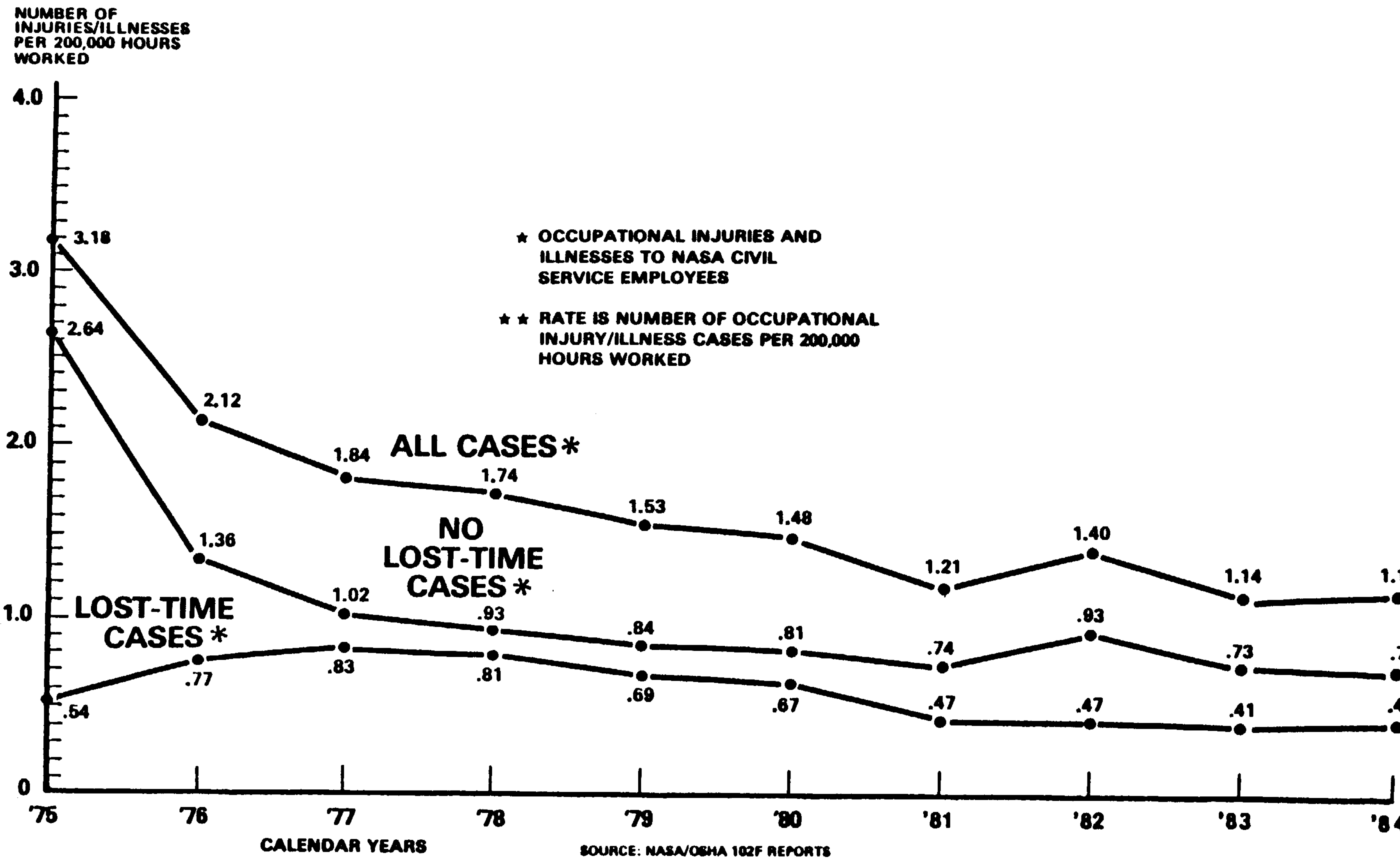


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TABLE 2. NASA COMBINED INJURY AND ILLNESS DATA BY INSTALLATION -- FY 1984
FEDERAL AND CONTRACTOR EMPLOYEES

| | HOURS(K) CIV.SERV. EMPLOYEES | NO. L-T CASES | FREQ. RATE | HOURS(K) CONTRACTOR EMPLOYEES | NO. L-T CASES | FREQ. RATE | HOURS(K) COMBINED TOTAL | TOTAL L-T CASES | COMBINED FREQ. RATE |
|---|---|---|---|---|---|---|---|---|---|
| ARC/DFRF | 4,294 | 6 | 0.28 | 2,735 | 32 | 2.34 | 7,029 | 38 | 1.08 |
| GSRC/WFF | 7,015 | 20 | 0.57 | 6,650 | 25 | 0.75 | 13,665 | 45 | 0.66 |
| HQ | 2,930 | 5 | 0.34 | 603 | 0 | 0.00 | 3,533 | 5 | 0.28 |
| JSC | 6,026 | 9 | 0.30 | 15,730 | 85 | 1.08 | 21,756 | 94 | 0.86 |
| KSC | 4,716 | 6 | 0.25 | 23,100 | 93 | 0.81 | 27,816 | 99 | 0.71 |
| LaRC | 5,347 | 4 | 0.15 | 2,570 | 28 | 2.18 | 7,917 | 32 | 0.81 |
| LeRC | 4,848 | 39 | 1.61 | 1,242 | 6 | 0.97 | 6,090 | 45 | 1.48 |
| MSFC | 6,082 | 4 | 0.13 | 2,357 | 10 | 0.85 | 8,439 | 14 | 0.33 |
| NSTL | 263 | 0 | 0.00 | 1,813 | 9 | 0.99 | 2,076 | 9 | 0.87 |
| TOTAL | 41,521 | 93 | 0.45 | 56,800 | 288 | 1.01 | 98,321 | 381 | 0.78 |

Lost-time injury/illness frequency rate = number of lost workday cases per 200,000 hours worked.

# TOTAL OCCUPATIONAL INJURY/ILLNESS RATES:

## PRIVATE SECTORS-ALL FEDERAL AGENCIES-NASA

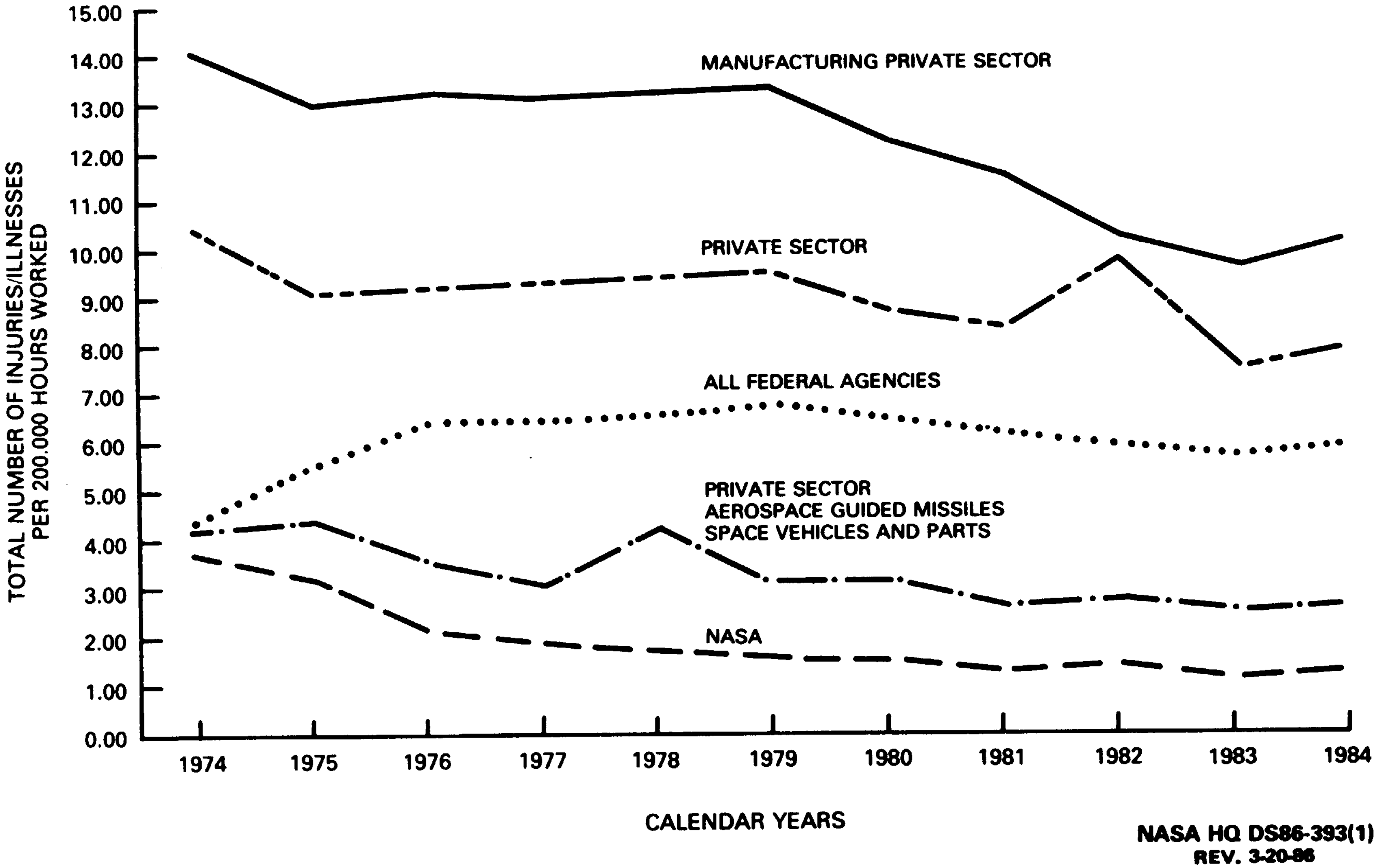
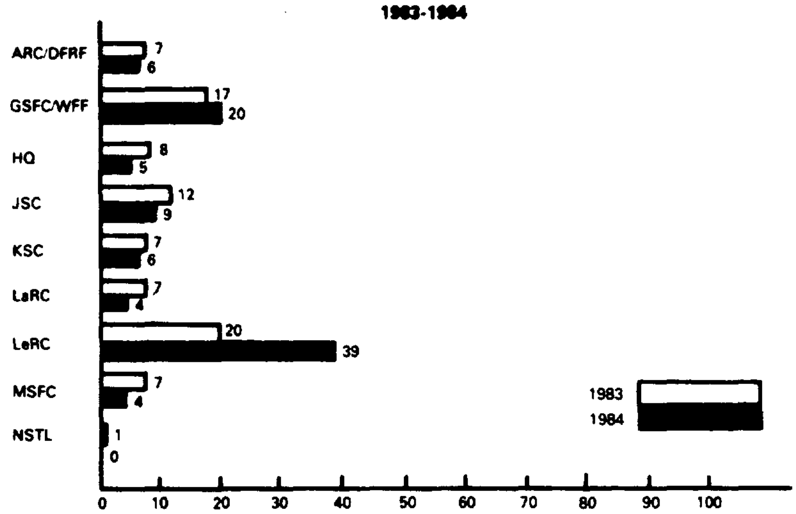
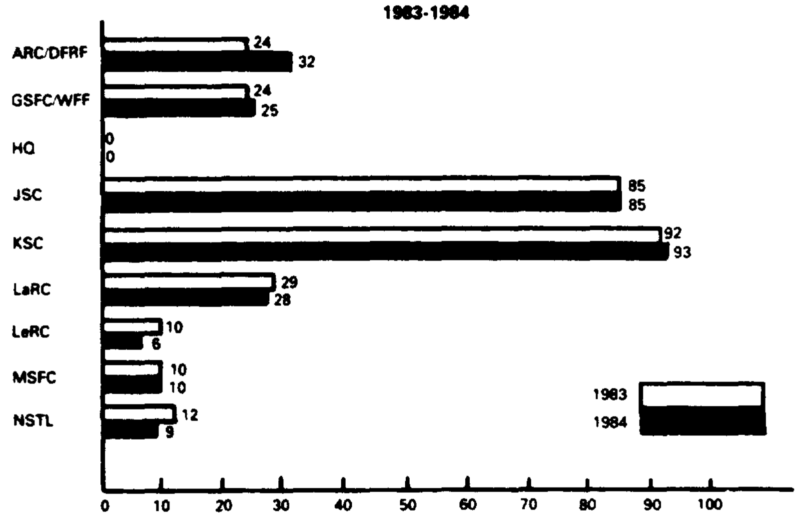



