U.S.S. WASP (CV7)

Loss in Action

South Pacific
15 September,1942

Class.....Aircraft Carrier	Length (W.L.).....690'-0"
Launched.....April 4,1939	Beam (W.L.)..... 80'-8"
Displacement.....14,700 Tons (Standard)	Draft..... 22'-2" (Designed)

Reference:

(a) C.O. WASP ltr. P6-1 (006) of 24 September, 1942 (Loss Report).

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1. USS WASP on fire after being struck by two submarine torpedoes.

2. Port bow of USS WASP. Fire has increased in intensity. Gasoline on the surface of the water on the starboard side is on fire.

3. Starboard bow of USS WASP taken after photo No. 2. Fire from gasoline on the surface of the water has spread up the starboard side.

4. Starboard bow of USS WASP probably taken after a gasoline vapor explosion. Fire has spread to the lee side of the island.

5. USS WASP down by the bow and burning fiercely. Most of the island structure is on fire.

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III - Arrangement of Gasoline Systems for CV's.

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SECTION I - SUMMARY

1. WASP (CV7) was torpedoed by a submarine during the afternoon of 15 September, 1942 while operating with a task force southeast of the Solomon Islands. When attacked, planes were being rearmed and refueled, and a large portion of her gasoline system consequently was in use. Two torpedoes struck and detonated against the starboard side, one about frame 36 in way of the gasoline stowage tanks and the other about frame 62 in way of the forward bomb magazines. About 20 seconds after the torpedoes detonated a third explosion, of somewhat less intensity, occurred. Immediately following the torpedo detonations and the explosion, gasoline fires broke out in the vicinity of the athwartship gasoline main on the second deck at frame 63 and low in the vessel in the vicinity of the ruptured gasoline tanks. In addition to these fires another serious conflagration was started in the forward portion of the hangar. Free gasoline pouring from the ruptured tanks onto the surface of the water was ignited, and soon WASP was completely enveloped in flames from frame 20 to frame 80. Within 25 minutes of the attack, three additional major gasoline vapor explosions occurred. Very little water pressure was available at the fire plugs on the hangar and flight decks. The order to abandon WASP was given about 35 minutes after the torpedoes struck. The vessel burned throughout the rest of the day and was sunk by U.S. destroyer torpedoes at nightfall.

2. With the exception of the forward diesel generators and the No. 1 main generator in the forward engine room, the engineering plant was intact and engineering personnel remained at their stations until WASP was abandoned. These circumstances, plus the fact that it was necessary for U.S. forces to complete WASP's destruction, are clear indications that structural damage and loss of buoyancy and stability were not fatal. The loss of the WASP thus must be attributed to the fires which resulted from the ignition of gasoline.

3. WASP was a new vessel, completed in 1940, and is considered to have been provided with an excellently arranged fire main system with ample pumping capacity. The inability to control the fire on the hangar deck is disappointing in view of the excellent facilities provided and the intact condition of the pumping plant. It was this fire which eventually forced WASP to be abandoned.

4. It appears that initially there were three distinct areas in which fires occurred. These areas were first, the hangar; second, the second deck in the vicinity of frame 63; and third, low in the vessel in the vicinity of the ruptured gasoline tanks. The fire on the second deck resulted from gasoline draining into this area from the mains above and on the outside of the ship. The fire low in the vessel came from free gasoline from the ruptured tanks. The fire in the hangar was undoubtedly caused by aircraft falling from the overhead onto other aircraft parked on the deck rupturing aircraft gasoline tanks and allowing gasoline to escape. After consideration of these factors, it has been concluded that the fire in the hangar, together with low fire main pressure on the plugs in the hangar, was primarily responsible for the

loss of WASP. If the hangar had been available as an area for damage control operations and had remaining facilities been utilized, it seems probable that the fire on the second deck would have been controlled quite readily, inasmuch as the quantity of gasoline feeding this fire was not very great. Whether the fire low in the ship could have been confined and eventually extinguished, had the opportunity been available to exert efforts to this end, is problematical. Other cases of fighting severe oil and gasoline fires indicate a probability that this might have been accomplished. On the other hand, severe gasoline vapor explosions might have prevented confinement of the fire.

5. The references report very low pressure at the fire plugs on the hangar deck. Some survivors have attributed this lack of pressure to destruction of the fire main by shock. After a thorough study of all the evidence, the conclusion was reached that the low pressure on the hangar deck fire plugs was caused by an open break in the forward loop of the fire main, and that the forward loop was never isolated from the balance of the system.

6. Thus the circumstances involved in the loss of WASP were somewhat similar to those which caused the loss of LEXINGTON (CV2)* inasmuch as both vessels had to be abandoned by reason of the raging internal uncontrolled fires followed by internal explosions. In neither case were the structural damage and loss of buoyancy and stability caused by the torpedoes sufficient to have caused the loss of the vessels.

7. The case of LEXINGTON (CV2) indicated a need for further improvement in gasoline stowage and handling arrangements for carriers, and the case of WASP emphasized this need. Shortly after the loss of LEXINGTON a program of research was inaugurated and, at the same time, an investigation was made of merchant marine and industrial practices for the stowage and handling of gasoline. The improvements and changes which are being placed into effect are discussed in some detail in Section III. It is hoped that a marked increase in resistance to damage of the gasoline system and ease of handling gasoline will result. Most of the improvements discussed in Section III will be incorporated in the later vessels of the ESSEX (CV9) class and the CVB41, new CVL and CVE105 classes of carriers.

SECTION II - NARRATIVE
(Plates I and II, All Photos)

8. The data on which this report is based were obtained from the Commanding Officer's report, reference (a). That reference included statements by several of the surviving officers, and is a more complete description than is usual in such cases of severe damage followed by loss. The extent of structural damage, however, is not of record and apparently was largely undetermined. The Bureau accordingly has supplemented the data contained in reference (a) with an estimate of the probable extent of structural damage. This estimate is based on a study of a number of cases of torpedo damage to vessels with underwater layouts similar to that of WASP. Plates I and II thus were prepared from a combination of the known facts and estimate based on other war experience. The

* BuShips War Damage Report No. 16

photographs are copies of pictures taken by the various photographic units attached to the task force. Plate III is a diagrammatic arrangement of the new type of gasoline stowage discussed in Section III.

