

U.S.S. CHICAGO (CA29)

Loss in Action

29-30 January, 1943

Guadalcanal Island

Class.....	Heavy Cruiser	Length (W.L.).....	582 ft.
Launched.....	10 April, 1930	Beam.....	66 ft.
Displacement.....	10,000 Tons	Draft (D.W.L.).....	19 ft. 8 in.
(Standard)			

References:

- (a) C.O. CHICAGO ltr. of 3 February, 1943 (Preliminary Report of Action of 29 and 30 January, 1943).
- (b) Buord ltr. S75-1 (42) (Re6a) of 12 May, 1944.
- (c) Buord Intelligence Report P-2; 6-44 of 1 Aug., 1944.
- (d) Study of Foreign Torpedoes by U.S. Naval Torpedo Station, Newport, R.I. - Project Re6a-201 of 22 July, 1944.
- (e) C.O. CHICAGO ltr. CA29/L11-1, Serial 0113 of 25 August, 1942.

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P L A T E

- I Probable Torpedo Damage and Flooding.
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## SECTION I - SUMMARY

1. CHICAGO underwent a series of aircraft torpedo attacks on 29-30 January, 1943, while operating as part of a task force south of Guadalcanal. On 29 January, she was hit twice in rapid succession. On 30 January, while under tow she was struck by four additional torpedoes. Even after the first two hits, her guns destroyed several of the attacking planes, and her personnel were just as aggressive in the manner in which they took action to control the damage. In spite of extensive flooding, CHICAGO undoubtedly would have survived the hits on 29 January. Four additional hits, however, were more than the ship could absorb without sinking. Loss of life was fortunately small, almost all casualties resulting from the direct effects of the torpedo detonations.
2. On the evening of 29 January, 1943, CHICAGO was hit on the starboard side by two aircraft torpedoes. At 1940, the first one struck in way of the after engine room, and about two minutes later, a second hit in way of No. 3 fireroom.
3. As a result of these hits all four shafts stopped, ship control was lost, and the rudder locked at 10 degrees left. Flooding extended from bulkhead 64 to about bulkhead 112, a distance of 192 feet or about one-third of the length. Almost immediately a starboard list developed, and the ship settled by the stern. The list to starboard quickly increased to 11 degrees. All steam pressure was lost.
4. The damage control organization began to function immediately. Flooding boundaries were established by plugging leaks and shoring weakened bulkheads. Normal power failed due to flooding, but the forward and after 100 KW emergency diesel generators started up and energized the emergency and casualty power circuits, including emergency lighting, electric fire pumps, and portable electric submersible pumps. Damage water was removed where possible by bucket brigades in addition to the portable electric submersible pumps. The list was checked at 11 degrees, and settling was stopped with about 6 to 8 feet of freeboard at the stern. At midnight, about 4-1/2 hours after the two hits, No. 4 boiler was lighted off in order to furnish steam for Nos. 1 and 2 fuel oil booster pumps in Nos. 1 and 2 firerooms respectively. About an hour later these pumps started pumping oil from intact starboard wing tanks, and all the list was removed about 7 hours after the damage occurred.
5. Shortly after midnight, on 30 January, CHICAGO was taken in tow by LOUISVILLE (CA28). With the ship underway, the rudder was brought amidships by opening the equalizing valves in the hydraulic system. The rudder then was locked in that position. At 0800 on 30 January, NAVAJO (AT64) arrived and took over the tow from LOUISVILLE. At 1624, about 21 hours after the first attack, while in tow, CHICAGO was torpedoed again by enemy planes, sustaining four more hits on the starboard side between frames 33 and 80. The vessel immediately assumed a starboard list and began to settle. About 19 minutes after this second attack, she rolled over slowly on her starboard side and sank by the stern. Casualties were light.

