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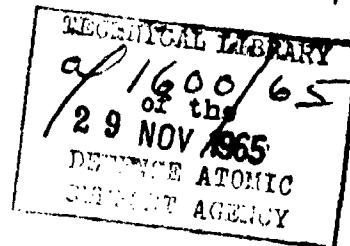
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OTI-55 (April 1969)

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**XRD-213** ✓  
Report Number

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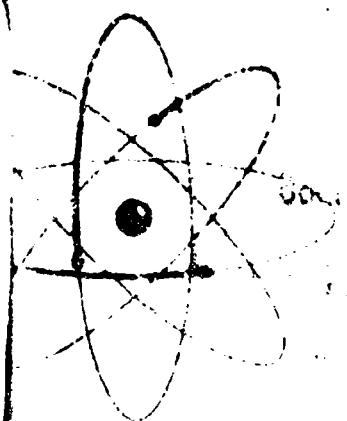
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XRD-213

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DIRECTOR OF SHIP MATERIAL

JOINT TASK FORCE ONE

OPERATION CROSSROADS

GROSS DAMAGE REPORT

TEST ABLE

6 JULY 1946

(12) 768

GROUP 1  
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DSN SERIAL: 00174

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REGISTERED NUMBER

840 001

111/Crossroads  
012A/LAK/ajo  
Serial: 00174

JOINT TASK FORCE ONE

(DIRECTOR SHIP MATERIAL)

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(14) XRD-213

XRD-174 <sup>an</sup> <sup>Comm</sup>  
C. REGISTERED NUMBER 16 T.P.

9 Report on Operations Crossroads  
11 6 Jul 46 12 76

From: Director Ship Material, Joint Task Force One.  
To: Deputy Task Force Commander for Technical Direction,  
Joint Task Force One.

Subject: ⑥ [Director] Ship [Material] [Gross] Damage Report [A-1, (Test  
ABLE re-entry plus five (5) days report.)] [43.60]

- Enclosures:
- (A) BuShine Group (DSM) - Preliminary report of Gross Damage, Test ABLE.
  - (B) Army Group (DSM) - Preliminary Damage Report Test ABLE plus five. (Also forwarded direct to CJTF-1, as CTG 1.4 file CTG 1.4/1 of 6 July 1946.)
  - (C) BuAero Group (DSM) - Preliminary report of Gross Damage, Test ABLE.
  - (D) BuOrd Group (DSM) - Preliminary report of Gross Damage, Test ABLE.
  - (E) BuMed Research Group (DSM) - Preliminary report of Gross Damage, Test ABLE.
  - (F) Electronics Preliminary Gross Damage Report, Test ABLE.
  - (G) BuY&D Group (DSM) - Preliminary report of Gross Damage, Test ABLE.
  - (H) BuSan Group (DSM) - Preliminary report of Gross Damage, Test ABLE.

1. During the five day period since Test ABLE, the Director of Ship Material and his staff have made a general survey of all target ships which did not sink, and in many cases damaged ships have been inspected in considerable detail.

2. The salient facts so far determined are as follows:

(A) Five ships were sunk:

- (1) U.S.S. GILLIAM (APA-57). Photographs so far available do not show this ship at all, indicating that she sank almost immediately after Mike hour. A running light of APA type was found on the ARDC-13.

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Subj: Director Ship Material Gross Damage Report A-1 (Test Able re-entry plus five (5) days report).

- (2) U.S.S. ANDERSON (DD-411). Time of sinking not yet determined from photos, but known to be prior to arrival of PBH Charlie about 0940. Photos from towers show an explosion in ANDERSON's location at Mike hour plus three (3) seconds. Fire at about 0902 is clearly visible in photos. The ship capsized to port about 0903, and was still visible at 0907. Part of a torpedo tube scon was found on deck of HDB 13, moored next to the ANDERSON, indicating that at least one torpedo on ANDERSON detonated.
- (3) U.S.S. CARLISLE (APA-69). The CARLISLE was visible in early photographs with fire burning amidships along port side. Time of sinking not established, except that it was prior to arrival of PBH Charlie at about 0940.
- (4) U.S.S. LYNCH (DD-367). This ship capsized to starboard (toward blast) and was seen floating in the lagoon until about 1400. Exact time of sinking not known.
- (5) Ex-Japanese Cruiser SAKAWA. Photographs show a fire at the stern of this ship almost immediately after Mike hour. This fire burned until the morning of ABLE plus one day. SAKAWA suffered very severe structural damage topside and at the stern, the latter permitting water to enter the hull. Progressive flooding undoubtedly took place, as drafts aft increased steadily until the morning of ABLE day plus one. Despite radiological conditions which were still not completely safe, this ship was taken under tow on the morning of 2 July with the intention of beaching her as directed by CJTF-1. At that time her stern was awash and her stability had been reduced to the vanishing point. Soon after being taken in tow, she keeled over to an angle of about 85 degrees to port and sank by the stern at 1044.

Diving operations have started for the purpose of examining the hulls of sunken ships and obtaining underwater photographs. Two divers were sent down in way of the GILLIAM on 6 July. They reported a severely wrecked hull with many pieces of wreckage on the bottom around it. One electrical junction box was recovered off the bottom.

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(DIRECTOR SHIP MATERIAL)

Subj: Director Ship Material Gross Damage Report A-1 (Test ABLE  
re-entry plus five (5) days report).

(B) The following ships would have been temporarily immobilized, or practically so, because of lost or severely damaged stacks, and ruptured uptakes and boiler casings:

- |               |  |
|---------------|--|
| (1) NEVADA    | (4) SALT LAKE CITY   |
| (2) ARKANSAS  | (5) HUGHES   |
| (3) PENSACOLA | (6) INDEPENDENCE (Damaged uptake, boilers apparently in good condition). |

Repairs have been undertaken in each of these cases to permit operation of one boiler and the testing of main propulsion machinery. These repairs are estimated to require from 4 to 10 days for completion, depending on the severity of the damage in each case.

(C) The following ships have received structural damage which would have severely reduced fighting efficiency:

- (1) INDEPENDENCE. The flight deck was so badly damaged that the ship could not have operated as an aircraft carrier without complete rebuilding of the flight deck, requiring at least 3 months, in time of war.
- (2) SKATE. This ship received severe damage to her superstructure and minor damage to a few ballast tank valves. Since the test, the ship has gotten underway on her starboard engines. The vessel's port engines cannot be operated without replacement of the port main muffler and repairs to the port outboard exhaust valve. Other repairs are required before the vessel can be dived.
- (3) RHIND. Despite the loss of her stack, the RHIND was able to get up steam on one boiler and could have continued operating at low power.

(D) One ship suffered a derangement to equipment which while not in itself serious would have greatly affected her military efficiency.

- (1) The SARATOGA while sustaining almost no structural damage was unable to operate her airplane elevator after the test because of distortion of the fore and aft equalizing shaft and pinion with respect to the vertical main rack. The inability to operate this elevator would have greatly reduced her military efficiency.

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Subj: Director of Ship Material Gross Damage Report A-1 (Test ABLE re-entry plus five (5) days report).

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The SARATOGA's other elevator had been blanked off for about two years. It seems reasonable to assume however, that if the SARATOGA had had additional elevators they might have received the same type of damage. In the case of an aircraft carrier which lost the use of all elevators, the reduction in military efficiency would be very serious, until such time as they could be repaired.

(E) The following ships would have had military efficiency severely reduced by loss of topside electronic equipment:

- |                  |                    |
|------------------|--------------------|
| (1) INDEPENDENCE | (6) SALT LAKE CITY |
| (2) NEVADA       | (7) CRITTENDEN     |
| (3) HUGHES       | (8) DAWSON         |
| (4) PENNSACOLA   | (9) RHIND          |
| (5) ARKANSAS     | (10) SKATE         |

(F) Had power been available most ships between 500 and 1000 yards of the bomb burst would have had armament operable at an estimated average of 75% efficiency. Ships on which fire control equipment, in addition to electronics, was seriously damaged are:

- (1) ARKANSAS
- (2) NEVADA
- (3) PENNSACOLA
- (4) INDEPENDENCE

No appreciable damage to guns or mounts of 5" caliber or larger has been discovered. Damage to a few smaller caliber guns was mainly from falling debris.

(G) Except for the ANDERSON which evidently suffered a violent explosion, no evidence has been found that any Navy ammunition or ammunition components exploded or were activated as a direct result of heat from the atomic bomb itself. Except for the burning and low order detonation of torpedoes in the INDEPENDENCE, there is no evidence, as yet, of any Navy ammunition exploding as a result of fire.

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(H) Major damage was suffered by all aircraft on weather decks of ships within about 2000 yards of the bomb burst. Fourteen (14) aircraft were sunk with target vessels or blown overboard. Major damage was suffered by 29 additional airplanes.

(I) Food, clothing and ship's store material stowed below decks were not affected to any practical extent. Some minor danger exists in the consumption of unsealed foods left on topsides.

(J) Approximately 90% of the test animals were recovered alive. Flash burn was not an important cause of death or injury. It is expected that most animals recovered from the U.S.S. NEVADA, INDEPENDENCE, FALLON, CATCON, and SALT LAKE CITY will suffer severe radiation illness and most will die. It is expected that most on the remaining outer target ships (outside of 1500 yards) will survive with or without permanent injury.

(K) No ship except those sunk had any appreciable underwater damage or flooding.

(L) No ship suffered appreciable loss of military efficiency from fires alone except in the case of INDEPENDENCE where the fires aft consumed her reserve supply of torpedoes. All other fires except in ships which sank were in exposed locations, and started in such materials as Army quartermaster equipment, cordage, signal flags, boats and gun bloomers. In all cases fires could have been put out by uninjured personnel on board.

(M) LST 52 suffered no grate damage. All other landing craft, seven (7) destroyers, seven (7) submarines and ten (10) attack transports showed either no damage or negligible damage.

(N) Bureau of Yards and Docks equipment exposed for test consisted of one concrete drydock and two concrete barges. The concrete drydock developed a few minor cracks, one of which was slightly below water, permitting slow flooding in one compartment. The concrete and wooden superstructure of YO-160 were almost completely demolished by the blast. Other damage, including fire damage, was minor. YOC-83 showed only negligible damage.

(O) By Able plus four, all ships had been cleared for reboarding by ship teams except YO-160 which still had too much radioactivity to permit continuous living on board. Ships which were not habitable had crews aboard only during daylight hours. By Able plus five, forty (40) ships, not counting LST's or any other landing craft, had reported all of their crews subsisting on board.

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(DIRECTOR SHIP MATERIAL)

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(P) Army equipment exposed on target ships showed the following results:

- (1) Heavy items such as guns and tanks were relatively unaffected.
- (2) The blast was destructive to lighter equipment at distances out to 1500 to 2500 yards, depending on size, construction and presentation of exposed surfaces.
- (3) Heat radiation was responsible for damage and loss of light combustible items up to distances of 2500 yards.
- (4) The effect of shielding was important. Items which when directly exposed sustained damage from either the blast or heat radiation, in some instances when shielded, were found undamaged at much closer exposures. In some instances, of two groups of similar items separated by a few feet, one was destroyed by fire while the other which was shielded was damaged only by singeing from the fire of the destroyed group.

(Q) It is noteworthy that none of the expected oil fires occurred either on ships remaining afloat or on the surface of the water. The ships which sank on Able day had heavy fires but it is not known if fuel oil was involved.

3. The fires noted at great distances from the burst are of special interest although the fires in themselves were inconsequential. A special effort is being made to collect information in each case in the hope that an analysis of all will provide a satisfactory explanation.


4. Enclosures (A) through (H) herewith comprise the separate reports of the technical groups operating in the organization of the Director of Ship Material. These reports contain detailed information in support of the summary set forth above, and considerable additional information of importance.

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(DIRECTOR SHIP MATERIAL)

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5. All technical groups in the Director of Ship Material Organization are continuing inspections of ships and materials and are making special studies of conditions which developed during the tests. No attempt is made at this time to draw conclusions from the tests, nor to make recommendations, pending the results of those further studies.