9. During the afternoon of 15 September, 1942 WASP was a unit of one of two carrier task forces operating jointly in an area southeast of the Solomon Islands. The sea was slight with a few whitecaps. The wind was about 14 knots from east southeast. The formation's base course was 280 degrees. WASP was duty carrier, periodically turning into the wind to launch and recover aircraft. The ship was in Condition II with the air department at flight quarters. Material condition "BAKER ALERT" was set. At 1420 WASP turned into the wind on course 120 degrees and launched 18 VSBs and 8 VFs. Immediately after the launching was completed the ship took aboard 8 VFs and 3 VSBs. Upon completion of recovery, the ship commenced to turn right with standard rudder at 16 knots to base course. This was at 1442. During flight operations refueling and rearming of aircraft on board were in progress. Torpedo planes in the hangar were armed with torpedoes but gasoline tanks had not been refilled and still contained CO_2. Scout bombers in the hangar were fully fueled and armed with depth bombs. Fighters on both the flight deck and in the hangar were fueled and armed. The gasoline system was in use. Orders had been given to re-spot aircraft and, in connection with this, the forward section of the gasoline system was being secured and the hoses were being walked back to drain gasoline into the tanks. This, however, had not been completed at 1445. At the same time the after section of the gasoline system was being prepared for use and gasoline was being pumped through the mains. It is not known whether fuel had reached the flight deck at 1445.

10. At 1445, while in a turn to the right, two submarine torpedoes were sighted close aboard approaching from about three points forward of the starboard beam. They appeared to have been fired from a point close to the vessel as they were still rising when sighted. They were estimated to have been between 10 and 15 feet below the surface when they struck and detonated. The first one hit at about frame 36, starboard. The second struck almost immediately afterward at about frame 62 just forward of the island structure. The ship immediately listed 15 degrees to starboard and finally came to rest at 11 degrees. Flooding resulted in a large trim by the bow. An examination of the photographs indicates that this trim was about 10 or 12 feet.

11. The first torpedo which struck the starboard side at approximately frame 36, destroyed the outer and inner skins of the vessel and ruptured gasoline tanks in A-10-Gas. The 5-inch handling room A-602-M was undoubtedly flooded as was probably the 5-inch powder magazine A-601-M immediately forward. The first platform was probably disrupted over a large area and the storerooms on this deck were flooded. The fourth deck was also probably ruptured as survivors abandoning the forecastle noted a hole in the starboard shell above the waterline despite the fact that the ship was down by the bow and was listing to starboard. The gasoline suction and discharge mains running under the first platform were probably destroyed

or broken as far aft as frame 45. The gasoline trunk A-512-T and the gasoline pump motor room were probably wrecked. This torpedo also may have ruptured the boundaries of the gasoline tanks in A-13-Gas. Gasoline quickly flowed from A-10-Gas onto the surface of the water above the hit. Gasoline was also probably sprayed through damaged first platform compartments.

12. The second torpedo, which struck almost immediately after the first, destroyed the inner and outer skins on the starboard side and flooded the bomb magazines in the area between frames 56 and 68. Bulkhead 62 was probably destroyed on the starboard side at least to the fourth deck. The first platform was undoubtedly disrupted, permitting the flooding of the storage spaces on this level from side to side between frames 49-1/2 and 76. The centerline bulkhead between frames 56 and 68 on the second platform was probably ruptured, flooding the bomb magazines on the port side. Bulkhead 68, separating the bomb magazines from the plotting room and central station was ruptured. The plotting room flooded rapidly with water and oil, and central flooded slowly through trunk A-619-T. Undoubtedly, the gasoline tanks in compartment A-13-Gas forward of this hit were also ruptured, and the after gasoline trunk A-521-T was damaged. The 1"1, 20mm, .50 and .30 caliber ammunition magazines in the hold below the second platform were probably flooded in way of this hit. The overall extent of damage and flooding was not reported but was probably about as shown on plates I and II.

13. Undoubtedly, the forward loop of the fire main, as shown on plates I and II, was ruptured at least in the starboard section in way of the two torpedo detonations. This made inoperative the fire main risers connected to the forward loop.

14. Survivor reports indicate that shock from the two torpedo hits was considerable. A ladder on the main deck about frame 20 was torn from its fastenings and hung straight down from the forecastle deck hatch. The four aircraft triced to the overhead forward fell and struck the planes parked on the hangar deck. The landing gears on all aircraft collapsed. This damage was evidently due to shock as no serious blast effects occurred in the hangar at this time. The forward diesel generators were thrown from their foundations and all lights went out in the forward half of the vessel. In the forward engine room the forward main distribution board was damaged. In addition, the shell of the forward dynamo condenser was reported to have split, permitting steam to escape into the forward engine room. Shock damage was also reported to instruments located in the control spaces in the island. Flexural vibration must also have been present inasmuch as whipping of the foremast was reported, which dislodged numerous rivets.

15. Simultaneously with the impact of the second torpedo hit, flames appeared on the water in way of the forward hit at frame 36. A short time later flames also appeared in the forward section of the hangar. This fire in the hangar was probably started by gasoline spilling from the tanks of the aircraft. Rupture of the tanks probably was caused by falling planes and debris. This fire quickly spread to the starboard

5-inch gun platform. A short time later ready service projectiles for 5-inch gun No. 3 began to detonate.

