PRELIMINARY REPORT

U.S.S. HELENA

TORPEDO AND BOMB DAMAGE

Dec. 7, 1941

Pearl Harbor

Class.	6" Cruiser (CL50)	Length. . . .	600 ft.
Date Launched. . . .	August, 1938	Beam.	61 ft.
Displacement (std.).	10,000 tons	Draft	24'-7" before damage 27'-4" after damage

References:

(a) Mailgram (Conf.) 140115 (December) from C.O. HELENA to Cincpac.
(b) C.O. HELENA conf. ltr. to Cincpac, CL50/A16-3/(0149) of December 14, 1941.
(c) C.O. HELENA conf. ltr. to Buships, CL50/A16-3/(0159) of December 20, 1941.
(d) C.O. HELENA conf. ltr. to Buships, CL/A16-3(06) of January 17, 1942.
(e) Comdt. P.H. conf. ltr. C-L11-1/S85/NY10 of December 19, 1941 (enclosed plans of damage to several ships).
(f) C.O. OGLALA conf. ltr. to Buships, CM4/A16-3/S81-3/(0103) of December 31, 1941.

Circumstances of the Attack

1. U.S.S. HELENA was moored port side to Berth 2, 1010 Pier, Navy Yard, Pearl Harbor, on the morning of December 7, 1941. The depth of water here is 42 feet. U.S.S. OGLALA was moored to the starboard side of HELENA with about 8 feet between ships. The weather was clear, with visibility somewhat hampered by scattered low clouds. The attack occurred at 0759, almost simultaneously with the sighting of enemy aircraft, and about a minute after General Quarters had been sounded. The ship was in Material Condition Baker (except for closure of battle ports).

2. A torpedo plane, flying low over the southern tip of Ford Island, released a torpedo at a range of about 500 yards. It passed under OGLALA and struck the starboard side of HELENA at frame 74, abreast the forward engine room, about

18 feet below the waterline. OGLALA, which was drawing 16 feet at the time, was sunk by the mining effect of the explosion.

3. The explosion was violent, described as "dull, though loud". One observer stated that water leaped as high as the stacks, some 70 feet. There was an extensive flash amidships, coming up through passageways from the forward engine room, through ventilation ducts to the main deck, and in the third deck uptake under the umbrella of the forward stack. Many of the crew suffered flash burns and concussion while running to General Quarters. The smoke of the explosion hung in the air as a light black haze.

4. The ship jumped upward about a foot at the center, then oscillated two or three times with a springy motion. Presumably this was the two-noded vibration which often occurs from underwater explosions.

5. At least one Japanese aircraft torpedo afterbody was recovered after the attack on December 7. It was 18 inches in diameter. No aerial torpedo warheads have been reported. The only information at present available in the Navy Department is that the Japanese have three types of 17-3/4 inch diameter aircraft torpedoes carrying charges of 337, 451 and 661 lbs. One type of Japanese 21-inch aircraft torpedo is reported to contain 868 lbs. of explosive. Any further indication of the torpedo used in this attack will be included in the final report.

6. The Commanding Officer of OGLALA reported in reference (f) that a bomb fell between HELENA and OGLALA and exploded underwater with a violent detonation. The position was about the same as that of the torpedo explosion. OGLALA gives

the times of torpedo and bomb explosions as 0757 and 0800. HELENA gives the torpedo explosion time as 0758 in reference (c), 0759 in reference (d), and there is no mention of the bomb explosion in any of the HELENA papers. The OGLALA report is quite specific, however, and it is possible that the bomb actually did explode between the ships in a position where its damage so combined with the torpedo damage that no separate effects were noticed in the later examinations.

7. About four near-misses from bombs are mentioned in reference (b), which caused a few fatalities and many injuries. Several observers reported a bomb explosion 50 to 75 feet to starboard, abreast the upper handling room of No. 3 5-inch twin mount. There were numerous fragment holes in structure on the starboard side.

8. A strafing attack was made just before General Quarters sounded. This caused little damage. Men had not then reached exposed topside battle stations.

General Consequences

9. A large hole was torn in the shell between frames 72 and 77, causing immediate flooding of the forward engine room and rapid flooding of the boiler room just forward of it (No. 2 boiler room, compartment B-3-1) as shown on Plate I. The boiler operating station flooded more slowly, and by 1000 No. 1 boiler room was also flooding.

10. Steam pressure, electric light and power were lost at once, since No. 3 boiler (in B-3-1) was the only one in use and the turbo-generator in the forward engine room was carrying the electrical load. The diesel generator forward was started

within a minute or two and power was restored to all gun mounts.