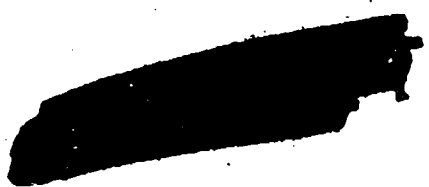
/s/ T. A. SOLBERG

T. A. SOLBERG,  
Rear Admiral,  
U. S. Navy.

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DIRECTOR OF SHIP MATERIAL

JOINT TASK FORCE ONE

OPERATION CROSSROADS

BUREAU OF SHIPS

GROSS DAMAGE REPORT

TEST BLE

6 JUL 1946

DATE

P. I. FOREST, Capt. USN

ENCLOSURE (A)

**CONFIDENTIAL**

REGISTERED NO. 16

840 009

I - INTRODUCTION

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1. The following report of gross damage to target ships has been compiled from information and data obtained from the sources listed below:

- (a) Aerial Photographs taken immediately after Mike Hour.
- (b) Report of Technical Observer in PBM Charlie.
- (c) Observations by Director of Ship Material.
- (d) Initial Boarding Team Reports.
- (e) Commanding Officer's Major Damage Reports.
- (f) Preliminary Staff Inspection Reports.

2. The ships are divided into three categories for discussion and are listed alphabetically by classes in each category. The first covers the vessels sunk; the second covers the vessels with major or significant damage; the third lists the vessels with negligible damage.

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Enclosure (A)

- 1 -

## II - REPORT OF DAMAGE

### A. SHIPS SUNK

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1. **SAKAWA (Ex-Japanese CL)** - The Sakawa became visible in the aerial photographs about 09-01-50 at which time she appeared to have a serious fire in the extreme stern. In these photographs she seems to be lying with her longitudinal axis about 30 degrees to the right of the axis of the Pensacola. The Technical Observer in PBK Charlie over the lagoon between 0950 and 1400 reported the Sakawa heavily damaged with a fire aft. By 1700 the water of the lagoon had been cleared radiologically sufficiently to permit approach close enough to the Sakawa for the Director of Ship Material to observe the damage from the Reclaimer (ARS-42). Observations were continued until darkness forced the withdrawal of the Initial Boarding teams. The superstructure aft was smashed down and forward into an unrecognizable mass of twisted wreckage. On the centerline the stern was crushed inward opening the plating above and below the water-line and the deck aft was crushed inward along the centerline. The stern therefore was open to the sea by at least one vertical tear about 12 inches in width at the water-line. At this time the vessel was down about two feet by the stern but did not appear to be settling appreciably. The tops of the after turrets were crushed in. The mainmast was broken off falling forward and to port. The foremast was blown forward and buckled over against the director house. The forward tower, while still standing, was badly distorted and torn. The tops of the forward turrets were dished in a fore and aft V having a 2 foot maximum depression. The forward face of #1 turret also was dished in somewhat. The forecastle deck was wrinkled to a depth of about 18 inches at frame 35. All life lines on the starboard side were laid flat. Indications are that the blast struck from above and slightly to starboard of dead astern.

During the night the draft aft increased about 12 feet and the vessel took a list to port. Despite the fact that the ship was still dangerous radiologically, an attempt was made to tow her into shallow water. The Achomawi went alongside at 0906 on the morning of 2 July for this purpose. Before this could be accomplished however, her list increased dangerously and the attempt had to be abandoned after moving her about 150 feet astern of her position. By 0930 the list had increased to 8 degrees and by 1000 the main deck was awash amidships on the port side. At 1033 the Achomawi had the Sakawa in tow secured to starboard chain and pulling astern in an effort to slowly turn her and get the ship clear of the target array. The Sakawa then rolled considerably to port and the stern commenced settling more rapidly. At 1034 she was almost on her port beam and about 75 feet of the stern was submerged. By 1035 she was submerged up to her amidships section and at this time the stern appeared to have rested on the bottom with the bow about 70 feet above water. From this point on she settled more slowly until at 1043 $\frac{1}{2}$  her bow disappeared. The elapsed time of the observation was 9 $\frac{1}{2}$  minutes. When the Achomawi cast loose the Sakawa had been moved astern about 150 feet.

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Enclosure (A) SECRET

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2. USS ANDERSON (DD411) - The only information available on the Anderson is that furnished by photographs from shore-based and aerial cameras. The following comments are based on pictures taken by the tower cameras and on a series taken by PEM-2, on film roll 94, and the times are those of the camera clock.

The Anderson first appeared out of the smoke cloud at 09-01-50. The bridge structure and guns appeared erect but everything else above the forecastle and superstructure deck was missing. A fire was burning just abaft the bridge structure. By 09-02-53 the fire appeared to have increased in intensity and was spreading aft along the port side. At 09-02-58 there was a considerable increase in the intensity of the fire amidships. By 09-03-06 the whole after section of the ship appeared in flames. About 09-03-12 the Anderson started listing to port and by 09-03-27 the vessel was lying on her beam end. Between that time and 09-03-43 when a cloud obscured the ship the Anderson lay on her port side smoking. When the vessel reappeared at about 09-05-50 she had rolled over further on her port side. All fires were out and there was an indication of settling by the stern. By 09-06-46, the last photograph taken in this series, only a portion of the bottom forward was visible. When PEM Charlie flew over the lagoon about 09-50 the Anderson had disappeared completely leaving an oil slick on the water.

Pictures taken by cameras mounted in the towers of Bikini and Enyu islands show a heavy explosion in the location of the Anderson about 3 seconds after the burst and while the ship is obscured. The spoon of a destroyer torpedo tube was found on ARDC-13 after the test. This gives confirmation to the belief that violent explosions of torpedoes and possibly depth charges did take place on the Anderson and contributed to her rapid sinking. The Anderson was about 200 yards from the ARDC-13, relative bearing ARDC-13 to Anderson about 300 degrees.

3. USS LAMSON (DD367) - The information on the Lamson used herein was obtained from the same series of films discussed under the Anderson. The Lamson first became visible about 09-02-13. A light haze was apparent around the ship and in the later pictures taken about 09-06-35 there was indication of a heavy fire on the bridge. Smoke from a fire on the Arkansas frequently obscured the Lamson but evidence of a list to starboard was apparent even in the early pictures. Again, as in the case of the Anderson, the stacks and light superstructure are missing. The last pictures of this series taken about 09-06-46 show the Lamson lying bow on to the Arkansas, almost at right angles, and listing to starboard.

When PEM Charlie reached the lagoon at about 0940 the Lamson was lying over on her starboard side with her bridge structure under-water and the port side of her bottom above the surface. A large oil slick trailed to leeward. The Lamson was still floating bottom up when PEM Charlie left the area about 1400. The Lamson was sighted by the Reclaimer after entering the lagoon about 1300 with the bottom barely showing. It is believed that she sank shortly thereafter as she definitely was missing when the lagoon was checked during a quick tour by the Reclaimer about 1700.

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4. USS CARLISLE (APA69) - The Carlisle first appeared in the serial photographs about 09-02-01. At this time the vessel appeared heavily on fire amidships on the port side with both stacks, the after kingpost, and the upper superstructure missing. The vessel was still burning when the last picture of this series was taken and was listing about 5 degrees to starboard. When PBM Charlie arrived over the lagoon at 0940 the Carlisle had disappeared.
  
5. USS GILLIAM (APA57) - The Gilliam was not seen after the burst and manner of her sinking is unknown. In the pictures taken from PBM-2 between 09-01-50 and 09-03, there are some in which the presence of an oil slick or disturbance in the water at her berth can be faintly discerned. Information on the nature of her damage and manner of sinking must await diver's inspection.

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**B. SHIPS WITH MAJOR OR SIGNIFICANT DAMAGE**

1. ARKANSAS (BB33) - The Arkansas suffered heavy damage from blast which apparently struck the ship from about 120 degrees relative and from an angle above the horizon of about 30 degrees. The main deck aft of turret #6 is dished downward about 18 inches and the wooden deck splintered. Abreast and between turrets 3 and 4 the main deck is dished slightly. Superstructure plating is buckled and blown inward generally with the worst damage being along the starboard side. The foremast tripod is not damaged above main deck but the starboard after leg is torn loose from the second deck and the entire structure is loose. The attached and surrounding house structures suffered heavily. The fore topmast is bent almost double and leaning aft. The main topmast is blown forward and hangs inverted. The mainmast is inclined about 5 degrees to port. A range finder on turret two was dislodged from its foundation leaning towards the direction of blast and was pushed off the turret by the Initial Boarding Team. The stack is collapsed along its fore and aft axis and is blown forward and to port lying across the superstructure deck. Light and miscellaneous items of topside fittings such as searchlights, radar and radio antenna, gear lockers, stanchions, halliards and light rigging were either demolished, missing or badly damaged. Many weather openings whether doors hatches or ventilation openings were severely damaged. Paint and surfaces towards the blast were scorched and blistered. Several small fires in the Army QM equipment and in light cordage were observed on Able and Able plus one day. No significant damage resulted from these fires.

The forward and after Diesel Generators are operable and with the exception of damage to the boiler casings and uptakes little damage to other machinery is expected. Fire-room floor plates and gratings are slightly disarranged.

The ship was not cleared radiologically until Able plus one day when the topside area aft to turret #3 was cleared.

The ship suffered no flooding or loss of stability and so far as inspections to date have revealed, only in the after section where the main deck is dished, is there an appreciable amount of structural damage. The damage does not seriously affect the overall strength of the ship.

2. KAGATO (Ex-Japanese BB) - The damage suffered by the Kagato is not as obvious nor as distinguishable as that suffered by some of the other ships for the following reasons: The ship had suffered two bomb hits during war which have not been repaired, and the Japanese had cut off the top of her stack and much of the light superstructure aft when using her as an AA defense ship in Tokyo Bay. In general the remaining superstructure was dished in an distorted in varying degrees. The remainder of her stack was flattened in on both sides. The forward superstructure tower withstood the blast well as a unit but the after port surfaces were dished in varying degrees dependent on the weight of plating. The fore top range-finder was dislodged from its circular track. Some small fires from cordage and miscellaneous gear did no significant damage.

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There was no apparent damage to the hull structure and no flooding.

The ship was radiologically dangerous on Able day but the radiation decayed to safe limits by 1415 on Able plus one day.

3. USS NEVADA (BB36) - The principal structural damage to the strength hull of the Nevada is the general deflection of the main deck. This deflection varies from several inches at the stern to negligible or none at the bow. There is a rectangular hole in the port side of the main deck near amidships. This hole is approximately 20 feet by 20 feet square and was due primarily to the location at this point of a plate, removable for handling of machinery. The deck in this area is not supported as well as elsewhere. Aft of #4 turret the main deck was forced down by the explosion but returned almost to its normal position, leaving general failure in the stanchions between the main and second deck in this area. There is a slight dish in the side plating on both the port and starboard quarter in the extreme stern. None of these failures seriously affect the overall structural strength of the ship.

There was no apparent leakage of water into the ship.

Above the main deck there is general blast damage to vent ducts, platform gun shields and miscellaneous stowages and fittings, and extensive damage to the smoke stack. The foremast structure is twisted and gun tube are distorted. The airplane crane is buckled. Airplanes at the stern were destroyed as was all of the Army equipment exposed.

The after face of the superstructure is blackened as is also the paint on the tops of the two after turrets. There is general scorching of wood decking.

The white paint and all paint in all forward turrets appears to be in perfect condition. The equipment found appears to be in good condition. There are some scorch marks on surfaces aft of the bridge.

The port side plating of the Nevada is blackened to a point about 1/3 the length of the ship from the bow. The starboard side is scorched only slightly forward of the stern.

Blast pressure has seriously damaged stacks and uptakes. Casings of all boilers were also damaged. Repairs now underway will permit lighting off one boiler, and operation test of machinery, all of which appears to be in satisfactory condition will proceed shortly.

4. USS NY YORK (BB34) - The New York suffered no material damage which would have appreciably affected her ability to conduct offensive action. The Mark III fire control radar antenna on the after fire control tower was dislodged from its turn-table, and fell to the port boat deck. The antenna could be replaced and operated by ship's force. The lower inboard boiler casing panels number 3 and 4 boilers were blown off and on boilers 1, 2, 5, and 6 were slightly distorted outward. Other damage consisted of superficial dishing of light structure. The blast and heat apparently hit the ship from 155 degrees relative as evidenced by the scorching and blistering of paint and indications of distortion in light structure.