6. Cruisers of 10,000 tons and larger standard displacement, including CA's and CL's, are of such size and design that a single torpedo hit should never result in their sinking. Up to the time of preparation of this report, ten have suffered single torpedo hits and all have survived. Their chances of surviving two hits are good, provided the hits are reasonably spaced and provided liquid ballasting is followed. To date four cruisers of this size have been hit by two torpedoes, of which MINNEAPOLIS (CA36)\* survived and CHICAGO probably would have. The loss of QUINCY (CA39)\*\* was due to the combined effects of the two torpedoes plus at least 36 known projectile hits. NORTHAMPTON (CA26)\*\*\* remained afloat over three hours after damage, and might have been saved if circumstances had permitted early limitation of progressive flooding.

## SECTION II - NARRATIVE

(Plate I)

7. This report is based on the brief account contained in reference (a) and on data obtained from studies of other cruiser torpedo damage. The plate was prepared by the Bureau of Ships.

8. On 29 January, 1943, CHICAGO as a member of a task force consisting of two other heavy cruisers, three light cruisers and six destroyers, was south of Guadalcanal, zigzagging on base course 305° true at a speed of 24 knots. All eight boilers were steaming. CHICAGO, the second ship of the right hand division, was in station 700 yards astern of WICHITA (CA45). The ship was darkened, in material condition YOKE, with all ZEBRA fittings closed except those required for ventilation and immediate access. Condition of readiness TWO was set, all anti-aircraft guns were manned, and radar searches were continuous.

9. At 1910, a large group of unidentified planes was picked up by radar at a considerable distance. As the planes approached the task force, they separated into two groups, on a bearing slightly abaft the starboard beam. At about 1924, near the end of twilight, the destroyer on the right flank, WALLER (DD466), commenced firing on the leading group of planes. Immediately thereafter CHICAGO opened fire with 40mm starboard battery followed by 5-inch, using full radar control. At the same time the ship went to General Quarters and set material condition ZEBRA. One plane was seen to have crashed between WALLER and CHICAGO shortly after fire was opened. Two planes approached from two points abaft the starboard beam, and one launched a torpedo at a range of 500 to 600 yards. These two planes crossed ahead of CHICAGO and apparently were not damaged. The wake of the torpedo was not seen. Immediately thereafter another plane crashed off the port quarter of CHICAGO.

\* Buships War Damage Report No. 36

\*\* Buships War Damage Report No. 29

\*\*\* Buships War Damage Report No. 41

10. At about 1938, the ship engaged the second group of planes which was attacking from bearing 090° relative. One plane crashed on the starboard quarter of WALLER. Another plane off the starboard bow of CHICAGO was hit repeatedly and exploded close aboard on the port bow. The flames from this plane were very brilliant, and as it was now completely dark undoubtedly silhouetted CHICAGO for the planes which followed. At about 1940, a torpedo struck CHICAGO on the starboard side in way of the after engine room at about frame 100. The wake of this torpedo was not observed. Within the next few seconds two more planes were observed to crash in flames, one on the port bow and one on the port quarter of CHICAGO. At about 1942, the wake of another torpedo was seen on the starboard beam, close aboard and approaching from 110° relative. Almost immediately this torpedo struck and detonated on the starboard side in way of No. 3 fireroom at about frame 80.

11. As a result of the first torpedo hit, the after engine room, crew's space D-301-L and evaporator room D-1E flooded immediately, and the boundaries of crew's mess C-204-L were ruptured. No. 4 fireroom flooded rapidly, and after gyro room D-502-E flooded slowly. As the water entered, a list quickly developed to starboard, and the ship started settling aft. Shafts Nos. 1, 2 and 3 stopped, and all ship control was lost. The two turbo generators in the after engine room stopped when that space flooded. The after 100 KW emergency diesel generator, located in compartment D-503-E, and the forward 100 KW emergency diesel generator, in compartment A-404-A, started up and energized the emergency and casualty power circuits. These included emergency lighting, electric fire pumps, portable electric submersible pumps, and radio motor generators.

