[redacted]

5. That the inflammable oil fog and explosive hydrocarbon products of the fire in the forward end of the port catapult machinery room passed out of this room through its open forward doorway 3-48-1 into the 3rd Deck passageways, from where it quickly expanded aft through the open 3rd Deck doors and passages and forward and up through open Watertight Hatchway 2-43 from whence it spread through the 2nd Deck officers' country and down into the wing 3rd Deck living spaces, again primarily through open doors and hatches and passageways.

6. That the explosive products which spread throughout the ship exploded when mixed with sufficient air and an ignition source was provided.

7. That although the most probable cause of fire within the hydro-pneumatic system is Diesel ignition at the piston valve, it will not suffice to eliminate only this source of ignition. Corrective action must include all possible sources of ignition.

8. That the other possible sources of ignition, but of lesser probability than the piston valve, are:

(a) Diesel action in the main hydraulic pumps.

(b) Oxidation in the vapor phase, liquid phase or the oil films of the accumulator or the liquid level gages, involving the presence of peroxides, catalysts, degenerated products of oil oxidation, increased oil temperature due to firing, etc.

(c) Generation of electrostatic charges due to friction or rupture of fluid surfaces and subsequent discharge to the steel wall of the accumulator.

(d) External heating, due to an outside fire, of some thin spot of the high pressure hydro-pneumatic system containing explosive vapor, such as the liquid level line or in the section of the air charging

[redacted]

line adjacent to the accumulator.

(c) Diesel action due to chattering of the relief valve.

9. That the air charging line from the pressure regulator to the tee-fitting does not indicate evidence of Diesel action.

10. That the carbon deposits in the middle and upper liquid level gages and the upper liquid level line leading to the 4 inch line of No. 1 air flask indicate that fire occurred therein.

11. That the liquid level line does not have the mechanism necessary to produce compression ignition.

12. That no fire occurred in the 4 launching air flasks.

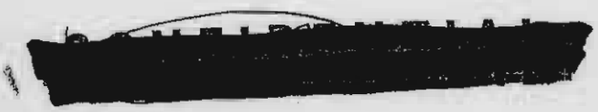
13. That the fire in the accumulator was initiated at approximately the time of piston valve closure for the 13th shot as evidenced by the following observations:

(a) The pressure indicator card showed a normal cylinder pressure pattern until a time approximately 1/3 second before the piston valve closed, the remainder of the record being illegible.

(b) The carbon deposits in the accumulator extended to approximately the low level reached by the oil in the accumulator for a shot at 2700 p.s.i.

(c) The low oil level in the accumulator exists for a very short time since the level starts to rise immediately after the piston valve closes.

14. That the continued action of the pumps, after the rupture of the brass elbow and the blowing-off of the relief valve, may have extended the amount of damage, due to continued supply of oil.



15. That the very dirty strainers on two of the pumps could account for their unusually noisy operation.

16. That the position of the launching pump regulator selector switch and the regulator settings indicate that the pumps were being manually controlled.

17. That the 13th shot was recorded on the indicator card and that the launching pressure pattern for this shot was normal for the 75 percent of the power stroke which was legible.

18. That the retraction panel operator had not yet started to recover retraction accumulator pressure when the casualty occurred.

19. That the hot-short temperature of the ruptured brass elbow, connecting the liquid level gage line to the 4 inch air line of No. 1 flask, is approximately 600° F.

20. That the recrystallization temperature of the severely cold-worked portion of the ruptured brass elbow was about 400° F.

21. That the section of low pressure piping between the middle and lower liquid level gages did not contribute to the casualty and indicated that sustained pressures in excess of 6,400 p.s.i. did not exist.

22. That there was no break in the hydraulic system that could have permitted the entry of fire into the accumulator and caused its initiation.

23. That the ruptured elbow in the liquid level line was defective in that the walls were abnormally thin or were weakened by inclusions.

24. That the relief valve and associated fittings did not fail as a result of fatigue or vibration.

[redacted]

25. That a minimum percentage of nitrogen content to prevent combustion of inflammable hydraulic oil as well as for safety fluids at high pressure has not been determined.

26. That copper and copper alloys are the most likely metallic catalytic agents for promoting oxidation of hydrocarbons.

27. That the non-accomplishment of the three (3) authorized H8 catapult Changes Nos. 19, 25 and 27 and one part of the H8 Catapult Bulletin No. 72 in no way contributed to the casualty.

28. That, although ALNAV 60 had not been seen by the Air Officer, the V2 Division Officer and the Catapult Officer, the provisions of this ALNAV were being essentially carried out by the ship through execution of other pertinent directives and that this non-sighting of ALNAV 60 did not contribute in any way to the casualty.

29. That the fact that the catapult logs were not maintained in strict accordance with current ComAirLant Standard Air Department Instructions did not contribute to the cause of the casualty.

30. That the port catapult crew were apparently forewarned of the catapult casualty as evidenced by Lieutenant B6 testimony.