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Two topside fires are believed to have been caused by the direct effect of the bomb. The first started apparently in the kapok padding on the towing bars of two seaplane recovery sleds stowed against the after starboard side of the secondary fire control tower and consumed the sleds. The second started in the port flag bag. The origin of this second fire is mysterious since there is no evidence of flash heat in the vicinity. There is an indication that some foreign matter fell into the flag bag and liquified. Burning material from the flag bag fell to the wooden deck below where it ignited the Army QM Corps test material and charred the deck. No secondary damage resulted from these fires.

The New York was radiologically safe when boarded on Able day. It is believed that except for casualties which might have resulted to exposed personnel and in the boiler rooms as a result of flare-backs the New York would have suffered negligible impairment of military efficiency had she been in action at the time of blast.

5. USS PENNSYLVANIA (BB38) - The Pennsylvania suffered no major material damage. There is some dishing of flat athwartship bulkheads and some distortion of boiler casing and of the outer casing of the smoke pipe. The wire gratings of the weather deck ventilation openings are distorted and some damage has been suffered by interior ventilation ducts. There is possibility of misalignment of the fresh-water pumps but this has not yet been established. A secondary fire in the Army QM Corps specimens burned the wooden deck between frames 60 and 70.

The direction of heat and blast as indicated by the flash heat scorching and blistering of paint and the dishing of light structure was from 220 degrees relative.

The Pennsylvania was radiologically safe when boarded on Able day. There was no flooding or loss of strength. With the possible exception of possible personnel casualties as noted under the New York, the ship would have suffered no appreciable loss in military effectiveness.

6. USS INDEPENDENCE (CVL22) - The Independence is the most severely damaged of the ships remaining and has suffered very severe damage to structure, equipment and fittings above the hangar deck level. This damage has little or no effect on the structural strength of the ship girder itself. The principal damage to the strength hull of the Independence is at the extreme after end of the port side plating. At this point there is heavy damage with heavy distortion and destruction of shell plating framing from the water line to the flight deck, with a short section of the after port corner of the flight deck bent upwards to a point some 12 feet above the original level. The damage at this point is unusual, particularly because although extremely severe it is also localized, in an area some 50 feet in diameter.

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The exposed shell, on the Independence is composed of relatively light plating, forming an external blister added to the cruiser hull when this design was created by modification of the original cruiser design. This exposed plating is relatively light and has been dished from amidships to the stern on the port side. This dished plating is external to the main strength shell plate of the original design and it is not considered that this dishing seriously affects the strength of the ship's girder. The force of the explosion has caused a deflection to starboard of the bow. This deflection is evidenced by a vortical buckle on the starboard side at approximately 40 feet from the stem. The stern, from a point aft of the after bulkhead of the hangar has also been deflected to starboard to an angle presently estimated at approximately 2 to 3 degrees. This deflection of the stern is evidenced by a buckle in the starboard side, and by several corresponding buckles in the main deck in the after elevator well.

Above the main deck the damage to the hangar side walls and to the flight deck is extensive and would require complete rebuilding of this structure. The load exerted on the underside of the flight deck and its girder supports in blast pressure, appears to have been sufficient to cause complete failure of these structural members in almost every instance. In the main, however, failure has not progressed to a point which will prevent reasonably satisfactory analysis of the action of the structure. While the strength of the structure has been completely destroyed, preliminary examination of the types of structural failures involved, indicates that the design as a whole is well balanced and that there are no significant points of particular weakness.

All hangar side roller curtains and all shelter plate of the port hangar wall has been blown in except in 3 panels. The damage to the starboard side structure of this type is considerably less. Both elevators have been blown overboard and have disappeared. The ship fittings and equipment inside the hangar were almost totally destroyed. Arresting gear units supported in the overhead in the hangar, have fallen down and are lying on the hangar deck.

All equipment exposed for test in the hangar was almost completely demolished. It is notable that for an appreciable distance aft of the forward elevators and forward of the aft elevators, damage to the supporting structure was apparently relieved by the release of pressure through the elevator opening in the flight deck.

Forward of the hangar and above the main deck, there is extensive general displacement of lockers and furniture throughout the living spaces. One door located on the port side just forward of the hangar and one deck level above the hangar deck was blown inward carrying ahead of it joiner bulkheads and miscellaneous gear.

A fire and low order explosion of twelve Mark XIII torpedo war-heads occurred just aft of the after bulkhead. This caused damage and bulging to the after bulkhead of the hangar dock. The fire itself created heat which burned a considerable area of the wood decking of the flight deck abaft the aft elevators. The flight deck as a whole was slightly scorched by the flash.

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Forward of the forward elevators there is relatively little distortion of the flight deck. Between elevators the pressure in the hangar below has caused bulging of the flight deck and its girder supports. These girder supports buckled sharply at the centerline causing a sharp ridge along which the wood planking of the flight deck was broken sharply. This ridge is approximately 10 feet above the normal line of the flight deck level. The general contour of the flight deck surface is irregular between the elevators.

Aft of the after elevators a large area of the flight deck wood has been burned and the deck is distorted upwards because of the severe local damage at stern previously discussed.

All flight deck galleries, arresting gear, operating mechanisms, gun sponsons, piping and similar equipment was demolished or severely mangled on both sides of the flight deck. All material exposed on the flight deck was demolished or blown overboard. Marks on the deck indicate that a large tank full of water on the port side and weighing approximately 50 tons, was not blown overboard but slid from port side completely across the deck and fell overboard upon reaching the starboard edge.

The radar antennas and other mast fittings were blown overboard leaving only the island structure itself. In spite of this severe damage to the external attachments of the island, the internal fittings were in general undisturbed with the exception of the heavy navigator's table which was apparently not well secured, and slid across the room. Glass airports at this level were not cracked or broken.

The airplane crane remained on board but was leaning slightly to starboard.

All 4 stacks had been blown down below the level of the flight deck, and severely damaged.

The pressure within the hangar caused dishing of the deck itself and in turn forced the main deck downward in this area causing some damage to stanchions and supporting structures beneath, between the main and second decks only.

The blast pressure entered ventilation systems and in addition to demolishing ventilation trunks within the hangar passed into these trunks, which were then blown out in spaces below the main deck.

With the exception of the damage to the stacks from hangar deck upward, there is no significant damage to stacks or boilers. Fire room gratings are somewhat displaced.

The forward Diesel Generator was started and operated, and some electrical equipment was placed in operation on the afternoon of 5 July as soon as the ship had been opened up by the ship's forces.

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The ship at present has a list of approximately 6 degrees to starboard possibly caused by the general movement of structure and heavy equipment above the hangar deck.

The preliminary examination of stability indicates no appreciable change in the ship's condition in this respect, with estimated GM of 3.25 feet based on an observed period of 360 degree roll of 11 seconds.

Up to the present time it has not been possible to obtain a check on the alignment of machinery. Certain areas in the after end of the ship have not been cleared radiologically and detailed examination has been impossible in steering compartments and similar spaces.

~~With the exception of a last order explosion of the torpedoes about the hangar, there is no indication of any blast on board the ship.~~

There is some indication that blast effect at after end of the ship may have had an upward component.

7. USS SARATOGA CV3 - While material damage to the Saratoga was minor, a casualty to her one elevator might have greatly reduced the military efficiency of the ship until it was corrected. The elevator was secured in the "up and locked position" for the test. After the test it was discovered that the elevator platform was dished slightly. When an attempt was made to operate it after the test, it was found that after four feet of downward travel the fore and aft equalizing shaft and pinions, meshing with stationary vertical main racks, had been displaced forward approximately one-quarter inch. The main pinion gouged large pieces of metal from the auxiliary rack. The elevator was returned to the flight deck and locked. No further attempt will be made to operate it until the full extent of the derangement is determined and corrected. Aside from glass being broken in the O.C.D. booth on the flight deck; the flight deck itself being charred to a depth of about 2 inches between frames 105 to 112 port where Army QM Corps specimens burned, and the sheering of the elevation securing pin for the SM antenna, no other damage has been discovered.

The ship was slightly above the 24 hour tolerance of radiological safety along the port side of the flight deck when boarded Able day but some of this may be attributable to an upwelling of radiologically unsafe water in the vicinity at the time she was boarded. The island structure and hangar docks were within safe limits and the entire ship was cleared on the morning of Able plus one.

The Diesel Generator which was in operation at the time of the test was still running when the ship was boarded at 1335 on Able day.

8. USS PONCACOLA (CA24) - The Poncacola is the most heavily damaged cruiser. The pattern of flash heat scorching and blast damage indicate the blow came slightly from above and from 165 degrees relative. The most serious structural damage occurred to the main deck in the well between the forward and after uptakes at about frame 65.

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Here the main deck between the stringer strakes is dished downward to a depth of about 3 feet on the centerline. There is a transverse crack in the way of the after edge of the forward uptakes which does not reach the stringer strakes. The stringer strakes in this region show slight transverse wrinkles. The main deck aft is also severely dished in and in some places ruptured. Between the main and second decks, stanchions and bulkheads are buckled and twisted in the way of the dishing of the main deck but damage to the second deck is minor. Only in the after engine room where one of the centerline stanchions shows a slight bow and in the way of the boiler uptakes is there apparent damage.

Light superstructure enclosures are extensively battered. Weather door and door frames suffered general damage. Aluminum structures in particular show no resistance to blast. Both stacks are crushed and blown forward and to port. The pole mast is bent forward and to port. A fire in the Army QM Corps specimens burned through the wood deck on the after port quarter.

Machinery damage is apparently confined to the boilers casings and uptakes which are severely distorted. A jury rig stack is being manufactured. Repairs to one boiler are being undertaken in order to provide steam for auxiliary purposes and for testing the machinery. The Diesel Generators are in operation providing power for lighting and some ventilation for the crew.

The ship suffered no flooding or loss of stability. It is considered that some reduction in longitudinal strength has resulted from the main deck damage amidships. The vessel was radiologically dangerous on Able day but radioactivity decayed to safe limits by the afternoon of Able plus one day.

9. PRINZ EUGEN (Ex-German CA) - The material damage suffered by the Prinz Eugen was of a superficial nature but quite extensive. The ship was hit by the blast and heat almost bow on. The relative bearing was estimated at about 355 degrees from the scorching of exposed surfaces and dishing of light structure. The fore topmast was bent slightly aft and splintered at the base. The main topmast carried away and is hanging by the stays. All radio antennae and most of the signal halliards were carried away. One radio antenna trunk on the stack was dislodged. The windshields on the open bridge were torn loose and the hangar hatch cover was blown down into the hangar. Life rafts, fire hose, bedding and other loose gear generally were adrift, and the deck was littered with broken glass from the torpedo tubes and instrumentation mirrors. On the superstructure deck level bulkhead 62 was deflected slightly forward. The machinery plant was undamaged.

When boarded on Able plus one day there were indications of radioactivity but none of a dangerous magnitude.

Personnel casualties topside and the loss of communication facilities would have reduced military efficiency to some extent for a short while.

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10. USS SALT LAKE CITY (CA-26) - Damage to the Salt Lake City follows the same general pattern as that to the Pensacola. The extent however, is somewhat less. The ship took the blow from about 240 degrees relative as indicated by flash heat scorching of exposed surfaces and by the pattern of blast damage. The forward stack is missing entirely and the after stack has been blown over to starboard. The mainmast is bent forward and to starboard. Dishing of the main deck and the distortion of superstructure bulkhead closely resembles that on the Pensacola but is less pronounced.

Damage to the uptakes and boiler casings while not so severe as in the Pensacola, repairs to the casings and uptakes and the installation of a jury stack will be required before a boiler can be lit off. The Diesel Generators are in operation and damage to the remaining items of machinery is not apparent.

There was no flooding and the stability is unaffected. It is considered that some reduction in longitudinal strength has resulted from the damage to the main deck amidships.

11. USS HUGHES (DD410) - The Hughes suffered general topside damage from blast. Indications are that the blow came from slightly to port of the centerline and after surfaces are heavily scorched. The stack and uptakes are crushed and torn and in general forced forward. The foremast is buckled and bent forward at the bridge level. Light superstructure plating, weather-tight doors and topside fittings suffered general distortion and damage. Aluminum doors and plating suffered most heavily. There is some dishing of the main deck aft of number 4 gun between the main deck stringer strakes, with evidence from scratch gages in this location indicating at least six cyclic flexures of the main deck with respect to the first platform deck.

Damage to the uptakes carried down into the boiler casings which are bulged and cracked. Repairs now in progress are necessary to permit lighting off one boiler. Operability tests of machinery will then proceed. The Diesel Generators operated upon re-boarding and the remainder of the machinery plant shows no apparent damage.