Figure 8

NASA FEDERAL EMPLOYEES
LOST-TIME ILLNESS/INJURY CASES
1983-1984




CONTRACTOR EMPLOYEES
LOST-TIME ILLNESS/INJURY CASES
1983-1984




COMBINED NASA AND CONTRACTOR
LOST-TIME ILLNESS/INJURY CASES
1983-1984

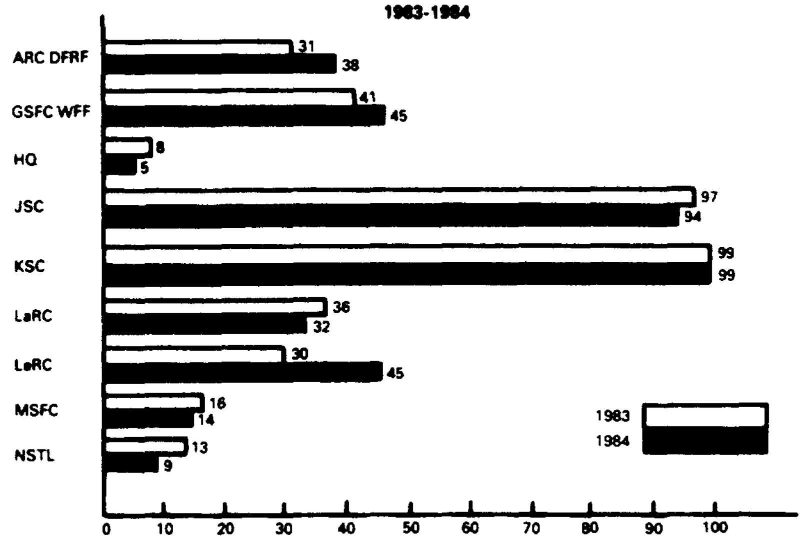



**Figure 9**

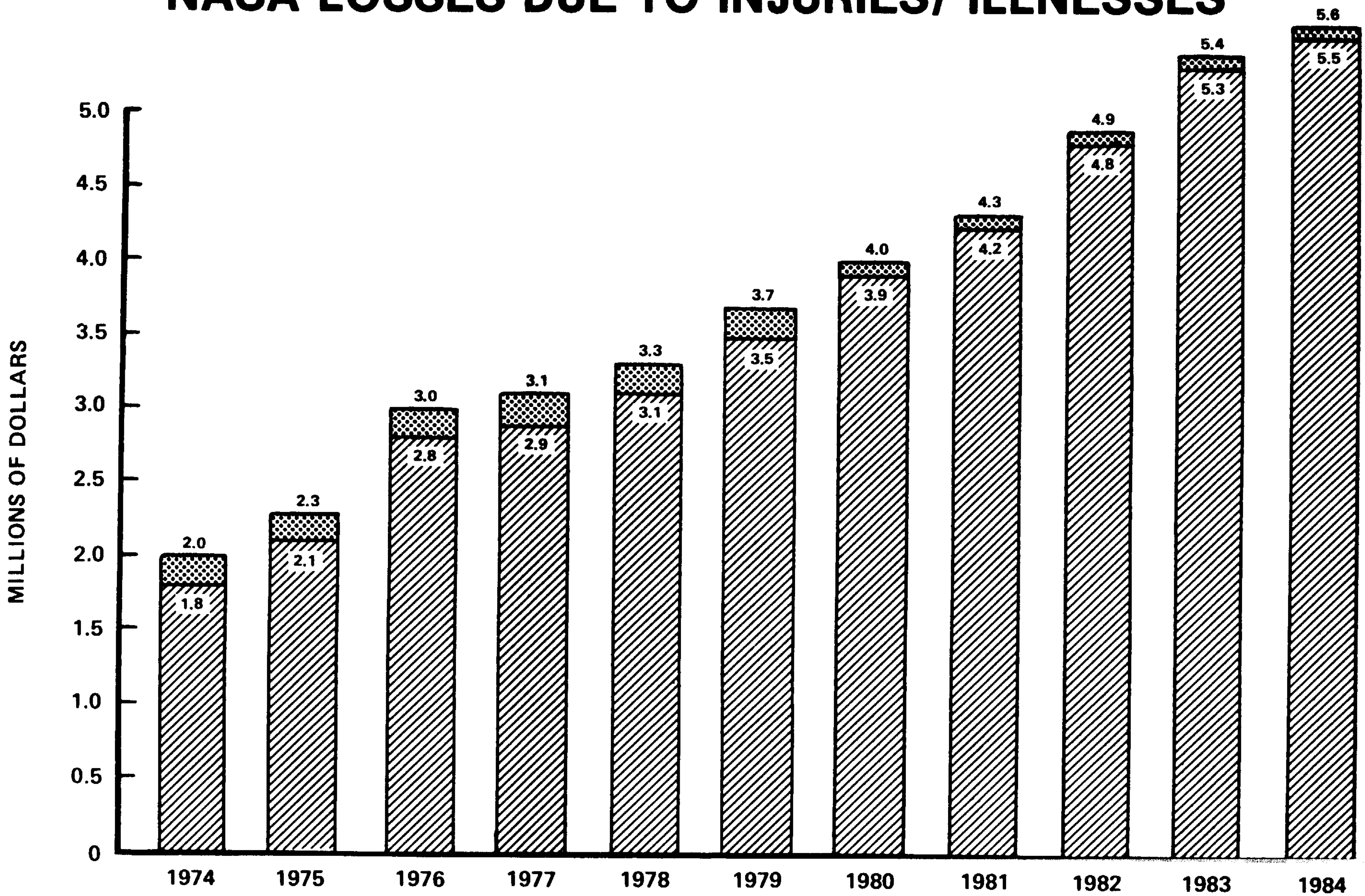
# CHARGEBACK BILLING

Chargeback billing is defined as money paid out by NASA as workers' compensation for death, long-term disability, and medical expenses. In any year, most of the chargeback billing is a result of illnesses and injuries which occurred in previous years.

Figures 10 and 11 illustrate the relationship between chargeback billing and NASA's total safety-related costs. These include fire, automobile, aviation, and other mishaps, as well as lost wages (continuation of pay). Of the $14.9 million total loss for FY 1984, $5.5 million, or 30.2%, were paid out in chargeback billing costs.

Figure 12 compares the cost of chargeback billing in the Federal Government to that in NASA for the last 11 years. The chart illustrates the rate at which costs for chargeback billing have been increasing. In 1974, chargeback billing costs for the Federal Government were approximately $230 million. By 1984, this cost had risen to $889 million, an increase of 470%. In comparison, chargeback billing costs for NASA over the same 11-year period increased by approximately $3.6 million or 300%.

# NASA LOSSES DUE TO INJURIES/ ILLNESSES




INCLUDES LOST WAGES AND CHARGE BACK BILLING TO THE FEDERAL EMPLOYEES COMPENSATION FUND, BUT DOES NOT INCLUDE CONTRACTOR LOSSES.