16. About 20 seconds after the torpedoes struck, a third explosion - somewhat less severe - was felt. This was reported by the Commanding Officer to have been a torpedo, but it is believed to have been of internal origin inasmuch as the flight deck cover to bomb elevator A-423-ET was blown violently upward and flames appeared in the shaft. The cause of this explosion is unknown, but possibly gasoline vapors from the gasoline tank A-13-Gas passed through the bomb magazine and into the bomb elevator trunk A-711-ET where they might have collected. Or possibly, they might have collected in the bomb arming stations A-309-L and A-310-L. The explosion was witnessed by a survivor who was on the first platform deck in trunk A-619-T. He saw the flash of the explosion on the third deck and was thrown down the trunk to the next deck. The blast apparently traveled up the bomb elevator trunk A-423-ET and blew off the bomb elevator hatch cover on the flight deck. Other blast effects were felt throughout the island structure and spaces on the second deck. Paint on the after side of bulkhead 76 in the log room, which is immediately aft of the bomb arming station, caught fire. The athwartships gasoline mains under the main deck at frame 63 were reported to have leaked, probably at the fittings, and the spilled gasoline burned. Whether the leaks in gasoline piping were caused by the vapor explosion or the torpedo detonation is open to question, but the Bureau considers that the vapor explosion is a more probable cause of this leakage. The second deck may have been ruptured by this explosion. The aluminum bulkheads on the starboard side were collapsed and disrupted as far aft as frame 87. The area between frames 62 and 76 on the second deck was soon on fire completely across the vessel. The after section of the gasoline system, which at the time of the torpedo hits was being placed into use, contained gasoline. These mains probably drained by gravity into the transverse gasoline mains at frame 63 on the second deck, inasmuch as the references contain no mention of attempts to cut out this section by the cut-out valves provided in the mains. Since this main was leaking, a constant source of gasoline was furnished for some moments to the vicinity of frame 63 on the second and the third decks. Three serious vapor explosions occurred in this area prior to the ship's abandonment.

17. The first of these explosions, "A" on Plates I and II, occurred at a time variously estimated to be from three to five minutes after the torpedoes hit. It evidently centered in the area around the athwartship gasoline main at frame 63, probably in the vicinity of the area disrupted by the previous explosion in the bomb arming station below. Structural damage from this explosion was not reported, but the shell was not torn open. The blast traveled up the already damaged bomb elevator trunk and sent flames and heavy smoke up the inboard side of the island structure. The bulkheads separating the No. 2 elevator pit from the scene of the explosion were probably disrupted as the blast lifted the elevator, which was at the flight deck, sending the light waterway cover plates about 20 feet into the air.

18. At 1505, 20 minutes after the torpedoes struck, the second heavy vapor explosion "B" occurred. It probably

centered in the third deck area in or adjacent to the explosion in the bomb arming station. This explosion manifested itself above the flight deck in a large ball of flaming gases which completely enveloped the forward portion of the island. These gases apparently came from the third deck area through the previously damaged bomb elevator trunk. The No. 2 1"1 quadruple gun mount immediately forward of the bridge was blown from its base. Twenty millimeter and 1"1 cartridges in the clipping rooms in this area started to go off with low order detonations because of the heat from the surrounding fires. The bridge was abandoned at this time.

19. The third major vapor explosion "C" occurred at 1510. Its effects were particularly noted in the hangar deck area. No. II elevator was lifted bodily and fell back on the flight deck so that it lay askew across the elevator opening. Steel plating, expansion joint covers and barrier stanchions around elevator No. II were blown as high as 150 feet into the air. An officer who was supervising the firefighting activities on the hangar deck was blown from his position aft of No. II elevator about 50 feet along the deck. The dense smoke from this explosion was noticed by the screening vessels. The center of this explosion was probably in the elevator pit on the second deck. This area had been wrecked by previous explosions.

20. The fire had already spread to the starboard forward 5-inch gun group and caused the detonation of some ready service projectiles for these guns. The bulkhead separating this platform from the interior of the ship was riddled and the crew's space A-0206-L was wrecked. Bulkheads and spaces forward and aft of this platform were ripped and torn. Bulkhead 25 separating the hangar from the wardroom country was reported to have been destroyed. The fire rapidly crossed through the ship and eventually resulted in the detonation of the ready service projectiles in the forward port 5-inch gun group. The whole area below the flight deck between the forward port and starboard gun groups was so completely wrecked that a large hole through the vessel was noted by the Air Officer after he abandoned the ship.

21. There were 16 aircraft, four SBD-3's and 12 F4F-4's on the hangar deck forward of No. 2 elevator. All were fully loaded with gasoline and .30 and .50 caliber cartridges. In addition, the four SBD-3's were armed with one 325-pound depth bomb each. The fires in the hangar forward of No. II elevator resulted in the .30 and .50 caliber cartridges exploding almost continuously until the ship was abandoned. The gasoline and depth bombs undoubtedly contributed immensely to the intensity of the fire. The depth bombs apparently did not detonate as no violent explosions were reported in the forward section of the hangar.

22. It is noteworthy that no evidence was reported in the reference which would indicate that a mass detonation of the bomb magazines or of the ready-service stowages for 5-inch and 1"1 guns occurred.

23. The fire main system on WASP was arranged in three loops with one loop forward of the main machinery spaces, one

loop in the main machinery spaces and one loop aft of the main machinery spaces. Cut-outs were provided in the engine rooms to permit isolation of any one loop from the others. Since the torpedoes detonated on the starboard side forward, the starboard section of the forward loop undoubtedly was ruptured. Thus, all risers from this loop were ineffective. The risers from the center loop were probably undamaged as evidenced by the fact that weak streams were reported at fire plugs at frame 98 and frame 105 on the hangar deck. Attempts were also made to use the fire plugs at frame 100 and frame 106 on the flight deck, but no pressure was available. The low pressure at the plugs was undoubtedly due to insufficient pressure in the system rather than damage to the risers in use inasmuch as there is no evidence that structural damage occurred aft of frame 100 until later.

24. Throughout the whole action power was not lost at any time, although difficulty was experienced in maintaining the feed water supply to the after boilers. Pressure was lost rapidly from the after part of the feed system through a leak which was never located. Large quantities of make-up feed water had to be pumped up from the bottoms and both of the main feed pumps aft had to be run at maximum capacity in order to maintain operating pressure. Emergency feed pumps in the boiler spaces were kept in a standby condition.