The Hughes suffered no loss of stability nor was there any flooding. The vessel was radiologically safe when boarded on Able plus one day.

12. USS RHIND (DD404) - Damage to the Rhind is most apparent in exposed light structure. The direction of heat and blast appears to have been from about 75 degrees relative. The stack was blown overboard; the mast is bent aft and slightly to port except for the top which has a kink to starboard. Superstructure and bulwark plating is generally dished in on the starboard side in some cases severely enough to cause tears in the panels and seams. Weather doors on the starboard side and some of the weather doors on the port side were dished inward.

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The spring loaded escape hatches to the machinery spaces in the main deck were found open with the hatch dogs undamaged, although they were closed prior to test. There is indication of minor panel dishing in the light shell plating forward on the starboard side.

Machinery damage appears to be confined to the uptakes and boiler casing but despite this damage and the loss of the stack the ship's force was able to light off a boiler and get up steam upon re-boarding.

There was no flooding and no loss of stability. No loss in longitudinal strength is apparent.

Although cordage about the decks is scorched, there appears to have been no fires except a gun bloomer on the after mount.

The Ehind was free of radiological hazards when boarded on Able plus one day.

13. USS RALPH TALBOT (DD290) - Damage to the Ralph Talbot was almost entirely superficial. The flash heat and blast as indicated by scorching and distortion, appears to have come from aft on the starboard side. The mast is bent forward and to port and the starboard after stay has parted. The stack is bent slightly forward and to port and the outer casings of the stack and uptakes are dished in. Dishing of light superstructure plating on the starboard side varies in severity with the thickness of the plating and its angle to the blast. Main radio antennas are down. The dome of the 36" searchlight is broken and inclined ladders are distorted in varying degrees.

The crew was able to light off boilers on reboarding and investigations to date reveal negligible machinery damage.

The ship suffered no loss of stability. There was no flooding and longitudinal strength is unimpaired.

The Talbot was free of radiological hazards when boarded on Able plus one day.

14. USS SKATE (SS305) - The Skate was the only submarine to suffer any appreciable damage. All of the light self flooding superstructure was either crumpled in to a twisted mass of wreckage or swept away completely. Aft of the conning-tower it is entirely gone. The half inch special treatment steel bulwarks around the open bridge above the conning-tower are folded forward. The periscopes and periscope shears are bent forward and to starboard and from the position of the other damaged structure it appears that the blow the Skate received, came from above and from a relative bearing of about 195 degrees. One curious aspect of the Skate's damage is that there is absolutely no evidence of scorched paint or any other indication of flash heat.

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The pressure hull and conning tower of the Skate are undamaged. Four main ballast tanks flooded. Number 7 flooded when a nearby gear was jammed against its vent valve pushing it open. Numbers 2B, 2C, and 2D flooded through the salvage air fittings which were damaged when the superstructure tore away from the strength hull. Adequate reserve buoyancy remained despite this flooding and the vessel was never in danger of sinking. The three degree starboard list on the Skate after the test was caused by the displacement of the periscope shears and the remaining superstructure to starboard and by the unsymmetrical flooding of the main ballast tanks.

The port main mufflers are missing and the auxiliary engine muffler is adrift. The starboard main muffler is intact. While the port outboard exhaust valves are distorted the starboard valves are intact and operable. Because of the rather spectacular appearance of the topside damage and because the Skate was extremely active radiologically, she was towed in to shallow water off Enyu Island and beached on Able plus one day.

The Skate was dangerously radioactive until Able plus three days when the radio-activity had decayed to a level permitting six hours exposure. By Able plus four days it was possible to place the crew aboard and open the vessel up. Interior damage to Hull, Machinery, and Electrical equipment appears insignificant. Assisted by the Widgeon (ASR1), the Skate backed off the beach at Enyu Island and at 1730, 5 July proceeded under her own power to her assigned berth in the vicinity of the Fulton (AS11).

15. USS BARROW (APA61) - The Barrow suffered moderate blast damage to topside structure. From the pattern of flash heat, scorching and structural distortion it appears the blow came from forward on the port side. The shell plating above the water-line on the port side is dished in a maximum of about 3 inches between frames 38 to 45, and the upper deck plating between the hatch coaming and the port side of the ship at frame 42 is bulged upward slightly. Both stacks are dished in on the port side and such items as Stokes stretcher, radio antennas and antenna stays, life rafts and life raft brackets are damaged. The pontoon hatch panels on one and two hatches were dislodged and some were bent at both upper and main deck levels. There was secondary fire atop the after deckhouse apparently started by gasoline from a handy-billy pump and there is evidence of a small explosion in the same area.

No damage to the machinery plant has been uncovered in inspections to date.

The ship suffered no loss in either stability or strength and there was no flooding.

No radiological hazards were found when the vessel was boarded on Able plus one day.

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16. USS BRULZ (APA66) - Damage to the Brulz is of particular interest because all weather openings except those leading to the magazine spaces were left open for the test. Impact of the flash heat and blast as indicated by the pattern of flash heat scorching and blast damage was from an angle of about 17 1/2 degrees above the horizontal and from about 125 degrees relative. Both stocks are dished in at the starboard after side and starboard and after bulkheads of the superstructure are dished in. The upper deck aft and the upper courses of shell plating show some distortion. In general weather deck doors and door frames are distorted to an extent which prevents satisfactory closure. Loose gear to wind was thrown about; the radio antennas suffered general damage and both starboard booms suffered distortion the fifteen ton boom being bowed about six inches and the five ton boom about 2 inches.

Interior damage was localized in the way of weather opening where joiner bulkheads were considerably distorted. Ventilation ducts showed some distortion but were usable. Loose gear in the interior of the ship was thrown about to a considerable extent. The inclinometers on the bridge and in the engine room indicate a roll of 70 degrees to both port and starboard. Fires occurred in the signal halliards aft and in two broom and swab racks on the superstructure aft.

Machinery damage discovered to date has been negligible. An oil ring on number one Ship Service generator fractured apparently from blast and caused a main bearing to burn out when the generator was started. The electrical controller panels for davits one and three are damaged beyond ship's force ability to repair.

There was no flooding and no loss in either strength or stability.

The vessel was free of radiological hazards when boarded on Able plus one day.

17. USS BUTTE (APA62) - The damage suffered by the Butte is for the most part attributable to secondary fires. The direction of impact of flash heat and blast as indicated by scorching of vertical surfaces and structural deformation was from approximately broad on the port bow. Hatch panels were dislodged and there is some indication of panel dishing in the shell plating above the water-line between frames 30 and 60 on the port side.

The most serious secondary fire occurred on top of the after deck-house where a paint locker and the top of the deck-house are completely burned out. An explosion occurred in this area and a ruptured acetylene bottle is in the debris. A second fire consumed a nest of life rafts at frame 128 starboard while a third fire occurred at about frame 70 on the upper deck. The most serious effects of these fires was to damage or destroy electrical cable and equipment in their vicinity, none of which was vital and most of which could have been quickly repaired.

No machinery damage has been discovered to date.

The Butte suffered no loss in strength or stability and there was no flooding. The vessel was free of radiological hazards when boarded on Able plus one day.

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18. USS CRITTENDEN (APA77) - The Crittenden is the most seriously damaged of the surviving APA's. The ship received the blast from forward on the port side. The foremast and mainmast broke off at the top of the kingposts and the outer casings of both stacks are badly dished and crumpled. The inner casing of the stacks, however, show almost no damage. The forward surfaces of the superstructure and bridge are heavily dished aft. The upper dock in the way of number one hatch is dished downward about two feet. The shell plating is wrinkled and dished from the upper deck to water-line between frames 30 and 50 port. The longitudinal house side between frames 118 and 122 on the starboard side is buckled to a maximum of 6 inches. The hatch pontoons for both number 1 and number 2 hatches were blown down into the hold.

Machinery damage uncovered to date is almost negligible. The weld at the base of the uptake of number 1 boiler failed but has been repaired by Ship's force. The boiler smoke periscopes broke around the mirror housing; the fireman ruptured in several places and developed numerous butts throughout the ship were also damaged in varying degrees.

The ship suffered no loss in stability and there was no flooding. The possible loss in strength if any has not yet been determined.

The ship was not found clear of radiological hazards until Able plus three days.

19. USS DAWSON (APA79) - The Dawson suffered moderate damage from blast which, as indicated by flash heat scorching and structural deformation, hit the ship from approximately 330 degrees relative. Superstructure plating on the port side is dished in and weather doors in many cases, particularly on the port side are so distorted as to be inoperable. There is some dishing of the upper and superstructure decks. The outer stack casings are badly crushed but the inner casings show only slight damage. The radar mast on the mainmast is bent aft about 30 degrees and the mainmast itself is bent slightly. Hatch beam to both one and two hatch are distorted and broken, and the hatch pontoons bent and fallen into the hold. The port boat davits are badly damaged and the aftermost port davit has collapsed. The forward starboard fifteen ton boom is bowed and the look-out tube on the forecastle have ripped loose from the deck.

Secondary fires in cordage and fenders caused no damage.

No damage to machinery other than that to the port boat davit operating equipment has been discovered in inspection and tests to date.

There was no flooding and no loss in either strength or stability.

The Dawson was found clear of radiological hazards when boarded on Able plus one day.

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20. LANDING CRAFT - The only landing craft to suffer any appreciable amount of damage were the LCM-1 which was anchored between the Nevada and Pensacola and the LST-52.

The damage to the LCM-1 was limited to the bow ramp being blown down; the portable plates over the engine compartments being dished and minor dishing of the ramp and side plating. The engines of the LCM-1 appeared to have suffered no damage.

The LST-52 suffered blast damage which dished the after and starboard deck-house side between frames 30 and 50 to a maximum depth of three inches. There is some dishing of the shell plating above the water-line starboard from frame 30 to frame 4. The elevator was blown in buckling the cross-beams and breaking the cable. The hatch boards on the after deck appear to have blown out. The side lights were torn loose as was the range-light and radio antenna were blown down. A gear locker at the pilot-house level was crushed.

No machinery derangements have been found in inspections to date.

There was no flooding and no loss of either stability or strength.

The ship was free of radiological hazards when boarded on Able plus one day.

21. CONCRETE CRAFT - ARDC-13, YO-160, and YOC-83

Details of damage to these craft is covered in the report of the Director of Ship Material Representatives from the Bureau of Yards and Docks.

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**II - REPORT OF DAMAGE**

**C. SHIP WITH NEGLIGIBLE DAMAGE**

**1. Destroyers:**

Corynham	DD 371
Marrant	DD 402
Mugford	DD 389
Mustin	DD 413
Stack	DD 406
Wainwright	DD 419
Wilson	DD 408

In so far as has been determined to date the damage to these ships in no case exceeds superficial dishing of light structure, scorching or blistering of paint work, or minor secondary fires which caused no damage.

**2. Submarines:**

Apogon	SS 308
Dontuda	SS 336
Parcho	SS 384
Pilotfish	SS 366
Searaven	SS 198
Skipjack	SS 184
Tuna	SS 203

Scorching of paint and in a few cases the spilling of mercury from the rotor bearings of the arma auxiliary gyrocompass represents the only damage found as yet on these submarines.

**3. Attack Transports:**

Banner	APA 60
Bliden	APA 63
Brecken	APA 64
Briscoe	APA 65
Carteret	APA 70
Fallon	APA 81
Fillmore	APA 83
Gasconado	APA 85
Geneva	APA 86
NIAGARA	APA 87

Varying degrees of scorched paint work superficial dishing of minor superstructure, minor secondary fires which did no damage to the ship and and general dislodgement of cargo hatch pontoons, describe the effect of the burst on the above listed ships. The most serious secondary fire was on the Gasconado where two LCVF were consumed.

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4. Landing Craft:

LST 133  
LST 220  
LST 545  
LST 651  
LCI 327  
LCI 329  
LCI 332  
LCI 549  
LCI 615  
LCI 820  
5 LCI's  
6 LCI's

LCT 414  
LCT 705  
LCT 812  
LCT 816  
LCT 918  
LCT 874  
LCT 1013  
LCT 1078  
LCT 1112  
LCT 1113  
LCT 1175  
LCT 1237

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1237

Inspection up to the present date show damage on these craft ranged from blistering of paint work and minor secondary fires which did negligible damage to no damage whatsoever.

