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REPORT BY THE U.S.

# General Accounting Office

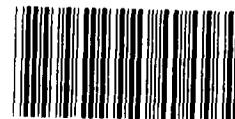
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## Better Equipment Maintenance And Personnel Training Needed To Improve Firefighting Capability On Navy Ships

Fires on ships reduce mission performance and are tragic and costly. They continue to be a problem, particularly on aircraft carriers.

Firefighting equipment on aircraft carriers is poorly maintained in many instances and, therefore, does not function properly. A contributing factor is the lack of personnel trained to maintain new firefighting equipment.

Also, current shore-based training programs for firefighters do not meet training demands, and formal selection procedures do not exist for filling training slots.



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*report*

PSAD-79-6  
JANUARY 16, 1979





UNITED STATES GENERAL ACCOUNTING OFFICE

WASHINGTON, D.C. 20548

PROCUREMENT AND SYSTEMS  
ACQUISITION DIVISION

B-163058

The Honorable W. Graham Claytor, Jr.  
The Secretary of the Navy *AFC00001*

Dear Mr. Secretary:

This report summarizes our study of the firefighting situation on Navy ships and suggests ways to improve it. We have informally discussed our findings with headquarters officials from your Department.

This report contains recommendations to you on pages 7 and 10. As you know, section 236 of the Legislative Reorganization Act of 1970 requires the head of a Federal agency to submit a written statement on actions taken on our recommendations to the House Committee on Government Operations and the Senate Committee on Governmental Affairs not later than 60 days after the date of the report and to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

We are sending copies of this report to the Director, Office of Management and Budget and the Chairmen of the House and Senate Committees on Appropriations and Armed Services, House Committee on Government Operations, and Senate Committee on Governmental Affairs.

We wish to acknowledge the courtesy and cooperation your staff extended to our representatives during the study.

Sincerely yours,

A handwritten signature in cursive script that reads "J. H. Stolarow".

J. H. Stolarow  
Director

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GENERAL ACCOUNTING OFFICE  
REPORT TO THE SECRETARY  
OF THE NAVY

BETTER EQUIPMENT MAINTENANCE  
AND PERSONNEL TRAINING NEEDED  
TO IMPROVE FIREFIGHTING  
CAPABILITY ON NAVY SHIPS

D I G E S T

Fires on U.S. Navy ships are trouble during peacetime and potentially disastrous during wartime. In peacetime, fires are tragic in terms of personnel injuries and deaths and costly in terms of damage to the ships. Even more important, during wartime, is the loss of combat capability resulting from the destruction of a ship's sophisticated weapon systems.

According to initial Navy estimates, fire damages since 1969 total \$26 million on aircraft carriers and \$135 million on other surface ships. The subsequent actual cost of repairing the damage, however, is usually three to four times greater because the initial Navy estimates are not updated to reflect actual costs. (See ch. 1.)

Effective firefighting is a combination of good equipment and trained personnel. Deficiencies currently exist in both of these areas.

BETTER MAINTENANCE OF  
EQUIPMENT NEEDED

Firefighting equipment on aircraft carriers is poorly maintained in many instances and, therefore, does not function properly. For example, 4 out of 13 types of firefighting equipment tested by the Navy on aircraft carriers between May 1975 and July 1977 failed over 28 percent of the time. Although the overall failure rate is improving, failure rates on some ships are still very high. According to Navy inspection reports, the reduced system readiness was a direct result of improper or incomplete maintenance.

Another contributing factor is the lack of personnel trained in maintenance. Personnel frequently are not trained to maintain new

firefighting equipment on ships. Because sufficiently qualified personnel are not available, maintenance does not get done and, as a result, equipment does not operate properly.

GAO recommends that the Secretary of the Navy take appropriate action to ensure that

- (1) --firefighting equipment on aircraft carriers is adequately maintained and in good operating condition at all times and
- (2) --personnel are adequately trained to maintain new firefighting systems. (See ch. 2.)

#### BETTER TRAINING FOR FIREFIGHTERS NEEDED

Fires on ships must be extinguished quickly to reduce the potential loss of men and equipment and to maintain combat effectiveness. Firefighting crews should be skilled in extinguishing such fires. The fleet's shore-based training programs are one of the Navy's basic means of improving firefighting skills.

GAO identified several weaknesses in the fleet's shore-based training programs which have potentially serious implications on firefighting capability:

- Firefighting schools cannot meet the fleet's training demands.
- No formal selection procedures exist for filling training slots.
- Quality of training may be declining.