25. During the period discussed above, steering control was aft, orders being transmitted from the bridge via the JV circuit. Immediately after WASP was hit, the rudder was changed to full left with the object of utilizing the wind to blow the fire away from the undamaged portion of the ship, and also to clear the burning gasoline and oil on the surface of the water. This was successful inasmuch as the wind was maintained on the starboard quarter. This prevented the surface fire from spreading aft, however, attempts to back clear of the burning gasoline and oil were unsuccessful because the gasoline and oil continued to rise to the surface from the ruptured tanks.

26. WASP settled with a list of about 11 degrees to starboard immediately after the torpedoes struck. Steps to reduce this list were taken immediately. Fuel oil was transferred from fuel oil tanks B-23-F and C-711-F to B-24-F either by the fuel oil transfer and booster pumps or the after damage control pump in the after engine room. In addition, tanks C-708-F and C-710-F were filled from the sea through the damage control main. This admitted about 153 tons of water. By the time the ship was abandoned, 35 minutes after the torpedo hits, the list was reduced to about four degrees to starboard.

27. By 1515 the fires had spread throughout the forward half of the ship and efforts to control them were futile. The Commanding Officer ordered WASP abandoned at 1520 to prevent unnecessary loss of life. This was completed at 1600. After the ship was abandoned, the fires traveled aft rapidly and several violent explosions occurred. These were reported by LANSDOWNE and SALT LAKE CITY to have occurred at 1627, 1746, 1757 and 1758. Throughout this period WASP's list gradually increased to about 15 degrees and the hangar

deck forward was awash. At nightfall LANSDOWNE was ordered to sink WASP. Between 1907 and 2010 five torpedoes were fired. Two hits were obtained on the starboard side, both amidships, and one on the port side just abaft the island structure. The fire by now had completely enveloped the stern. Both the ship and the pool of gasoline and oil in which she was floating were burning with great flames, illuminating a large area. At 2100, while listing heavily to starboard, WASP sank bodily by the bow.

28. Summarizing, it appears that the following events took place aboard WASP at the times stated:

1445 - Two torpedoes struck the starboard side almost simultaneously about frames 36 and 62.

1445 - Internal explosion (20 seconds later) - possibly in the vicinity of the bomb arming station.

1449 - First gasoline vapor explosion "A" - under inboard edge of island, probably on second deck.

1505 - Second gasoline vapor explosion "B" - under forward section of island on either second or third deck.

1510 - Third vapor explosion "C" - in vicinity of No. 2 elevator pit.

1450-1520 - Numerous minor explosions - ready service projectiles, aircraft gasoline tanks and machine gun cartridges.

1520 - Hangar in flames forward of No. 2 elevator. Ship ordered abandoned.

1600 - Abandoning completed - fire working aft - minor explosions continuing.

1627 - Large explosion - noted by LANSDOWNE.

1746 - Extremely violent explosion - noted by LANSDOWNE and SALT LAKE CITY.

1757 - Large explosion - noted by SALT LAKE CITY.

1758 - Large explosion - noted by SALT LAKE CITY.

1908-2011 - Five torpedoes fired by LANSDOWNE - three hits.

2011 - Fires spread to stern.

2100 - WASP sank bodily, going down by the bow.

SECTION III - DISCUSSION

A. Type of Torpedoes

29. Two types of 21-inch Japanese submarine torpedoes are known to exist. The larger contains 660 pounds of hexa in

the warhead and the smaller is estimated to carry a charge of 450 pounds of hexa. In view of the fact that WASP was in no immediate danger of sinking as a result of flooding, structural damage could not have been unusually extensive. The warhead charges employed could not well have been larger than 660 pounds and possibly were as small as 450 pounds.

B. Damage Control Measures

30. The starboard list of 11 degrees was quickly reduced to 4 degrees by transferring fuel oil and counterflooding two empty fuel tanks. Some 20 minutes after the attack these measures were completed.

31. It is noted however, that two fuel tanks, C-708-F and C-710-F, which were required to be kept full of either fuel oil or salt water at all times inasmuch as they constitute a portion of the liquid protection for the after magazines, were empty. The reason for their being empty was not reported. Although in this instance their empty condition provided rapid counterflooding capacity, it is nonetheless extremely dangerous to leave gaps in the underbody liquid layer. A liquid layer surrounding the magazines is provided in part for the purpose of reducing the effects of fragments following underwater explosions. Almost all high explosives are subject to detonation by fragments, and the danger of a magazine explosion is therefore greatly reduced when a liquid layer is provided. In this connection the magazine explosion which caused the loss of the bow of NEW ORLEANS* resulted from a torpedo detonation against the shell plating of a bomb magazine where no liquid layer was provided. Very probably the mass detonation of the bombs was caused by fragments of the torpedo and ship structure produced by the torpedo explosion.

32. As noted in the summary, the inability to control the fire in the hangar deck was one of the vital factors which caused the entire situation to become hopeless in such a short period of time. The Commanding Officer reported that lack of pressure at the hangar deck fire plugs prevented effective firefighting measures. The question of pressure on the fire main is discussed in considerable detail in part E of this section. It is noted, however, that the reference does not contain any mention of attempts to cut out the damaged portion of the fire main forward of the engine room or the portion of the gasoline mains aft of frame 63. The fire on the second deck was undoubtedly fed by gasoline draining through local fractures in the main in the vicinity of frame 63. It is also probable that vapor from the main gasoline tanks contributed to fires and vapor explosions in this area. The gasoline pumps had been started just prior to the time of the torpedo attack in order to fuel planes on the after portion of the flight deck. Although these pumps were stopped by the torpedo detonation, possibly the mains and risers were full of gasoline at the time of damage. If the mains and risers were full, not more than 300 gallons of gasoline were available to feed the fires in the vicinity of the break at frame 63. This quantity of gasoline would drain through the leaks quite

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*BuShips War Damage Report No. 38.

slowly. This probably accounts for the appreciable time interval between the vapor explosions which occurred in the second and third deck areas.