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**III. GENERAL OBSERVATION**

1. The overall pattern of material damage to the target ships indicated that the fission of the bomb took place over a point bearing between 280 degrees and 290 degrees true from the Nevada and at a distance from the Nevada of about 600 yards.

2. The reason for the many small fires on the outer vessels of the array is being studied and while the investigation is not complete the indications are that most of them started in flax lamp and manila cordage and in cocoa mat fenders.

Curiously enough there were few if any fires in the straw placed around the exposed animals.

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DIRECTOR OF SHIP MATERIAL  
JOINT TASK FORCE ONE  
OPERATION CROSSROADS

ARMY GROUND GROUP, CTG 1.4  
GROSS DAMAGE REPORT FOR TEST ABLE  
(ABLE PLUS FIVE DAYS)

6 JULY 1946  
(Date)

*J. D. Frederick*  
J. D. FREDERICK, Colonel Inf CTG1.4

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**SECRET**

Registered Number 28

Enclosure (B) to Director of Ship Material Serial 00174.

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File  
CTG 1.4/1

HEADQUARTERS  
ARMY GROUND GROUP  
USS WHARTON

5 July 1946

To: COMMANDER, JOINT TASK FORCE ONE

Subj: Preliminary Damage Report - Test Able Reentry Plus Five

1. Operations:

(a) Inspection of displays of Army test items aboard target ships made by the CTG 1.4 and his Technical Staff during the four days immediately preceding Test Able, established the fact that preparation for the test was complete in every detail and in conformity with Annex "N", Operation Plan, Com Joint Task Force One, No. 1-46. Photographs of all displays of test items, numbering approximately 1400, were taken prior to the evacuation for Test Able in order to provide adequate means of comparing their condition before and after exposure to the forces of the atomic bomb. Evacuation of personnel of TG 1.4 was effected as part of evacuation of target ships' crews, in a manner satisfactory to CTG 1.4. Selected personnel of TG 1.4 were among the last groups to leave target ships on 4-1 day.

(b) The phenomena accompanying the dropping of the atomic bomb was witnessed by all hands from transports standing off at distances of from 18 to 20 miles.

(c) Army inspection personnel assigned to target ships re-boarded as scheduled with Teams A & B of the target ships. An Army Ordnance Bomb Disposal Officer accompanied Initial Boarding Team No. 7 in visits to target ships displaying Army ammunition. Reports of visual inspection of damage began to reach CTG 1.4 over the TG 1.4 radio net on the evening of 2 July. During that afternoon the CTG 1.4 had boarded the USS SARATOGA, USS PENNSYLVANIA and USS NEW YORK. As of the evening of 5 July, the CTG 1.4 accompanying the Evaluation Board of the JCS, or accompanied by members of his technical staff, had boarded fifteen (15) of the twenty-five (25) ships displaying Army test items. All ships carrying Army test items were afloat except the USS GILLIAM (sunk) and ARDC-13 (beached). As of 5 July 46 each Task Unit Commander of TG 1.4 had inspected test items under his cognizance on all target ships.

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ENCLOSURE (B)

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File  
CTG 1.4/1

HEADQUARTERS  
ARMY GROUND GROUP  
USS WHARTON

5 July 46

Subject: Preliminary Damage Report - Test Able Reentry Plus Bino

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2. Observations: Inspections to date of Army items exposed to test reveal the following facts:

(a) In general, the selection of ships for exposure of Army test items was satisfactory in that graduated damage was obtained for practically all items.

(b) Heavy items such as tanks and guns were relatively unaffected by any force. Minor damage to some light parts such as optical elements, machine gun brackets, strapping and closures was evident. All heavy items were mechanically operational without need of corrective maintenance.

(c) The blast was destructive to lighter equipment to distances from fifteen hundred (1500) to twenty-five hundred (2500) yards, depending on size, construction and presentation of exposed surfaces. Lighter items such as airplane sections, electronic instruments, searchlights and trucks were severely damaged on ships near the center of the array. Generally these items showed only minor damage at a distance of fifteen hundred (1500) yards or more from the USS NEVADA. Some of the damage sustained was appreciably magnified because the items, firmly secured to the deck, had no resiliency and therefore excessive pressures were built up on surfaces normal to the blast.

(d) Uncovered ammunition displayed at 0 degrees true bearing and a distance of eight hundred (800) yards from the USS NEVADA, suffered only minor destruction. No ammunition in wooden or metal containers at the same distance was destroyed.

(e) Rubber elements, such as automotive tires and cables were undamaged. Thin rubber items such as eye shields were singed but still usable.

(f) Heat radiation was responsible for damage and loss of light combustible items up to distances of twenty-five hundred (2500) yards. Light crated and boxed supplies suffered destruction by burning on ships close to the center of the array. Thin wood with rough, splintered finish is believed to have been the only wood which ignited. Baled items and fabrics were destroyed by fire at distances over two thousand (2000) yards. Apparently some impregnated fabrics

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ENCLOSURE (B)

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CTG 1.4/1

HEADQUARTERS  
ARMY GROUND GROUP  
USS WHARTON

5 July 46

Subject: Preliminary Damage Report - Test Able Reentry Plus Five

and coarse fabrics with a porous weave and many loose fibres were highly susceptible to ignition. It is believed that bundled fabrics absorbed, rather than reflected, heat, which could not readily escape or be dissipated by the blast. This retained heat then initiated smoldering and finally active combustion of the bundles. Singeing of materials exposed to direct radiation was so superficial that a thin layer of wood, paper, paint or other material was sufficient in most instances to provide adequate protection. Inflammables in containers did not burn unless the containers themselves first caught fire.

- (g) The effect of heat on paints is evidently dependent on the composition, color and method of application as evidenced by differential ignition, blistering and discoloration.
- (h) Limited checks of electrical and electronic equipment at the closest distance have not revealed any malfunction attributable to radiological forces or causes.
- (i) The heat radiation and radiological forces did no perceptible metallurgical damage.
- (j) Containers of chlorinated lime, insect repellent, soap, methyl bromide and other chemicals retained radioactivity over a much longer period than metals.
- (k) No visual damage was observed on containers of fuels and lubricants, except for an evident photo-chemical change in color of certain samples of pure hydrocarbons.
- (l) Certain laminated panels of materials such as Doron, plastic glass, and thin metals were separated to some degree on ships in the center of the array.
- (m) The effect of shielding was immediately noticeable on all ships. Items which when directly exposed sustained damage from either heat radiation or blast, in some instances when shielded were found undamaged at much closer exposures. The directional effect of both forces was very marked. In some instances, of two groups of similar items separated by a few feet, one was destroyed by fire while the other which was shielded was damaged only by singeing from the fire of the destroyed group.

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ENCLOSURE (B)

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ARMY GROUND GROUP  
USS WHARTON

5 July 46

Subject: Preliminary Damage Report - Test Able Reentry Plus Five

(n) Some plastics were found to be very susceptible to ignition from the heat radiation. Plastics were fumed or burned up to distances of thirty-six hundred (3600) yards.

(o) The major defensive problem with respect to forces, other than radiological, would appear to be the development of protection from, or resistance to, the blast and heat radiation.

*J.D. Frederick*  
J.D. FREDERICK  
Colonel Inf  
CTG 1.4

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GFI

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ENCLOSURE (B)

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DIRECTOR OF SHIP MATERIAL  
JOINT TASK FORCE ONE  
OPERATION CROSSROADS

BUREAU OF AERONAUTICS GROUP  
GROSS DAMAGE REPORT FOR TEST ABLE  
(ABLE PLUS FIVE DAYS)

6 JULY 1946  
(Date)

TC. Lonquest  
T. C. LONNQUEST, Captain, USN

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Registered Number 16

Enclosure (C) to Director of Ship Material Serial 00174

840 035

**CONFIDENTIAL**

4 July 1946

ENCLOSURE " C "

**Subject:** Preliminary Report on Bureau of Aeronautics Material

1. The Bureau of Aeronautics target exposure program for Test Able comprised, 73 complete airplanes of surplus but substantially service types. These airplanes were embarked on vessels at various distances from the center of the target array in such manner as to simulate, as closely as practicable, the normal disposition of shipborne aircraft on combat vessels.

Closely paralleling the plan for exposure of target ships and ships' material, the target aircraft exposure plan had, as its broad objective the determination of the effect of the atomic bomb blast upon aircraft as a function of distance from the center of the burst.

2. With the objective indicated above, observation type aircraft were embarked in NEVADA, ARKANSAS, NEW YORK, PENNSYLVANIA, PENNSACOLA and SALT LAKE CITY. Carrier type aircraft were embarked in INDEPENDENCE and SARATOGA. Because of the limited number of combat vessels available, exposure of the remaining number of carrier type aircraft necessary to insure adequate coverage from the center to the perimeter of the target array was effected by embarking two aircraft in each of fourteen selected APA's of the GILLIAM class - one aircraft secured on the weather deck and one aircraft secured below on the second platform deck of the cargo hold - thus simulating carrier flight deck and hangar deck conditions as nearly as practicable.

3. Included in the aircraft target array were two surplus Coronado seaplanes - one moored at the estimated minimum survival distance and a second moored 600 yards farther out.

4. Based upon a preliminary and necessarily limited survey, the attached table describes, in general terms, the structural damage sustained by each airplane as a whole. Later reports will present in more detail, the comparative strength or weakness of the various separate components and equipment items comprising each airplane. The results set forth in the attached tables may be summarized as follows on next page:

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4 July 1946.

ENCLOSURE " C "

Subject: Preliminary Report on Bureau of Aeronautics Material. (Cont'd)

- (a) MISSING - Sunk with target vessels or blown overboard from target vessels - - - - - 14 Airplanes
- (b) MAJOR DAMAGE DUE TO BOMB BLAST - - - - - 22 Airplanes
- (c) MAJOR DAMAGE RESULTING WHOLLY FROM FALLING SHIP DEBRIS (Principally unsecured elements of hatch covers) - - - - - 7 Airplanes
- (d) LIGHT DAMAGE - Damage readily repairable. All aircraft usable for Test Baker - - - - - 11 Airplanes
- (e) NO DAMAGE - - - - - 19 Airplanes
- TOTAL - - - - - 73 Airplanes

- (NOTE:- Airplanes in categories (b) and (c) would require survey or major overhaul. Approximately 9 airplanes out of a total of 29 airplanes in categories (b) and (c) appear usable for Test Baker)

5. In addition to complete aircraft, other target exposure material under the cognizance of or of primary interest to the Bureau of Aeronautics included certain items of ships' material intended for arresting, handling and launching of aircraft principally arresting gear, barriers, elevators, airplane handling cranes and catapults. Results of a preliminary survey of this material are tabulated below:

TARGET VESSEL	EQUIPMENT	DAMAGE
USS SABATOCA	: Two H-3 Catapults	: No visible damage
	: Arresting Gear	: No visible damage
	: Barriers	: No visible damage
	: Fwd Elevator	: Elevator damaged - will only
		: lower four feet below flight
		: deck
	: Airplane Crane	: No damage
USS INDEPENDENCE	: GENERAL: This vessel sustained severe structural	
	: damage abaft the forward elevator and above the	
	: hangar deck as a result of bomb blast and of sub	
	: sequent fires and explosions abaft the after elevator.	
	: The overall effects on ship's structure included	
	: severe upward distortion and pronounced center line	
	: fracture of the flight deck and port side bents	
	: supporting same together with extremely severe dis-	
	: tortion of all structure from water line to flight	

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4 July 1946

ENCLOSURE " C "

Subject: Preliminary Report on Bureau of Aeronautics Material. (Cont'd)

TARGET VESSEL	EQUIPMENT	DAMAGE
USS INDEPENDENCE (Cont'd)	: deck abaft the after elevator. The damage to air- : plane handling equipment appears to be primarily : a reflection of this distortion of the flight deck : and related structure. : Two E-2 Catapults : Arresting gear : Barriers : Elevators : Airplane handling : Crane	: Machinery apparently intact, : Possibly displaced; tracks : tracks possibly warped from : distortion of flight deck : Gear damaged from distortion : of deck. All arresting gear : engines fell to hangar deck. : Gear damaged from distortion : of flight deck, engine fell : to hangar deck. : Elevator platforms missing. : Blown upward and overboard : by blast. : Tilted outboard and displaced : from foundations. Possibly : struck by elevator platform.
USS NEVADA	: P-6 Catapult : Airplane crane	: Warped and canted primarily : from dishing in of after : weather deck : Bent down over catapult
USS NEW YORK	: P-4 Catapult : Airplane cranes	: No visible damage : No visible damage
USS PENNSYLVANIA	: P-6 Catapults : Airplane crane	: Inoperable prior to the bomb : blast as a result of battle : damage. No significant in- : crease in damage. : Inoperable prior to the bomb : blast as a result of battle : damage. No additional damage : sustained, still inoperable

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4 July 1946

ENCLOSURE " C "

Subject: Preliminary Report on Bureau of Aeronautics Material. (Cont'd).