GAO recommends that the Secretary of the Navy take appropriate action to ensure that:

- (3) --Fleet procedures for selecting personnel to attend firefighting training courses are improved so that personnel assigned firefighting duties on ships will get priority for attending advanced training courses.
- (4) --All personnel assigned to firefighting teams on ships complete one of the advanced training courses as soon as possible.

5) --Firefighting training schools have enough training slots to meet the fleet's essential training requirements. (See ch. 3.)

AGENCY COMMENTS

GAO obtained informal comments concerning this report from various Navy officials. Regarding the declining quality of training, they said that firefighting training courses had recently been revised and an overall evaluation of these new courses indicates that they provide realistic training for fleet personnel. Other comments are included in the body of the report.



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ABBREVIATIONS

FFAT	Fire Fighting Assistance Team
GAO	General Accounting Office



## CHAPTER 1

### INTRODUCTION

Fires on U.S. Navy ships are trouble during peacetime and potentially disasterous during wartime. In peacetime, fires are tragic in terms of personnel injuries and deaths and costly in terms of damage to the ships. Even more important, during wartime, is the loss of combat capability resulting from the destruction of a ship's sophisticated weapon systems.

### SHIPBOARD FIRE LOSSES

There were 1,346 reported fires on ships from January 1969 to August 1977. These fires had an estimated damage cost of over \$169 million. Sixty-six of these fires each had an estimated damage cost of over \$100,000 and accounted for 96 percent of the total damage cost as follows.

	<u>Number of fires</u>	<u>Estimated damage cost</u>
Aircraft carriers	17	\$ 25,689,000
Other surface ships	47	135,334,000
Submarines	<u>2</u>	<u>1,810,000</u>
Total	<u>66</u>	<u>\$162,833,000</u>

The actual cost of repairing the damage, however, is usually three to four times greater because the initial Navy estimates are not updated to reflect actual costs.

Some of the largest fires in terms of dollar losses, deaths, and injuries have occurred on aircraft carriers. These ships carry hundreds of explosive and flammable items, multimillion dollar aircraft, computers, electronics, and 4,000 to 5,000 personnel. Since 1969 aircraft carriers in the fleet have experienced 17 major fires. Initial Navy estimates of the damage caused by these 17 aircraft carrier fires totaled about \$26 million. (See app. I.)

Fires on ships have also resulted in numerous deaths. For example, a fire on the U.S.S. Enterprise in 1969 resulted in 27 fatalities. Two other earlier aircraft carrier fires during the mid-1960s resulted in the loss of 177 lives.

Naval reports show the fire situation continues to be a problem although efforts by the Navy to improve fire-fighting on ships have been going on for over a decade. For

example, ships today carry hundreds of chemical compounds that exceed the explosive potential of gunpowder. These hazardous materials include an extremely broad range of solvents, lubricants, paints, and high energy fuels. When a fire does occur, these materials provide an abundant source of fuel. The use of aluminum and other lightweight materials in ship superstructures and in the new high performance ships also makes them extremely vulnerable. Aluminum has several undesirable characteristics in a fire situation. At 700 degrees Fahrenheit, it loses nearly all of its strength; and at 1,200 degrees, it will melt. Some other materials currently used in ships are not fire resistant, or they produce smoke or toxic fumes when exposed to fire. In addition, today's ships are being designed to require fewer people, which in turn reduces the number of people to detect fires on the ship.

#### NAVY EFFORTS TO REDUCE FIRES

As a result of the fires on the U.S.S. Oriskany and U.S.S. Forrestal in the mid-1960s, the Chief of Naval Operations formed a study group called the Panel to Review Safety in Carrier Operations. It was to determine the causes of fires, to make recommendations for prevention, and to determine methods of combating fires aboard carriers. As a result of the fire on the carrier U.S.S. Enterprise in 1969, the Chief of Naval Material formed an additional study group within the Naval Air Systems Command called the Carrier Aircraft Support Study group.

Numerous problem areas were identified by the two study groups, which made 87 recommendations. Since the early 1970s, the Navy has been studying these recommendations, and many ship alterations and research and development programs have resulted. Fires continue to be a problem, however; and the Navy still needs to improve fire protection.

In 1973 a special effort was made to centralize the fragmented activities of shipboard fire protection and damage control in one group. This group, called the Fire Protection and Damage Control Action group, consisted of permanent members from activities such as the Office of the Chief of Naval Operations, Board of Inspections and Survey, the Fleet Commands, Naval Safety Center, Naval Training Command, Office of Naval Research, Navy Research Laboratory, and others.

This group divided the problem areas identified by the previous study groups into numerous program areas. Most of these program areas were further divided into subprograms

which corresponded to recommendations made by the two previous study groups. The action group identifies, monitors, and reports the progress of the various programs.