33. It appears that some chance of successfully controlling the gasoline fire on the second deck and of confining the fire in the vicinity of the gasoline tanks would have existed had the fire on the hangar deck been controlled and extinguished within a comparatively short length of time. The fact that the hangar was aflame in the forward portion effectively prevented any efforts to control and isolate the fires lower down in the vessel. It is problematical, however, whether these lower gasoline fires, being fed from the main gasoline tanks and with frequently recurring vapor explosions, could have been extinguished even with full use of the facilities available to WASP. These facilities, as discussed later herein, included an excellent fire main system, hangar sprinkling and water curtain systems, but did not include later developments described in section E, including portable and fixed fog nozzles.

34. The forward repair party locker and headquarters were located on the third deck in compartment A-306-1L between frames 37 and 43. The damage deep in the ship killed the personnel at this station, and surrounding fires prevented access and use of its equipment. The question of proper location of repair parties with the necessary communication facilities and equipment is one in which several conflicting opinions need to be reconciled before it can be definitely settled. In the case of WASP damage control efforts in general and firefighting efforts in particular undoubtedly would have been better coordinated had the repair parties, or at least one or two of them, been located on the hangar deck. There has also been a suggestion that a secondary damage control station, with minimum essential facilities, be provided in cruisers and larger ships. This proposal is being given careful consideration. It appears that such a station might have been of considerable benefit in this case in providing a means for coordinating damage control efforts within the machinery spaces with those out side the machinery spaces. Specifically, it is quite possible that the fire main was not isolated because the personnel in the forward engine room had not received definite information as to the damage or definite instructions to isolate the fire main.

C. Machinery Damage

35. Damage to the main propulsive machinery did not occur. The main machinery remained in operation until orders to abandon ship were received. Damage from shock did occur to some of the auxiliaries. The forward diesel generators were thrown from their foundations when the two torpedoes detonated. The forward distribution board was also damaged. In addition, it is reported the forward dynamo condenser shell split and that steam escaped into the forward engine room. The shell of this condenser was made of 1/4-inch steel marine boiler plate with welded seams. The details of this failure were not reported. This is the first instance reported of failure

of a condenser shell due to shock. This failure, although extremely inconvenient to operating personnel in the forward engine room, did not prevent the operation of the main propulsion machinery, fire pumps and some of the other auxiliaries.

D. Fires and Explosions

36. The first interior explosion occurred about 20 seconds after the two torpedo hits. This explosion is reported by the Commanding Officer to have been caused by a third torpedo. There were four survivors however who, as eyewitnesses, reported seeing the wakes of only two torpedoes. Vessels in the screen also reported observing only two torpedo detonations. In addition, it is believed that flooding and structural damage would have been much more extensive than appears actually to have been the case, if a third torpedo had struck and detonated. An analysis of the reports of survivors who were in below-deck spaces indicates that this third explosion occurred on or below the third deck in the vicinity of the after torpedo hit, and was of considerably less intensity than the two torpedo detonations. This third explosion probably was a gasoline vapor explosion. Since the second torpedo had detonated about frame 62, the gasoline tanks in A-13-Gas were undoubtedly torn open. The gasoline vapors then would have been quickly disseminated throughout the damaged area and up the vertical trunks possibly into the bomb handling stations in A-309-L and A-310-L. Ignition of the vapor could have occurred from any one of a number of sources. The conjecture has been advanced that this third explosion was a bomb detonation in the bomb arming stations on the third deck. This appears improbable inasmuch as the bombs in this station were reported in reference (a) to have been 1,000 pounds. Bombs of this size and type are not particularly sensitive to shock. Further, when bombs of this size do detonate in confined spaces next to the shell the shell itself would unquestionably be extensively ruptured by blast and fragments. No damage to the hull above the waterline in the vicinity of the bomb arming stations was reported and none is evident in any of the photographs.

37. The three explosions at 1449, 1505 and 1515 apparently resulted from the ignition of gasoline vapors released by the leaks in the gasoline delivery main at frame 63 on the second deck. Since the gasoline system was in use, the gasoline drained into this area and was ignited by the fires started from the torpedo hits and the first interior explosion discussed above. It was reported in reference (a) that the gasoline main "shattered" as a result of the shock imparted by the torpedo detonations. This is highly improbable as the gasoline mains were made of copper with silver soldered joints and are highly resistant to shock. It appears more probable that the blast of the first interior explosion distorted the supporting structure sufficiently to break the main at fittings or that fragments pierced the pipe permitting gasoline to spill into the second and third deck spaces at frame 63.

38. The rupture of fuel oil and gasoline tanks by the torpedo detonations undoubtedly resulted in the spreading of inflammable liquids by flooding throughout the damaged area below the fourth deck as well as on the surface of the water

abreast the hits. Ignition of the vapor could have been caused by a spark from any one of a number of sources or by hot fragments or shorts in energized electrical circuits. The oil and gasoline on the surface of the water were then ignited in turn.

39. The fire in the hangar in all probability resulted from ruptured gasoline tanks in airplanes. The lashings of the planes triced to the overhead carried away and the planes crashed onto those below on the hangar deck. Under the circumstances the gasoline tanks of planes could scarcely have escaped damage, and probably gasoline ran out on the deck. Its ignition would almost inevitably have resulted under the circumstances because of loose debris and sparks from the fires below. The fire in the hangar rapidly spread among the aircraft. Gasoline from the fuel tanks of previously undamaged aircraft undoubtedly augmented the fire. Depth bombs on the armed aircraft must have added to the conflagration although no detonation of any of these seems to have occurred. The cases of the depth bombs undoubtedly split open from heat and the charges burned violently.

40. The fire in the hangar spread up into the forward starboard gun group where a short time later the 5-inch projectiles began to detonate. A survivor reported an explosion in this gun group. It is possible that powder charges in one or more ready-service boxes caught fire and built up pressure within the box so as to burst it in a manner resembling an explosion. On the other hand the box would probably not withstand much internal pressure. Hence it seems more probable that the explosion reported was a detonation of one of the 5-inch projectiles. Other cases of war damage have demonstrated that 5-inch projectiles will heat up and detonate in severe fires, after a period of roughly fifteen to twenty minutes. The fire in this area was sufficiently intense to detonate the 5-inch projectiles whether nearby powder burned or not, but it is probable that the powder also burned without necessarily producing any explosions.