11. The starboard outboard main machinery unit (No. 1 H.P. and L.P. turbines, condenser and reduction gear) was pushed inboard. Some idea of the machinery damage can be gathered from Photos 3 and 4. Boiler No. 3 was ruptured.

12. Boilers 5 and 6 (No. 3 boiler room) were lit off in half an hour, despite rising water in this space. By 0900, Boilers 7 and 8 (No. 4 boiler room) were lit off and flooding in No. 3 boiler room was under control. Preparations for getting underway on the after engine room were completed by 1015. But the supply of reserve feed water was so low that the ship could not have run for more than a few hours, and the vessel consequently did not get underway.

13. A good deal of trouble was caused by leakage through cables. The main distribution board in the forward engine room was demolished and all cables in the starboard cable run were broken. Water seeped through cables to many points in the ship's power system, causing numerous faults including loss of power to the steering gear because of grounds on the control panel in the steering gear room.

14. The starboard outboard shaft was bent. Eccentricity at the gland in bulkhead 82 would probably have so damaged the bulkhead that boiler room No. 3 would have flooded if the ship had been underway; and if the ship had got underway after the damage, this shaft might have been rotated by propeller drag with the same effect.

15. Thick smoke in compartments on the third and second decks over the forward engine room greatly impeded initial

damage control activities and a serious fire was suspected. No fire was found and the smoke gradually cleared. Evidence of fire was later found in the engine room, however; large sections of the lagging covers over pipes were brown and brittle. Presumably fire did break out but was almost immediately extinguished by the inrush of water from the sea.

Structural Damage

16. Details of structural damage are not available for this report. Plate I combines all information which can be gleaned from the references and photographs. The hole in the shell extends between frames 72 and 77, and from below the armor belt into 'B' strake. The hole in the inner bottom is considerably larger.

17. Wrinkling and distortion of the hull extended beyond the area of major damage. The keel was set downwards between frames 74 and 76, and the plating of 'A' and 'B' strakes on the port side was slightly dished between the same frames.

18. Generally speaking, rips in the hull appear to have been along riveted connections. This shows in the photographs and is mentioned in reference (c). The plating was crumpled and distorted but not fractured, except for the portions of 'D' and 'E' strakes which were blown away between frames 72 and 77.

19. Bulkhead 71-1/2 ruptured below the third deck, over about a third of its width. This was the major cause of the flooding of No. 2 boiler room. The third deck bulged upward about 2 inches maximum between frames 74 and 78, the bulge extending inboard about 12 feet. On the third deck, the bottoms of transverse bulkhead 77 and the inboard longitudinal bulkhead of passage B-305-1L (both extending between

the second and third decks) were crumpled by this upward movement of the third deck. The Engineer's Office was severely damaged, as was also the adjacent ship's store in B-306-L; see Plate II.

20. Bulkheads 61 and 82 bulged slightly at the second platform level due to water pressure in the adjacent flooded compartments.

Flash and Gas Venting

21. There was an extensive flash of flame from the explosion, as mentioned in paragraph 3, which caused some fatalities and many injuries to personnel. The general paths of the flame are shown on Plate II, prepared from data given in reference (c). The flame followed three paths: one issuing from each of the two engine room access trunks, and the third via one (or more) of the vent trunks.

22. Flame issuing from access trunk B-309-T blasted the ship's store on the third deck, went aft into the crew's serving room B-311-L and forward into passage B-305-1L and the engineering office. It also must have spread similarly on the port side, as shown on Plate II. Flame from both sources reached the second deck through access hatches 2-79 and A-81, and spread into passageways and compartments on both sides of the ship.

23. The exhaust vent trunk from the engine room carried flame up through the decks into the uptakes of No. 3 boiler room (B-5) and thence they vented under the umbrella of No. 2 stack*. The trunk ruptured between the second and main decks, and flame blew out from it somewhat as indicated on Plate II.

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*Reference (c) states that venting was via the umbrella of No. 1 stack, but it appears that No. 2 stack was meant.

24. Except for the rupture of the vent trunk, the gases did not seem to develop much pressure. Light objects were not torn loose except in the ship's store. Structural damage to the store and the engineering office, as well as the distortion of doors 3-77-1 and 3-73-1 and their frames, are ascribed to the movement of the third deck and to local shock. Other doors and hatches were undamaged. Paper was charred as far away as the barber shop.

25. The extensive flame within the ship suggests that the torpedo head had penetrated the shell, if not the inner bottom, before exploding.

Flooding

26. The liquid loading before damage and the subsequent flooding are shown on Plate III, for spaces in the vicinity of the explosion. The major flooding was:

B-4 (forward engine room) flooded immediately.