LOST WAGES    CHARGE BACK BILLING

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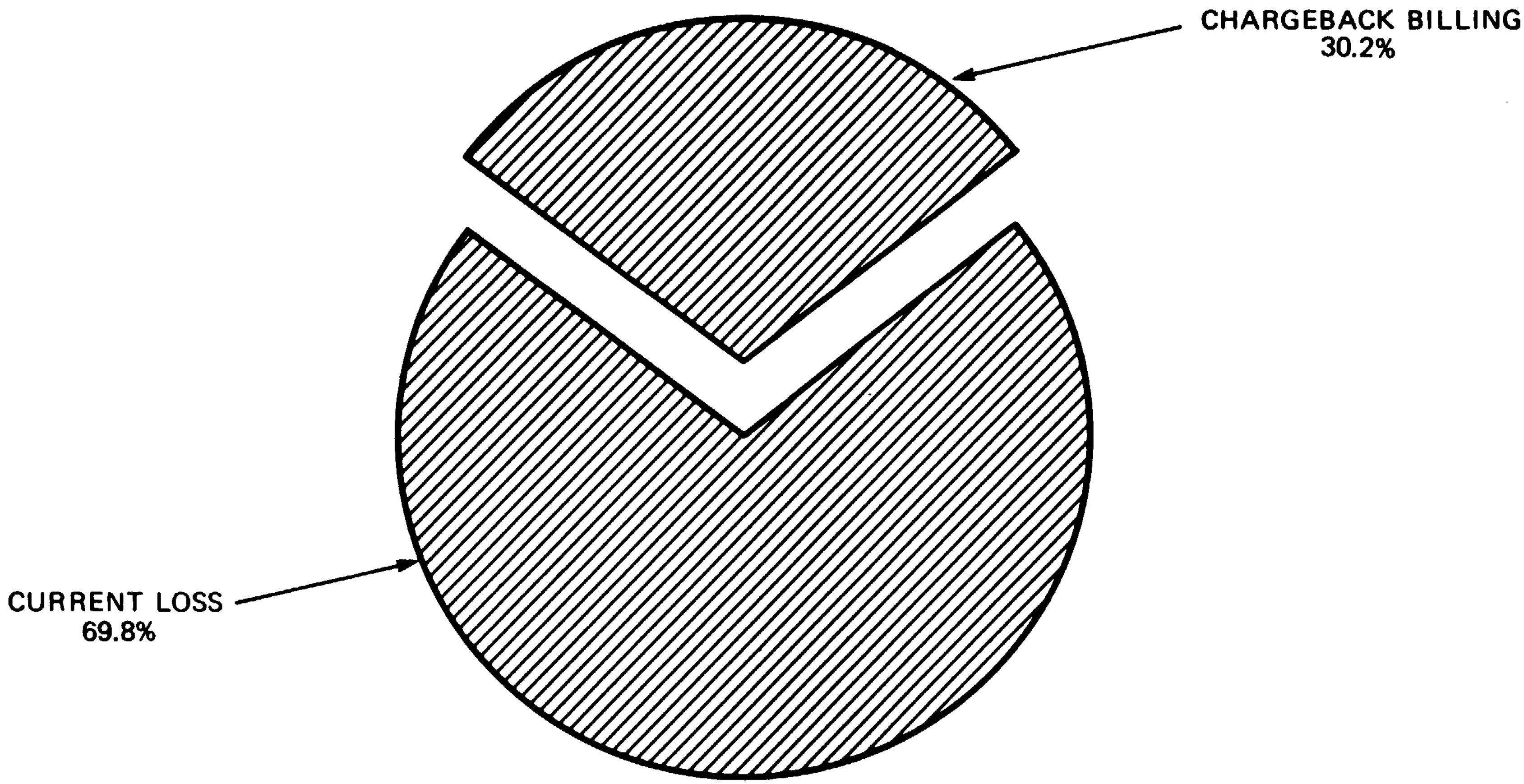
Figure 10

# COST OF FY 84 NASA ACCIDENTS/INCIDENTS/INJURIES

## TOTAL LOSS = $ 14,900,000




* EXCLUDES CONTRACTOR DATA

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Figure 11

# TIME HISTORY OF (OWCP) CHARGEBACK BILLINGS

## COSTS FOR ALL FEDERAL GOVERNMENT AGENCIES AND NASA

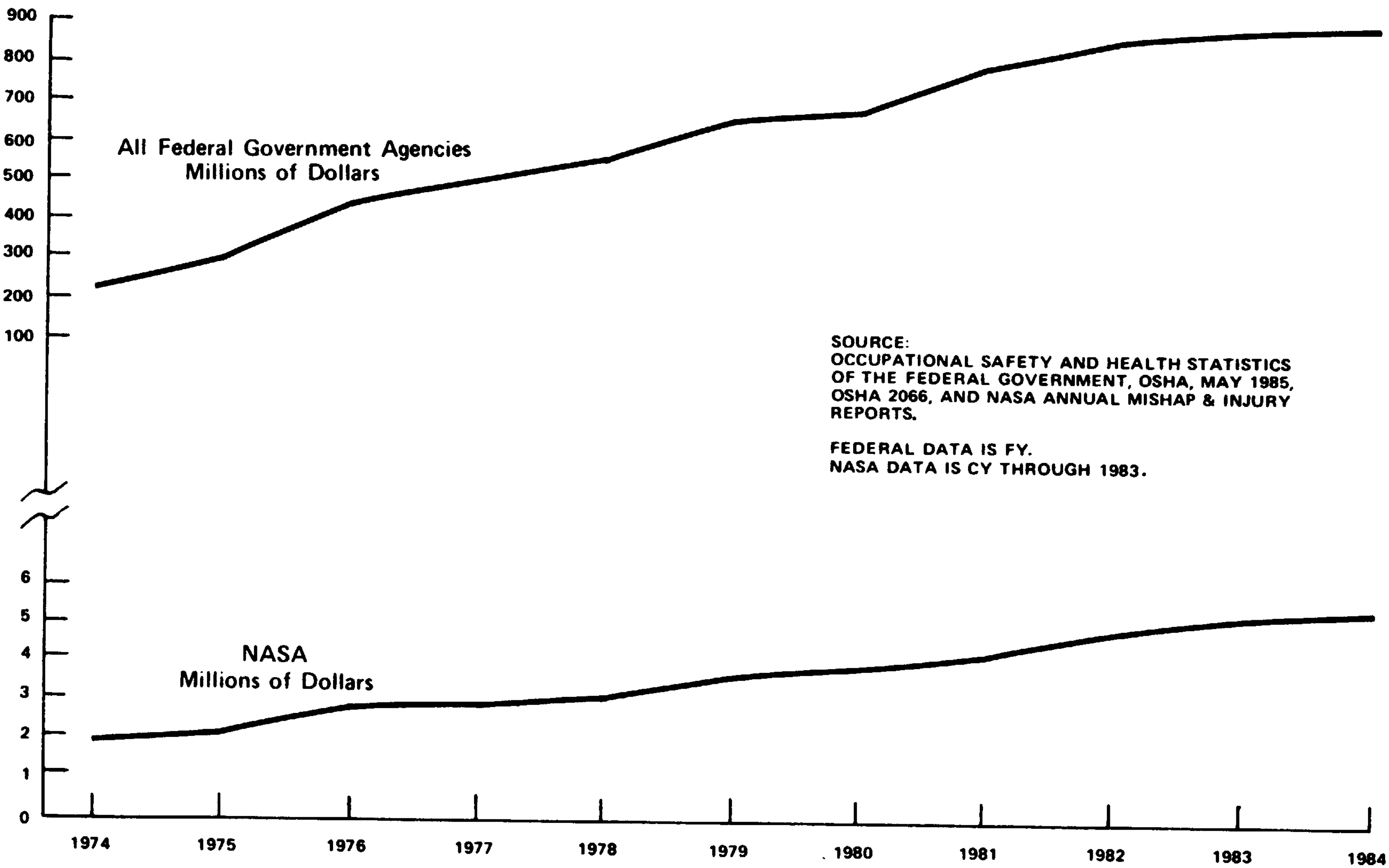


Figure 12

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## MATERIAL LOSSES

Table 3 lists the FY 1984 NASA mishap statistics by center. The material losses* for all NASA are summarized below:

| TYPE OF MISHAP | NUMBER | DOLLAR LOSS |
|---|---|---|
| Aviation | 4 | $ 23,000 |
| Automobile | 22 | 16,938 |
| Fire | 1 | 7,500 |
| Other | 5 | 9,249,490 |
| Total | 32 | 9,296,928 |

Figure 13 illustrates total costs of material losses due to mishaps over the last 11 years. NASA experienced an increase of $8.7 million in mishap costs over last year. The most costly mishaps in 1984 are discussed in a later section of this report.

*Mission and test failures are not included.