- - - - -

Effective firefighting requires trained personnel and good equipment. Our review looked into both the human and hardware aspects of firefighting. Chapters 2 and 3 discuss the equipment and training aspects of the problem.

## CHAPTER 2

### BETTER MAINTENANCE OF

#### FIREFIGHTING EQUIPMENT NEEDED

Firefighting equipment on aircraft carriers is, in many cases, not working properly because it is poorly maintained. An effective firefighting capability requires well maintained equipment. The problem of equipment failure has been recognized by the Navy for many years, but failures continue to plague the fleet.

#### FIREFIGHTING EQUIPMENT FAILURE RATES

Inspections of firefighting equipment on aircraft carriers during the period from November 1972 through November 1974 showed failure rates ranging from 21 to 60 percent. The inspections were made by the Navy's Fire Fighting Assistance Team (FFAT), which was created in September 1972 to inspect firefighting equipment on aircraft carriers. The team was composed of technical experts from the Naval Material Command, Naval Ship Engineering Center, Naval Sea Systems Command, Naval Research Laboratory, and other activities. It conducts reviews of major aircraft carrier firefighting systems ranging from foam storage tanks to high capacity fog foam stations.

During the period November 1972 through November 1974, the team made 32 inspections of aircraft carriers. Its report covering this period was presented to the Fire Protection and Damage Control Action group (see p. 2) in December 1974. It showed firefighting equipment failure rates ranging from 21 to 60 percent as shown below.

Firefighting systems

FFAT summary  
11/72 to 11/74

High capacity fog foam FP-1000 proportioners (notes a, b, and c)	608
Machinery space FP-180 proportioners (notes b and c)	29
Portable FP-180 proportioners (notes b and c)	21
Aqueous film forming foam storage tank	27
Washdown systems	50
Washdown system's flush deck nozzles	29

a/The FFAT summary defines a failure as not achieving foam concentrations of 3.5 percent or higher. The correct concentration is 6 percent.

b/A proportioner is a measuring or metering device which mixes the firefighting agent and water in correct amounts.

c/The numerical designation of proportioner systems refers to the delivery capacity of the system expressed in gallons per minute.

The FFAT report indicated the seriousness of these equipment problems. The major problem found with the proportioning systems was related to built-in degradation of equipment, lack of training, and lack of maintenance. The failure rate for one of the proportioners to produce an effective firefighting foam was exceptionally high. Also, system readiness condition of the flight deck washdown/firefighting aqueous film forming foam systems was found to be poor. This condition was mainly attributed to lack of maintenance.

For comparison purposes, we obtained copies of more recent FFAT reports to determine whether equipment failure rates have improved since 1974. A summary of eight FFAT visits occurring during the period May 1975 through July 1977 is shown in the last column of the table below. A comparison of the two columns shows that equipment failure rates have improved in four of the six categories. We believe, and Navy officials generally agree, that this improvement can be largely attributed to the efforts of the FFAT.

Equipment Failure Rates  
on Aircraft Carriers

<u>Firefighting system</u>	<u>FFAT summary</u> <u>11/72 to 11/74</u>	<u>GAO sample</u> <u>of FFAT visits</u> <u>5/75 to 7/77</u>
High capacity fog foam FP-1000 proportioners	60%	36%
Machinery space FP-180 proportioners	29	46
Portable FP-180 propor- tioners	21	40
Aqueous film forming foam storage tank	27	7
Washdown systems	50	29
Washdown system's flush deck nozzles	29	14

While the overall statistics appear to be improving, equipment failure rates on some ships remain unusually high, as illustrated by the following data taken from these recent eight FFAT reports.

U.S.S. Ranger:

13 of 17 high capacity fog foam stations failed.  
3 of 6 FP-180 proportioners failed.

U.S.S. Independence:

8 of 16 high capacity fog foam stations failed.  
4 of 6 FP-180 proportioners failed.

U.S.S. Midway:

16 of 29 FP-180 proportioners failed.  
7 of 16 aqueous film forming foam storage tanks  
contaminated.  
3 of 4 twin agent units in unsatisfactory condition.

U.S.S. America:

4 of 6 FP-180 proportioners failed.  
9 of 17 washdown system's zones failed.  
120 of 297 washdown nozzles clogged.  
3 of 3 twin agent units in unsatisfactory condition.

U.S.S. Kitty Hawk:

9 of 17 high capacity fog foam stations failed.  
8 of 13 washdown system's zones failed.  
13 of 23 aqueous film forming foam storage tanks were  
filled to only 55 percent or less of capacity.

