The Board, after inquiring into all the facts and circumstances connected with the incident which occasioned the inquiry, and having considered the evidence, finds as follows and submits the following opinions and recommendations:

I. Cause, Training, Safety and Responsibility.

a. Findings of Fact.

1. On the morning of 14 January 1969, USS ENTERPRISE (CVAN 65), Captain , USN. Commanding, was operating about 70 miles southwest of Pearl Harbor, Oahu, Hawaii as CTU 178.1.1 in company with USS BAINBRIDGE (DLGN 25), USS ROGERS (DD 876) and USS BENJAMIN STODDERT (DLG 22), under the operational control of CTG 178.1, Commander Fleet Air Hawaii, who was conducting a scheduled Operational Readiness Inspection (ORI) of ENTERPRISE and its embarked Air Wing in accordance with COMFAIRHAWAII OP ORDER 308-69.

2. Captain . USN, Commander, Fleet Training Group, Pearl Harbor and Commander Task Group 54.3 was aboard as a member of the ORI Observing Party and was the Senior Officer Present.

3. Captain . USN, Chief of Staff, Commander Fleet Air Hawaii was aboard as the Assistant Chief Observer of the ORI.

4. Rear Admiral , USN, Commander Fleet Air Hawaii, Commander Task Group 178.1, and OCE was Chief Observer of the ORI, was not on board but was scheduled to board on the afternoon of 14 January 1969.

5. The OTC was Commanding Officer, ENTERPRISE.

6. BAINBRIDGE was on her assigned picket station 270°T, 75 miles from ENTERPRISE. She rejoined at 1105.

7. ROGERS was astern in plane guard station. She closed the port quarter and brought fire hoses to bear at 0840.

8. BENJAMIN STODDERT was detached at 0720 and proceeded on ISE. She rejoined and brought fire hoses to bear on the starboard quarter at 0847.

9. Carrier Air Wing NINE, consisting of the following squadrons, was embarked:

VF-92, VF-96, VA-145, VA-146, VA-215, VAW-112, RVAH-6 and VAQ-132

10. Helicopter Support Squadron ONE Detachment 65 was embarked.

11. 105 personnel of various ranks and rates composed the ORI observing party, of these 32 were from Fleet Training Group, Pearl Harbor, 33 from

Fleet Air Hawaii, and the remaining from various other Pacific Fleet activities.

12. Various inspections, drills and exercises were scheduled, beginning with the ship's transit of a simulated swept channel and simulated low visibility piloting from Pearl Harbor at 0738 on 13 January.

13. The observing party and some of the ship's company were anticipating that the shock of an exploding practice depth charge or grenade would simulate a hit on the ship at about 0915 on the 14th and that the ship would go to General Quarters and commence damage control drills.

14. On 13 January, flight operations commenced at 1110 and were completed at 0038 on the 14th. The air department continued at work until 0200 when one half of the men were secured. At 0230 the remaining group of approximately 180 men were secured.

15. Reveille for the air department was held at 0400, flight quarters was sounded at 0530 and flight operations commenced at 0645 on 14 January. Flight operations were scheduled to continue until 2200.

16. At 0645 the ship commenced launching an exercise strike group consisting of the following aircraft: 3 F-4s, 4 A-6s, 5 A-7s, 1 KA3B and 1 E-2A.

17. At 0830, the ship was scheduled to commence launching 6 F-4s, 7 A-7s, 1 RA-5C, 1 EKA-3B and 1 E-2A.

18. At 0819 the ship's position was 20°27'N, 158°27'W, the course was 090°True, speed 10 knots.

19. The 0817 ENTERPRISE weather observation was: 3000 broken clouds, 10 mile visibility, temperature 76°F, dew point 60°F, true wind 280°/19 knots. There was no precipitation.

20. Fuel and weapons were loaded on aircraft as is indicated in exhibits 7 and 95.

21. Additional weapons were located as is indicated in exhibit 71, ENTERPRISE Weapons Officer statement.

22. At about 0800 aircraft were manned or being manned by flight crews as indicated in exhibit 104.

23. The flight deck spot aft of Frame 190 at 0815 was as indicated in exhibit 104.

24. At about 0815 an MD-3A jet aircraft starter unit was positioned on the starboard side of an F-4J, aircraft side number 105, such that its exhaust outlet was in line with and within twenty-four inches of a loaded LAU-10 ZUNI rocket launcher mounted on the starboard wing of the aircraft.

25. The MD-3A starting unit had been or was being employed to start 105 and its jet exhaust gasses were, or had been impinging on the ZUNI rockets.

26. The GTC 100-54 gas turbine aircraft starting unit mounted in the MD-3A tractor has an exhaust temperature of approximately 590°F two feet from its exhaust port when operating in the bleed or start condition. When operating in the no bleed or idle condition the exhaust temperature is approximately 326°F two feet from the exhaust.

27. An MD-3A starting unit is normally operated in the bleed mode for about two minutes when starting both engines of an F-4J. It is normally alongside an aircraft between three to five minutes and is in the no bleed mode or idle condition unless starting an engine.

28. The LAU-10 rocket pod mounted on F-4J 105, starboard wing, station eight, contained four ZUNI MK-16 MOD 1 rockets fitted with MK-32 MOD 0 warheads which were fuzed with MK 188 MOD 0 fuzes.

29. The MK-16 MOD 1 ZUNI rocket motor consists of a lightweight aluminum alloy tube fitted with a solid grain extruded N4 propellent and a combination black powder/flaked magnesium igniter.

30. The MK-32 MOD 0 warhead which was fitted on the ZUNI rockets weighs forty-five pounds, it contains fifteen pounds of Composition B high explosive, a small amount of Tetryl in the initiator-booster assembly, and a PETN primer cord.

31. MK-188 MOD 0 nose fuzes were fitted on the warhead of the ZUNI rockets and that the following explosives are used: lead azide primer mix (primer), lead azide tetryl (detonator and booster).

32. A temperature of 358°F is sufficient to cause detonation of the explosive material in a MK-32 ZUNI warhead.

33. The VF-96 F-4J's 103, 105, etc., were configured with two 370 gallon capacity external wing tanks and that each of these tanks contained approximately 370 gallons of JP-5 fuel.

34. The VF-92 F-4J's, 202 and 214 were configured with one 600 gallon capacity, external, centerline tank and that each of these tanks contained approximately 600 gallons of JP-5 fuel.

35. Approximately 5,640 gallons of JP-5 fuel was in external tanks on the F-4J's aft.

36. The 370 and 600 gallon wing tanks are constructed principally of aluminum.

37. The VF-96 tanks were suspended from wing stations one and nine thus they were located outboard of, parallel to, and within twenty-two inches of the LAU-10 ZUNI launchers on 105.

38. Each of the A-7 aircraft aft were fueled with approximately 1500 gallons of JP-5 fuel.

39. EKA-3B 614, which was adjacent to and forward of F-4J 106 was configured to perform a dual ECM tanker mission and was fueled with approximately 3,530 gallons of JP-5 fuel.

40. The total fuel in the fifteen aircraft aft, depicted in exhibit 95, was approximately 34,000 gallons.

41. F-4J's 103, 105, 106 and 113 were each loaded with six MK-82 bombs fitted with MK-904E2 fuzes with M9 delay elements and two LAU-10 rocket launchers each loaded with four ZUNI rockets.

42. A-7 aircraft 312 and 313 spotted aft on the flight deck were each loaded with six Mk-82 bombs fitted with MK-904E2 fuzes with M9 delay elements and two LAU-10 rocket launchers each loaded with four ZUNI rockets.

43. A-7 aircraft 403, 414 and 415 were each loaded with six MK-76 practice bombs and one LAU-68 rocket launcher loaded with seven 2.75" rockets with inert warheads.

44. A witness testified that he saw a LAU-10 launcher disintegrate on F-4J 105, and that other witnesses testified that an explosion occurred near that airplane at 0819.

45. The shrapnel from the explosion of the MK-32 warheads on F-4J 105 was propelled with high velocity in various directions and that a concentration of shrapnel flew in a path normal to the center line of the airplane and that some of the shrapnel impacted with sufficient force to injure men, damage aircraft, and gouge the flight deck.

46. The explosion of the warheads on F-4J 105 damaged one or more of the fuel tanks on that aircraft, the adjacent aircraft forward, F-4J 106, EKA-3B 614 and F-4J's 103 and 214, which were spotted on the starboard side and at the ramp respectively.

47. Fuel from the damaged tanks was ignited under and in the vicinity of F-4J 105 and that the subsequent fire spread rapidly to and ignited fuel on the deck near and around F-4J 106 and F-4J 214, and across the deck to F-4J 103 on the starboard side.

48. The fires cooked-off MK-82 bombs, which exploded with sufficient intensity to cause serious damage to the ship, aircraft, equipment and to seriously injure personnel and spread fires.

49. At least four men, three of whom have been identified, were aware that the MD3A starting unit was either improperly positioned or was creating a hazard to weapons while it was positioned alongside F-4J 105.

50. Airman Apprentice of VF-96 observed the exhaust of the MD-3A unit blowing on the LAU-10 ZUNI rocket launcher suspended from the starboard wing of F-4J 105.