TABLE 3. NASA MISHAP DATA BY INSTALLATION -- FY 1984

| | AUTO MISHAP FREQ. RATE | | AIRCRAFT MISHAPS | | FIRE LOSSES | | OTHER MISHAPS | | TOTAL MISHAPS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | GOV | POV | NO. | RATE | NO. | COST($K) | NO. | COST($K) | COST($K) | RATE($K) |
| ARC | 0 | 0 | 3 | 70.70 | 0 | 0 | 2 | 545.40 | 563.39 | 131.20 |
| GSFC | 14.84 | 3.06 | 0 | 0 | 0 | 0 | 0 | 0 | 4.82 | 0.73 |
| HQ | 40.05 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.85 | 0.29 |
| JSC | 1.02 | 4.18 | 0 | 0 | 0 | 0 | 0 | 0 | 9.69 | 1.61 |
| KSC | 0 | 0 | 1 | 103.52 | 0 | 0 | 0 | 0 | 5.72 | 1.21 |
| LaRC | 3.59 | 0 | 0 | 0 | 0 | 0 | 1 | 20.00 | 21.58 | 4.04 |
| LeRC | 2.78 | 0 | 0 | 0 | 0 | 0 | 1 | 10.00 | 14.08 | 2.90 |
| MSFC | 0 | 0 | 0 | 0 | 1 | 7.5 | 1 | 8,611.10 | 8,618.60 | 1.42 |
| NSTL | 1.80 | 0 | 0 | 0 | 0 | 0 | 1 | 63.00 | 63.72 | 242.20 |
| TOTALS | 1.60 | 1.22 | 4 | 19.33 | 1 | 7.5 | 6 | 9,249.50 | 9,296.93 | 223.91 |
| LAST YEAR | 1.81 | 0.16 | 3 | 14.48 | 8 | 6.9 | 6 | 492.25 | 554.04 | 13.08 |

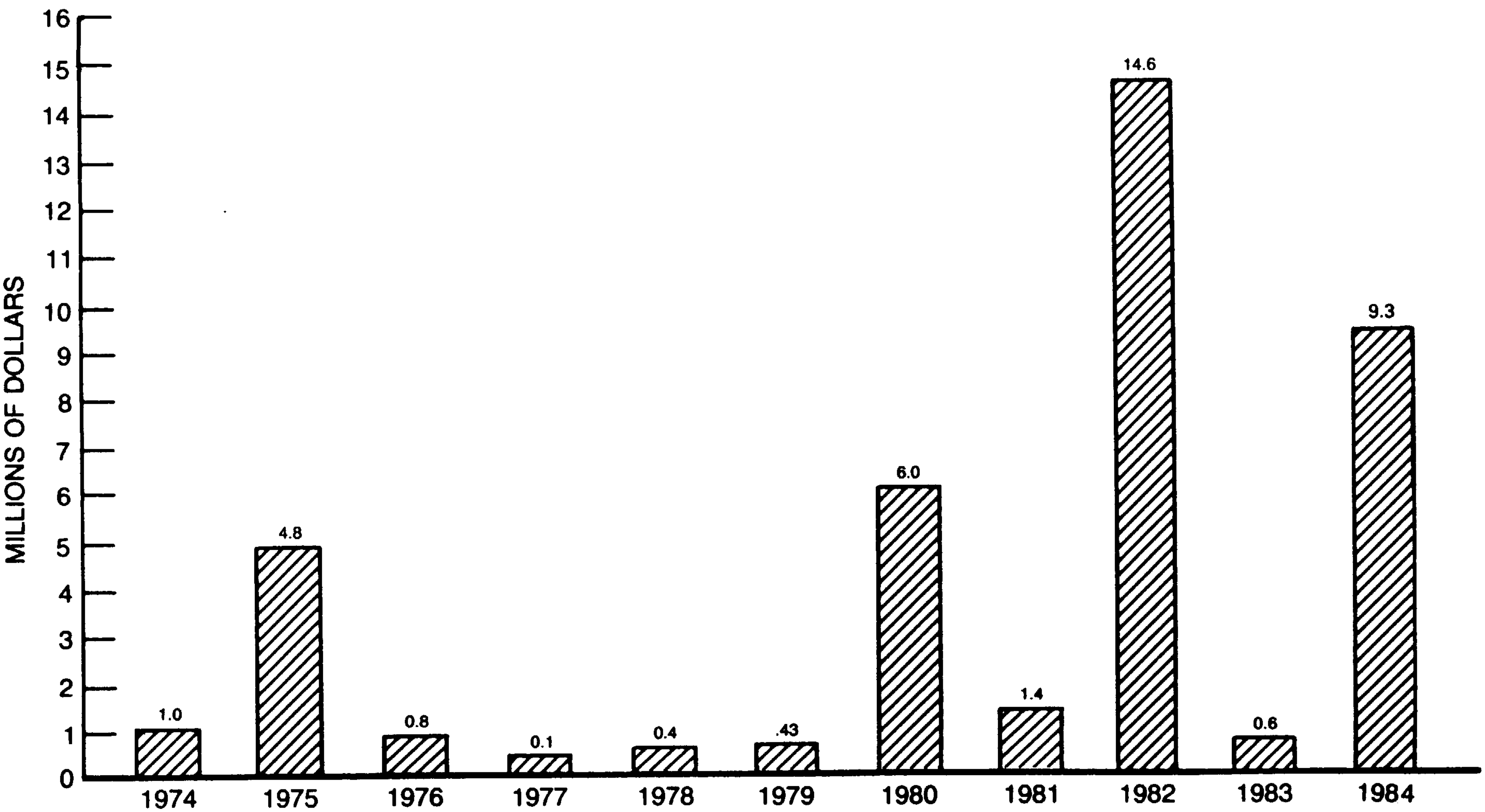
1. Aircraft Mishap Frequency Rate = No. of Mishaps per 100,000 hours flown.

2. Motor Vehicle Mishap Frequency Rate = No. of Mishaps per million miles driven.

3. Total Cost of Mishaps includes repairs/replacements of motor vehicles and damage and tort claims (as on obsolete OSHA Form 102 FF).

4. Mishap Cost Rate = Total cost of Mishaps per million hours worked.

# NASA MATERIAL LOSSES DUE TO MISHAPS*




* INCLUDES AIRCRAFT, VEHICLE, AND FIRE MISHAPS AND LOSSES OF OTHER PROPERTY.
DOES NOT INCLUDE CONTRACTOR LOSSES.
DOES NOT INCLUDE MISSION FAILURES.
DOES NOT INCLUDE TEST OPERATIONS LOSSES.

NASA HQ DS86-395(1)
2-21-86

Figure 13

## NASA AVIATION SAFETY RECORD

NASA experienced no major aircraft accidents in FY 1984. Damage to engines was sustained in several incidents, but no major damage to aircraft and no injuries occurred as a result of these incidents.

NASA's relatively low number of flight hours (approximately 20,475) accounts for the deceptively high mishap frequency rate when compared with the 100,000-flight-hour standard.

Figure 14 shows the cost of aircraft losses over the last 11 years.

## NASA MOTOR VEHICLE SAFETY RECORD

The NASA 1984 government automobile accident frequency rate of 1.60 accidents per million miles driven was the lowest rate recorded in the past 11 years. This rate was significantly lower than the goal of 5.0 accidents per million miles driven that NASA established in 1980. The cost of these accidents was approximately $17,000. Figures 15 and 16 show the frequency rates and costs of automobile accidents for the last 11 years.

## NASA FIRE EXPERIENCE

As shown in Figure 17, the number of fire mishaps at NASA facilities decreased dramatically from 8 in 1983 to 1 in 1984. This single fire occurred at the Marshall Space Flight Center where a welder working with an inadequate shield over a cable tray caused ignition of data cable in the Filament Wound Case Structural Test Facility. The continuing decline in the number of fires is a direct result of the implementation of extensive fire prevention protection measures and an increase in fire safety awareness at all NASA installations.

Figure 18 illustrates the cost of losses due to fires over the last 11 years.