Several FFAT reports attributed many of the equipment failures to lack of training and maintenance. Other Navy inspection reports stated that many problems of reduced system readiness were a direct result of improper or incomplete maintenance. These include failure to (1) flow test a system with sea water at least every 6 months, (2) take corrective action on flush deck nozzles known to be clogged, (3) take adequate measures to cover flight deck nozzles during overhaul periods or during deck resurfacing to preclude entrance of dirt and debris, and (4) periodically lubricate and manually operate solenoid valves to ensure freedom of mechanisms.

In several cases the maintenance problem was compounded by introducing firefighting systems with little or no operational or maintenance training being provided to personnel. For example, when the fleet changed from protein foam to aqueous film forming foam stations, no maintenance courses were conducted. Consequently, shipboard personnel were not capable of maintaining or repairing the equipment. Other examples of systems introduced with little or no operational or maintenance training include the (1) twin agent unit, (2) Halon fire extinguishing system for avionic test shops, and (3) recharger for the survival support device.

In commenting informally on this report, Navy officials said that the performance problems associated with the proportioners have been recognized. The FP-1000 proportioners have been replaced on all but four carriers, and the FP-180 proportioners will be replaced as soon as the new proportioners are available.

#### CONCLUSION AND RECOMMENDATION

An effective firefighting capability requires well maintained equipment. Some of the firefighting equipment aboard aircraft carriers does not function properly because it is poorly maintained. This problem has been recognized by the Navy for many years, but failures continue to plague the fleet. For example, the failure rates exceeded 35 percent for equipment like the high capacity fog foam FP-1000 proportioners, machinery space FP-180 proportioners, and portable FP-180 proportioners.

We recommend that the Secretary of the Navy take appropriate action to ensure that (1) firefighting equipment on aircraft carriers is adequately maintained and in good operating condition at all times and (2) personnel are adequately trained to maintain new firefighting systems.

### CHAPTER 3

#### BETTER TRAINING OF FIREFIGHTERS NEEDED

Fleet shore-based training programs have several weaknesses which affect firefighting capability:

- Firefighting schools cannot meet the fleet's training demands.
- No formal selection procedures exist for filling available training slots.
- Quality of training may be declining.

#### FIREFIGHTING SCHOOLS CANNOT MEET TRAINING DEMANDS

During fiscal year 1977, the San Diego Firefighting School did not meet the Pacific Fleet's demands for firefighter training as shown below.

<u>Advanced training courses</u>	<u>Slots requested</u>	<u>Slots available</u>	<u>Percent of requests not filled</u>
Shipboard basic	9,004	4,752	47
Shipboard refresher	5,347	4,644	13
Aviation basic	2,970	2,088	30
Aviation refresher	3,036	2,808	8

For fiscal year 1978, San Diego school officials anticipated meeting about 60 percent of the slots requested. According to various Navy officials, the Navy cannot currently meet the fleet's firefighting training requirements for advanced training courses.

In commenting on our report informally, Navy officials said that the course capacity of the shipboard basic course at San Diego had been increased in fiscal year 1978 from 4,752 slots to 7,340 slots as a result of shortening the course from 3 days to 2 days.

An important element in firefighting is the advanced shore-based training programs. According to the Navy's firefighting training requirements, all personnel assigned to firefighting duties, engineering divisions, duties on flight or hangar decks, or who routinely handle flammable or explosive materials must receive advanced firefighting training. To meet this requirement, advanced courses in

theoretical and practical firefighting for both shipboard and aviation personnel are provided by the training commands of the Pacific and Atlantic Fleets.

Many of the personnel assigned to firefighting duties on ships in the Pacific Fleet have not received the required advanced firefighting training. A random sample of 25 ships from a total of 182 in the Pacific Fleet showed that only 63 percent of the at-sea-firefighting personnel were graduates of an advanced firefighting course.

#### NO FORMAL SELECTION PROCEDURES EXIST FOR FILLING AVAILABLE TRAINING SLOTS

Although firefighting training slots are in short supply, the Navy does not have a system to ensure that personnel assigned to firefighting duties are selected for training first. According to a Navy damage control officer, without establishing definite priorities, there is no assurance that primary firefighters will be trained first. Ship commanders usually send individuals to the firefighting schools because of their availability. Also firefighting duties are usually assigned to the newest and least qualified individuals, while the higher rated veterans are given more prestigious assignments.

Although some members of fire parties had not received the required training, others were repeating the same courses within a 1-year period. Course repeaters are a particular problem in the two basic courses (shipboard basic and aviation basic) because of the large percentage of unfilled requests. (See p. 8.) A sample of two shipboard basic classes and one aviation basic class totaling 243 students showed that 38 students (16 percent) were second or third time course repeaters.