51. Airman did communicate with Chief Aviation Ordnanceman Edwin CARNAHAN and indicate his concern about the ZUNI rockets and the exhaust from the MD-3A.

52. Some aircraft engines had been started at 0810, therefore the level of noise on the flight deck made conversation difficult.

53. Chief did observe the exhaust from the MD-3A unit to be close to the warheads of the ZUNI rockets on the starboard wing of F-4J 105, and he did recognize this situation to be unsafe.

54. Chief and other ordnance personnel attached to VF-96 were pressed for time and were rushing to complete their task of fuzing bombs on VF-96 aircraft.

55. Chief did indicate to Staff Sergeant Gyles T. BRUZENAK, USMC, an ORI observer who had been assigned to observe VF-96 weapons handling, his concern with the MD-3A unit and the LAU-10 launcher.

56. Staff Sergeant did observe the MD-3A starting unit to be in position along the starboard side of 105, and that he testified he relayed his concern with regard to its location to an unidentified member of the flight deck crew, who was wearing a yellow jersey. He has not been identified and probably did not survive.

57. The ORI observers had the authority to stop unsafe practices during the ORI.

58. Staff Sergeant had 14 years experience with air weapons and was experienced in Marine Corps operation of land based F-4 aircraft, and had served as an ORI observer in USS KITTY HAWK.

59. Staff Sergeant stated that the jet starting units used by the Marine Corps normally exhaust at the top of the unit and are usually positioned on the port side of F-4's because the inlet fitting for the air hose is located on the port side of the aircraft.

60. Shortly after Staff Sergeant talked to the unidentified person wearing a yellow jersey the initial explosion occurred.

61. That Rear Admiral USN, Commander Carrier Division ONE and his staff had been embarked in ENTERPRISE during the ship's transit from Alameda to Pearl Harbor and was temporarily based ashore during the ENTERPRISE ORI.

62. Rear Admiral boarded ENTERPRISE on the 14th and commenced a preliminary investigation of the accident in accordance with COMNAVAIRPAC message 150133Z JAN 69 and previous verbal orders.

63. The Board of Investigation reviewed the results of the preliminary investigation, consisting of more than 700 individual statements, photographic evidence, ship's records and diagrams.

64. On 16 January the Board utilized undamaged aircraft in ENTERPRISE to reconstruct the flight deck spot aft. Considering the adjustments necessary to avoid holes in the flight deck, the reconstructed deck spot, as shown in photographs marked exhibit 93, represented the flight deck spot aft as it was at 0819 on the 14th of January, 1969.

65. Those air crews, squadron personnel, and flight deck personnel who were available to the Board, and who were on the flight deck aft at about 0819 on 14 January 1969, were present and were located at their approximate positions in the reconstructed deck spot.

66. On 24 January the Board convened at Tripler Army General Hospital where it questioned four ordnancemen attached to VF-96 who were injured under or in the vicinity of F-4J 106 when the initial explosion occurred.

67. Industrial Test Laboratory Report No. 140304 dated 22 January 1969, which was completed by Mr. Senior Chemist at the Pearl Harbor Naval Shipyard, states that of four pieces of shrapnel removed from Chief Aviation Ordnanceman Edwin who was wounded in the initial explosion while working under F-4J 106, two were similar in composition to the steel used in the manufacture of MK-32 ZUNI warheads. Additional shrapnel removed from four other persons injured in the initial explosion was chemically analyzed by the Naval Weapons Laboratory at Dahlgren and was identified as having metalurgical characteristics similar to metal in the MK-32 ZUNI warhead and dissimilar to fragments which could be expected from a MK-82 bomb.

68. On 25 and 26 January at Naval Air Station Barbers Point, the Board partially reconstructed the deck spot aft as it was at 0819 on 14 January 1969.

69. Based on a photograph marked exhibit 102P, which was taken at approximately 0821 on 14 January, aircraft simulating F-4J's 105 and 106 were positioned as they were at 0819 and that a photograph of this phase of the reconstruction, marked exhibit 55, supports the validity of the reconstruction when compared to exhibit 102P.

70. The aircraft configured with inert ordnance loads, and starting equipment were positioned as they were at 0819 as testified to by witnesses and as indicated above.

71. Personnel were positioned under the F-4J simulating 106 and these men reenacted the position, postures, motions, and observations of Chief Aviation Ordnanceman Aviation Ordnanceman Second Class and Aviation Ordnanceman Second Class as testified to by them at Tripler Hospital on 24 January.

72. An engineering drawing of the after portion of the flight deck was used in conjunction with a transit theodolite to insure accuracy in the placement of the aircraft without reference to the location of the bomb damage. Exhibit 10, which was prepared by Mr. , a naval architect assigned to the Naval Ships Engineering Center, was then used to compare the location of the bomb holes with the spot. As shown in photographs in exhibit 55 the outlines of damaged areas did agree with the simulated deck spot.

73. The proceedings of the Board regarding the partial reconstruction at Naval Air Station Barbers Point were recorded by the Senior Member at the scene and marked exhibit 55.

74. The partial reconstruction of the after flight deck spot at Naval Air Station Barbers Point and the Board's proceedings therewith provided further verification of the Board's conclusion that heat from the MD-3A starting unit alongside F-4J 105 exploded ZUNI warheads on that aircraft.

75. The results of a test reported in Naval Weapons Center, China Lake message 020030Z FEB 69 indicate that when a MK-32 warhead mounted on a ZUNI rocket is placed approximately eighteen inches from a GTC-85 jet starting unit, operating in bleed air mode, the surface temperature of the warhead will rise to 850°F and that the warhead will deflagrate in one minute and eighteen seconds. The test report also indicated that warhead fragments were propelled to a distance of approximately 300 feet and that the reaction was considered violent enough to damage aircraft structures and initiate fuel fires. The referenced message is marked exhibit 89.

76. A USS ENTERPRISE safety report dated 14 April 1968, marked exhibit 73, states that a MK-82 bomb located two feet from a starting tractor was heated to a temperature sufficient to make it too hot to touch.

77. A USS ENTEPRISE safety report dated 8 May 1968, marked exhibit 74, states that a SHRIKE missile became too hot to touch after being heated for approximately ten minutes by a starting tractor exhaust.

78. The Air Department is responsible for safety on the flight deck and is organized in accordance with NAVAIRLANT/NAVAIRPAC CV Ship Instruction 5400.1A of 1 July 1968.

79. The ENTERPRISE Weapons Handling/Safety Training Group is under the administrative control of the Weapons Department and composed of Weapons Department and Air Wing personnel who provide on-the-scene safety inspections, conduct training in support of the ship's Ordnance Officer and the Air Wing Ordnance Officer, and prepare daily reports in writing for the Commanding Officer and other interested parties on observed weapons malpractices.

80. The ENTERPRISE Aviation Safety Council as shown in ENTERPRISE Notice 1301 of 10 January 1969 does not list the Weapons Officer as a member nor is his membership required by any directive from higher [illegible]

81. The Weapons Officer is responsible for the safety of air launched weapons throughout the ship.

82. The Air Officer is responsible for safety on the flight deck and hangar deck.

83. The Weapons Handling/Safety Group members have the authority to stop unsafe practices when observed.

84. The training received by squadron personnel in qualifying for the designation of plane captain does not include the hazards of explosives in air weapons.

85. The training received by the MD-3 operators does not include the hazards of explosives in air weapons.

86. Flight deck personnel including ordnancemen testifying before the Board demonstrated little knowledge of the explosives contained in air weapons or hazards associated therewith.

87. The ground support equipment used by the Air Wing to start aircraft when shore-based is not the same model as that used in the ship. Because of the design differences, different operational procedures were required with the same type aircraft.

88. The Naval Air Technical Training Command does not teach, in its MD-3 training program, the hazards of air weapons.

89. VF-96 weapons supervisory personnel, LTJG BERGHULT and Chief , were performing or were directly involved in final fuzing of weapons on squadron aircraft just prior to the explosion.

90. In a memorandum dated 14 July 1968, marked exhibit 101, the Commanding Officer of VF-142 reported to the Air Officer of USS CONSTELLATION that a huffer had burned out the wiring of a TER on an F-4 airplane. A part of the memorandum is quoted as follows:

> "A separate informal investigation is underway within VF-142 to determine the extent and possible further ordnance problems which may be encountered as a result of huffer outlet temperatures. The following areas are suspect and all yellow shirts and tractor drivers should be cautioned:
>
> a. AIM-9D SEEKER HEADS. May be rendered useless due to overtemp. Huffer temperatures could possibly cause low order motor fire on the AIM-9D/B.

b. ZUNI ROCKET PACKS. Huffer temperatures may cause rocket motor low order detonation on ZUNI or any other rocket pack.

c. BOMBS AND BOMB FUSING. Overtemperature can cause critical explosive possibilities with loaded ordnance.

The possibility of lengthening huffer hoses to preclude the necessity to place a huffer exhaust in close proximity to ordnance should be investigated and, if feasible, implemented...."

91. In a notice dated 19 July 1968, marked exhibit 100, the Commander Attack Carrier Air Wing FIFTEEN states that a skid load of MK-82 bombs was heated by a jet starting unit aboard the USS CORAL SEA during her 1967/68 deployment.