# NASA AIRCRAFT LOSSES

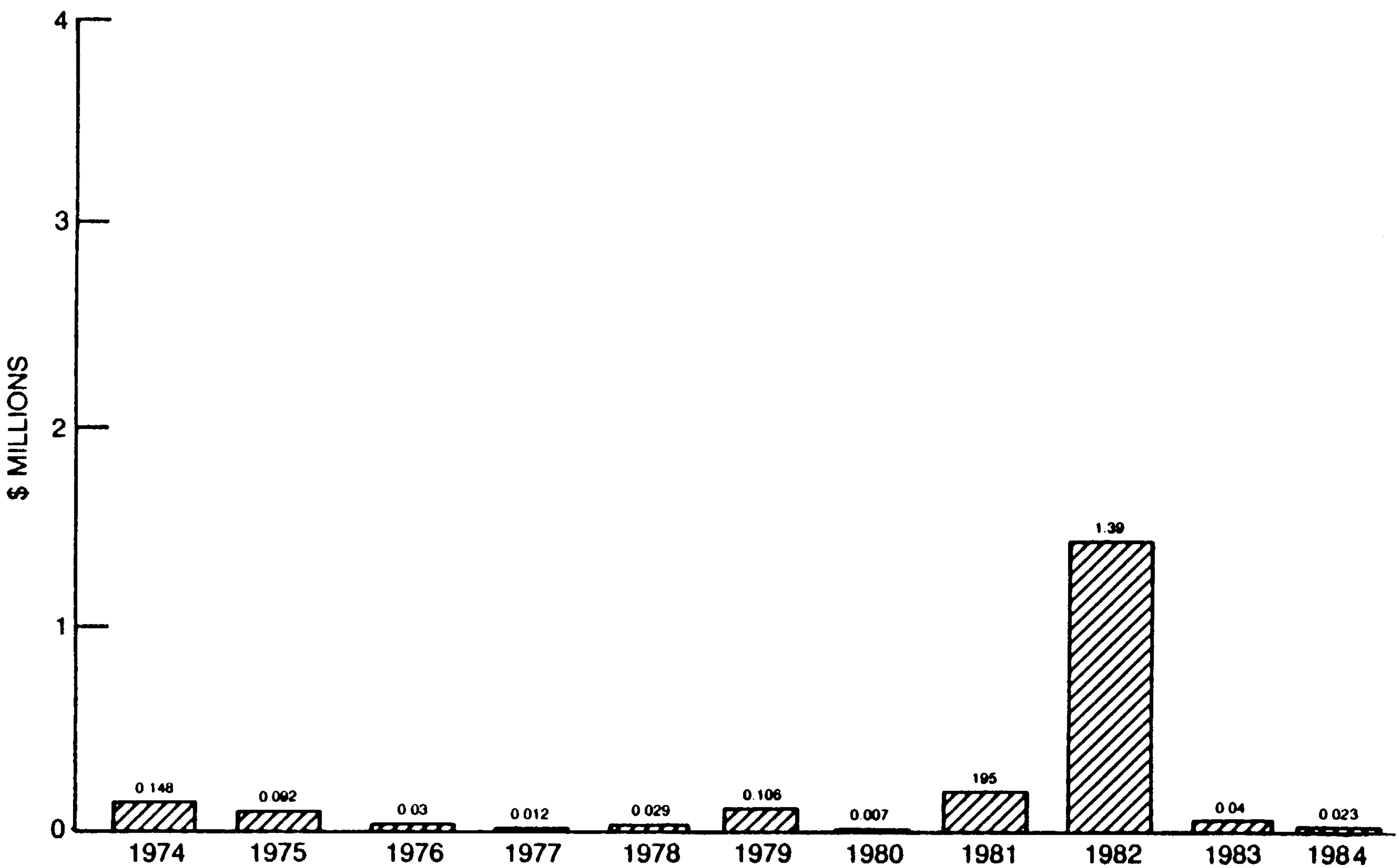



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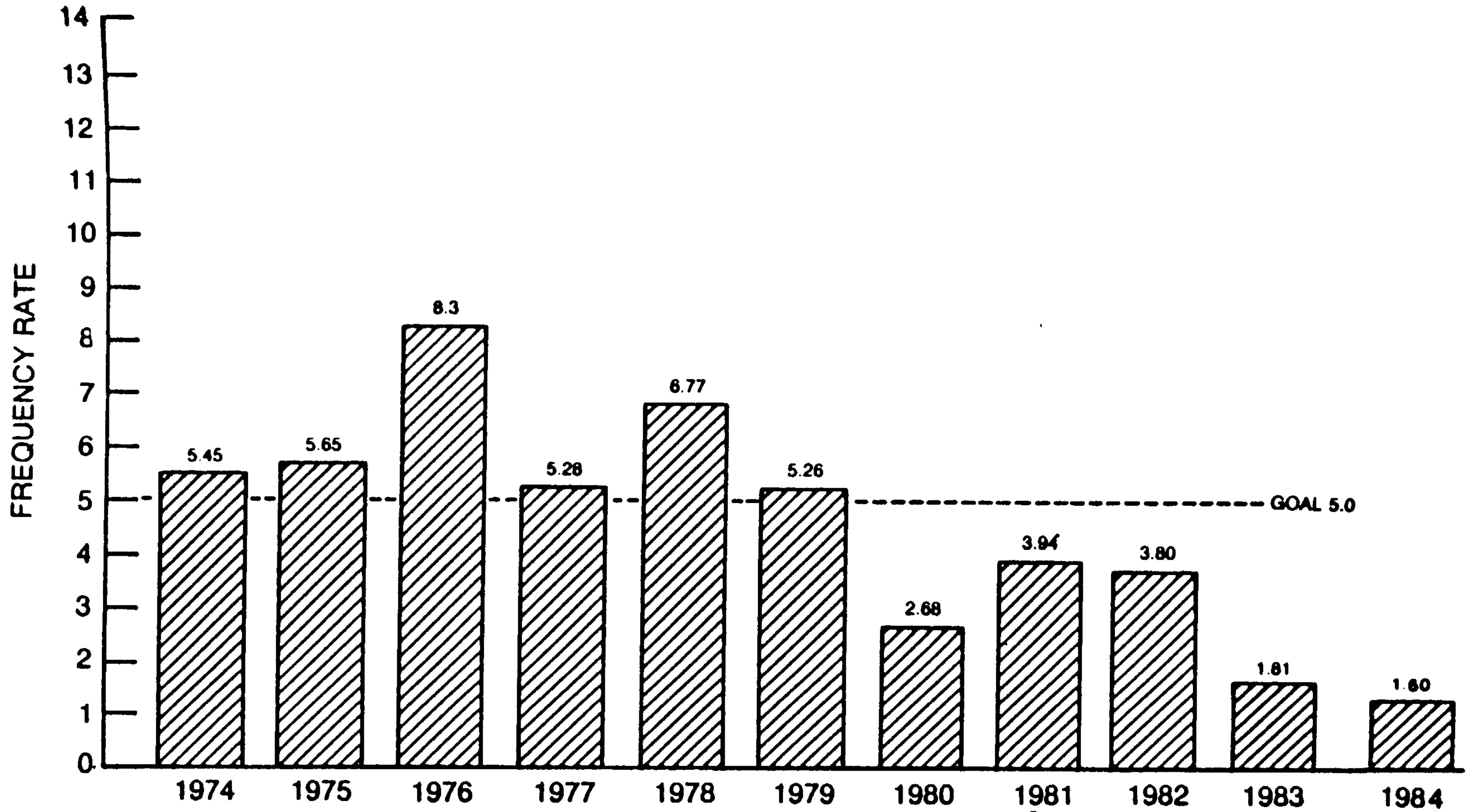
Figure 14

# NASA GOVERNMENT MOTOR VEHICLE ACCIDENTS

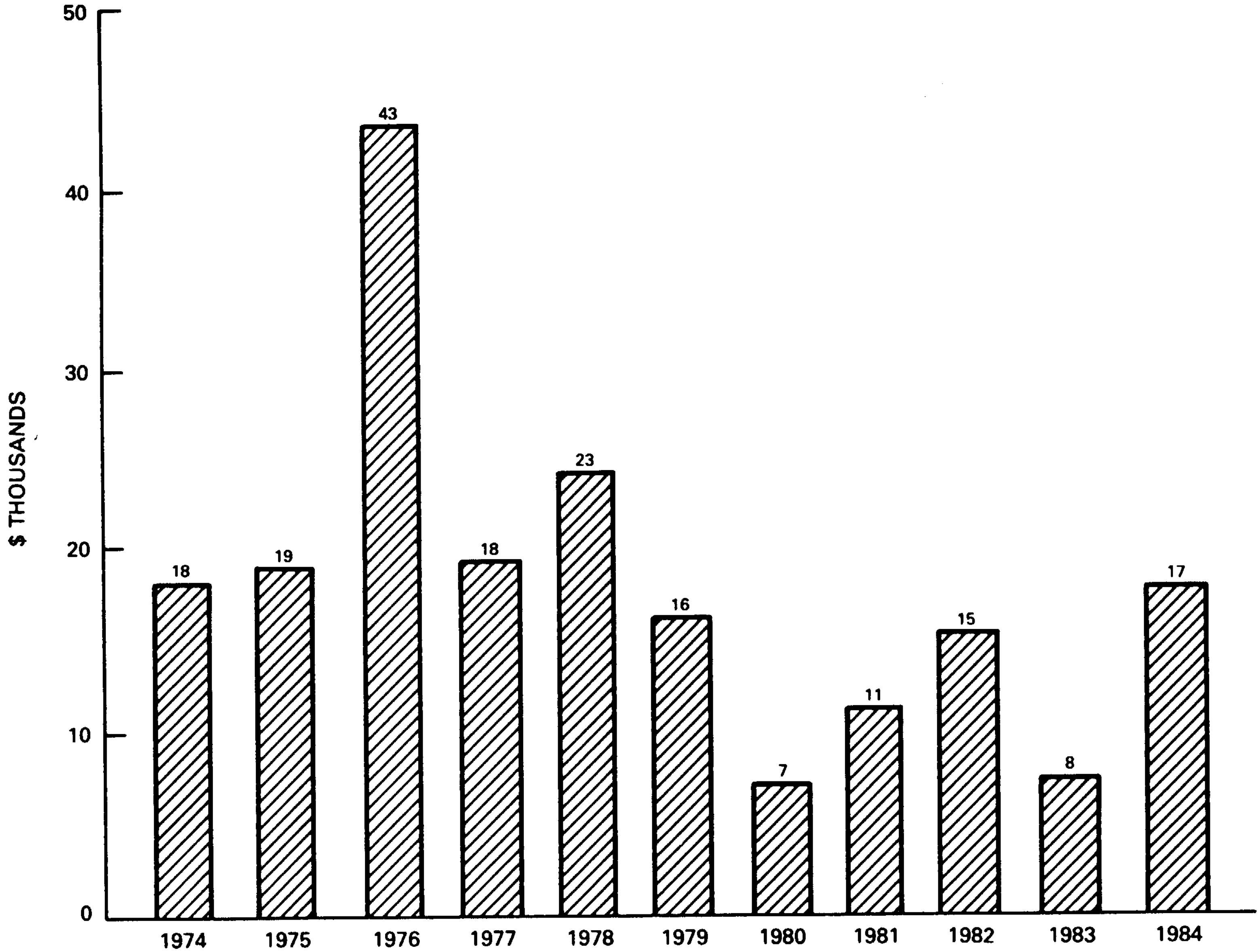



FREQUENCY RATE IS THE NUMBER OF MOTOR VEHICLE ACCIDENTS PER MILLION MILES DRIVEN.