5. Pending completion of more detailed studies and tests now in progress, general analysis of the results of the bomb blast upon aeronautical material will be limited at this time to the following broad summary:

(a) Damage to catapults, barriers and arresting gear appears to be primarily the result of distortion of ships' structure supporting the item in question.

(b) The most vulnerable parts of exposed aircraft appear to be:

- (1) Control surfaces, many of which were blown off or otherwise damaged.
- (2) Cockpit canopies, particularly flat plexiglass plates, many of which were shattered.
- (3) Folded wings of carrier aircraft particularly where the wing surfaces were approximately normal to the blast.

(c) Analysis of the relation of damage to distance is somewhat obscured at this time by lack of accurate information relative to the exact point of bomb burst. Subject to the foregoing it would appear that:

- (1) No major damage resulted directly from the blast in the case of airplanes stowed in cargo holds outside the 1500 yard circle. Damage which was incurred in cargo holds of APA's appears to have been largely if not wholly due to the fact that main deck hatch pontoons and miscellaneous loose material were dislodged by the blast and fell into the hold on the airplanes located on the second platform deck, hazards which would be absent in carrier hangar deck storage.
- (2) Major damage was sustained by all aircraft on weather decks inside the 2000 yard circle.
- (3) Damage to exposed aircraft outside the 2000 yard circle was progressively lighter.

(d) Radiological characteristics of target aircraft after the bomb blast did not differ significantly from the characteristics noted in surrounding material.

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4 July 1944.

ENCLOSURE "C"

Subject: Preliminary Report on Bureau of Aeronautics Material. (Cont'd).

(c) The standard "Heavy Weather" method of securing aircraft (Aircraft Carrier Bulletin No. 13) for aircraft utilized throughout test Able, provided tie down strength adequate to secure the airplane under local blast or wind conditions sufficiently severe to cause the loss or destruction of numerous minor components (control surfaces, cockpit enclosures etc) and up to the point of failure of major cable attachment areas.

6. The response of aircraft electronic components to the Able Day test are covered in the preliminary report of the Electronics Coordinating Officer.

APPENDIX: - Table of Damage to Aircraft Eleven (11) sheets (Preliminary)

Copy to: Army Representative (Col. Frederick)

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DIRECTOR OF SHIP MATERIAL - BUREAU OF AERONAUTICS GROUP (OLAJ)

TARGET VESSEL	AIRCRAFT SER. & MOD. NO.	LOCATION OF TARGET VESSEL	REPORT *	REMARKS
USS SARATOGA CV-3	TBM-3E 69197	Stbd H.D. Frame 130	N.D.	
USS SARATOGA CV-3	TBM-3E 39188	Port H.D. Frame 130	N.D.	
USS SARATOGA CV-3	TBM-3E 69095	Stbd H.D. Frame 120	N.D.	
USS SARATOGA CV-3	TBM-3E 69169	Port H.D. Frame 120	N.D.	
USS SARATOGA	TBM-3E	Port F.D.	L.D.	Port tire burned slightly. Cockpit Plexiglass broken. Rudder and elevator battens broken. Flap warped. Tail gunner window broken. Elevator slightly warped on left side.
USS SARATOGA CV-3	TBM-3E 69094	Center F.D. Frame 100	L.D.	Plexiglass cockpit hoods broken. Elevator battens broken. Paint on elevator blistered by fire on flight deck.
USS SARATOGA	TBM-3E	Port F.D.	L.D.	Elevator battens broken - surface OK. Plexiglass in cockpit broken. Plexiglass in turret Broken

\* M-MISSING; MD - MAJOR DAMAGE; LD - LIGHT DAMAGE; ND - NO DAMAGE

Sheet 1 of 11

ENCLOSURE "C"

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DIRECTOR OF SHIP MATERIAL - BUREAU OF AERONAUTICS GROUP (014J)

SHIP	AIROCRIFT SER. & MOD NO.	LOCATION OF TARGET VESSEL	DAMAGE REPORT #	REMARKS
USS SARATOGA CV-3	F6F-5N 77637	Center H.D. Frame 60	N.D.	
USS SARATOGA CV-3	F6F-5N 7 8068	Stbd. F.D. Frame 95	N.D.	
USS SARATOGA CV-3	F6F-5N 78086	Stbd H.D. Frame 80	N.D.	
USS SARATOGA CV-3	77749	Stbd H.D. Frame 95	N.D.	
USS SARATOGA CV-3	F6F-5N 77648	Port H.D. Frame 85	N.D.	
USS SARATOGA CV-3	F6F-5N 77960	Port F.D. Frame 60	L.D.	Elevator Batton broken No damage to surfaco
USS SARATOGA CV-3	SBF-4E 31853	Contor F.D. Frame 90	L.D.	Placiglass - cockpit hoo d broken Turtlo back light damage Batton on elevator broken

\* M-MISSING; MD - MAJOR DAMAGE; ID - Little Damage; ND - No Damage

Sheet 2 of 11

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DIRECTOR OF SHIP MATERIAL - BUREAU OF AERONAUTICS GROUP (OLAJ)

1. SUBJECT	2. AIRCRAFT SER. & MOD. NO.	3. LOCATION ON TARGET VESSEL	4. DAMAGE REPORT	5. REMARKS
USS SARATOGA CV-3	SBF-4E 81839	Port F.D. Frame 90	L.D.	Placard glass in cockpit broken Elevator buttons broken
USS SARATOGA CV-3	SBF-4E 81859	Stbd F.D. Fantail	L.D.	Elevator buttons broken. Elevator slightly warped - fabric torn. Cockpit placard glass broken. Right alleron down
USS SARATOGA CV-3	SBF-4E 31889	Port H.D. Frame 100	N.D.	
USS SARATOGA CV-3	SBF-4E 31850	Stbd H.D. Frame 100	N.D.	
USS SARATOGA CV-3	SBF-4E 31894	Port H.D. Frame 110	N.D.	
USS SARATOGA CV-3	SBF-4E 31840	Stbd H.D. Frame 110	N.D.	

\* M - Missing; MD - Major Damage; LD - Light Damage; ND - No damage

Sheet 3 of 11

ENCLOSURE "C"

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DIRECTOR OF SHIP MATERIAL - BUREAU OF AERONAUTICS GROUP (014J)

TARGET VESSEL	AIRCRAFT SER. & MOD. NO.	LOCATION ON VESSEL	DATE REPORT	DAMAGE
USS INDEPENDENCE CVL-22	TBM-3E 69124	Stbd F.D. Frame 140	M	Blown over the side
USS INDEPENDENCE CVL-22	TBM-3E 69063	Port F.D. Frame 80	M	Blown over the side
USS INDEPENDENCE CVL-22	TBM-3E 69239	Stbd F.D. Frame 90	M	Blown over the side
USS INDEPENDENCE CVL-22	TBM-3E 69114	Stbd H.D. Frame 83	M.D.	Completely Demolished
USS INDEPENDENCE CVL-22	TBM-3E 69275	Port H.D. Frame 92	M.D.	Completely demolished
USS INDEPENDENCE CVL-22	F6F-5N 77453	Port F.D. Frame 60	M	Blown over the side
USS INDEPENDENCE CVL-22	F6F-5N 77492	Stbd F.D. Frame 65	M	Blown over the side

\* M - Missing; MD - Major Damage; LD - Light Damage; ND - No Damage

Sheet 4 of 11

ENCLOSURE "C"

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DIRECTOR OF SHIP MATERIAL - BUREAU OF AERONAUTICS GROUP (0143)

TARGET VESSEL	AIRCRAFT SER. & MOD. NO.	LOCATION ON TARGET VESSEL	DAMAGE REPORT #	REMARKS
USS INDEPENDENCE CVL-22	F6F-5N 77569	Port H.D. Frame 65	M.D.	Completely Demolished
USS INDEPENDENCE CVL-22	F6F-5N 77349	Stbd H.D. Frame 65	M.D.	Completely Demolished
USS INDEPENDENCE CVL-22	SBF-4E 31849	Port H.D. Frame 77	M.D.	Completely Demolished
USS INDEPENDENCE CVL-22	SBF-4E 31852	Port F.D. Frame 70	M	Blown over the side
USS INDEPENDENCE CVL-22	SBF-4E 31843	Stbd H.D. Frame 77	M.D. M.D.	Completely Demolished
USS INDEPENDENCE CVL-22	SBF-4E 31856	Stbd F.D. Frame 70	M	Blown over the side
USS INDEPENDENCE CVL-22	SBF-4E 31857	Port F.D. Frame 140	M	Blown over the side

\* M-Missing; MD - Major Damage; LD - Light Damage; ND - No Damage      Shoot 5 of 11

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TARGET VESSEL	AIRCRAFT SER. & MOD.	LOCATION ON TARGET VESSEL	DAMAGE REPORT	REMARKS
USS ARKANSAS BB-33	OS 20-3 39632	Top No. 3 Turret	M	Blown overboard
USS NEW YORK BB-34	XSC-1 35300	Catapult Aft	M.D.	Fuselage and wings buckled. Landing flaps torn off. Wing floats dented
USS NEW YORK BB-34	SC-1 35561	Port dock near turret No. 3	M.D.	Fuselage and wings buckled. Landing flaps torn off. Wing floats dented. Engine on port side bent down. Cockpit hood glass broken.
USS NEVADA BB-36	OS 20-3 5765	Fantail Stbd side	MD	Completely demolished. Parts scattered
USS NEVADA BB-36	OS 20-3 5742	Fantail on catapult	M D	Completely demolished. Parts scattered over deck aft.
USS PENNSYLVANIA BB-38	OS 20-3 5342	Catapult Fantail	M.D.	Blown off catapult on to dock. Starboard wing buckled. Control Surfaces demolished. Cockpit canopy shattered
USS PENNSYLVANIA BB-38	OS 20-3 5584	On dock Fantail	M.D.	Blown off car to dock. Control surfaces demolished. Cockpit canopy shattered. Right float damaged

\* Missing; MD - Major Damage; LD - Light Damage; ND - No Damage

Sheet 6 of 11

ENCLOSURE "C"

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TARGET VESSEL	AIRCRAFT SER AND MOD.	LOCATION ON TARGET VESSEL	DAMAGE REPORT *	REMARKS
USS PENSACOLA CA-24	OS2U-3 5956	Port Catapult; Mount Fr. 65	M.D.	Blown over port side. Hanging by strap passed around propeller hub 85% submerged
USS SALT LAKE CITY CA-25	OS2U-3 09874	Stbd Catapult; Mount Fr 60	M	Blown over Side
USS GILLIAM APA-57	FM-2 73535	Cargo Hold Second Platform dock;	M	Sunk with Gilliam
USS GILLIAM APA-57	FGF-5 71358	Main Deck Port Side Aft;	M	Sunk with Gilliam
USS BANNER APA-60	FM-2 55299	Cargo Hold Second Pltfm Deck	M.D. #	Hatch cover dropped on the fuselage breaking the fuselage and smashing the component. Wings were dropped down to the deck but not torn from the plane
USS BANNER APA-60	FG-1D 87847	Main Deck Port Side Aft	M.D.	Fuselage on stbd side buckled. Corling on engine buckled. Elevators damaged. Fabric on wings damaged. Flaps and aileron missing. Cockpit hood glass broken
USS BARROW APA-61	FM-2 47238	Cargo Hold second pltfm dock	M.D. #	Fuselage crushed by 3 panels from platform dock above. Panels fell across fuselage and wings

\* M-Missing; MD - Major Damage; LD - Light Damage; ND - No Damage  
# Caused Wholly by falling debris

Sheet 7 of 11

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DIRECTOR OF SHIP MATERIAL - BUREAU OF AERONAUTICS GROUP

(0143)