41. Mention was made in reference (a) that the wood on the flight deck was on fire. This is another of the few instances reported of a wood deck catching fire. On ERIE* the wood main deck was consumed by fire. Instances where wood decks have been charred are more usual. The degree of burning depends, of course, on the intensity of the fire and the length of time involved.

42. In conjunction with the fires and explosions, it was reported by the Medical Officer that 99% of the injuries were burns of varying degrees of severity, mostly about the face, upper extremities and trunk.

E. Damage to the Fire Main System

43. The Engineering Officer reported in reference (a) that, "breakage of the damage control main and fire mains prevented delivery of water to the vicinity of the fire". The reports of other survivors indicate, however, beyond a doubt that a

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*BuShips War Damage Report No. 31.

large portion of the fire main system aft of frame 100 was intact. This is evidenced by the fact that at least two hose lines were used and these were connected to plugs at frames 98 and 105 on the hangar deck, although the pressure at these hoses was very low. It appears probable that the starboard section of the fire main loop forward of the forward engine room was cut by the detonations of the torpedoes and that this section was not isolated, although out-out valves for the port and starboard sections of the forward loop were located in the forward engine room at frame 76. With the exception of the turbo generator, the dynamo condenser and the main distribution board, the machinery in the forward engine room remained operable and in an undamaged condition, and the engine room watch continued at their stations until WASP was abandoned. It also appears that Nos. 3, 4, and 5 water curtains on the hangar deck were not placed in operation because the steam-driven damage control pump in the after engine room was not placed on the supply risers to the curtains, although this pump was warmed up and in a standby condition at the time WASP was torpedoed. It is possible that the damage control pump was utilized for reducing the 11 degree list to 4 degrees as the Commanding Officer reported that tanks C-708-F and C-710-F were filled from the damage control main. The Commanding Officer's report also indicated that some water was delivered to No. 3 water curtain, at frame 104, although the water supply lasted for only a few seconds. This indicates that the riser for this water curtain was intact. The source of water was probably the fire main. No mention was made by survivors of efforts to use the hangar sprinkling system which is supplied by the damage control system. This system consists of sprinklers in the hangar overhead located between water curtains and fed by the damage control main or the fire main. It appears probable that all water curtains and sprinklers, and piping thereto, were intact from No. 2 water curtain at frame 73 to the aft end of the hangar - at least until the two vapor explosions "B" and "C" occurred about twenty minutes after the torpedo hits. If the riser at frame 76 was broken by these vapor explosions, the water curtains, sprinklers and piping aft of and including No. 3 water curtain at frame 99 should have remained intact thereafter.

44. WASP had an excellent fire main system. There was one 500 g.p.m. steam-driven fire and flushing pump in each engine room, and a total of five steam-driven 200 g.p.m. fire and bilge pumps located one in each engine room and one in each of the three boiler operating stations. The total pumping capacity was thus 2,000 g.p.m. at a pressure of 150 pounds per sq.in.. The fire main proper was subdivided into three complete loops below the first platform. One loop, which undoubtedly was cut by the torpedo detonations, extended from forward of bulkhead 76 (the forward bulkhead of the forward engine room) to the forward magazines. The second loop made a complete circuit of the main engineering spaces, and the third loop extended aft from bulkhead 110-1/2 (the after bulkhead of the after engine room) to the after magazines. The various loops were provided with adequate cross-connections and cut-out valves so that a damaged section of the system could be isolated readily. WASP also was provided with two 10,000 g.p.m. damage control pumps capable of delivering water at a head of 100 feet. One of these was steam-driven and

located in the after engine room and the other was motor-driven and located in the forward engine room. The damage control pumps could be utilized for a wide variety of purposes. Thus, they could be connected to any of the following systems as desired: the fire main, the fuel-oil filling and transfer system, the drainage system and the sprinkling system and water curtains in the hangar. There were two sources of supply to the sprinkling system and water curtains: one, as noted above, from the damage control system, and the other from the fire main system. Either source could be used. As far as could be determined, it appears that all of these facilities were available with the exception of the forward loop of the fire main and the motor-driven damage control pump which may have been temporarily inoperative because of the casualty to the forward switchboard. In other words, pumping capacity of 2,000 g.p.m., sufficient for six large (2-1/2-inch diameter) hoses, was available to the two after loops of the fire main, and 10,000 g.p.m. from the after damage control pump could have been used for the water curtains and sprinkling system. The fact that the forward loop was broken would reduce the pressure on the balance of the fire main system to a negligible value if the damaged loop were not cut out.

45. It is noteworthy that in the case of SAVANNAH, which recently received very severe damage from a large A.P. bomb, the forward fire main was broken by the direct effects of the bomb explosion, but this broken portion was isolated by closing cut-off valves. Although the main sources of electrical power failed, emergency means were used to get full pressure from several fire hoses at the scene of the fire within about six minutes after the bomb detonation. All fires were extinguished in a reasonably short time. It should be noted, however, that these were not gasoline fires.

46. A survivor from WASP reported that, "the fire main was ruptured in the trunk to central and not in the torpedoed spaces". He stated in connection with this that, "the reason for this fracture, I feel, was due to cast iron piping". This Bureau has but one authentic report in its files of war damage which tends to substantiate in even the slightest degree the statements quoted above. The one specific case of fracture occurred on STERETT*. In the case of STERETT a branch connection welded in the fire main piping and located in No. 1 fireroom was fractured by the shock of the detonation of an enemy projectile. The failure was in the weld and possibly may have been due to defective weld metal. It is noted that this damage was caused by shock from a projectile and not from a torpedo. On the other hand, there are reports available which indicate that numerous combatant ships which have been torpedoed did not suffer fracture of the fire main as a result of shock. To name a few, SARATOGA, CHESTER, PENSACOLA, PORTLAND, O'BRIEN and NORTH CAROLINA all were torpedoed and, in all of these cases, the fire main piping remained substantially intact except in the area subjected to direct attack by fragments or the blast effect from very close detonations. It is also pointed out that the fire main on WASP was of tough ductile material which

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*BuShips War Damage Report No. 33

cannot be shattered like a brittle material such as glass or cast iron. Fire main piping on WASP was galvanized wrought iron It is thus exceedingly difficult to reconcile the quoted statements with the known characteristics of the system in question, and the known performance of similar systems on other vessels.