B-3-1 (No. 2 boiler room) flooded rapidly, but there was time to secure the steaming boiler (No. 3).

B-2 (boiler operating room) flooded principally through burner barrel openings in bulkhead 68.

B-1-1 (No. 1 boiler room) flooded from 2 to 3 hours after the hit, through burner barrel openings in bulkhead 64.

Comment on leakage through the bulkheads bounding B-1-1 is given in paragraphs 36 to 39.

27. The situation as regards tanks which were affected in the vicinity was:

Fuel Oil Tanks	% Full before damage	After damage
B-921-F	Full	Gone
B-929-F	Full	Gone
B-933-F	76	Gone
B-934-F	77	Leaking
B-941-F	Full	Gone
B-931-F	91	Damaged
B-932-F	81	Damaged
Reserve Feed Tanks		
B-944-W	38	salted up (see para. 40)
B-945-W	35	possibly leaked
B-917-W	Full	possibly leaked

The reserve feed water situation is discussed in paragraphs 40 to 43.

28. Since wing storage tanks were full, as required by the Damage Control Books for this class of cruisers, and since wing service tanks were full or nearly so, no appreciable list developed. If these wing tanks had been empty the ship would have taken a list of about 5°. The seepage on the third deck would have accumulated on the starboard side, gradually increasing the list until corrective measures could be taken. There was minor seepage of fuel oil (up to about 4 inches) on to the third deck, and certain compartments on this deck between frames 61 and 82 were isolated because of fire hazard.

29. In compartment B-301-L, outboard on the starboard side of the third deck, over the forward boiler compartments, flooding was controlled by a submersible pump used intermittently. Apparently no pumping was necessary elsewhere on the third deck. There were numerous small leaks through electric cables in bulkhead 61, into the plotting room, I.C. room, and the forward diesel generator room. Bulkheads 61 and 82 were shored.

30. No. 1 propeller shaft was cocked in the gland in bulkhead 82, and leakage into No. 3 boiler room from around

the gland was at a rate between 1000 and 1500 gallons per hour. An open bilge suction in the drainage line in the port shaft alley caused this compartment to flood from No. 3 boiler room, but it was pumped out as soon as the engine room fire and bilge pump brought the inflow into the boiler room under control. The starboard lower corner of bulkhead 82 was buckled but not ruptured.

Machinery Damage

31. The explosion occurred almost directly under the starboard outboard high pressure turbine. The turbines, reduction gear and condenser on this side were wrecked, as mentioned in paragraph 11. No details of machinery damage are available, but the extent of damage to the principal items is indicated by the following table:

In Forward Engine Room

Item	Percent Salvageable
Stb'd. H.P. turbine (No. 1)	20
Stb'd. L.P. turbine (No. 1)	20
Stb'd. main reduction gear	5
Stb'd. main condenser	20
Stb'd. main circ. pump	30
25 KW diesel generator	50
500 KW turbo generator (No. 2)	100

In No. 2 Boiler Room

Boiler No. 3 (stb'd.)	50
Boiler No. 4 (port)	100

32. The port main machinery unit (No. 4) in the forward engine room was not damaged. All auxiliary machinery was fully salvageable or nearly so, with a few minor exceptions. All auxiliary machinery in No. 2 boiler room can be completely salvaged. The reduction gear and casing was blown away from its connections to the turbines and shaft. It moved upward and forward, landing in the middle of the distribution board and moving the board about two feet. Jumpers were run to restore essential circuits.

Electrical Damage

33. A tabulation of electrical damage and the equipment affected by destroyed circuits is given in reference (d). The main distribution board in the forward engine room (No. 2 distribution board) was demolished, and all cables terminating thereon were wrecked. All cables in the starboard cable run were demolished. Three vent set motors and the turning motor on No. 1 shaft were wrecked beyond repair. All electrical equipment in the flooded compartments required overhauling and rewinding, etc., but little appears to have been damaged beyond practicable repair.

34. A number of sound-powered telephone circuits were inoperative. All ship's service telephones were out of service aft of frame 103 on the second deck and above it, and on the third deck and below it aft of frame 61. About three hours after the hit, all ship's service telephones were secured because of leakage into the automatic exchange. Four of the battle announcing circuits were also out of operation.

Engineering Features Requiring Special Comments and Recommendations

35. A detailed discussion of features requiring special comment is given in reference (d), from which the following notes have been prepared.

36. Boiler room bulkheads: The boilers on this ship are operated by personnel stationed in the boiler operation stations, each operating station serving two boiler rooms. Water from No. 2 boiler room flooded the boiler operating station B-2. The principal leakage was through the burner barrel holes in bulkhead 66. Other openings in this bulkhead which contributed to the leakage included the lighting-off port hole, operating rod glands, burner bellows gaskets, and the lack of tightness of the air-lock door.