92. The Aviation Support Equipment Lesson Guide No. 12.1.1.3, published by the Naval Air Maintenance Training Group in May 1964, marked exhibit 58, is used in ENTERPRISE and other carriers in the training of operators of the MD-3A starting unit. This publication cautions against directing the exhaust of the unit at aircraft or other equipment but it does not comment on or make any reference to the hazard of heating weapons with the unit exhaust.

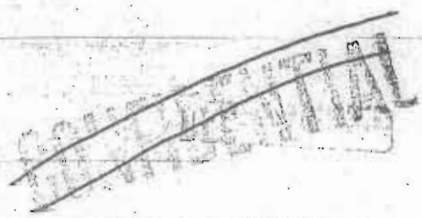
93. The publication concerning operation of the MD-3 unit, NAVAIR 19-105B-3f, contains no warning of the hazard of the exhaust to explosives or volatile fuels.

94. The MD-3A operators had not received specific instruction on the hazards of the unit exhaust on air weapons.

95. "Aircraft Rockets" (NAVWEPS OP2210), published by direction of the Commander, Naval Air Systems Command on 15 September 1966 with Change 3 dated 30 April 1968, does not contain any precautions or comment pertaining to the hazard of heat from starting units. The Safety Summary in the publication, which is not included in the index, contains sixteen sections listing various safety precautions concerning rockets. With the exception of an entry concerning the prohibition of matches, naked lights, flame producing devices, or any open flame in the vicinity of rocket stowage, no information, precautions or guidance is provided regarding the hazard from heat. The table of temperatures provided on page 1-48 of the publication pertains to rocket storage. It also states that ZUNI rocket motors are relatively insensitive to temperature.

96. The aircraft starting and cooling system (ASCAC) installed in ENTERPRISE was out of commission. It was reported as a casualty on 9 April 1968.

97. The Air Start System (ASCAC) as normally configured will not service aircraft on the after end of the flight deck.



b. Opinions

1. That the primary cause of the accident in ENTERPRISE was the design of the MD-3A starting unit. Properly applied design and safety criteria would have prevented the introduction of flight deck support equipment that was physically capable of rapidly initiating the cook-off of a weapon.

2. The secondary cause of the accident was the failure at many levels of responsibility to recognize the hazard to weapons which is inherent in the MD-3 unit, and to issue appropriate, specific and emphatic warning and directives concerning its operation. For example:

(a) Operating instructions which include safety precautions do not contain information on the temperature profile of the MD-3A starting unit exhaust or make any reference to the hazard of the unit to explosive weapons.

(b) Information received from five CVA's in the Pacific Fleet and other commands reveals that there was no documented recognition of the hazard or existence of appropriate safety instructions for the MD-3A starting unit at squadron, wing, ship or higher levels.

(c) Finally, in the carriers and squadrons there was a failure to fully appreciate the hazard of the MD-3A and treat it as a major item of concern, worthy of the attention of higher authority.

(1) Instances of weapons being heated by the MD-3A unit were recorded in ENTERPRISE, CONSTELLATION and CORAL SEA, but the true hazard was not realized and no action was taken to disseminate information regarding these locally-known problems with the MD-3 exhaust.

(2) ENTERPRISE took remedial internal action on two previous reports of hot ordnance caused by MD-3A exhaust which, although consistent with the level of appreciation of the danger then held throughout the fleet, did not make this problem known to other Pacific Fleet CVA's.

(3) Exhibit 99 indicates that action was taken in the CONSTELLATION to alleviate the MD-3 exhaust problems by lengthening the hose on nine of the units to 26 or 27 feet. It has not been determined when it was accomplished in the CONSTELLATION, and it was not considered serious enough to cause CONSTELLATION to submit a Safety Unsatisfactory Report.

3. The lack of correlation between technical publications is a factor contributing toward the lack of information concerning the hazard of heat from the MD-3A. Each of the two publications cited in the facts is well written, easily understood and informative in its specific area, but they do not relate to each other and in no way relate to the environment in which each of the subjects, rockets and starting units, are utilized together.

4. The information providing bomb and missile cook-off times, which is a product of the FORRESTAL investigation, is useful, but it is incomplete. No information pertaining to the cook-off times of the ZUNI rockets is provided. Heat hazards from jet aircraft support equipment exhaust are not discussed. No recommendations are provided concerning what to do when a bomb is heated.

5. Other contributing causes are related to people and their training, experience, knowledge, and the environment in which they work.

(a) The operator of the MD-3A unit placed the unit alongside F-4J 105 in a dangerous position in that its exhaust impinged on the rockets. Tow bars attached to the nose gear of the airplane were extended to port. This influenced the operator's decision to position the unit on the starboard side of the airplane. The twenty foot length of hose with which the unit is equipped required him to back in under part of the airplane to permit attaching the hose to the inlet fitting at the rear of the airplane. If Airman John R. WEBSTER, who was operating the unit, had been aware of the cook-off temperature of the ZUNI rockets, and observed the position of the exhaust from his unit in relation to the rockets, he might have avoided the accident and saved his life by moving the tow bars and repositioning the unit.

(b) The above comments pertain as well to Airman Patrick L. BULLINGTON, the Plane Captain of F-4J 105, who also lost his life.

(c) The VF-96 Weapons Officer, LTJG Carl BERGHULT, was in the vicinity of F-4J 105. He could be expected to have had the knowledge and awareness to observe, recognize and correct the hazard. However, his attention was probably directed to fuzing details.

(d) Airman Apprentice is the first of three living persons to have observed the problem with the MD-3A and the rockets. He took appropriate but limited action in directing a Chief Petty Officer's attention to the situation and then going about his business. Had he known more about the temperature relationships between the ZUNI rockets and the MD-3A exhaust he might have taken more positive action which may have prevented the explosion.

(e) Chief Petty Officer did observe the situation and did recognize it as an unsafe practice. He was aware that heat and explosives were a dangerous mixture but he was not aware, nor was anyone, to the Board's knowledge, that a ZUNI rocket in these circumstances can be cooked-off in one minute and eighteen seconds. Thus, because he was rushing to complete a task which he should have been supervising rather than doing, installing arming wires on the bombs on 106, he passed on his concern about the situation at 105 to another person. It should be recognized that the time element might have precluded Chief from taking effective action and that the general lack of awareness in the Navy of the critical nature of the problem provides the explanation for the absence of more positive action by Chief

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(f) Staff Sergeant background must be considered in evaluating his actions. He had the authority to stop the action which was creating the hazard, but his understanding of the degree of hazard did not impell him to do it directly and instantly. Actions of an undetermined nature may have been initiated at F-4J 105 as a result of Staff Sergeant BRUZENAK's warning, but they were neither timely nor effective. They probably involved Airman WEBSTER, the Plane Captain, BULLINGTON, an unidentified flight deck director, and perhaps LTJG BERGHULT, all deceased.

6. That fatigue as a causative factor was not established, however, it is apparent that a number of key squadron and flight deck personnel had but a few hours sleep prior to the commencement of flight operations on the fourteenth.

7. ENTERPRISE safety policy for air weapons is realistic but lacks clarity as to responsibility for weapons safety on the hangar/flight deck during flight operations.

8. While the Weapons Handling/Safety Group does report safety violations to the Commanding Officer and lectures weapons personnel on safety during General Quarters drills, it is apparent that all Group IX personnel on board are in need of this training. General air weapons safety should be a major concern to all personnel who in the performance of their duties come in contact with those weapons.

9. The designation of the Weapons Officer as Safety Officer and the Air Officer as Aviation Safety Officer without clearly defining cognizant areas of responsibility has reduced the effectiveness of air launched weapons safety on the flight deck. This division imposes the interpretation of responsibility on working level personnel. This could contribute to the reluctance of personnel to take remedial action immediately.

10. Training of personnel to take positive and instant action on safety violations on the flight/hangar decks is required.

11. Follow-up action after identification of safety malpractices to preclude the possibility of recurrence is an equally important part of the ships safety program.

12. The pressure generated by the necessity of meeting a specific launch time, increased by the receipt of improper arming wires, may have caused supervisory personnel to be diverted to functional duties and in turn may have been a contributing factor to the accident.

13. Clearly established safety criteria and technical guidance in relation to the MD-3 and weapons is lacking in Naval Air Systems Command publications supporting this equipment.

14. NAVAIRINST 4700.2 has not achieved its desired purpose for reporting safety problems with aeronautical material. The previous problems on ENTERPRISE and other CVA's with the MD-3 huffer exhaust impinging on air weapons should and could have been reported as Safety Unsatisfactory Reports.

15. The ENTERPRISE weapons safety organization exceeded those requirements imposed by higher authority.

16. The terms used to quantitatively describe explosions in COMNAVAIRPAC NOTICE 08000 of 23 October 1968 and 08000 of 6 October 1967, which forwarded the reports of the cook-off tests conducted by NWL DAHLGREN, are in conflict and create confusion as to the type and intensity of explosions that could result from various weapons cooking-off.