TARGET VESSEL	AIRCRAFT SER & MOD	LOCATION ON TARGET VESSEL	DAMAGE REPORT #	REMARKS
US BARROT APA-61	FM-2 56736	Main Deck stbd side aft	M.D.	Tail Whool broken off. Fuselage buckled aft of cockpit. Fuselage caved in ahead of cockpit. Left wing split open
US BLADEN APA-63	FM-2 47265	Cargo Hold second pltfm deck	N.D.	
US BLADEN APA-63	FG-1D 87896	Main Deck stbd side aft	L.D.	Cockpit canopy sides blown off. Fabric on rudder charred. Port wing rear tip fabric torn.
US EUTTE APA-68	FM-2 65901	Cargo Hold second pltfm deck	M.D.	Back of fuselage broken, wings damaged by section of cargo hatch cover falling on airplane
US BUTTE APA-68	FG-1D 82433	Main deck stbd side aft	M.D.	Both wings broken loose from jury struts wing folding longeron of right wing broken. Contor section damaged with wing folded too far
US CARLISLE APA-69	FM-2 47336	Cargo Hold second pltfm deck	M	Sunk with Carlisle
US CARLISLE APA-69	F6F-5 71544	Main deck stbd side aft	M	Sunk with Carlisle

\* M-Missing; MD - Major damage; LD - Light Damage; ND - No damage  
# Caused wholly by falling debris

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DIRECTOR OF SHIP MATERIAL - BUREAU OF AERONAUTICS GROUP (014J)

TARGET VESSEL	AIRCRAFT MOD & SER	LOCATION ON TARGET VESSEL	DAMAGE REPORT	REMARKS
USS CARTERET APA-70	FM-2 56954	Cargo Hold Second Pltfm deck	N.D.	
USS CARTERET APA-70	FC-1D 88040	Main Deck Starboard side aft	M.D.	Starboard wing torn from the plane Engine cowling buckled. Fuselage buckled. Fabric on port wing missing. Hood glass missing
USS CORTLAND APA-75	FM-2 56756	Cargo Hold second Pltfm deck	N.D.	
USS CORTLAND APA-75	F6F-5 71753	Main deck starboard	L.D.	Fabric on left aileron and port side of rudder ruptured and scorched
USS CRITTENDEN APA-77	FM-2 56945	Cargo Hold second pltfm Deck	M.D.	Buried under debris of first deck and second deck cargo hatches and mass of lockers and bunks from living quarters on deck above hold. Complete wreck
USS CRITTENDEN APA-77	FM-2 55266	Main deck starboard side aft	M.D.	Plane completely wrecked. Fuselage, empennage; wings crushed and broken. Pilots cockpit wrecked. Landing gear buckled. Auxiliary tank torn off.
U DAINSON 79	FM-2 73874	Cargo hold second pltfm deck	M.D.	Crushed by sections of hatch cover falling on airplane

\*Missing; MD - Major Damage; L.D. - Light Damage; ND - No damage  
# Caused wholly by falling debris. Sheet 9 of 11

ENCLOSURE "C"

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DIRECTOR OF SHIP MATERIAL - BUREAU OF AERONAUTICS GROUP (01230)

TARGET VESSEL	AIRCRAFT SER & MOD	LOCATION ON TARGET VESSEL	DAMAGE REPORT	REMARKS
USS DAMSON APA-79	F6F-5 71553	Main deck starboard side aft	N.D. : :	General damage to fuselage, wings and control surfaces
USS FALLON APA-81	FM-2 74203	Cargo hold second pltfm deck	M.D. # : :	Left wing off, fuselage badly broken from hatch cover falling on airplane
USS FALLON APA-81	FG-1D 88033	Main deck starboard side aft	M.D. : :	Fuselage buckled, tail surfaces and ailerons broken, left wing buckled, flaps broken, cockpit canopy shattered
USS FILLMORE APA-83	FM-2 55449	Cargo hold second pltfm deck	M.D. # : :	Fuselage broken, wings broken off, crushed from hatch cover falling on airplane
USS FILLMORE APA-83	F6F-5 71606	Main deck starboard side aft	L.D. : :	Cockpit canopy sides blown off. Starboard wing partially unfolded, undamaged
USS GASCONADE APA-85	FM-2 74277	Cargo hold second pltfm deck	N.D. : :	
USS G. SCONADE APA-85	FG-1D 87882	Main deck starboard side aft	L.D. : :	Fabric on port side of rudder torn and burned

M-Missing; MD - Major damage; LD - Light damage; ND - No damage  
# Caused wholly by falling debris

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ENCLOSURE "C"

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DIRECTOR OF SHIP MATERIAL - BUREAU OF AERONAUTICS GROUP (014J)

TARGET	AIRCRAFT	LOCATION ON	DAMAGE	REMARKS
VESSEL	SER & MOD	TARGET VESSEL	REPORT #	
USS NIAGARA	FM-2P	Cargo hold	N.D.	
APA-87	74675	second fltm		
		deck		
USS NIAGARA	F6F-5	Main deck	L.D.	Starboard wing blown from jury lock.
APA-87	58662	port side aft		Dorsal fin slightly dented.
VPB CORONADO	PB2Y-5E	Moored in	M.D.	Hatches and ports on port side only
Seaplane	7052	target area		blown in. Frinkles and open seams in upper
				part of hull aft of stern cargo hatch.
				wings and power plant intact. Watertight
				interior satisfactory
VPB Coronado	PB2Y-5E	Moored in	M.D.	Hatches and ports on port and starboard
Scaplane	7085	target area		blown in. Starboard windshield blown in
				hull ruptured aft of stern cargo hatch
				port side. Bomb bay doors ruptured.
				wings and power plants intact. Watertight
				interior OK.

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\*H-Nisasing; MD - Major damage; LD - Light damage; ND - No damage Sheet 11 of 11

ENCLOSURE "C"

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DIRECTOR OF SHIP MATERIAL  
JOINT TASK FORCE ONE  
OPERATION CROSSROADS

BUREAU OF ORDNANCE GROUP  
GROSS DAMAGE REPORT FOR TEST ABLE  
(ABLE PLUS FIVE DAYS)

6 July 1946

*E. B. Mott*  
E. B. MOTT, Captain, USN

**CONFIDENTIAL**

Registered Number 16

Enclosure (D) to Director of Ship Material Serial 00174.

840 052

**CONFIDENTIAL**

JOINT TASK FORCE ONE  
U.S.S. WHARTON (AP-7)

6 July 1946

JTF-1/014L,src  
File: A16-3/A9  
Serial: 00337

**From:** Officer-in-Charge, Ordnance Material Group.  
**To :** The Director of Ship Material.  
**Subject:** Ordnance Material Group report on Gross Damage  
after Test ABLE.  
**Reference:** (a) Director of Ship Material Staff Memorandum  
No. 3, dated 19 April 1946.  
**Enclosure:** (A) Subject report.

1. Enclosure (A) is submitted herewith in compliance  
with reference (a).

*E. B. MOTT*  
E. B. MOTT.

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Enclosure (D)

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U.S.S. WHARTON (AP 7)

BUORD REPORT ON GROSS DAMAGE AFTER TEST "ABLE"

1. DAMAGE

Damage to Ordnance Material in general was much less than anticipated and blast, rather than heat or radioactivity was the most damaging factor. Initial ruggedness in design to withstand blast, heat and battle damage contributed largely, it is believed, to the surprisingly light damage to Ordnance Equipment. In most cases, in vessels still afloat, ordnance equipment is inherently or potentially operable. Guns and Mounts suffered very little damage even though they were obviously subjected to searing heat and high blast pressures. In cases where the breech and operating mechanisms were protected by shields the mount was in somewhat better condition than were the unprotected mounts. Open mounts were subjected to searing heat and blast, but this in general did not extend to ships beyond 1,000 yards radius from the center of burst. Damage beyond the 1,000 yard radius was negligible. Open mounts within the 1,000 yard radius appear operable except in a few cases. Grease was carbonized in most cases on open mounts and some galling may be expected. It is considered that personnel in open mounts would suffer heavy casualties whereas enclosed mounts, even with light shields, would afford proportionate protection from blast. The amount of protection from radioactivity in enclosed mounts and directors is not fully developed, but is believed to be much greater than in open mounts and directors. Turrets and heavier shields appear to afford most protection from radioactive elements.

Fire control equipment at considerable heights above the water-line suffered the most damage and is considered the weakest component of all batteries. Fire control radar antennae were particularly vulnerable and damage to them occurred at greater distances from the fire ball than any other type of ordnance equipment. A good example is the PENSACOLA in which every fire control radar antenna, including Gun Fire Control System Mk. 63 antenna, was badly damaged or destroyed. Guns and directors, however, stood up quite well. The shield protected Directors Mk. 33 are operable on the SALT LAKE CITY and the range finders were not damaged. The latter however, were protected by covers. Doors of the square shields were dished in and window openings blown in; also the shields themselves were dished in and partially ruptured. The main battery directors on the PENSACOLA are higher and suffered somewhat more damage from blown in windows and dished in shields. Such internal damage as occurred in directors however, was due to partial collapse of doors and shields. Directors and radar panels in most instances withstood shock very well and only negligible damage was noted. Optics stood up very well also and accurate ranges have been obtained from the Rangefinders Mk. 42 of the NEVADA. The Directors Mk. 37 on the NEVADA, by visual examination, suffered no internal damage and foundations remained rigid. In all cases the radar antennae were destroyed within the 1,000 yard radius of center of burst.

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U.S.S. WHARTON (AP 7)

BUOY REPORT ON GROSS DAMAGE AFTER TEST "ABLE"

The most serious loss of fighting efficiency of ordnance equipment was due to the loss of power in such vessels as: NEVADA, PENSACOLA, SALT LAKE CITY, HUGHES, ARKANSAS, and others within the 1,000 yard radius. Had power been available most batteries within the 1,000 yard radius would have been operable at an estimated average of seventy-five percent efficiency. This estimate is at present subject to alignment and other pre-firing checks when power is restored. Estimate at least fifty percent of all Mk. 51 type directors potentially operable within 1,000 yard circle. Gun sights Mk. 14 and 15 in most cases are unbroken.

About ninety percent of the vessels in the target array have been inspected by the Explosives Unit to date. No evidence has been found except in the case of the ANDERSON that any Navy ammunition or ammunition components exploded or were actuated as a direct result of heat from the Atomic bomb itself. This includes mines, torpedoes, depth charges, etc. There is evidence of secondary explosions in some instances from shipboard fires started by the bomb. A case in point is the INDEPENDENCE in which the twelve (12) torpedo warheads of the fully ready torpedoes burned or exploded low order. A torpedo tube spoon and spoon extension were found on ARDC 13 and as the ANDERSON was anchored close to the ARDC 13; and was sunk within a few minutes after the test, it is possible that the spoon came from this ship. The Underwater Photography Unit of this group will attempt to obtain evidence in this regard.

Further investigation of photographs reveals that ammunition type explosions occurred in the vicinity of the ANDERSON two (2) or three (3) seconds after the Atomic explosion.

The Armor and Metallurgical Unit of this Group reported no visible damage to armor. It is understood that every effort will be made to remove the armor ballistic samples of 3" thickness and less prior to Test "Baker". Brinell hardness and other metallurgical analyses will be made of guns and ordnance equipment where such procedure is warranted.

The Underwater Ordnance Unit reports that the RHIND and the SKATE are the most interesting vessels from the standpoint of possible damage to torpedoes, torpedo tubes, mines, and depth charges. These vessels are now being inspected by that Unit. The probability of damage to underwater ordnance in other Destroyers and Submarines is slight. The submarine fire control equipment on the PARCHE is undamaged.

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Aviation fire control equipment was not damaged but as most of this equipment was installed on a vessel which was a considerable distance from the blast and as the aircraft on board were not damaged, this is not surprising.

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U.S.S. WHARTON (AP-7)

HUOED REPORT ON GROSS DAMAGE AFTER TEST "ABLE"

GENERAL REPORTS OF DAMAGE TO ORDNANCE EQUIPMENT BY SHIPS FOLLOWS:

ARKANSAS - No power is available and therefore all results have been obtained by visual inspection and manual operation. The forward and after 3" Gun Director Mk. 50 are probably inoperative. The Main Battery and 5"/51 battery directors are damaged and probably will not operate. Radars are all inoperative due to antenna damage. Optics suffered considerable damage. The guns, turrets and mounts appear operable except one (1) 20 MM gun which was damaged by falling debris. No ammunition failures.