F. Stowage of Aircraft in the Overhead Bays of the Hangar

47. It has been noted in paragraphs 4, 14 and 39 that the tricing arrangements for four planes triced to the overhead in the forward portion of the hangar carried away because of shock and permitted the planes to crash onto other aircraft parked on the deck. The plane gasoline tanks could not have escaped damage and gasoline must have spread into the hangar. This gasoline was unquestionably the origin of the fire in the hangar.

48. War experience on other carriers subjected to bombing attack has demonstrated that fires among triced aircraft are not only apt to occur but that such fires are very difficult to control and extinguish because of the overhead location. Fires among triced aircraft occurred on both ENTERPRISE and HORNET, and in both cases were difficult to extinguish.

49. The dangers of overhead stowage for planes have been recognized since the early days of the present war, and on 21 March, 1942 the Secretary of the Navy approved the design characteristics for the CVB41 class which stated, "reserve airplane stowage to be provided, if practicable, on the same level as and adjacent to the ends of the hangar to eliminate plane stowage overhead".

50. Overhead plane stowage has been omitted on some of the vessels of the CV9 class because of the strengthening of the flight deck required to permit operation of the latest types of heavy planes. Strengthening involved the addition of girders under the flight deck which prohibited the installation of tricing arrangements. The removal of tricing arrangements from all other carriers in service or under construction is now under serious consideration.

G. Improvements in Gasoline Systems of Aircraft Carriers.

(Plates III and IV)

51. As noted in paragraph 7 of the summary, an exhaustive study of gasoline stowage and gasoline systems aboard carriers has been made. Many improvements have been developed and are being made on carriers now under construction. Where practicable, changes will be made in existing carriers.

52. For the purpose of discussion, these improvements have been subdivided into four phases:

(a) The protection of gasoline stowage against underwater attack, shells, bombs, splinters, etc.,

(b) The means of limiting the spread of gasoline and vapors once the given protection is penetrated,

(c) The equipment and devices for fighting and controlling such fires if and when they occur,

(d) The thorough training or operating personnel in order that the handling of gasoline will be accomplished with maximum safety and that the proper operation of the facilities provided will be insured.

53. Improvements in protection:

(a) In large carriers, gasoline stowage tanks will be located within the main armored protection and the fully developed torpedo protection system. This will be done in the later vessels of the CV9 and CVB41 classes. Underwater protection for the light carriers CVL22 and CVL48 classes and for the escort carriers CVE6 and CVE55 classes is necessarily limited by the basic characteristics of the types. In the CVL22 class a blister was added for stability and some increase in underwater protection thus resulted; but, in none of these classes of light and escort carriers is the underwater hull sufficient to resist penetration by contact torpedo explosions. Hulls of the CVE26 and CVE105 classes are similar to those of modern oil tankers and inherently possess a fair measure of resistance to fatal torpedo damage because of the rather heavy hull construction and large depth of liquid carried next to the shell. Comparison of plate III with plate IV will give an approximate idea of the increased protection afforded in new CVs beyond that given WASP.

(b) The gasoline stowage tanks will be subdivided into three tanks similar to the arrangement shown on plate III. The provision of draw-off tanks permits increasing the total effective stowage capacity by several percent without increasing the gasoline stowage space. In addition, as gasoline is used the protection against underwater explosions becomes more effective. This "saddle tank" arrangement has been designed for the forward tanks of the CVB41 class and will be fitted in the stowage of the later vessels of the CV9 class and the CVE105 class. The after gasoline stowage in the CVB41 class is not of size and shape to permit the use of the "saddle tank" to advantage. This stowage, however, is well in from the sides of the ship and inboard of the outboard shaft alleys. A modified "saddle tank" arrangement will be installed in the new CVL48 Class.

(c) The inboard gasoline piping mains will be made as short as possible and will be in an STS protected trunk from the point where they penetrate the armored deck to the point where they emerge from the ship through the shell plating. This installation will be followed for the CVB41 class and for the later vessels of the CV9 and CVL classes. These trunks are being installed on the CVE105 class but are not of STS.

54. Improvements to prevent the spread and ignition of gasoline vapor:

(a) Improvements in subdivision by the omission or elimination of doors and other openings through vertical boundaries on the lower decks will tend to prevent the spread of explosive vapors after battle damage.

(b) The installation of ventilation piping to voids surrounding gasoline stowages is being discontinued on new carriers. It will be removed on existing carriers as soon as practicable. This piping has been a potent means for spreading gasoline vapors through the ship after damage.

(c) Drainage piping for gasoline stowage tanks and the surrounding voids will be modified in order to minimize piping penetrations of the boundaries. This piping has also been a means for spreading gasoline vapors through the ship after damage.

(d) Each void will be fitted with its own permanently installed eductor, with the supply and discharge piping terminating at hose connections within watertight boxes located in the pump room. These boxes afford additional watertight protection where the void boundaries are penetrated. The eductors are actuated by a fire hose from a nearby fire plug and where possible will discharge through a hose connected to the salt water overflow line of the gasoline system, otherwise discharge will be directly overboard (see plate III). The gasoline tanks are not fitted for drainage and portable eductors are to be used whenever drainage is necessary.

(e) Voids surrounding gasoline tanks will be charged with an inert gas, i.e., one that will not support combustion. This will reduce the hazard of the presence of gasoline vapors and possible leaks in adjacent gasoline tanks. This protection will be effective, however, only so long as the boundaries of the voids are gas-tight. Once these boundaries are ruptured or damaged so that the inert gas and vapor will flow into an adjoining compartment, it is known that sufficient oxygen will be present to form inflammable concentrations.