17. NAVORD OP 4, originally conceived to provide the Naval Officer aboard ship with improved knowledge in the field of ammunition and issued in 1958 is of little value in the jet age Navy. OP 4 provides no useful assistance in the field of air launched weapons and should be replaced.

c. Recommendations

1. That the MD-3 unit be replaced or modified so as to make the cook-off by this unit of weapons either on aircraft or elsewhere on the flight and hangar decks a physical impossibility.

2. That until such replacement or modification is achieved, the MD-3A be treated as potentially dangerous to weapons and aircraft and subject to special instructions and management. ENTERPRISE Instruction 13800.1 dated 11 February 1969 provides new operating and safety precautions on starting units. It is recommended that it be distributed to other attack carriers for review and evaluation. If the instruction so merits, it should then be adopted and published as a type commanders directive. It is attached as exhibit 115.

3. That a Ground Support Equipment (GSE) Board be established at appropriate level to:

(a) review all existing GSE, establish requirements, determine duplication of function, lack of required support and initiate action to correct recognized problems.

(b) Subject all subsequent requirements for new GSE to the above review before release of contract for preliminary design.

(c) Conduct thorough test and evaluation programs under laboratory conditions and review design constraints of the operation of all GSE.

(d) Subject new design and class I/II change modifications to a carrier environment Safety Study prior to release to the operating forces.

(e) Require that all components of air weapons; aircraft, GSE, and weapons be mutually compatible in the carrier environment.

4. That a formal safety organization should be established in each CVA. The precise structure and staff support required for such an organization cannot be defined without further study. The nucleus members of the organization should be permanently assigned on a full time basis to BUPERS approved billets. Professional qualifications should include ability to enforce and monitor recognized criteria. Initial guidelines may be available from analysis of industrial safety programs in hazardous areas of industry with comparably rated work type and plant account value.

5. That technical publications supplied to the operating forces relating to GSE, aircraft and weapons, be revised. Sections in each publication should describe the relationship to the operational environment and to each other. The relationship once established should be described in detail, in language that is easily understood by the user. Specific rather than general guidance should be provided, giving detailed information of inter-

related hazards and appropriate precautions. Adequate publications should be available prior to fleet introduction of specific equipment.

6. That all Navy personnel receive basic instruction during recruit training on the types of explosives used in Navy weapons in order to create a broader awareness of the general nature of and hazards associated with Naval explosives.

7. That all Naval aviation personnel receive intensive and thorough instruction on the specific hazards of air weapons during their training cycles.

8. That the sensitiveness of all weapons should be thoroughly examined. Reduction in sensitivity is desired. Precise knowledge of sensitivity is mandatory. Weapons and all their components must be designed to be compatible with the environment in which used. Aircraft exhaust is "open flame, naked light, and heat," and it will continue to be a part of the carrier environment.

9. That the carrier NATOPS Manual and other directives be revised to include comment cautioning weapons supervisors of the consequences of engaging in tasks other than direct supervision.

10. That carriers be required to report air weapons safety problems in accordance with Chapter 15 of NAVAIRINST 4700.2. This is the correct administrative channel by which evaluations of problems by competent personnel can be effective and corrective measures initiated for problem resolution.

11. That whenever possible, the same ground support equipment that is used in operations aboard CVA's should be used during the air wing training cycle ashore and that when this is not possible, significant differences in equipment should be properly recognized.

12. That scheduled periods for flight operations be reduced in ORI's to twelve hour periods with a minimum twelve hour break between successive periods. Extended hours of operation can be tolerated under combat conditions, but should not be imposed as a part of the inspection process.

13. That ENTERPRISE be equipped with the necessary machinery to restore the aircraft starting and cooling system to operational condition and that the system be expanded to provide for starting aircraft at all deck spots.

14. That all carrier Weapons Handling/Safety Groups include Air Department personnel.

15. That no administrative or disciplinary action be taken concerning the personnel named in this report or others who were involved.

II. Extent of Damage and Damage Control.

a. Findings of Fact.

1. The primary damage to the ship was caused by major explosions of weapons which broached the flight deck sending large high velocity fragments into compartments below. This damage is accurately described in exhibits 6 and 8.

2. The five large holes in the flight deck were produced by MK 82 bombs which cooked-off in the fire.

3. The holes in the flight deck and holes in lower decks, caused by fragments, allowed burning fuel to enter lower deck compartments starting class A, B and C fires. Subsequently, these holes also provided access to the fire for fire fighting water.

4. Burning fuel spilling over the sides damaged equipment in and around the catwalks and the Point Defense Missile Launchers.

5. Shrapnel and debris from the explosions on the flight deck damaged the port Point Defense Missile Launcher, and the AN/SPS-33 radar and LSO platform.

6. The estimated total cost to restore the ship to the conditions which obtained prior to the fire is summarized as follows:

(a)	Shipyard Repairs	$10,500,000
(b)	Ship's Equipage	37,880
(c)	Ship's Consumables	112,658
(d)	Personal property	129,176
	Total:	$10,778,714

7. Shipyard repairs are scheduled to be completed on 15 March 1969.

8. The holes in the flight deck aft were clear of the landing area.

9. The catapults and arresting gear were not damaged.

10. Damage to aircraft, ground support equipment, aircraft installed equipment, and air launched weapons equipment was caused by fire, explosions and salt water and is described in detail in exhibit 53. Aircraft destroyed were:

TYPE	BUNO
F-4J	155804
F-4J	155758
F-4J	155756
F-4J	155785

F-4J	155776
F-4J	155793
F-4J	155791
F-4J	155796
A-7B	154426
A-7B	154429
A-7B	154444
A-7B	154446
A-7B	154461
A-7B	154457
EKA-3B	138918

11. The estimated cost to repair or replace aircraft and associated equipment is as follows:

(a) Aircraft	$44,109,442
(b) Ground Support Equipment	611,389
(c) Aircraft Installed Equipment	24,500
(d) Air Launched Weapons Equipment	452,200
(e) Air Launched Weapons	290,360
Total:	$45,487,891

12. The Air Department is responsible for fire fighting on the flight and hangar decks and is organized to perform this function in accordance with the Ship Organization and Regulations Manual for CV types as promulgated by NAVAIRLANT/NAVAIRPAC CV SHIP INST 5400.1A dated 1 July 1968. The organization is also in accordance with Battle Control NWIP 50-1B.

13. The Engineering Department is responsible for all shipboard fire fighting with the exception of fires involving aircraft on the flight and hangar decks and is organized to perform this function in accordance with the Ship Organization and Regulations Manual for CV types as promulgated by NAVAIRLANT/NAVAIRPAC CV SHIP INST 5400.1A dated 1 July 1968. The organization is also in accordance with Battle Control NWIP 50-1B with one exception. Repair parties 4 and 5 (propulsion repair) are under the control of the Reactor Officer when fighting fires in the main machinery spaces.

14. Within the framework of their individual responsibilities the Engineer Officer and Air Officer can take unilateral fire fighting action. In this case the Air Department activated hangar sprinkling, flight deck fog foam, and requested and obtained activation of the water washdown system.

15. The status of fire fighting equipment prior to the fire is found in exhibit 36. Significant equipment which was out of commission included:

(a) #10 Steam Driven Fire Pump
(b) #15 Electric Fire Pump

16. The High Capacity Fog Foam (HCFF) stations had been overhauled and tested individually prior to the ship's departure from CONUS on 6 January 1969.

17. Up to date Planned Maintenance System instructions are not available for these stations.

18. ENTERPRISE had four Twin Agent Units in commission at the time of the fire.

19. Twin Agent Unit #23 was positioned on #1 elevator and was manned by AN

20. Twin Agent Unit #23 proceeded to the starboard side in the vicinity of A-7B 312 arriving there less than one minute after the first explosion.

21. The nozzle of unit #23 was manned by AN who was one of the hot suit men.

22. Twin Agent Units when fully charged carry 80 gallons of Light Water and 120 pounds of Purple K.

23. Examination of Unit #23 after the fire showed that all the Light Water was expended and all of the Purple K remained. This examination also revealed that the hoses had been severed and the Purple K tank had been ruptured by shrapnel.

24. Prior to the fire, Twin Agent Unit #20 was positioned behind the island.

25. Twin Agent Unit #20 proceeded to the port side in the vicinity of F-4J 105 and 106 and was fighting the fire about 2 1/2 to 3 minutes after the initial explosion.

26. This unit was manned by AN Ernest L. FOSTER, ABH1 and AN

27. Examination of Unit #20 after the fire showed that there were 5 gallons of Light Water and 120 pounds of Purple K remaining.

28. An explosion killed nozzleman FOSTER and heavily damaged Twin Agent Unit #20.

29. Testimony concerning tests conducted at NAS Jacksonville, indicate that extinguishing a fire involving 1000 gallons of JP-5 in a 67 ft. diameter circle is the approximate capability of a Twin Agent Unit.

30. Two Twin Agent Units located on the hangar deck were not used in fighting the fire because deck edge elevators were not available.

31. Exhibit 32 describes certain difficulties in operating the Twin Agent Unit.

32. There were 3 or 4 fog foam hoses and a like number of salt water hoses employed in the fire fighting prior to the major explosion which occurred about 3 minutes after the initial explosion.