12. As a result of the second torpedo hit, flooding of No. 3 fire-room took place immediately and of the forward engine room at a slightly slower rate. Machine shop C-203-E was opened to the sea and was described by reference (a) as being "demolished". Except for minor leakage through bulkhead 64 there was no reported damage to the two forward firerooms. No. 4 shaft stopped, leaving the ship dead in the water. Flooding of the forward engine room put the two turbo generators in that space out of commission, and the two emergency diesel generators then provided the only source of electricity for the ship. The rudder locked at 10 degrees left. This was reported as being due to a power failure. As the draft increased, crew's mess C-204-L flooded partially. The additional flooding that resulted from the second hit caused the starboard list to increase rapidly to 11 degrees, where it was checked. The ship continued settling by the stern until the free-board aft was observed to be about 6 feet.

13. Immediate steps were taken to establish flooding boundaries. Shoring of bulkheads abaft the flooded engineering spaces was begun promptly. Leaks into laundry D-304-E and ice machine room D-305-E were plugged. Bucket brigades and portable electric submersible pumps were employed continuously throughout the night to keep the water down in crew's spaces C-201-L and D-201-L. There is no mention of any necessity or effort to shore bulkhead 64 between the forward engine room and No. 2 fireroom. Water leaked at a slow rate through this bulkhead.

As discussed in paragraph 38, this water was removed subsequently when No. 2 fuel oil booster pump was furnished steam for operation. Careful and continuous inspections were made in case flooding should progress. Damage Control parties likewise extinguished small fires in galley C-101-L, and in radio II, located on the upper deck at frame 89.

14. Shortly after midnight, as the result of preparations begun about 2030, the ship was taken in tow by LOUISVILLE (CA28), using 60 fathoms of starboard chain and LOUISVILLE's towing hawser. About 0100 the rudder was brought amidships by opening equalizing valves in the hydraulic system. The rudder then was locked in that position.

15. Also at about midnight, No. 4 boiler was lighted off, and between 0100 and 0230 the list was removed by pumping oil from starboard wing tanks, using Nos. 1 and 2 fuel oil booster pumps in Nos. 1 and 2 firerooms. No. 2 fuel oil booster pump was used subsequently for removing water leaking through bulkhead 64.

16. At 0800 on 30 January, NAVAJO (AT64) arrived and took over the tow from LOUISVILLE. Towing was on a southeasterly course at 3 to 4 knots. At about 1630, a group of eleven enemy planes was sighted approaching from 080° relative at a distance of 7 miles. LaVALLETTE (DD448), stationed off the starboard beam, opened fire followed by CHICAGO's starboard 5-inch battery in local control at an initial range of 8,000 yards. Automatic weapons commenced firing at their extreme ranges. A number of planes were shot down by surface gunfire, while a friendly combat patrol engaged the remaining enemy planes as they crossed the track of CHICAGO. Shortly after surface fire had ceased, five torpedo wakes were observed approaching the ship from the starboard beam. Since the ship was being towed at about only 3 knots and since the steering gear was inoperative, it was impossible to maneuver her out of the path of the torpedoes. At 1624, one detonated upon impact with the starboard shell at frame 33, causing a flood of water and debris to fall on the forecastle and bridge. A few seconds later three more torpedoes detonated in rapid succession between frames 60 and 80, starboard. The fifth torpedo missed astern. There was no fire of any serious consequence as a result of these hits.

17. Immediately after the first torpedo hit, at approximately 1624, since it was apparent CHICAGO would sink rapidly, the Commanding Officer had the order to abandon ship passed over the battle telephones and general announcing system. NAVAJO cut the towing wire. The list was increasing steadily to starboard and considerable difficulty was encountered in launching the port life rafts and floater nets. However, most of them had been cast loose and placed on deck during the previous night, and it was possible eventually to put all of them over the side. All hands not killed as a direct result of the various torpedo hits probably succeeded in getting off the ship and were recovered. At about 1643, about 19 minutes after these last hits, CHICAGO slowly rolled over on her starboard side and sank by the stern. According to reference (a) and the official records of the Bureau of Naval Personnel, out of 1130 officers and men who were aboard at the time of the attacks 1069 were rescued. Among those rescued were 43 wounded, one of whom died later.