Figure 15

NASA HQ DS83-2429(1)
REV. 5-7-85

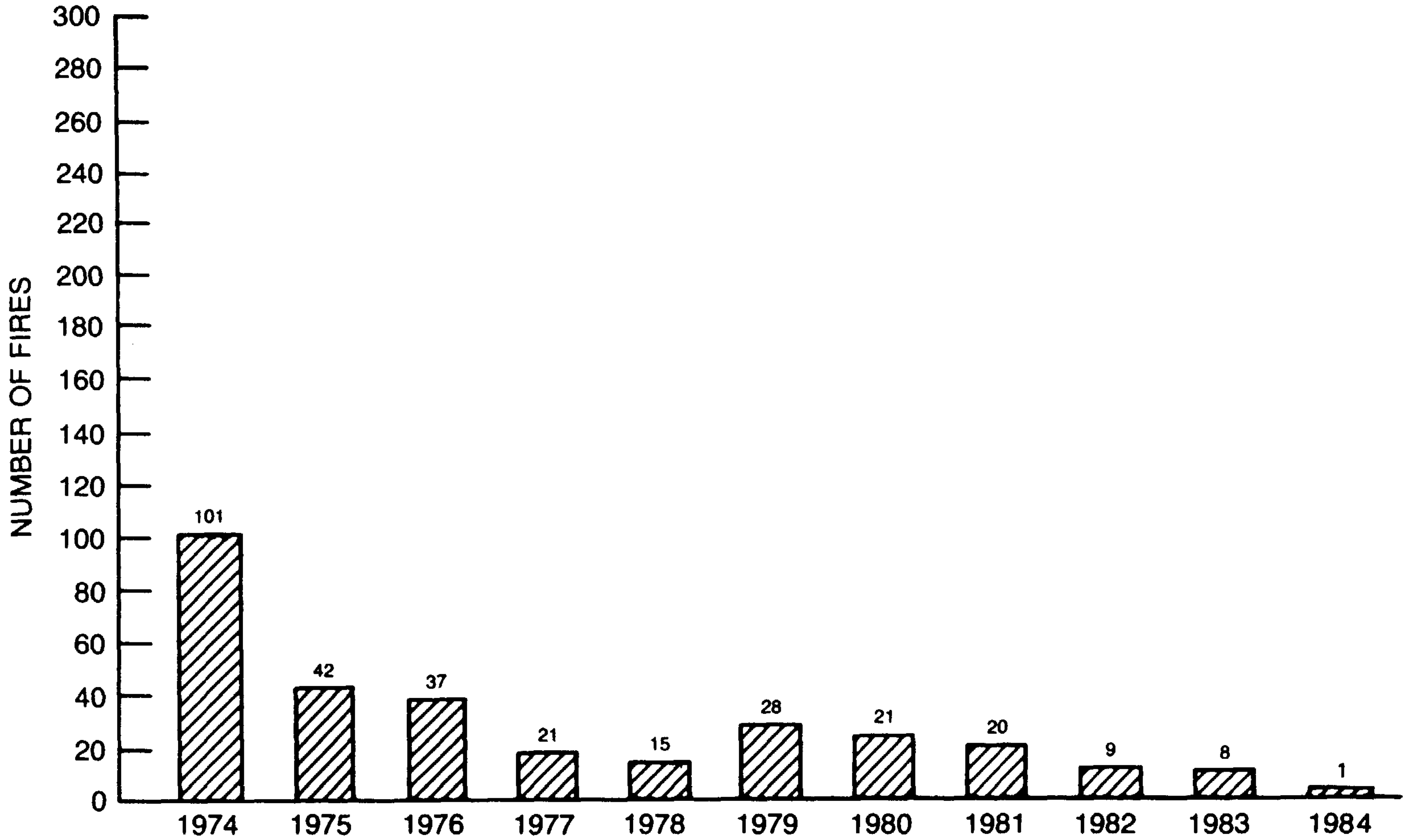
# NASA AUTOMOTIVE LOSSES




NASA HQ DS86-389(1)
2-21-86

Figure 16

# NUMBER OF NASA FIRE MISHAPS

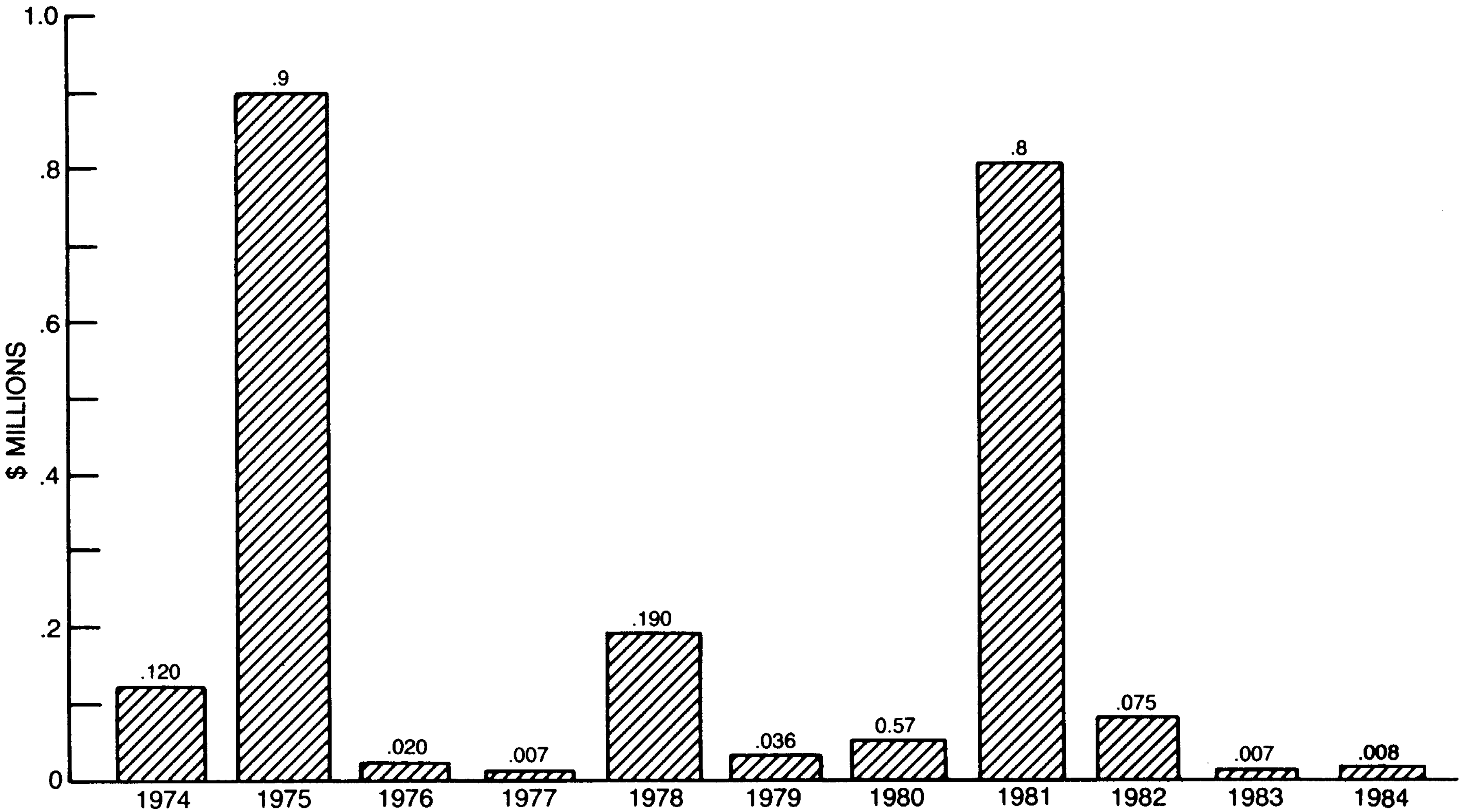



DOES NOT INCLUDE TEST OPERATIONS
DOES NOT INCLUDE MISSION FAILURE

NASA HQ DS86-397(1)
2-21-86

Figure 17

# NASA FIRE LOSSES




DOES NOT INCLUDE MISSION LOSSES OR TEST OPERATIONS LOSSES.

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2-21-86

Figure 18

## NASA MISHAPS IN FY 1984

Definitions

TYPE A MISHAP: A mishap causing death, damage to equipment or property equal to or exceeding $500,000, destruction of an aircraft, or destruction of space hardware. NASA Type A Mishaps are investigated by a board appointed by the appropriate program or institutional Associate Administrator.

TYPE B MISHAP: A mishap resulting in permanent disability to one or more persons, hospitalization of five or more persons, or damage to equipment or property costing from $250,000 to less than $500,000. NASA Type B Mishaps are investigated by a board appointed by the Director of the field installation.

TYPE C MISHAP: A mishap resulting in damage to equipment or property costing from $25,000 to less than $250,000, or causing occupational injury or illness which results in a lost work day (or days) or restricted duty. NASA Type C mishaps are analyzed locally by committees or individuals unless circumstances dictate a more formal investigation.

MISSION FAILURE: Any event of such a serious nature that it prevents accomplishment of the majority of the primary mission objectives. Mission failures are usually investigated by a formal board.

TEST FAILURE: An unexpected event which jeopardizes a test, prevents accomplishment of major test objectives, causes premature test termination, or destroys test hardware, test stands, or monitoring equipment. Test failures generally result in monetary losses of $25,000 or more, or have significant impact on the program, or political or public visibility. A program may call for the use of low cost models and other test items which are specifically designed to meet certain test conditions where damage is likely to occur. When these are damaged or destroyed, circumstances will determine if a test failure did in fact occur or if the damage was a likely result of the test. Test failures are investigated or analyzed as determined by program personnel. (When a part of assembly fails without causing a significant monetary loss or program delay, a test failure according to this definition has not occurred.)

INCIDENT: An unplanned occurrence which results in injuries to personnel of less severity than that in a Type C Mishap or which results in property loss or damage in excess of $500 but less than $25,000. A close call that could generate wide-spread interest may be included in this category.

POTENTIAL MISHAP: An unplanned occurrence in which there is no injury, property damage, or interruption of work, but which has the potential for any of these.

COSTS: Direct costs of repair, retest, delays, replacement, or recovery of NASA materials, including hours, material, and contract costs but excluding indirect costs of cleanup, investigation, injury, and normal operational delay.

NASA MISHAP: Any unplanned event or anomaly that may be classified as a Type A, B, or C mishap, incident, or mission or test failure involving NASA personnel, equipment, or facilities.