33. Initial efforts with fog foam and salt water were directed against F-4J's 105 and 106.

34. After weapons began to detonate the hose teams were knocked down, injured, and forced to continually fall back and regroup.

35. During initial fire fighting efforts the effectiveness of fog foam and salt water hoses was reduced due to the low fire main pressure.

36. Shrapnel from exploding weapons pierced hoses and forced hose crews to shut down and insert new lengths.

37. ENTERPRISE did not have new neoprene wrapped fire hose which has been approved for use on carriers.

38. Standard fog nozzles and applicators were employed below decks in extinguishing fires and cooling bulkheads aft of Frame 200.

39. All fog foam and salt water stations in the catwalk aft of Frame 200 were destroyed by the fire. This included fog foam stations numbers 11 through 16.

40. Shrapnel from the large explosion which occurred about 3 minutes after the initial explosion ruptured the fire main riser serving the island.

41. Until this was repaired there was no fire fighting water immediately available in the island.

42. After the last major explosions of weapons, fog foam and salt water hoses extinguished the fires.

43. Hangar sprinkling was activated in both Bays 1 and 2.

44. Control of the hangar sprinkling was not precise and there was some difficulty in securing one group in Bay 2.

45. The remote starting controls for the HCFF stations located on the flight deck, hangar deck and CONFLAG Control Stations are on the same circuit. As a result, when the flight deck stations were destroyed, control was lost in the hangar.

46. The "E" call circuit for sound powered phones connecting flight deck hose stations and HCFF stations is wired so that damage to one station knocks out all stations on flight and hangar decks.

47. At about 0820, immediately after the first explosion, the Washdown Countermeasures System was ordered activated.

48. Groups 6, 11 and 12 of the Washdown Countermeasures System were not activated. This includes all flushdeck nozzles aft of Frame 190, flushdeck nozzles outboard of the shell port side Frames 150-185 and 2 solid stream nozzles port side at Frames 150 and 170. As a result, none of the area of the flight deck directly involved in the fire was sprinkled by the system.

49. It was the responsibility of unit repair parties 76 and 78 to activate the after portions of the Washdown Countermeasures System by opening manually operated valves.

50. The aircraft initially involved in the fire; F-4J 105 and 106, were parked over Washdown Countermeasures System nozzles which are a part of group 12.

51. Branches of group 12 were damaged by the explosions which ruptured the flight deck on the port side.

52. There is an alteration, SHIPALT CVAN 3410, which converts the washdown system to a fire fighting system. It includes push button control and facilities to dispense sea water or a combination of sea water/light water. This alteration has not been incorporated on ENTERPRISE.

53. Prior to the start of the fire the total potential fire pump capacity immediately available was 17,000 GPM.

54. Electric pump #14 was out of service in order to provide double valve protection to electric pump #15.

55. After about 30 to 40 minutes the #10 Steam Driven Fire Pump was placed back in service. This pump was not available during the early stages of fire fighting.

56. Electric Pump #14 was placed back in service but was not used.

57. Cooling water requirements for the AN/SPS 32-33 radars, jet blast deflectors and arresting gear are approximately 2,250 GPM.

58. Jet blast deflector cooling water was secured approximately 5 to 10 minutes after the start of the fire.

59. Bilge eductors operating prior to the start of the fire require about 1,400 GPM.

60. If none of the sections aft of Frame 200 are activated the Washdown Countermeasures System requires 10,599 GPM.

61. The fire main pressure was identified as being low at various times by Commander , Commander and Lieutenant Commander

62. Action was taken to correct low pressure on the after port section of the fire main by opening valve 2-103-2 and thus cross-connecting it with the forward and midship port section.

63. Action was taken to correct low pressure on the midship starboard section by opening valve 2-107-1 and cross-connecting it with the forward starboard section.

64. Steam chest pressure on the three steam driven fire pumps was raised to the maximum in order to increase fire main pressure.

65. There is no capability to open valves and start electric fire pumps from Central Control.

66. Of 3,123 ship personnel, 2,997 had attended fire fighting school.

67. Of 2,039 Air Wing personnel, 1,753 had attended fire fighting school.

68. During August and September 1968, the ship held several 2 day fire fighting classes at Manchester, Washington which trained 1,091 officers and men.

69. The ship has a damage control training group which provides instruction and evaluates repair parties during General Quarters drills.

70. The ship has a competitive program among repair parties in order to increase effectiveness.

71. The ship has been frequently drilled at General Quarters since completion of the Selected Restricted Availability in September 1968.

72. TRAPAC Report 3500-2 of 1 November 1968 reports the results of interim refresher training exercises and the final Battle Problem. The ship received a grade of 75 per cent (good) for damage control on the final Battle Problem.

73. COMCARDIV ONE letter serial 054 of 13 December 1968 reported the results of the Operational Readiness Evaluation conducted during the period 2-9 December. For the Damage Control portion of this exercise, the ship received a grade of 84.3 per cent.

74. For the first day of the Operational Readiness Inspection, the Fleet Training Group, Pearl Harbor, had assigned the ship a grade of 75.0 per cent (good).

75. At the time of the fire, the following portable damage control equipment shortages existed:

(a) 15-seal beam lights
(b) 10-24" bolt cutters

76. At the time of the fire, the following portable damage control equipment was out of commission:

(a) 2-P250 pumps
(b) 1-P500 pump
(c) 4-seal beam lamps
(d) 8-flame safety lamps
(e) 2-red devil blowers

77. The ship expended 811 - 5 gallon pails of protein foam during the course of fighting the fire on 14 January 1969.

78. The allowance is 1,080 - 5 gallon pails of protein foam.

79. The ship has an allowance of 70 lengths of ducting and 20 portable blowers. In the gallery deck, runs of up to 200 feet may be necessary during de-smoking of compartments. Ducting provided is cumbersome and difficult to assemble.

80. About 900 OBA cannisters were consumed during the fire fighting.

81. The ship has an allowance of 3,300 OBA cannisters.

82. Fire parties experienced difficulties in de-smoking compartments due to the susceptability to damage of the aluminum coupling devices on portable blower ducts.

83. The eductors used in de-watering compartments operate on 3 1/2 inch fire hose which is difficult to handle.

84. There are 2 1/2 inch eductors available which operate off standard fire hose.

85. Portable lighting for fire fighters is a head lamp employing a diffusion type lens.

86. The OBA was employed by repair party personnel in controlling fires within the ship.

87. No difficulties were reported with the OBA, and personnel using the device were generally satisfied with its performance.

88. The MK-5 Gas Mask was employed successfully by repair party personnel to screen out irritating smoke and protect the eyes.

89. Personnel were aware of the limitations of the mask and used it accordingly.

90. There is no evidence that the mask was actually employed as an escape breathing device.

91. Some personnel at the immediate scene of the first explosion were severely burned.

92. In the opinion of personnel fighting the fire on the flight deck, their clothing was effective in preventing burns.

93. The hard shell skull cap and goggles were reported to have been particularly effective in preventing injury.

94. Officers and other key personnel do not wear readily distinguishable clothing or equipment, relying, essentially, for identification from stencils on jerseys.

95. Personnel who wore gloves reported them to be very useful.

96. Both of the hot suit men were injured when their hoods were blown off by the blasts from the explosions.

97. The performance of the Twin Agent Unit is dependent to some degree on the ability of the operator to get close to the fire. Hence, effectiveness is enhanced if the nozzle operator is wearing a hot suit.

98. Fire fighting crews applied high velocity fog to weapons under F-4J 106.

99. The EOD personnel disposed of bombs which were blown forward as a result of explosions aft. Chief , personally defused and, with the assistance of flight deck personnel, jettisoned a burning 500 pound bomb which was located on No. 3 Elevator.

100. Weapons loaded on aircraft on the bow were down-loaded and jettisoned from the No. 1 Elevator, the end of the angle deck, and the forward jettison chute on the starboard side.

101. Napalm in the No. 3 Deck Edge Elevator Well was jettisoned.

102. MK 24 flare lockers on the weather deck were jettisoned. MK 24 flares stowed in magazine 5-167-M, which was equipped with sprinkling, were brought topside and jettisoned.

103. Pyrotechnics in lockers on the 01 Level aft were jettisoned.

104. Magazine 03-176-1-M was sprinkled by Repair Unit 76 shortly after General Quarters was sounded. This action was taken without the permission of Damage Control Central. This magazine contained gun pods.

105. Very few of the personnel involved in the fire fighting had working knowledge of the cook-off characteristics of the weapons involved in the fire.

106. The fire fighting personnel were trained to fight the fuel fire which they initially encountered, but were untrained and unprepared for the explosions which followed.

107. Approximately 371 casualties were handled. Injuries involved: burns, missile wounds, fractures and lacerations.

108. Casualties were handled in Sick Bay, Forward and After Battle Dressing Stations and the Forward and Admidship Auxiliary Battle Dressing Stations. The After Auxiliary Battle Dressing Station was evacuated because of smoke and minor damage.

109. Injured personnel were treated initially by first aid. Less serious casualties were held at the Battle Dressing Stations thus leaving the Sick Bay free to handle the major casualties.