(f) Electrical equipment which would cause ignition of gasoline vapor will not be installed in compartment adjacent to these voids because gasoline vapors may be present in the voids, which vapors are kept non-explosive by the inert gas only as long as the proper mixture obtains. If the boundaries of the voids are ruptured, the inert gases will be diluted and explosive mixtures may easily develop. This provision eliminates the possibility of ignition from this source in case of damage to void boundaries. Where electrical fittings must be installed in these adjacent compartments, they will be required to have explosion-proof characteristics.

(g) Where these "adjacent" spaces require ventilation, they will be ventilated by independent systems which will lead directly to or from the weather deck and will not serve other spaces not "adjacent". Two or more of these "adjacent" spaces may be served from the same system when they are located between the same main transverse bulkheads.

(h) The gasoline trunk and pump room will be ventilated by an independent system which leads directly to or from the weather deck. This system may also serve the pump motor room, the ducts being guarded by flame-proof screens.

(i) The gasoline supply main within the ship will be a double-walled pipe. The inner pipe will carry the gasoline and the space between the inner and outer pipe will be filled with a fire extinguishing agent under pressure.

(j) Means are being provided for filling the mains with inert gas under pressure when the gasoline has been drained. This is primarily a safety precaution to insure detection of leaks in the system rather than a means of increasing resistance to damage. Flushing with water is of questionable value from the standpoint of fire protection. Beginning with the CV9 class the mains can be blown empty by the inert gas fed into them at 20 pounds pressure. Actually on test, mains on the CV9 have been emptied by this means in 7 minutes.

(k) Inert gas pressure gages are being supplied in order to permit ready detection of leaks by observation without the necessity of pumping gasoline through the lines.

(l) Two or more electrically-driven gasoline pumps, with the motors located in separate watertight compartments, will be used in lieu of single large pumps. This will give a more flexible pumping system with the obvious advantage of reducing the rate of delivery of gasoline to the system when only a portion of the system is in use and hence reducing the rate of discharge in case a line in use is broken. This will be done on CVB41 class.

(m) The piping and valves within the gasoline pump rooms will be arranged to permit the use of the pumps to accelerate the drainage of the mains.

(n) The salt water compensating lines between the pump rooms and the tanks are being reduced to a minimum in order to limit the penetration of the tank boundaries.

55. Improvements in firefighting:

(a) A complete discussion of the latest developments in firefighting equipment and technique are contained in the Bureau's letter, file No. C-S93-(1)(3688)(8688), C-EN28/A2-11 of 25 February, 1943 which has been distributed to all vessels.

(b) The Firefighting Manual, issued by the Bureau in 1943, contains the latest instructions regarding the shipboard use of the Navy's standard firefighting equipment and a complete description of the technique for fighting fire. Much of the equipment as described in this publication is either newly designed or redesigned to embody the latest improvements.

(c) Firefighting schools - see paragraph 56(c).

56. Training of personnel:

(a) The Bureau is in the process of preparing well illustrated gasoline system operating manuals for use on carriers.

(b) The establishment of schools for special training in gasoline handling has been approved. Complete working models of ship gasoline systems and all associated apparatus, such as inert gas systems, are nearing completion for use in these schools.

(c) The firefighting schools which have been well established offer the opportunity at all major yards and bases for thorough training of key personnel, both officer and enlisted, in combatting shipboard fires using the most modern equipment and the latest technique.

H. Design Characteristics of WASP

57. WASP was designed during 1934 and 1935. The displacement of WASP was limited to 14,700 tons by the restrictions on total tonnage of aircraft carriers imposed by the Limitation of Naval Armament treaties then in force. It is not possible to provide in a vessel of this size a fully-developed system of underwater protection. In an effort to overcome this handicap, WASP was subdivided into relatively small compartments and a liquid layer inboard of the shell was provided. Although the primary purpose of the liquid layer is to reduce the angle of list following underwater attack, it has been found that the liquid layer will also reduce the velocity of fragments from underwater explosions to the point where there is little or no danger of initiating detonations among explosives carried within the magazines. In addition, a liquid layer will reduce the extent of structural damage to the shell. Apparently, the liquid layer on WASP in way of the torpedo detonations was full, either of fuel oil or water, at the time of the attack. The value of such a layer was well demonstrated in this case inasmuch as the angle of list assumed was not excessive; and furthermore, the detonation of the torpedo at frame 62 did not cause detonation of the bombs in the bomb magazines, although the latter were directly in way of the torpedo.

58. The new CVL's, converted in 1941 and 1942 from cruisers of the CL55 class, are somewhat smaller than WASP. Their underwater layout is much the same as for WASP except that a blister was added. This will give a deeper liquid layer. However, in the event of torpedo attack, it can be expected that rupture of the gasoline tanks will occur if the torpedo strikes in way of them. The improvements in gasoline stowage and handling discussed in part F, however, will result in much better resistance to gasoline vapor fires and explosion.

I. Conclusions

59. WASP, in spite of her small size, would have survived the damage to the hull had there been no fires. Watertight subdivision, stability characteristics and reserve buoyancy were all adequate to absorb the damage from two torpedoes, located as these were, without fatal consequences. It is noted that for some time after the attack WASP was still in a condition to proceed from the scene of action under her own power

if the fires had been controlled. After she was abandoned she was struck by three additional torpedoes. Even after this, she did not sink immediately, although by then she was completely gutted by fire. Considering the durability of WASP, it was unfortunate that fire caused her loss.

(a) Full use was not made of the firefighting facilities available for various reasons as discussed in this report.

(b) It is problematical whether the intense gasoline fires could have been controlled even with full use of available facilities.

60. With respect to gasoline stowage and handling, design improvements in later carriers of larger size have been directed toward:

(a) Improving protection of gasoline tanks and systems with the objectives of reducing the probability of fires following damage in battle.

(b) The improvement of firefighting facilities to permit better control of gasoline fires if they do occur.

61. It should be remembered, however, that gasoline is an extremely hazardous liquid and will continue to be so in spite of all precautions that can be taken in design. The utmost vigilance on the part of operating personnel will be required even in our newest ships during normal operations and particularly so after damage has been incurred.