NASA CONTRACTOR MISHAP: Any unplanned event or anomaly that may be classified as a Type A, B, or C mishap, incident, or mission or test failure that involves NASA contractor personnel or equipment in support of operations at NASA. These are normally investigated by the contractor and reviewed by NASA, or depending upon the circumstances, investigated separately by NASA when directed by a NASA official with board appointment authority.

The significant mishaps shown in Tables 4 and 5 are those reported by the NASA field installations and contractors as having significance beyond the minor dollar losses or injury incident categories. These mishaps provide "lessons learned" for all NASA accident prevention programs.

Figure 19 presents an 11-year overview of NASA Type A, Type B, and the recently defined Type C mishaps. These categories are defined in terms of dollar amount of loss, and the limits for each category have been escalated over the years, largely due to inflation.

Figure 20 illustrates the relationship among chargeback billing costs, lost wages, and total NASA monetary losses due to mishaps over the last 11 years.

## TABLE 4. FATAL ACCIDENTS

| | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NASA EMPLOYEES | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 4 | 1 | 0 | 0 |
| CONTRACTOR EMPLOYEES | 1 | 1 | 1 | 3 | 1 | 0 | 0 | 5 | 1 | 0 | 1 |
| PUBLIC EMPLOYEES | 2 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MILITARY EMPLOYEES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTALS | 3 | 3 | 1 | 6 | 1 | 1 | 0 | 9 | 2 | 0 | 1 |

## TABLE 5. TYPE A/B/C MISHAPS BY FIELD INSTALLATION

| | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ARC/DFRF | 0/2 | 0/1 | 1/1 | 0/0 | 1/3 | 0/6 | 0/0 | 2/3 | 2/3 | 1/0/2 | 1/0/5 |
| GSFC/WFF | 1/2 | 0/2 | 0/2 | 1/4 | 0/0 | 0/1 | 1/1 | 0/3 | 1/0 | 1/0/1 | 0/0/0 |
| HQ | --- | 2/1 | 0/0 | 0/1 | 0/0 | 0/0 | 0/0 | 0/0 | 0/0 | 0/0/0 | 0/0/0 |
| JSC | 0/5 | 0/1 | 0/0 | 2/1 | 0/1 | 0/2 | 1/0 | 2/0 | 0/1 | 0/0/0 | 0/0/0 |
| KSC | 2/1 | 4/1 | 0/0 | 2/1 | 0/0 | 0/0 | 0/1 | 5/3 | 1/2 | 0/0/1 | 0/0/0 |
| LaRC | 0/1 | 0/2 | 1/1 | 0/0 | 0/1 | 0/0 | 0/0 | 3/4 | 1/0 | 0/0/0 | 0/0/0 |
| LeRC | 0/0 | 0/1 | 0/1 | 0/0 | 0/0 | 1/1 | 0/0 | 0/2 | 0/0 | 0/0/2 | 0/0/0 |
| MSFC | 1/0 | 1/1 | 0/0 | 1/0 | 0/0 | 0/0 | 2/1 | 1/0 | 4/2 | 0/1/2 | 2/0/0 |
| NSTL | 0/0 | 0/1 | 0/1 | 1/0 | 0/0 | 0/0 | 0/0 | 1/1 | 1/0 | 0/0/0 | 0/0/0 |

1. Type "C" was first defined in 1983 and replaced the previously defined Type "B" mishap.

2. Types "B" and "C" individual injuries are not shown in this table. See Table 1.

3. Mission and test failures are not included in these statistics.

# NASA TYPE 'A', 'B', AND 'C' MISHAPS

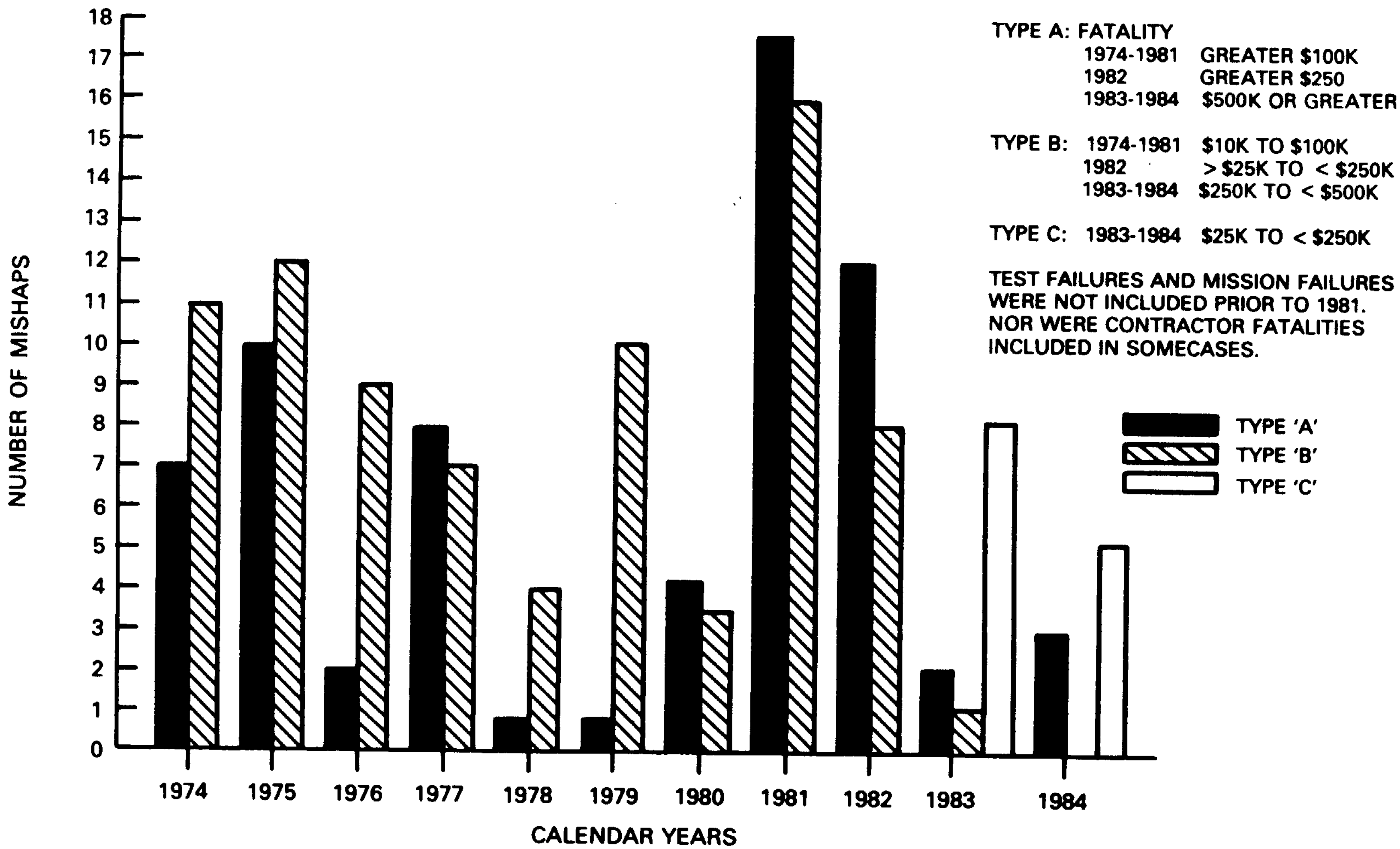
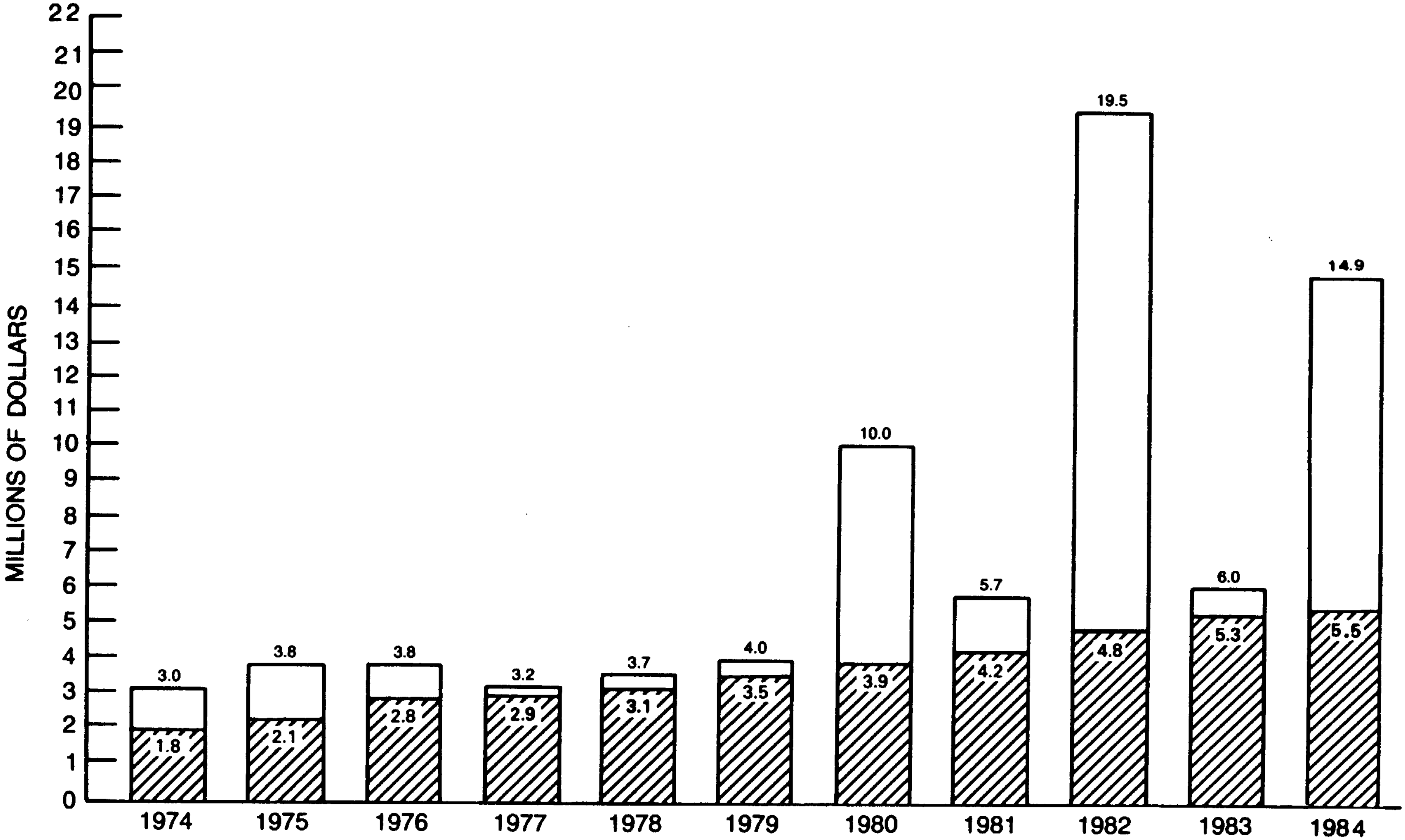