31. That the three bodies found in the port catapult machinery room were members of the port catapult crew.

32. That the existing service instructions do not specifically prescribe the frequency and scope of tests to determine suitability of used catapult hydraulic fluid, but that the absence of such specific instructions did not contribute to the initiation of this casualty.

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[redacted]

33. That Nos. 5, 6, 7, and 8 boilers were salted to approximately 25 E.P.M. due to contamination of the L.P drain system, apparently caused by continued operation of the forward evaporators unattended.

34. That the ventilation system, though contributing to the extension of damage played only a secondary part in the spread of damage as compared to the part played by open doors and hatches and open passageways leading from the port catapult room and as compared to drafts through these passageways.

35. That the damage sustained by the armored hangar deck and to the compartment below does not condemn the design of this deck, for it was not intended to limit damage beneath when attacked from beneath.

36. That assistance furnished by outside Naval and Coast Guard Commands and civil activities in providing air-lift, doctors, corpsmen and other services was prompt, adequate, and commendable.

37. That helicopters minimized effects of personnel casualty by early and rapid transfer of doctors and corpsmen to the ship and of the injured to hospitals.

38. That, although handicapped by the death of one doctor and one Medical Corp specialist, first aid was ably rendered with the assistance of many volunteers trained in first aid.

39. That, although the ship was handicapped by loss of key personnel, dense smoke, and fire, damage control and rescue work were executed effectively.

40. That there were adequate medical stores aboard.

41. That, in general, damage control equipment was adequate to carry out damage control and rescue operations.

[redacted]

[redacted]

42. That no sabotage occurred.

43. That safety precautions issued as a result of the LEYTE accident were being followed in the BENNINGTON.

44. That all the studies and investigations recommended by the LEYTE Court of Inquiry have been initiated and prosecuted and that, as rapidly as could be expected, the results of these studies and investigations have been, and are being, applied.

45. That the BENNINGTON casualty would not have occurred had nitrogen been in use in the catapults.

46. That the BENNINGTON casualty would not have occurred had a non-flammable hydraulic fluid been in use in the catapults.

47. That the discipline and general performance of duty of personnel in damage control and rescue operations was outstanding, and in keeping with the best traditions of the service.

48. That the catapult personnel, including officers and crew, were efficient and well-trained.

49. That no fault or blame should accrue to Captain Commander Lieutenant or Lieutenant .

50. That the explosions were not due to the intent, fault, negligence or inefficiency of any person in the naval service or connected therewith.

51. That the deaths of, and injuries to all Naval and Marine Corps personnel which were suffered or sustained as a result of the explosions here under inquiry were incurred in the line of duty and not as a result of the misconduct of any of them.

[redacted]

[redacted]

52. That the deaths of, and injuries to, all Naval Reserve and Marine Corps Reserve personnel which were suffered or sustained as a result of the explosions here under inquiry were incurred while such reserve personnel were on extended active duty within the meaning of Public Law 108, 81st Congress (Ac of June 20, 1949; 34 U. S. Code 855c-1) and in line of duty and not as a result of misconduct of any of them.

53. That the death of the civilian involved, which was suffered as a result of the explosion here under inquiry, was incurred within the line and scope of his employment by Westinghouse Electric Company while he was on authorized temporary duty on board the U.S.S. BENNINGTON and not as the result of his own misconduct.

54. That the deaths of, and injuries to, all personnel which were suffered or sustained as a result of the explosion here under inquiry were not caused by the intent, fault, negligence or inefficiency of any person or persons in the naval service or connected therewith.

55. That it has been known for many years that localized Diesel ignition has occurred in the submerged areas of catapult engines. This ignition was not considered dangerous due to the limited air supply and quick smothering effect of the large surrounding oil volume. This is supported by many years of catapult operations involving hundreds of thousands of catapult launchings, wherein no casualties or mechanical problems resulted therefrom. The U.S.S. LEYTE casualty was attributed to Diesel ignition in the pneumatic system, which is obviously dangerous. Corrective action was initiated and safety precautions were issued to prevent recurrence of this casualty. As a result of the U.S.S. BENNINGTON casualty it now appears that there is a possibility (65) of Diesel ignition, in submerged areas of the catapult, which may reach the [redacted]

[redacted]

pneumatic section in the accumulator due to unusual circumstances. This indicates that Diesel ignition in any section of the catapult is dangerous and must be completely eliminated. It is believed that compliance with the recommendations set forth herein will eliminate all possible future casualties of this type.

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RECOMMENDATIONS

1. That a fully non-flammable fluid be developed for use in high pressure hydro-pneumatic systems in Navy ships in lieu of presently used flammable hydraulic oils.

2. That, until such time as a fully non-flammable fluid suitable for use in high pressure hydro-pneumatic systems can be found, the least flammable suitable fluid be used.