37. No leakage can occur through burner barrel openings when the burners are in place, but they are not kept in place when idle in a steaming boiler because the sprayer plates cake. Apparently several were out at the time of damage. A swing check valve, seating with air pressure in the boiler room, is fitted to close each hole when the burner barrel is removed. But oil drips cause carbon which prevents the valves from seating properly, and this cannot be easily cleaned off when the boilers are steaming.

38. Temporary closures for idle burners were later installed by the ship's force. These not only ensure that the operating space will not flood from the boiler room through burner barrel openings, but also that the reverse will not occur by opening of the swing check valves.

39. The numerous fittings required in these bulkheads make it difficult to preserve water or airtightness.

40. Reserve feed water and evaporators: Lack of feed water was the primary reason that HELENA did not get underway after the attack. Plate III shows the situation with regard to reserve feed bottoms. The cross connection between forward and after tanks was ruptured in the forward engine room. The undamaged boilers aft could therefore not make use of the uncontaminated reserve feed water forward. There were only about 10,000 gallons aft (in tanks B-944-W, 945, 954, 955) and at least one tank, B-944-W, salted up - in this case through an indicating vent in the forward engine room. References (b) and (c) state that tanks B-944-W and B-945-W flooded, though reference (d) indicates that this did not happen; but at any rate, most of the available feed water was soon used up by the after boilers and in warming up the after engines.

41. Both sets of evaporators are forward of the forward boiler room (frames 56-61), and both were put out of action by loss of steam forward. It was recommended that one set be shifted to a position aft of the after engine room, and that an auxiliary evaporator, of 5,000 gallons daily capacity, be installed in each engine room.

42. Air systems: This ship has three air systems: H.P., gas ejection and L.P. (ship's service). The compressors are:

2 H.P. ..... After E.R.
2 gas ejection ..... Forward E.R.
1 L.P. ..... Forward E.R.

The compressors in the forward engine room were out of action, and the H.P. and gas ejection piping was broken. No gas ejection air was available on any gun except from the air banks in the turrets*. The forward diesel generator had no supply of H.P. starting air other than that in its bank, and no H.P. air was available for charging the recoil and rammer systems of the forward guns except that in the forward banks.

43. It was recommended that one of the two H.P. air compressors in the after engine room be shifted to the forward engine room, and that the H.P. air piping be duplicated on the port side.

44. Fire main and pumps: HELENA has but one fire main, which runs in the machinery spaces under the third deck on the starboard side. It is supplied by:

Two 500 GPM rotary fire and flushing pumps, one in each engine room.

Four 200 GPM reciprocating fire and bilge pumps, one in each engine room and one in each boiler operating room.

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*This is not serious for A.A. guns. 375 rounds were fired during the raid without any gas ejection air.

45. The fire main was broken in the forward engine room and half the pumping capacity was lost (both pumps in the engine room and the one in the boiler operating space). A jumper was run between risers on either side of the broken section of fire main.

46. It was recommended that (a) a fire main "ring" be installed throughout the ship; or, at least, that the main be duplicated on the port side in the machinery spaces; and (b) that an electrically-driven fire-flushing pump be installed forward and aft of the machinery spaces.

47. Diesel generators: HELENA has a 700-KW diesel generator forward and a 500 KW set aft of the machinery spaces, in addition to one 500-KW turbo generator in each engine room. The diesel generators were of the utmost value, as electric power was available within two minutes after steam was lost. They were also useful later, when the ship was in dry dock, in supplementing Navy Yard power for welding on both HELENA and HONOLULU.

48. A small 25 KW "emergency use" diesel generator on the starboard side of the forward engine room was completely wrecked. It was recommended that this be not replaced, and its place taken by a H.P. air compressor (see paragraph 43) or an auxiliary evaporating plant (see paragraph 41).

49. Remote control of valves: The rupture of the auxiliary steam line in the forward engine room would have bled down the boilers in No. 1 boiler room if they had been steaming because the stop valve in this line cannot be operated from the deck above. Operation of the forward boiler room auxiliaries and the evaporators could have otherwise been maintained.

50. Other instances showing the desirability of third-deck control of valves in the auxiliary steam and exhaust systems can be visualized. The installation of such controls for six valves was consequently recommended in reference (d).