#### QUALITY OF TRAINING MAY BE DECLINING

The quality of the Navy's firefighting training may be declining. The Navy has been shortening its courses to meet increasing fleet demands for firefighting training. For example, San Diego's shipboard basic course had decreased in length from 2 weeks in 1959 to 3 days in January 1977. Recently the shipboard basic course was changed to a 2-day course when the Navy restructured the firefighting training courses.

According to several training officials, the quality of the curriculum has suffered due to the shortening of courses.

For example, the present courses do not allow enough time to absorb the information presented or to develop the required firefighting skills. The director of the Firefighting School in San Diego also believed that Navy personnel were not receiving adequate training. He stated that students are exposed only briefly to firefighting methods and equipment and that, in his opinion, the basic course should be lengthened. Both the director and a fire training officer at another school stated that it would take at least 10 days to teach students what they should know about firefighting.

In commenting informally on our report, Navy officials said that the Navy firefighting training courses were recently restructured. Overall evaluation of the restructured training has been favorable. Another improvement in the training courses, according to Navy officials, is a computer-controlled firefighting training device which will provide for a greater student throughput. A prototype device is scheduled to be operational in late 1979. Because of these changes, Navy officials said it appears that firefighting schools are now meeting realistic fleet training needs.

#### CONCLUSION AND RECOMMENDATIONS

Ships need trained firefighters. In our survey of 25 ships, however, only 63 percent of designated firefighting personnel were graduates of the fleet's firefighting schools.

In our opinion, two remaining weaknesses in the shore-based training have potentially serious implication for firefighting capability. First, firefighting schools cannot meet fleet training demands; and, second, no formal selection procedures exist for filling training slots. Improvements are needed in these areas so that personnel assigned firefighting duties will be adequately trained.

To correct these training deficiencies, we recommend that the Secretary of the Navy take appropriate action to ensure that:

- Fleet procedures for selecting personnel to attend firefighting training courses are improved so that personnel assigned firefighting duties on ships will get priority for attending advanced training courses.
- All personnel assigned to firefighting teams on ships complete one of the advanced training courses as soon as possible.
- Firefighting training schools have enough training slots to meet the fleet's essential training requirements.

## CHAPTER 4

### SCOPE OF REVIEW

In Washington we interviewed officials and reviewed records of the Naval Material Command and the Air and Sea Systems Commands. In the field we interviewed officials of the Naval Surface and Air Force Commands for the Pacific and the Atlantic Fleets and visited seven ships, including a 5-day stay aboard the U.S.S. Enterprise. We also interviewed Navy research and engineering personnel at the Naval Ship Engineering Center, Washington, D.C., and Philadelphia, Pennsylvania; Naval Ship Research and Development Center, Carderock and Annapolis, Maryland; Naval Research Laboratory, Washington, D.C.; Naval Air Engineering Center, Lakehurst, New Jersey; and Naval Weapons Engineering Support Activity, Washington, D.C.

We also interviewed officials of the Pacific and Atlantic Training Commands and visited six firefighting schools at San Diego, California; Treasure Island, California; Norfolk, Virginia; Mayport, Florida; Philadelphia, Pennsylvania; and Lakehurst, New Jersey. At the San Diego school we participated in classroom and live firefighting exercises. At all of the schools we reviewed curriculums, student critiques, and test results; interviewed training officers, instructors, and students; and observed shipboard firefighters during live and simulated exercises.

AIRCRAFT CARRIER FIRES (note a)

<u>Year of fire</u>	<u>Name of carrier</u>	<u>Estimated dollar losses</u>
1969	<u>Forrestal</u>	\$ 323,358
1969	<u>Lexington</u>	1,000,000
1971	<u>Kennedy</u>	109,225
1972	<u>Forrestal</u>	10,050,000
1972	<u>America</u>	108,711
1972	<u>Saratoga</u>	580,000
1972	<u>America</u>	211,875
1972	<u>Ranger</u>	411,000
1973	<u>Saratoga</u>	5,031,725
1973	<u>Kitty Hawk</u>	201,725
1974	<u>Enterprise</u>	3,720,000
1974	<u>Coral Sea</u>	110,537
1975	<u>Kitty Hawk</u>	916,000
1975	<u>Saratoga</u>	136,958
1975	<u>Kennedy</u>	2,460,000
1976	<u>Ranger</u>	200,960
1977	<u>Ranger</u>	116,600
	Total	<u>\$25,688,674</u>

a/This list includes only those fires in which damage exceeded \$100,000.

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