110. The Main Sick Bay facilities were adequate for the number of personnel treated and could have handled more if necessary.

111. The ENTERPRISE Medical Team was assisted by Medical Officer observers aboard for the ORI.

112. The number of casualties treated represents about the maximum that could be treated, personnel-wise, without establishing an expectant category. This is the category in triage which is not treated, with the expectancy that the patient will probably die.

113. The After Auxiliary Battle Dressing Station serves as a squadron office.

114. One of the dental officers was trained in general anaesthesia and thus was able to assist a medical officer in performing an operation.

115. The patients evacuated to Tripler Army Hospital were well stabilized and generally had received excellent treatment prior to evacuation.

116. Repair party and other personnel were very effective in transporting the injured to Battle Dressing Stations and Sick Bay.

117. Forward bomb elevators were used to move casualties from the flight deck to the Forward Battle Dressing Station.

118. The No. 1 Pilots Elevator was used to move patients from the Midships Auxiliary Battle Dressing Station to Sick Bay. This elevator is large enough to accommodate a man lying prone on a stretcher.

119. Access to the Forward Auxiliary Battle Dressing Station is tortuous.

120. The gasoline system was inerted with nitrogen and pressurized to 20 psi.

121. The JP-5 system was drained to the filter level on the third deck.

122. attempted to extinguish fires on the port quarter using the 2 1/2 inch fire hoses mounted on the forward gun mount, the flying bridge, and torpedo deck.

123. The fire hoses were ineffective because of high relative wind deflecting the hose stream.

124. was exposed to shrapnel and debris from explosions on the flight deck.

125. The port missile launcher was loaded with one sparrow with an inert warhead.

126. The crash crane was not used to jettison aircraft during the course of the fire.

127. The decision not to employ the crane to jettison aircraft was made in deference to the lack of protection afforded the operator from exploding ordnance.

128. There was concern that burning hulks pushed over the side might jeopardize other portions of the ship.

129. Cable runs in the gallery deck are not sealed at the structural bulkheads.

130. There was evidence that smoke and flame crossed bulkhead 03-255-4 through one of these openings.

131. Flush deck aircraft start/servicing stations are constructed so that liquids (salt water or fuel) may enter the ship if the flight deck hatch is not closed and dogged.

132. The Air Officer controlled the fire fighting efforts on the flight deck utilizing the 5MC and AN/SRC-22 for communication.

133. The Engineer Officer and Damage Control Assistant controlled the efforts of repair parties by using the sound powered phones, 4MC and J Dial telephone systems for communication.

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134. The Senior Medical Officer controlled the treatment of injured personnel at battle dressing stations by using the J Dial telephone system for primary communications.

135. Communications from the Hangar Deck Officer and other personnel in the hangar to Hangar Deck Control were largely by word of mouth and runners.

136. In the opinion of the senior observer from the Fleet Training Group, the flow of information to the bridge was excellent and the Commanding Officer was kept fully informed of the progress of the fire fighting.

137. Because of explosions in the immediate vicinity, Repair 7A was not manned during early fire fighting efforts.

138. Unit Repair Parties (75, 76, 77, 78) normally under the control of Repair 7A continued to function under the control of Damage Control Central.

139. EOD and ship ordnance personnel were not equipped with AN/SRC-22.

140. Information on the progress of fire fighting and conditions existing on the flight deck was not passed to below decks personnel.

141. Condition Zebra was reported set in 4 to 6 minutes.

142. Condition Zebra was not completely set in the areas for which Repair 7A and Repair 35 were responsible,

143. Initial fire fighting efforts on the flight deck consisted of employment of the Twin Agent Units, hand line fire fighting in the form of fog foam and salt water hoses, and activation of Washdown Countermeasure System. Exhibit 102 is a series of photographs of fire fighting.

144. Flight deck crews aggressively attacked what initially was a large fuel fire.

145. Fire fighting leaders testified that at the start they were confident the fire could be contained.

146. The cook-off of a 500 lb bomb after about 3 minutes caused an explosion which injured fire fighters, damaged fire fighting equipment, and spread the fire.

147. Aircraft located immediately aft of the island were moved forward which established a fire break.

148. After each explosion, flight deck personnel remanned their hoses and attacked the fire.

149. Damage within the ship was well contained and generally limited to the areas directly affected by the blast of explosions and fragmentation associated therewith.

150. The fire on the flight deck was reported under control by about 0857.

151. All fires had been extinguished by 1138.

152. On an aircraft carrier there are large numbers of people, particularly air wing personnel who may not be directly involved in fire fighting.

b. Opinions

1. Unilateral damage control actions taken simultaneously by the Air Officer and Engineer Officer may work at cross purposes. In the case at hand the initial demands of the Air Officer for salt water probably exceeded the available pumping capacity.

2. Initially there were approximately 3,000 - 5,000 gallons of JP-5 involved in the fire. This large fuel fire exceeded the capabilities of the Twin Agent Units.

3. The primary source of the large quantities of burning fuel which spread over a large area was the external tanks on the F-4 aircraft.

4. Because of its limitations and the size of the fire, the presence of a third Twin Agent Unit in the initial fire fighting efforts would not have prevented the cook-off of the first bomb.

5. Hand line fire fighting systems were ineffective in extinguishing the initial fire and in keeping ordnance cool enough to prevent cook-off. After the first major explosion the performance of hand line systems was further degraded in that hose crews were forced to retreat, regroup and re-attack the fires. In short, hand line systems are totally inadequate for use in fires involving ordnance.

6. Quick disconnect couplings and a device for rapidly patching ruptured hose would have greatly aided fire fighting efforts.

7. Hangar sprinkling was not well controlled. This was at least in part due to design deficiencies which resulted in the loss of control of sprinkling from Conflag Control Stations. This placed additional demands on an already over taxed fire main and caused unnecessary salt water damage to aircraft. However, the immediate activation in the after section of Bay 2 was justified in light of the uncertainty of the situation on the flight deck.

8. The Washdown Countermeasures System was not activated aft because of the initial lack of communications with Repair 7A and hence with Unit Repair Parties 76 and 79.

9. Because of the position of the nozzles on the flight deck, the after port section of the Washdown Countermeasures System (group 12) might have delayed the cook-off of weapons on F4-J 105 had it been activated. However, it is doubtful that washdown water would have prevented eventual cook-off.

10. The effect of the Washdown Countermeasures System forward was primarily to wet down and cool aircraft and possibly prevent secondary fires caused by burning fragments projected forward by the explosions. During the initial phase of the fire the effect of activating the forward system resulted in a net loss of fire fighting effectiveness and the subsequent decision to shut it down was correct.

11. Remotely controlled power operated valves if installed would have ensured the rapid activation of the Washdown Countermeasures System.

12. In the first five minutes after General Quarters sounded the following demands were placed on the fire main system:

	DEMANDS (GPM)
a. Forward portion of Washdown Countermeasures System was activated	10,595
b. Hangar Sprinkling, Bay 2 plus one group in Bay 1	9,000
c. Cooling water for AN/SPS 32 and 33, JBD's and arresting gear	2,250
d. Fire hoses on flight deck (4 fog foam, 4 salt water)	2,400
	24,245

These demands may not have been simultaneous, however, at any given time the requirements would have exceeded the 17,000 GPM available. As a result, the pressure was reduced below the acceptable minimum. In addition there was a short term high demand created by the ruptured riser in the island.

13. After the Washdown Countermeasures System was secured, the fire main pressure was restored to normal.

14. The installed pumping capacity is insufficient to permit the activation of a large portion of the Washdown Countermeasures System and sprinkling in the hangar bay and still maintain sufficient reserve capacity to supply hand line fire fighting and magazine sprinkling should it prove to be necessary. Additional reserve should also be available to permit routine maintenance on one or two fire pumps.

15. There is in addition to the need for more fire pump capacity a need for a system which will permit remote start from Central Control. The available pumps could then be brought into operation quickly when a large demand exists.

16. A high state of training with respect to damage control existed aboard ENTERPRISE prior to the fire on 14 January 1969.

17. The shortages in portable damage control equipment out of commission did not adversely affect the fire fighting efforts on 14 January 1969.

18. The non-availability of portable damage control equipment out of commission did not adversly affect the fire fighting efforts on 14 January 1969.

19. Smoke did not prove to be a serious problem during the fire because of the natural vents created by the holes in the flight deck. However, the de-smoking equipment proved to be ineffective when required.

20. The problem of providing lighting, both fixed and portable, which is effective in smoke filled, darkened compartments persists. During the early stages of this fire, electrical power to the gallery deck was not secured thus making escape from damaged compartments and early fire fighting efforts much easier.

21. The allowance of portable damage control equipment with the exception of portable blower dects is adequate.

22. The allowance of protein foam is adequate.

23. The ability of repair party personnel to effectively utilize the OBA and MK-5 gas mask is directly related to their state of training. Experience on board ENTERPRISE shows that the OBA is a satisfactory breathing device when properly used by adequately trained personnel.

24. The injuries to the hot suit men caused by the hood could be avoided by re-designing the hood liner to fully cover the head and providing a chin strap which will fasten the liner to the wearer's head.