3. That an inert gas such as nitrogen be used in high pressure hydro-pneumatic systems, except small piston type, giving due consideration to the hazards involved in its onboard manufacture, and that some means such as scenting be used for detection in event of leakage.

4. That, in the event it is impracticable to provide 100 percent nitrogen in the hydro-pneumatic system, a lesser amount be used; the minimum amount of nitrogen which will provide safety to be determined by test.

5. That, in the interim, until a suitable Hydrolube, and insofar as practicable, an adequate percentage of nitrogen, are in use in catapults, such action as the following be taken:

   a. Use of catapults and other similar systems operating on the high pressure hydro-pneumatic principle be limited to the absolute minimum consistent with urgent military requirements.

   b. If urgent military necessity demands the firing of catapults operating with flammable oil and air, every possible precaution be taken to prevent another casualty, by use of: Maximum cycle times, maximum liquid level in the accumulator, lowest possible launching pressures, strict compliance with instructions and safety precautions.

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c. The gasoline system be inerted during catapult launchings.

d. Magazines and bomb elevators be secured during catapult operations.

6. That the accumulator over-pressure relief system be redesigned to accommodate full discharge of the hydro-pneumatic system, including combustion products resulting from a fire within the accumulator, without subjecting any portion of the hydro-pneumatic system to pressures exceeding design working limits.

7./

8. That such compartments as catapult compartments containing high pressure hydro-pneumatic systems using flammable fluids be considered hazardous, that instructions be issued to vent such spaces to the atmosphere, and to isolate them from the remainder of the ship, and that sources of sparks, such as exposed lighting fixtures, be eliminated.

9. That future hydro-pneumatic system designs avoid arrangements having direct liquid-gas contact.

10. That Hydrolube for service use be thoroughly laboratory tested under conditions which may be encountered in service to prove its safety, including tests in partial nitrogen atmosphere.

11. That the present research and test program at the Engineering Experiment Station, in Diesel ignition and in the evaluation of hydraulic fluids and of pressure snubbers and flame screens, be continued with high priority.

12. That the present research and test program at the Naval Research Laboratory, in the studies at high pressure of the properties of air-oil vapor mixtures and the ignition in all sorts of dispersion of

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hydrocarbons in various oxygen-nitrogen mixtures, be continued and expedited all possible. The focus of this program should be the determination of these facts which will demonstrate the degree, and will set the limits, of safety of those hydraulic fluids of operational interest, particularly Houghto-Safe 271, in air and air-nitrogen mixtures up to 4,000 psi.

13. That the present research program at Pennsylvania State University in flame propagation in air lines be continued.

14. That the study of the firefighting problems, and of improvement of equipment and techniques for fighting fires arising from hydro-pneumatic systems, be continued.

15. That a study of electrostatic charges in air-oil systems to determine whether a hazard exists at or near bulk oil surfaces be undertaken.

16. That catapult gravity tank vents be discharged overboard.

17. That supplementary service instructions be issued which more specifically prescribe the frequency and scope of tests required to determine the suitability of used hydraulic fluids.

18. That emphasis be placed on meticulous cleaning of all hydraulic systems to remove all foreign matter such as lint, grit, etc.

19. That a hydrostatic overload test of 50 percent over maximum working pressure be applied to the catapult hydro-pneumatic system after initial installation and during each shipyard overhaul.

20. That, pending development of a suitable over-pressure relief system, a periodic check of the relief valve lifting pressure on top of the launching and retracting accumulators be prescribed.

21. That instructions for catapult log preparation be more specifically set forth.

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[redacted]

22. That, in the event a relief valve opens, the inside of the top of the accumulator be inspected for evidence of combustion and a report be made by message to the type commander.

23. That action be taken to obtain isolation in order to prevent widespread distribution of explosive gases, flame, and blast effects from any source within combatant ships.

24. That emergency trip valves for cutting off fuel oil supply to boiler burners be made more easily operable, the trip to be easily found in the dark and operable from both the upper and lower levels.

25. That a study be made to determine the advisability of limited supply of OBA equipment in certain isolated key control centers, such as the Damage Control Central.

26. That the following be emphasized:

(1) Frequent and realistic damage control drills, simulating loss of key personnel.

(2) Self-aid and first aid, especially for flash burns.

(3) The value of clothing in protecting the body against flash burns.

(4) Importance of dispersal of key personnel in the same specialty, and of medical supplies, throughout the ship.

(5) Drills in using emergency trip for cutting off fuel supply to boilers.

27. That no action of a legal nature or for disciplinary purposes be taken, and further, that no disciplinary action is indicated and none is recommended as to Captain , Commander , Lieutenant and Lieutenant.

[redacted]

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[redacted]

28. That the Commanding Officer, U.S.S. BENNINGTON submit a list of those persons most deserving of commendation and the degree thereof.

Rear Admiral, U.S. Navy, President,

Rear Admiral, U.S. Navy, Member,

Captain, U.S. Navy, Member,

Captain, U.S. Navy, Member.

[redacted]

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