Figure 19

NASA HQ DS86-403(1)
REV. 3-20-86

# TOTAL COSTS TO NASA DUE TO MISHAPS*




* DOES NOT INCLUDE CONTRACTOR LOSSES.
* DOES NOT INCLUDE MISSION FAILURES.
* DOES NOT INCLUDE TEST OPERATIONS LOSSES.


NASA HQ DS86-394(1)
REV. 3-20-86

Figure 20

## MAJOR MISHAPS IN 1984

The following are selected summaries of major mishaps which occurred in 1984.

### NATIONAL GEOTECHNICAL CENTRIFUGE

On January 25, 1984, the National Geotechnical Centrifuge, located at the NASA Ames Research Center, experienced a catastrophic failure of the 18,000-horsepower drive motor thrust bearing. The failure permitted the 100-ton drive motor armature to drop approximately one inch, bringing the centrifuge to an abrupt halt. As a result, the drive motor and the drive train components suffered extensive electrical and mechanical damage. There were no injuries to personnel. The estimated cost of repairs was $550,000, and the time required to repair the centrifuge was estimated at one year.

The National Geotechnical Centrifuge is a modification of the Ames 50g Manned Flight Simulator. In 1978, the Ames Research Center (ARC) and the National Science Foundation (NSF) signed an agreement to modify the simulator into a geomechanics and research facility. Under the terms of the agreement, ARC provided the engineering and construction management to make the modifications, and NSF provided the funding. The University of California-Davis (UCD) was designated by the NSF to operate the facility. During operation, ARC was to provide some minimal technical support and to be responsible for assuring the safe operation and security of the facility.

The failure of the drive motor thrust bearing has been attributed to a lubrication scheme that prevented an adequate supply of grease from reaching the inner portions of the bearing. This design flow had existed since the motor was initially installed. Prior to the start of the modification, the motor had been operated for only ten hours. It was estimated that the total running time of the motor at the time of the accident had been 20 hours. All of the damage incurred was a direct result of the bearing failure. The "lessons learned" from this accident are as follows:

1. When modifying an existing research facility, be sure that the configuration of the facility is defined and verified. A complete review of the existing facility design should be held early in the modification planning process.

2. A Center should never take on a project when it has no vested interest in its success. The lack of such interest may result in the project's becoming a low priority with little timely technical support or management attention.

3. Emphasis must be placed on the importance of adhering to operational procedures and keeping accurate operational and maintenance logs. The low priority given this project may have contributed to this laxness.

4. Abnormal operating conditions should be completely investigated before proceeding with further testing. Care should also be taken to evaluate all data output, not only obvious anomalies, but data comparisons as well. Had this been done on the centrifuge, the deteriorating condition of the bearing would have been discovered.

5. All facility drawings should be kept in an up-to-date, controlled condition.

6. The design of automatic shut-down systems and their associated warning annunciators should be subjected to review prior to initial operation.

## SRM CASTING PIT EXPLOSION

On March 2, 1984, while a solid rocket motor forward segment was being cast at Morton Thiokol, Inc. for the Space Shuttle solid rocket boosters, the propellant, an ammonium perchlorate based composite using polybutadiene-acrylic acid-acrylonitrile (PBAN) as a binder, was ignited in the casting building. The subsequent blast and fire in the casting pit and fire in an adjacent pit resulted in approximately $12 million damage to government and contractor facilities and property.

The most probable cause of ignition was friction-induced sparking caused by the rolling of the dump station wheels across spilled propellant on the dump station transfer rails. The sparks fell into the loaded casting hoppers immediately below the dump station and ignited the exposed propellant in them. The ensuing flames and splattering propellant caused the fire to spread up to the dump station and down into the rocket motor segment being filled in the casting pit. The exposed uncured propellant at the top of the rocket motor burned for a short period of time after which the hollow core casting mandrel was ejected, and a violent deflagration occurred, destroying the casting house and speading burning propellant to a rocket motor in an adjacent pit and throughout the area.

The Mishap Investigation Board recommended that the quantity-distance siting criteria for uncured composite propellants be reviewed in light of the blast and potential for incendiary hazard demonstrated by this mishap. To provide greater protection for existing operations currently sited at Class 1.3 distances, the board recommended that for all critical facilities, e.g., mix houses, personnel shelters, and oxidizer grinding buildings, line-of-sight barricades be constructed, roofs be hardened to withstand burn-through from airborne burning propellant chunks, adjacent casting pit doors be thermally hardened, and emergency bunkers and shelters be modified to withstand more severe overpressures and to provide emergency breathing capability for personnel.

## CONTRACTOR FATALITY

A contractor employee died at the Marshall Space Flight Center's Michoud Assembly Facility on August 10, 1984. The employee failed to adhere to the established confined space procedure in which he had been trained. The confined space procedure was reviewed and found to be adequate. Lessons learned applicable to the agency included a re-emphasis on confined space entry with the following recommendations:

1. Survey existing facilities. Identify and placard areas that may pose a confined space entry hazard but may not be readily recognizable as confined spaces.

2. Orientation materials for new employees should include reference to confined spaces to alert them, especially those who would not normally come into contact with confined spaces, as to what constitutes a confined space. New employees should also be made aware of the hazards and procedures associated with confined space entry.

3. Designated personnel in all areas of plant or facilities which have potentially hazardous spaces or operations should be trained in first aid and rescue.

## TEST FAILURES AND MISSION FAILURES

Although test operational failures and mission failures are not included in Figure 13, the following summaries are presented in order to transmit lessons learned.

## SPACE SHUTTLE MAIN ENGINE TEST FAILURE

On February 14, 1984, a test was begun on an improved fuel turbopump blade design for the Space Shuttle Main Engine (SSME). The test, conducted at the National Space Technology Laboratories on engine number 0108, was planned for a duration of 890 seconds, 820 seconds at full power. The test proceeded normally until, at approximately 611 seconds, it was terminated by the automatic shutdown sequence because of excessively high temperature. Before the shutdown was completed, however, the speed of the High Pressure Fuel Turbopump (HPFTP) decreased rapidly, and the inlet volute ruptured. The ensuing fire caused severe internal damage to the engine but only minor external damage. The total cost to NASA was approximately $7 million.

Based on an inspection of the failed hardware and a review of the test data, the Investigation Board determined that the most probable cause of the engine failure was the buckling of the coolant liner of the HPFTP and the subsequent collapse of the turnaround duct as the coolant liner pressed against and deformed the turnaround duct.

The most likely causes of the coolant liner collapse were the blockage of the coolant liner discharge orifices by ice resulting from combustion product leakage into the coolant cavity and the further pressurization of the coolant cavity by leakage of liquid hydrogen through the HPFTP liftoff seal stack. The resulting rise in pressure in the coolant cavity caused the coolant liner to deform and press on the turbine hot gas turnaround duct until that duct collapsed, choking the turbine discharge flow. The choked flow resulted in a rapid decrease in the HPFTP speed and the rupture of the pump inlet volute.

## ATLAS/CENTAUR 62 MISSION FAILURE

Atlas/Centaur 62 (AC-62), carrying the seventh Atlas/Centaur Intelsat V payload, was launched from the Kennedy Space Center on June 9, 1984. The Atlas booster and sustainer phases of flight were normal. During the Atlas/Centaur separation sequence, however, a significant structural disturbance was noted on both structural and vehicle attitude measurements, and a significant $LO_2$ leak developed in the Centaur tank on the aft bulkhead. The vehicle ultimately tumbled out of control, and the mission was lost, costing NASA approximately $100 million.

The Mission Failure Review Board determined that a 4-inch crack had developed in the $LO_2$ tank aft bulkhead at station 415. The crack occurred at the time of shaped charge firing at Atlas/Centaur stage separation. The crack was most likely the result of high stress loads caused by augmentation of the shaped charge firing due to the presence of solid oxygen in the shaped charge area. It is believed that a minor oxidizer tank leak, not detectable prior to launch, allowed solid oxygen to collect in the tank/interstage adapter (ISA) station 412 cavity. At ISA shaped charge firing, the fuel-rich shaped charge combustion products reacted with the solid oxygen and generated an additional release of energy, increasing the tank gore tensile stresses and resulting in $LO_2$ tank failure.

In support of the failure investigation, a test program was instituted. This program consisted of component tests as well as a full-scale Centaur tank test.