## SECTION III - DISCUSSION

### A. Type of Torpedoes

18. Since the start of the war several types of Japanese aircraft torpedoes have been recovered intact, and examined and tested under the direction of the Bureau of Ordnance. In addition, considerable supplementary information has been accumulated from a number of sources by the Office of Naval Intelligence. Data available at present are reported in references (b), (c) and (d). These references indicate the Japanese now may be employing any one of various types and sizes of aircraft torpedoes, the first of which was developed about 1931. Several kinds of warhead explosives are listed. The four Japanese aircraft torpedoes which have been recovered and examined to date were about 18 inches in diameter and had warhead charges of Type 97 explosive weighing from 338 to 830 pounds. Weights of Japanese aircraft torpedo charges as reported in the references vary from 338 to 867 pounds. The full range of weights, including torpedoes employed by submarine and surface craft, is 338 to 1036 pounds.

19. On 30 January, 1943, during the attack in which CHICAGO received the four hits which finally sank her, LaVALLETTE also was struck by an aircraft torpedo from one of the Japanese planes. A study of the damage incurred by LaVALLETTE, which survived, indicates the warhead may have been similar to one of those which have been recovered and examined, containing about 522 pounds of Type 97 explosive. It is probable, therefore, that the last four aircraft torpedoes which hit CHICAGO were similar to the one striking LaVALLETTE during the same attack. In the case of the two aircraft torpedoes which struck CHICAGO on the first night, warheads of the same size and type as that which struck LaVALLETTE might reasonably have caused the structural damage both reported and assumed, in order to account for the flooding.

### B. Structural Damage

20. Caisson tests and studies of damage to five of the cruisers which have survived torpedo hits, including PORTLAND (CA33)\*, PENSACOLA (CA24)\*, CHESTER (CA27)\*\*, MINNEAPOLIS (CA36)\*\*, and DENVER (CL58)\*\*\*, and one which was lost - NORTHAMPTON (CA26)\*\*\*\*, have permitted the accumulation of considerable data indicating how torpedo detonations affect various components of the hull structure. Consequently, it is possible to estimate in a general way the structural damage to a cruiser of about 10,000 tons standard displacement that would result from torpedo warheads with charges varying in weight from about 522 to about 880 pounds and composed of any of the explosives now assumed to be in use by the Japanese.

\* Buships War Damage Report No. 35.

\*\* Buships War Damage Report No. 36.

\*\*\* Buships War Damage Report being prepared (not yet published).

\*\*\*\* Buships War Damage Report No. 41.

21. Warheads in this latter range are the types and sizes which probably caused the damage in the six cases listed above. The detonations blasted holes in the shell and inner bottom from about 40 to about 45 feet in length, the longitudinal extent of wrinkles and buckles in the plating and framing serious enough to permit flooding being about 10 to 15 feet beyond each end of the ruptures. In four of the five cases where measurements were possible when the ships were undergoing repairs, the maximum girth dimension of the ruptures varied from about 25 to 35 feet.

22. Three of the cases listed in paragraph 20 gave an indication of the ability of the main transverse bulkheads in the machinery spaces of these and similar vessels to withstand the direct force of torpedo detonations occurring in the compartment of which the bulkhead was a boundary. For 10,000-ton cruisers now in service, it is probable that main machinery transverse bulkheads (welded or riveted) will remain intact when exposed to the direct force of a detonation from the more powerful of the present Japanese torpedo warheads provided the point of impact is somewhat greater than about 30 feet away, and provided that secondary factors such as broken shafts do not cause bulkhead ruptures.

23. The vertical location of the point of impact exerted a great influence on the vertical extent of the damage. Depending upon the distance below a particular armored deck at which a torpedo detonated, the armor apparently had considerable value as a shield in reducing the damage to the structure above. With hits nearer than about 12 feet below 1-inch STS decks and a few feet closer for those of 2-inch STS, most of the shielding value probably would be lost. On those early 10,000-ton cruisers where the second deck is the armored deck, that would mean a torpedo with a shallow depth setting of about 4 feet or less.