25. Because of the lack of distinctive markings or devices it is difficult to identify the personnel in key leadership positions on the flight deck.

26. The brave act of Chief and the men who assisted him removed a serious threat to the island and aircraft located nearby. This is particularly significant in that at the time fire fighting water was not available to the island.

27. In general, the efforts to remove weapons, flares, pyrotechnics and other materials which were not directly involved in the fire were timely and effective.

28. While not contributing to the fire, some MK-24 flares were unnecessarily exposed when removed from the magazine and brought topside for jettisoning.

29. The unnecessary sprinkling of magazine 03-176-1-M may have contributed to the problem of maintaining adequate fire main pressure during the first few minutes of the fire and was therefore unwise.

30. All personnel engaged in fighting flight deck fires should have a working knowledge of the cook-off characteristics of weapons involved. Supervisory personnel should have detailed knowledge. This knowledge will not only enhance fire fighting efforts, but probably save lives. The significance of the presence of live weapons should be stressed in schools teaching flight deck fire fighting.

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31. All personnel engaged in the movement and treatment of casualties aboard ENTERPRISE generally performed in an outstanding manner. Of particular significance was the quality of the first aid applied on the scene. Through the efforts of all concerned, the number of deaths and the personal suffering were greatly reduced.

32. The movement of casualties to lower deck medical facilities via the bomb elevators is efficient and no doubt in this case, saved lives. However, this access route should only be utilized with the permission of D.C. Central in view of the possible compromise of watertight or ballistic integrity.

33. Relocation of the Forward Auxiliary Battle Dressing Station should be considered.

34. The use of the After Auxiliary Battle Dressing Station was at least in part impeded by the presence of equipment associated with its primary function as a squadron office. This additional equipment made the working space inadequate.

35. The ship's aviation fuel system did not contribute to the fire on ENTERPRISE on 14 January 1969. Actions taken to protect the system were timely and correct.

36. The Commanding Officer of USS ROGERS (DD-876) displayed courage and skillful ship handling in maneuvering his ship close alongside to aasist ENTERPRISE in fighting the fire. Such traditional response in coming to the aid of a ship in distress should be encouraged and supported by improvement in fire fighting capability.

37. The destroyers and other escort ships have inadequate topside fire fighting capabilities to render effective fire fighting assistance to ships in distress.

38. The decision not to employ the crash crane while there was still a risk of explosions was correct.

39. It would assist efforts of fire fighting personnel if those sections of the flight deck where aircraft might be safely jettisoned were clearly marked.

40. It is difficult, if not impossible, to establish fire boundaries on bulkheads penetrated by unsealed cable runs.

41. It is reasonable to expect that some of the flight deck servicing stations would be in use prior to an incident such as occurred on ENTERPRISE and that subsequent fires or explosions would make it impossible to close and dog the flight deck hatches.

42. The ENTERPRISE was organized, trained, and equipped to function in an emergency in an effective manner under the control of the Commanding Officer and his subordinates and did so.

43. The ship rapidly brought the equipment available to bear upon the fire. Prior to the first major explosion firefighting efforts proceeded in accordance with prescribed doctrine.

44. The fire fighting systems employed were ineffective and there was a major explosion as a result of the cook-off of a MK-82 bomb.

45. The introduction of live weapons to the flight deck immediately raises the level of risk of a major accident and at the same time places a requirement for reduced reaction time on those charged with controlling the spread of damage. Consequently, with existing equipment, a higher degree of damage control readiness than generally used during flight operations is necessary.

46. After the first major explosion control of the fire was no longer practicable and containment became the matter of most concern.

47. The most effective containment technique was to move the aircraft aft of the island to establish a fire break.

48. The lack of more direct communications on the hangar deck probably contributed to the problem in controlling the hangar bay sprinkling system.

49. Personnel not directly involved in the flight deck fire fighting efforts should in so far as practicable have been kept informed of the general situation as it developed. Repair Party personnel on the 03 level should have been informed of the conditions which existed above them on the flight deck.

50. The high state of training which existed aboard ENTERPRISE produced the individual leadership at all levels which is necessary to an effective damage control organization. Under the exceptionally fine leadership of the Air Officer and his key subordinates flight deck fire fighting teams fought against what to some appeared an impossible situation. After each major explosion hose teams regrouped and resumed their efforts. When men fell, trained backup men took their place. In any event, the aggressive but controlled efforts of these fire fighting crews prevented the explosions of more 500 pound bombs which almost certainly would have occurred had the fires been allowed to burn unopposed.

51. The two small holes in the vicinity of frame 236 port were probably caused by ZUNI Rocket warheads which also cooked off in the fire.

52. Sponsons and catwalks tend to impede the flow of liquids over the side and the jettisoning of aircraft and debris.

53. The ship's operational capability would have been limited by the loss of the aircraft, certain radar radio antennas and the LSO platform. Had the operational circumstances dictated, the ship could have continued to conduct flight operations with those undamaged aircraft remaining. Launching could have commenced as early as 1200; recoveries could have begun at about 1400.

The following opinions of the Board concerning the ENTERPRISE fire are related to the Russell Report and the numbers in parenthesis refer to recommendations as numbered in that report.

54. (1-1) Advanced Flight Deck Fire Fighting System - The need for massive and quick response is reaffirmed. Anything less will not be satisfactory. Remote control is essential to reduce personnel casualties.

55. (1-2) Purple K/Light Water System - Twin Agent Units employed on ENTERPRISE were ineffective in the face of the huge initial fire which developed.

56. (1-3) Washdown Countermeasures System - This system was not fully activated on ENTERPRISE. Sections in the fire area were not operating and hence no evaluation can be made. Those portions in the forward section of the ship which were activated did cool the aircraft and may have prevented fires from being initiated by burning fragments projected forward by explosions aft. As was anticipated, the additional demands for salt water associated with activation of the washdown system could not initially be accommodated and the fire main pressure was reduced below acceptable minimums. Consequently, there is some question as to the advisability of activating the system without some assurance that conventional fire fighting systems will not be degraded.

57. (1-6) Marking of Escape Routes - There were no specific problems encountered by personnel egressing from damaged areas on ENTERPRISE, and this was probably due to the fact that electrical power in the gallery deck was not lost immediately. Nevertheless, a standardized marking and lighting system is desirable.

58. (1-7) Additional Bomb Jettison Chutes - For the most part, weapons were jettisoned over the angled deck and elevators. Only one jettison chute was employed. The design of the chutes should be checked to insure compatibility with the skids used to handle weapons.

59. (1-8) Flight Deck Water System - The island monitor proposed has some merit, however, a deluge system using large nozzles located along the edge of the flight deck would probably be more effective in applying water where it is most needed, on the weapons.

60. (1-9) Interior Communications - The 1MC was effective in alerting personnel when General Quarters was sounded.

61. (1-10) Fire Hose - The new neoprene wrapped hose was not in use aboard ENTERPRISE. Hose which is more shrapnel resistant and equipped with quick disconnect couplings would have aided fire fighting efforts.

62. (1-14) HCFF Maintenance - HCFF Stations performed satisfactorily, however, Planned Maintenance System Instructions have not been received aboard ENTERPRISE. Because of deficiencies reported on an INSERV inspection, the ship had all foam pumps over hauled and stations tested prior to departure.

63. (1-20) Portable Exhaust Blower - The difficulties experienced in removing smoke from gallery deck compartments again justifies the need to provide a better portable blower for this purpose.

64. (1-21) Crash Crane Jettison - The crash crane was equipped with a blade and was used to jettison debris after the fires were extinguished. The crane cannot be employed effectively during a fire involving ordnance unless some degree of protection is provided the operator. Consideration should be given to installing light weight armor around the cab. It would also have been beneficial to equip the crash crane boom with nozzles which in turn could be connected by flexible piping to fittings to which fire hoses could be quickly attached.

65. (1-22) Damage Control Equipage Allowance - The ENTERPRISE allowance for OBA's, cannisters, foam, fire extinguishers and hoses was adequate.

66. (1-27) Battle Dressing Station Accessibility - The access routes to the Forward Auxiliary Battle Dressing Station require modification, otherwise the flow of injured personnel to Sick Bay and Battle Dressing Stations was expeditious and orderly.

67. (2-1) Current MK-5 Mask Capabilities - The MK-5 Gas Mask was effectively employed aboard ENTERPRISE during the fire. Based on this performance, its continued use as an escape breathing device appears to be warranted provided personnel have knowledge of its limitations.

68. (2-5) SRC-22 (MICKEY MOUSE) for Weapons Personnel - Weapons and EOD personnel were not equipped with AN/SRC-22 during the fire on ENTERPRISE. This equipment would have increased their effectiveness. In addition, it would be advantageous to equip key crash and salvage personnel such as Twin Agent Unit drivers with the AN/SRC-22.

69. (2-6) Flight Deck Personnel Equipment - In general the flight deck clothing provided adequate protection for crews fighting the fires. However, more fire resistant clothing which fits snugly at the wrists and ankles would have prevented some of the burns. Gloves should be standard apparel for flight deck personnel and be available as normal issue.

70. (2-7) OBA Improvement - The performance of the OBA was adequate and further modifications to this equipment, though probably desirable, should be given low priority in deference to improving other more critical fire fighting equipment.