51. Shock resistance of boilers: It has usually been assumed in damage control exercises that boiler brickwork would be knocked down by the shock of an underwater explosion. The actual experience on HELENA is therefore of interest:

> No. 3 boiler (only one in use): outboard water drum pushed forward by crumpling of bulkhead 61, and boiler room flooded at once. 100 bricks were dislodged on the superheater side, other bricks loosened, and the plastic front was badly cracked. The bricks dislodged were directly under the shifted drum.
>
> No. 4 boiler: some loose bricks; plastic front undamaged.
>
> Nos. 1 and 2 boilers: no damage.
>
> No. 5 boiler: here the displacement of No. 1 shaft evidently shook the boiler foundation through its connection with bulkhead 82. About 40 bricks were loosened; plastic front undamaged.
>
> Nos. 6, 7, 8 boilers: no damage.

It thus appears that boiler brickwork has a higher shock resistance than had been anticipated.

52. Cable: Cable leakage caused numerous difficulties, as mentioned in paragraph 13. At about 1000 salt water started to drip from terminals on No. 1 distribution board (at the forward diesel generator (just forward of No. 1 boiler room), which led from the flooded engine room. From this time on salt

water appeared at the terminals of all cables leading from the distribution board there (No. 2 board) or which parted in the flooded spaces. In many cases cables had to be cut to prevent leakage to the backs of the other three distribution boards, because they could not be disconnected without de-energizing the boards. There were several flashovers from drips on bus-ties. A number of fires were caused, all of which were quickly extinguished. No. 4 generator had to be secured while the voltage regulator rheostat was dried out and a dripping cable cut from No. 4 distribution board; this took 20 minutes. The control panel in the steering room was grounded by a leaky cable leading from the board in the forward engine room. Fire control, ship's control, and other cables leaked at connection and cut-out boxes but were usually cut out before damage occurred.

53. This cable leakage existed in all types of cable. Water travelled along the outside of each conductor and between the strands of the conductors. The sheath remained impervious. No water appeared between the cable armor and the sheath. The asbestos conductor covering appeared to carry the water, and there was of course a fairly clear channel between the strands. All leakage came from damaged ends or terminals.

54. Shock resistance of electrical gear: There were practically no cases of circuit breakers (AQB switches) tripping from shock, even in the forward engine room. There were numerous cases of these breakers tripping from short-circuits. A number of these cases are analyzed in reference (d), showing the damage or difficulty which would have been caused if the switch had been locked in position. The conclusion drawn is that

locking circuit breakers in to prevent them opening from the shock of an explosion is a procedure of highly questionable merit.

55. No fuzes were dislodged, either of the cartridge or knife-blade type. Lighting boxes examined in the forward engine room had broken bulkhead connections, distorted cases, etc., but the cartridge fuzes remained in their clips.

56. About 20% of the electric lamp filaments were broken between frames 70 and 82, starboard. One bracket type telephone was torn from the bulkhead.

57. No securing lugs were broken from any aluminum electric fixtures, except in one case. Phenolic fixtures were damaged in some cases by screw heads pulling through bases of fittings. One or two springs were found unhooked in spring-mounted emergency light fixtures.

58. General announcing systems: The effectiveness of these systems as a positive and quick means of control was clearly demonstrated. Many sound-powered and all ship's service telephones were out of operation, and the only remaining system of disseminating information was the Battle Announcing System. Certain recommendations for extension of general announcing systems are made in reference (d).

Miscellaneous Comment

59. The importance of protective clothing against flash burns was forcefully demonstrated.

60. The vicinity of the signal bridge and pilot house is almost untenable during full action of all A.A. batteries.

61. The sky lookouts should be centrally located in the immediate vicinity of the sky control officer.

62. No time was wasted going for magazine keys. Locks were broken at once on all magazines, ready lockers and clipping rooms as necessary. Service ammunition was at the guns in a few minutes.

63. The shock ruptured many cans of paint in the paint locker, which is close to the bow on the second deck. Shock also weakened the foundations of the smoke screen generators at the stern and broke air supply lines. This indicates the violence of the oscillations at the ends of the ship.

Summary

64. In comparison with other cases of torpedo damage in the present war, the damage to HELENA is about what would be expected from a moderate sized torpedo containing a 500-600 pound charge. The ship structure performed well and the extent of structural damage was not greater than would be expected from results of similar cases. The extent of flooding is not considered excessive except for that through fittings in boiler room bulkheads 64-1/2 and 68.

65. One of the outstanding lessons from this damage is the importance of keeping wing tanks filled. The ship's Damage Control Book requires wing storage tanks to be filled with either oil or salt water. It is also very important to keep wing service tanks filled approximately to the water-line, as far as operating requirements permit.

66. Bureau action and comment on the various recommendations in this preliminary report are reserved for the final report.