24. The transverse extent of severe structural damage was about 40 to 45 feet. As discussed in the analysis of the loss of HELENA\*, a cruiser of 10,000 tons or larger standard displacement should not break in two when hit by a single torpedo in way of the main machinery spaces, where full transverse sections and relatively heavier scantlings, including armor, offer the maximum resistance to torpedo detonations. In the cases of CHESTER and MINNEAPOLIS, calculations indicate a sharp reduction in the longitudinal strength from single hits in the machinery spaces, the loss in sectional modulus being about 30 % for each ship.

25. In the case of CHICAGO on the night of 29 January, 1943, the first torpedo which struck was reported to have detonated on the starboard side in way of the after engine room at about frame 100. This was about 40 feet aft of the forward bulkhead in this space, at frame 90, and 8 feet forward of the after bulkhead, at frame 102. In addition to the after engine room, crew's space D-301-L and evaporator room D-1E flooded immediately. No. 4 fireroom was reported to have flooded rapidly and after gyro room D-502-E slowly. Directly above the after engine room, crew's mess C-204-L was opened to the sea. The boundaries of crew's space D-201-L also were impaired. If the assumption is correct

\* Buships War Damage Report No. 43.

that the warhead consisted of 522 pounds of Type 97 explosive, the rupture in the shell and inner bottom from this hit extended probably from about frames 95 to 105. Plating and framing may have been distorted seriously as far forward as frame 92-1/2 and as far aft as frame 107-1/2.

26. Undoubtedly bulkhead 102, close to the detonation, was ruptured below the second deck and permitted the flooding in D-301-L and D-1E immediately aft. Although they may have been buckled slightly, the main transverse bulkheads at frames 90 and 112 were far enough from the detonation to have remained intact. The rapid flooding of No. 4 fireroom which followed this hit may have been due to faulty fittings or open drain lines. The slow flooding of after gyro room D-502-E also may be attributable to non-watertight fittings. Apparently, the structural damage to crew's mess C-204-L was so great that it was impossible to unwater it when partial flooding occurred later. This indicates rupturing of either the 1-inch STS second deck or the shell in way of it, or both. Structural damage at this level indicates the point of impact was fairly close to the second deck. On the other hand, it was sufficiently deep so that the heavy second deck was able to shield the main deck from any apparent damage. In addition, the use of bucket brigades and portable submersible pumps in crew's space D-201-L to keep ahead of the flooding implies the damage to this compartment was relatively minor. It is probable, therefore, that the torpedo struck about 14 feet below the second deck. Based on an assumed mean draft of about 22 feet before damage, the torpedo probably had a depth setting of about 6 feet.

27. The second torpedo struck the starboard side in way of No. 3 fireroom, at about frame 80. Since this was about 80 feet forward of where the first torpedo hit, it is improbable that the structural damage overlapped. The point of impact was separated from main transverse bulkheads 64, 76, 83, and 90 by about 64, 16, 12, and 40 feet respectively. As a result of the second torpedo, No. 3 fireroom flooded immediately and the forward engine room almost as quickly. Machine shop C-203-E was opened to the sea. Assuming a warhead similar to the first, the second hole in the side extended probably from about frame 75 to about frame 85. Structural damage probably tapered off at about frames 72-1/2 and 87-1/2. Bulkheads 76 and 83 were so near to the detonation that they undoubtedly were ruptured severely. Even after this hit, bulkhead 90 was far enough away to remain intact. Moreover, bulkhead 83, which intervened, undoubtedly lessened the force of the detonation acting on bulkhead 90. Slow leaks through bulkhead 64 were probably due to faulty fittings. Rather severe damage to C-203 and apparent absence of damage to the main deck, again indicates the point of impact was about 14 feet below the 1-inch STS second deck.

28. The section modulus in way of each damaged region must have been greatly reduced as a result of these first two hits. The stresses in the remaining effective structure may have been increased considerably by the change in the bending moment due to the added weight of water. While there was no report in reference (a) of the structural damage caused by the four torpedo hits received the second day, it is probable the damage overlapped to make the combined effect very extensive. Even after these last hits, however, there was no mention of sag in the main deck or of any other indication of longitudinal structural failure. The moderate sea conditions undoubtedly helped prevent excessive longitudinal stresses from developing.