71. (2-8) Improved Proximity Suit - Both Hot Suit men in ENTERPRISE were injured when their hoods were blown off. Improvements to the hot suit should include redesign of the hood.

72. (3-1) Improved Survivability of Aircraft - The large fire which developed after the first explosion was fueled by JP-5 from ruptured drop tanks. Design changes to these tanks which would suppress the spread of fuel would complement improvements in fire fighting capability.

73. (4-1) Increased Munitions Cook-Off Time - The critical factor in fighting fires involving weapons is the elapsed time to cook-off. The fire fighting system must be designed to react rapidly enough to prevent cook-off. Concomitantly, future weapons must be designed to survive within the reaction time of the fire fighting system.

74. (5-1) Air Wing DC/Fire Fighting Training - The fire fighting training of air wing personnel on ENTERPRISE was evidenced in the performance of the flight deck fire fighting crews which included many air wing officers and men.

75. (5-2) Fleet Damage Control Training Facilities - The ENTERPRISE utilized the inactive fire fighting school at Manchester, Washington while the ship was in the Puget Sound Naval Shipyard. Fleet Training Center, San Diego and Naval Schools Command, Treasure Island personnel assisted. This is an effective inexpensive method of enhancing the damage control training capability on the West Coast.

76. (8-2) Responsibilities of Air Officer and Damage Control Assistant -- The division of responsibility between the Air Officer and the Damage Control Assistant and the problems associated therewith were apparent during the fire on ENTERPRISE. Two manifestations of this division were the simultaneous activation of the Washdown Countermeasure System and hangar sprinkling which overloaded the fire main and the lack of information being provided repair parties in the 03 level concerning the status of fires on the flight deck.

77. (8-3) Duties of Crash and Salvage Crew - ENTERPRISE was organized with an independent crash and salvage crew. Their rapid reaction time in attacking the fire with Twin Agent Units is evidence of the wisdom of this change.

78. (9-1) Damage Control Training Requirements - The ENTERPRISE conducted damage control drills in one form or another daily. This training was reflected in the performance of the crew.

79. (9-2) Ship Maneuvering During Fires - An authoritative treatise on the maneuvering of a carrier during a fire would have perhaps assisted the Commanding Officer.

c. Recommendations

1. That as a matter of the highest priority, a new system be developed to control flight deck fires, whether self or enemy inflicted, involving fuel, aircraft and weapons. This system must include massive cooling as well as rapid extinguishment. It must provide flexibility, selectivity, and redundancy. The system must not compete with other systems for power, water or extinguishing agents. Controls must provide for remote activation and response must be immediate. There must be a capability to test the system regularly without damaging the aircraft or flight deck equipment. The dynamics of the carrier flight deck are unique and the fire fighting system must be structured accordingly. The requirement for this system is documented by 161 lives, 200 million dollars, and the loss of 8 CVA months of operating time since 29 July 1967. The system should be a military characteristic for all CVA's and rank in importance with the armament and aircraft launch and recovery systems.

2. That special conditions of readiness for flight deck fire fighting be established that are compatible with the levels of risk of explosion and fire which are present at any given time. The risk levels should relate to the amount and types of weapons present on the flight deck. Readiness conditions should fall between Condition III and General Quarters and include men on charged fog foam hoses, personnel stationed at Washdown Countermeasures System valves and preparation in the form of special spotting or towing arrangements which permit the rapid establishment of a fire break.

3. That ENTERPRISE be provided with sufficient salt water pumping capacity to meet the demands of all fire fighting systems which might reasonably be expected to be activated during an emergency such as occurred on 14 January 1969. Sufficient reserve capacity must also be available to provide for magazine sprinkling and preventive or corrective maintenance on a percentage of the pumps.

4. That the principles of human engineering be applied in a restudy of the design of the Twin Agent Unit in order to determine the number of operators required and at the same time the optimum configuration to permit rapid activation.

5. That men on the crash and salvage team designated to man the Twin Agent Unit nozzle be dressed in hot suits.

6. That updated Planned Maintenance System documentation for the High Capacity Fog Foam Stations be provided all carriers at the earliest feasible date.

7. That flight deck fire hoses be equipped with quick disconnect couplings and that the ship damage control allowance be revised to include Cooper Leak Stop and Coupler devices to permit rapid repair of leaking fire hoses.

8. That an alternate fire main supply to the island be installed.

9. That remote starting controls for the HCFF Stations from the Conflag Stations, hangar and flight deck stations be separately wired in order to preclude loss of control of hangar sprinkling because of damage to the flight deck controls.

10. That separate "E" call circuits be provided between each control station and the associated HCFF station.

11. That until such time as remote controls are installed on valves to activate the Washdown Countermeasures System, two personnel in each repair party be specifically assigned the responsibility of activating each valve in the system.

12. That PriFly and the Bridge be equipped with small scale diagrams of the washdown system showing the location of each group sprinkling the flight deck.

13. That activation valves be clearly marked with the number of the washdown group controlled.

14. That a status board be kept in Damage Control Central on which is recorded the opening or closing of washdown system valving in order to ensure activation in the event of an emergency.

15. That doctrine and training in the employment of the washdown system stress the need to selectively activate the system in order not to exceed the available salt water pumping capacity.

16. That all electric fire pumps be configured for fully remote start from Central Control or from Engineering Operating Stations.

17. That the ENTERPRISE concept of a ship's Damage Control Training and Evaluation Team is well founded and should be adopted as a standard for all carriers.

18. That the use of the fire fighting school facilities at Manchester, Washington be made standard practice for all carriers in restricted availability or regular overhaul at Puget Sound Naval Shipyard.

19. That a better portable exhaust blower be developed for use in desmoking compartments.

20. That the damage control allowance include additional lengths of ducting for existing portable exhaust blowers and that a more rugged coupling be provided.

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21. That the damage control allowance be revised to include eductors which operate off 2 1/2 inch fire hose.

22. That a study be made to develop a portable headlamp for repair party personnel which is more effective in smoke.

23. That fleet personnel continue to employ the MK5 gas mask as an escape breathing device with the proviso that they be thoroughly briefed on its limitations.

24. That all flight deck personnel be equipped with the hard shell skull cap and gloves.

25. That developmental efforts be continued to provide more fire resistant clothing for flight deck personnel. This clothing should be designed with a snug fit at the wrists and ankles.

26. That a distinctive marking system be adopted which will permit easy identification of officers and senior chief petty officers on the flight deck and in particular those responsible for directing the fire fighting and weapons disposal.

27. That the design of bomb jettison chutes be reviewed to ensure that there is sufficient clearance for AERO series handling skids.

28. That the Commanding Officer, ENTERPRISE have applicable instructions concerning the protection of ordnance in magazines reviewed and changed if necessary to prevent the inappropriate removal and jettisoning of weapons in deep sprinkled magazines.

29. That an authoritative manual be written which describes the behavior of weapons in a fire. This manual should include cook-off times, temperatures, and a description in understandable terms of reference of the force of the explosion which might be expected.

30. That dental officers on CVA's be trained in general anesthesia so that they might assist medical officers in an emergency such as occurred on ENTERPRISE.

31. That better access to the Forward Auxiliary Battle Dressing Station be provided or the station be relocated.

32. That the space assigned for the After Auxiliary Battle Station be used exclusively for this purpose or rearranged to ensure that adequate working space is available in emergencies.

33. That a brief summary of lessons learned with respect to ship handling in emergencies such as occurred on ENTERPRISE be prepared. This document should include major incidents from World War II as well and be made available to prospective Commanding Officers.

34. That the shipalt to modify the Washdown Countermeasures System be accomplished on ENTERPRISE and other carriers as an interim solution until such time as the advanced system is completed.

35. That the crash crane be modified to provide better protection for the operator and fittings on which to attach fire hoses.

36. That safe aircraft jettison locations be designated on each carrier and flight deck crews be instructed accordingly.

37. That sponsons and catwalks be designed insofar as practical to rapidly drain liquids and permit the jettisoning of aircraft and other debris.

38. That all cable runs in the gallery deck be sealed at the main structural bulkheads.

39. That flush deck aircraft starting/servicing stations be modified to prevent liquids from entering the ship even though the hatch may be open.

40. That ship ordnance and EOD personnel be equipped with AN/SRC-22 "Mickey Mouse."

41. That damage control doctrine be revised to ensure there is a flow of information across the interface between air department and repair party fire fighters. It is particularly important that repair party personnel on the 03 level be kept informed of the status of fire fighting on the flight deck.

42. That damage control doctrine be revised to ensure that personnel not directly involved in the fire fighting efforts be kept informed of the situation as it develops and utilized as reserves when the need arises.

43. That studies be initiated to determine the feasibility of suppressing the spread of fuel from aircraft drop tanks when struck by high velocity projectiles.

44. That damage control doctrine, training, and drills be revised to recognize the coordination problems generated by the split fire fighting responsibilities between the damage control organization and the Air Department. The Bridge must be prepared to act as the coordinating point and where competing requirements develop, exercise overall control.

45. That destroyers and other escort type ships be equipped with increased topside fire fighting equipment to render assistance to other ships.