### C. Machinery Damage

29. The flooding which resulted from the two torpedo hits on 29 January put the two turbo-generators in each engine room out of commission, thereby leaving the ship without normal electrical power. Fortunately, however, in order to spread the risk should damage similar to this occur, 100 KW emergency diesel generators had been installed well forward and aft of the main machinery spaces. One was located in compartment A-404-A, and the other in compartment D-503-E. Immediately after the first hit, these started up and energized the emergency and casualty power circuits. This contributed greatly to the successful damage control work immediately following the initial damage, by providing power for emergency lighting and also for the portable electric submersible pumps used to eliminate the free surface in crew's spaces C-201-L and D-201-L.

30. After the second hit, the rudder locked at 10 degrees left, apparently due to power failure. CHICAGO's steering gear had two sources of electrical power supply, normal from the turbo-generators and emergency from the after emergency diesel generator. The electrical cables from the after emergency diesel generator may have been grounded, due to some unreported reason. While the ship was being towed by LOUISVILLE, the equalizing valves in the steering gear hydraulic system were opened. This equalized the pressure at both ends of the rams, and the rudder was then free to move unrestricted by the rams. The rudder then was reported to have swung to the amidships position where it was secured, probably by closing the equalizing valves again. It has been estimated that the form and balance of the rudder, together with the pressure forces developed at top speed, result in a point of zero torque or balance at about 16 degree rudder angle. However, at the reported towing speed of only 3 knots, it is estimated that the maximum negative torque developed at rudder angles up to 16 degrees would have been of the same order as the frictional force in the rudder bearings. As a result, the rudder could have been expected to come to rest at any angle up to 16 degrees, depending upon the amount of wave or other external force that may have been applied. In this case, it appears that the rudder might have been swinging with practically zero torque, and was caught and held as it passed the amidships position. This swinging may have been initiated by forces resulting from the fact that there was a starboard list on the ship of 11 degrees, while the rudder was at an angle to port.

31. Had opening the equalizing valves not resulted in centering the rudder, it is possible that emergency or casualty power could have been used for that purpose. In that event, it might have been necessary for a short time to remove part of the load being employed for damage control from the after emergency diesel generator.

32. In order to provide emergency means for centering the rudder in cases of failure of both normal and emergency power, certain alterations which were not on CHICAGO have been authorized for all cruisers where applicable. Installations are being made as availability permits. Emergency rudder positioning equipment is being provided by two means. One of these consists of chain falls to be used in conjunction with pad eyes on the rudder crosshead and the hull structure.

The other is the use of a hand-operated hydraulic pump. Although the hand pump is designed primarily for rudder positioning, there have been some reports from forces afloat of moderate success when employed for emergency steering. In addition, for cruisers with hydraulic ram steering gears a compact emergency hydraulic pump unit has been designed which may be used for steering in event of flooding or other casualty to the main source of steering power. Delivery of these units has already started. They are being installed in the steering gear compartment, and are designed for hand-operation as well as for both local and remote electrical control. On two cruisers, PENSACOLA (CA24) and SALT LAKE CITY (CA25), with screw type steering gears, emergency diesel units are installed. As explained in the case of the damage incurred by SALT LAKE CITY\*, there are numerous disadvantages to having a diesel engine in the steering gear room.

33. The case of CHICAGO indicates that for cruisers with similar rudders, the rudder probably can be centered without the use of emergency gear, simply by opening the equalizing valves and proceeding at very slow speed - around 3 knots. If the steering gear is inoperable, the rudder can be locked in the center position by closing the equalizing valves and the ship can be maneuvered by use of the screws if at least one screw on each side of the centerline remains in operation.

#### D. Flooding and Stability

34. Reference (a) did not specify the drafts prior to damage. However, when CHICAGO was torpedoed on 29 January 1943, she had been operating away from her base about the same number of days as the time damage was incurred on 9 August 1942 (reported in reference (e)). It is assumed, therefore, that the conditions of loading were approximately the same on both occasions. Based on assumed drafts of about 22 ft. - 6 in. forward and 21 ft. - 6 in. aft, calculations using Inclining Experiment Data indicate CHICAGO prior to damage on 29 January 1943 had a displacement of about 13,325 tons and a GM of about 4.3 feet (corrected for free surface in ship's tanks).

35. Plate I shows the reported flooding and also the additional spaces which probably flooded. Calculations indicate about 5570 tons of damage water were taken aboard as a result of the first two torpedo hits, producing estimated new drafts of about 27 ft. - 0 in. forward and 31 ft. - 1 in. aft. This corresponds to a displacement of about 18,895 tons. The GM after damage on 29 January was about 1.4 feet at the new displacement. Thus, in spite of the extensive flooding, which included four main machinery spaces, the initial righting moment was still adequate to absorb considerable further flooding. The range of stability, however, was substantially reduced due to the loss of freeboard, the new waterline at the midships section measured at the centerline being about at the second deck level. The calculated freeboard at the stern was about 8 feet as compared with a reported value of about 6 feet.

\* Buships War Damage Report No. 42. -----

36. As the result of flooding, CHICAGO acquired a list of about 11 degrees to starboard. Liquid loading instructions call for liquids in wing tanks to be even with the waterline, for tanks extending above the waterline. At the assumed operating drafts prior to damage, this would result in a void space about 8 feet deep below the second deck in way of tanks abreast the main machinery spaces. Wing tanks aft of the main machinery spaces did not extend above the first platform deck and did not have ballasting connections. At the most they may have been about 95 per cent full of fuel oil, while at the least, the oil would have been at the level of the low suction. Assuming starboard wing tanks in way of main machinery spaces were filled to the required level, rupture and severe deformation of the shell plating in way of the starboard wing tanks permitted a considerable amount of unsymmetrical flooding, from about frame 69 to at least frame 102. Calculations indicate that the reported angle of heel is consistent with the off-center moment created by this probable amount of unsymmetrical flooding above the original waterline in association with the impaired GM.

37. At about 0000 on 30 January, almost 4-1/2 hours after the initial damage, No. 4 boiler was lighted off in order to provide steam for auxiliary machinery in Nos. 1 and 2 firerooms. About an hour later, Nos. 1 and 2 fuel oil booster pumps, in Nos. 1 and 2 firerooms respectively, started pumping oil from intact starboard wing tanks in order to remove the list. All the list was off the ship by about 0230, not quite 7 hours after the initial damage.

38. In the meantime, water had been leaking slowly through bulkhead 64. As soon as the list was removed, No. 2 fuel oil booster pump was used for removing this water. The details explaining how the pump was able to take suction on the water were not reported. At the time CHICAGO did not have the alteration, since authorized for cruisers, permitting the installation of a hose connection on the suction side of the fuel oil booster pumps in order to handle flooding. In the case of the damage incurred by CHESTER\*, the boiler repair party succeeded in cutting a hole in the pump suction line below the floor plates.

#### E. Conclusions

39. The loss of CHICAGO resulted from extensive flooding caused by six torpedo hits. Except for the additional damage and flooding incurred on the day following the first two hits, CHICAGO probably would have been towed successfully to a friendly port. The determining factors after the initial damage were the prompt and effective manner in which the flooding boundaries were established, progressive flooding stopped, and the list removed. Details are lacking on the extent of additional damage and immediate flooding as a result of the 4 additional torpedo hits incurred by CHICAGO. However, it is hardly conceivable that any ship of this type could have survived such an attack. Apparently due to negative GM and unsymmetrical flooding, capsizing occurred 19 minutes after these last hits.

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\*Buships War Damage Report No. 36.

40. The experience of CHICAGO following the initial damage was a valuable demonstration that a ship of this type and size can survive two torpedo hits. It was further demonstrated that in order to absorb such damage and remain afloat, damage control measures must be initiated promptly and intelligently and executed efficiently. It is unfortunate that the determined and exemplary efforts of the officers and crew in this case were vitiated by the overwhelming effects of the second attack.