NEW YORK - No damage to fire control equipment except the after Main Battery Radar Mk. 3 is inoperable due to antenna damage and a broken telescope mounting on the after Main Battery director. No ammunition failures.

NEVADA - No power is available and therefore all results have been obtained by visual inspection and manual operation. Both Main Battery directors appear inoperable. The 5"/38 battery seems completely operable if power were available, except for radar. All radar is inoperable due to antenna damage. Optics suffered little damage. One (1) Gun Director Mk. 51 was damaged by falling debris. The guns, mounts, and turrets all appear operable. No ammunition failures.

PENNSYLVANIA - No damage to fire control equipment, guns, mounts or turrets except that the Rangefinder Mk. 33 in turret one (1) has a loose prism. No ammunition failures.

NAGATO - No ammunition failures or changes in guns and turrets.

PENSACOLA - No power available and therefore all results have been obtained by visual inspection and manual operation. Starboard Gun Fire Control System Mk. 63 damaged beyond repair but port system appears operable except for the radar antenna. The forward and after Gun Directors Mk. 33 have no serious damage. The forward 5"/25 battery stable element Mk. 2 is inoperable due to tube failures. Both Main Battery Directors Mk. 35 appear operable. All radar is inoperable due to antennae failure. All guns and mounts are operable. No ammunition failures.

SALT LAKE CITY - No power available and therefore all results have been obtained by visual inspection and manual operation. All radars are inoperable due to antennae damage. All directors and fire control equipment appear operable and undamaged except for misalignment of forward Gun Director Mk. 33 optics. Optics generally are not damaged. No damage to guns and mounts. All ammunition unaffected.

SAKAWA - No equipment of interest on board.

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U.S.S. WHARTON (AP-7)

BUOYED REPORT ON GROSS DAMAGE AFTER TEST "ABLE"

GENERAL REPORTS OF DAMAGE TO OCEAN WCE EQUIPMENT BY SHIPS FOLLOWS (Cont'd)

PRINZ EUGEN - No damage to fire control equipment, guns, mounts and turrets except forward main battery director on mainmast jumped it's roller path. All ammunition was unaffected.

SARATOGA - No damage to fire control equipment, guns, and mounts. Operating equipment was still operating satisfactorily when boarded by Initial Boarding Teams. All aviation fire control equipment in planes undamaged. No effect on ammunition, torpedoes or mines.

INDEPENDENCE - No power available and therefore all data is from visual inspections. The 40 MM guns and corresponding Directors Mk. 51 are inoperable due to what appears to be secondary damage from fires and falling debris. Twelve (12) torpedoes in C-101-B were destroyed by secondary fires but apparently did not detonate high order. The after bodies remain and will be recovered. Other ammunition on board apparently did not detonate. Inert loaded mines and torpedoes remain relatively undamaged and will be recovered.

LAMSON - No data due sinking.

RALPH TALBOT - Gun Director Mk. 33 has damaged optics and the Stable element Mk. 2 is damaged. There are cracks in the director base. All guns and mounts are operable. All ammunition unchanged.

HHIND - Moderate damage to fire control equipment including inoperable Stable Element Mk. 2 due to damaged gimbal mounting; Radar Mk. 28 inoperable due to antenna damage; and some fogging of Gun Sights Mk. 14. All guns and mounts are operable. No damage to torpedo tubes but analysis of torpedoes is being made with no damage anticipated. Ammunition was unaffected.

STACK - Light damage to fire control equipment including a crack in the leveler's scope window on the Director Mk. 33; a damaged Gun Sight Mk. 14; and an inoperable Stable Element Mk. 2. The latter had forced a gimbal and has since been repaired by this group. All guns and mounts are operable. All ammunition including torpedoes and depth charges was unaffected.

WILSON - All fire control equipment is operable that was operable prior to test Able. All guns and mounts are operable. All ammunition including torpedoes and depth charges unchanged.

HUGHES - No power available and therefore the results are from visual inspections and manual operation. All fire control gear appears operable except the radars which have damaged antennae. All guns and mounts are operable. All ammunition, including torpedoes and depth charges, unchanged.

ANDERSON - No data due sinking.

WAINWRIGHT - All fire control equipment is operable but Gun Director Mk. 37 is erratic in automatic train. All guns and mounts are operable. All ammunition including torpedoes and depth charges are unchanged.

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U.S.S. WHEATON (AP-7)

BUOY REPORT ON GROSS DAMAGE AFTER TEST "ABLE"

GENERAL REPORTS OF DAMAGE TO ORDNANCE EQUIPMENT BY SHIPS FOLLOWS (Cont'd)

MUGFORD - No damage.  
CONYNGHAM - No damage.  
MAYRANT - No damage.  
MUSTIN - No damage.

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SEA RAVEN - No apparent damage.  
TUNA - No apparent damage.  
APAGON - No apparent damage.  
DEWUDA - No apparent damage.  
PABOEZ - No apparent damage.  
PILOT FISH - No apparent damage.  
SKIPJACK - No apparent damage.

SKATE - This submarine was damaged but no comprehensive report of damage to ordnance material is yet available.

GILLIAM - No data due sinking.

CARLISLE - No data due sinking.

BARROW - No damage except that on the 5"/38 gun the trainers' handwheel does not engage. Reason has not yet been ascertained.

BANNER - No damage except minor damage to after Director Mk. 51 and accompanying Gun Sight Mk. 15. However both are operable.

CRITTENDEN - Two Gun Sights Mk. 14 are inoperable. Number eight 20 MM gun is jammed in train but can easily be freed. Number four 20 MM gun has the armor shield bent back on the mount, preventing train. No other damage.

DAWSON - The After Gun Director Mk. 51 has minor damage (due to failure of holding down bolts) which is easily repaired but makes the director inoperable. Two Gun Sights Mk. 14 are inoperable.

The following vessels had no apparent damage to Ordnance equipment:

U.S.S. BUTTE  
U.S.S. FILLMORE  
U.S.S. BRACKEN  
U.S.S. GASCONADE  
U.S.S. CORTLAND  
U.S.S. CATRON  
U.S.S. BLADEN  
U.S.S. BRUL  
U.S.S. CARTERET  
U.S.S. GENEVA  
U.S.S. FALLON  
U.S.S. NIAGARA

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DIRECTOR OF SHIP MATERIAL  
JOINT TASK FORCE ONE  
OPERATION CROSSROADS

BUREAU OF MEDICINE AND SURGERY MEDICAL RESEARCH GROUP  
GROSS DAMAGE REPORT FOR TEST ABLE  
(ABLE PLUS FIVE DAYS)

6 July 1946  
(Date)

R. H. DRAEGER, Captain, (MC), USN

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Registered Number 18

Enclosure (E) to Director of Ship Material Serial 00174.

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APA67/JTF-1/014M  
Serial: 0013

JOINT TASK FORCE ONE  
U.S.S. BURLINSON (APA-67)  
Fleet Post Office,  
San Francisco, California

**CONFIDENTIAL**

5 July 1946

To: Director of Ship Material.

Subj: Five Day Interim Report of Naval Medical Research Section, Test ABLE.

The U.S.S. BURLINSON, under the command of Capt. Charles L. CARPENTER sailed from San Francisco 1 June 1946 after being outfitted at Hunter's Point. The Staff of the Naval Medical Research Section consisted of Capt. R.H. DRAGGER, (MC), USN, Officer-in-Charge, Capt. S. WARREN, (MC), USNR, Executive Officer, Capt. F.R. LANG, (MC), USN, Comdr. R.H. LEE, H(S), USNR, Cmdr. J.L. TULLIS, (MC), USN, LtCdr. E.P. CROMBIE, (MC), USN, Maj. D.H. CARMON, (MC), USA, Lt. S.W. BIVERT, MAC, USA, Capt. L.P. WAGERS, (VC), USA, Lt. R.J. MADSEN, H(S), USNR, Lt(jg) HARRIS, (MC), USNR, 1st. Lt. E.D. HODMAN, (CWS), USA, 1st. Lt. C.L. BOYERS, (CWS), AUS, Tns. J.T. PARK, (D)L, USNR, Mr. BACHELOR, Mr. FRANKFELD, Mr. R.F. COVING, and Mr. E.L. EVANS. The enlisted personnel of the section consisted of ninety-five men.

The U.S.S. BURLINSON arrived at Bikini 12 June 1946 after an uneventful voyage. The Health of the animals was excellent.

Animals were placed aboard 22 of the target ships by the Medical Research Section. This was done in order to determine the probable effects of an atomic bomb explosion upon personnel aboard ship. The target ships were chosen to provide information as to the effect of distance from the center of the explosion, the dispersal of radioactive materials by wind and the location on the ship. Various types of ships were included.

The animals placed aboard the target ships included 176 goats, 147 pigs, 3030 rats, and in addition 58 guinea pigs and 116 mice. These animals were exposed so as to give information regarding injury from air blast, solid blast and radiation blast. Specific experiments were performed to test the protection of clothing and anti-flash creams against flash burns.

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Subj: Five Day Interim Report of Naval Medical Research Section, Test ABLE.

Tests were also made of an air filtration device constructed by the Chemical Warfare Service, Edgewood Arsenal. From A-10 to A-1 the animals and test objects were placed on the target ships and photograph made for the record of each completed target location.

Animals, instruments, and other test objects to provide pertinent information were placed on the following ships:

NEVADA	BLADEN
SAZAMA	BUTTE
INDEPENDENCE	GENEVA
SALT LAKE CITY	NIAGARA
TULLON	WAINWRIGHT
CANTON	LCI 327
PENNSYLVANIA	LCI 329
PARCHE	LST 133
BRACKEN	MAY RABT
HILLMORE	LCT 1013
LST 661	LCT 705

Items placed as test objects on board the above named ships include the following:

- Ginea Pigs
- Goats
- Pigs
- Rats
- Mice, Strain A (Lung tumor)
- Mice, Strain C3H (Breast tumor)
- Mice, Strain C (Low Tumor)
- Mice, Strain LAFI (Long life)
- Biological Radiation Packet
- Chemical Radiation Packet
- Agricultural Radiation Packet, Seeds and soil
- Agricultural Radiation Packet, insects
- Biological Warfare Agents, simulants in drums
- Biological Warfare Agents, simulants in bombs
- Biological Warfare Agents, simulants
- Collective protectors, control
- Collective protectors, mechanical filter
- Collective protectors, mechanical and chemical filter
- Sonne camera
- Pressure gauge, oil
- Film pack
- R. Meter, 1000 r
- R. Meter, 100 r
- R. Meter, 10 r
- Ultra Violet Meter
- Cloth swatches
- Thermal plaque
- Acceleration indicator
- U.V. Vicor red indicator

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Subj: Five Day Interim Report of Naval Medical Research Section, Test ABLE

Gamma ray indicator, vicor rod  
Gamma ray indicator, glass pile  
Jerome Camera  
Wire recorder  
Neurospora

Medical and dental supplies are being collected from the target ships for study and a survey of damage to medical and dental test equipment is being made for the section by questionnaire through the Task Force Medical Officer.

It is planned to place two Sonne cameras on the U.S.S. PENNSYLVANIA, but it was found that her angle of swing was too great to permit accurate alignment with the blast center, therefore, a gyroscopically controlled 5-inch turret on the U.S.S. SARATOGA was used as a mount.

156 of 176 goats were recovered alive, 131 of 147 pigs were recovered alive, and over 2500 of 3030 rats were recovered alive. A complete rat census is in progress.

The detailed recovery of large animals from each target ship is given as follows:

Ship	Goats		Pigs	
	No. Placed	No. Recovered Alive	No. Placed	No. Recovered Alive
NEVADA	7	6	9	9
SAKAWA	7	0	9	1
INDEPENDENCE	3	1	9	8
SALT LAKE CITY	13	9	9	9
LST 705	6	6	3	3
LST 661	9	9	6	6
PENNSYLVANIA	13	13	9	9
MAINFRET	6	6	3	3
LST 133	9	9	6	6
LCI 327	11	11	0	0
LCI 329	11	11	0	0
CATRON	11	11	12	12
FALLOX	11	9	12	12
FILMORE	11	10	12	12
BRACKEN	11	11	12	9
GENEVA	11	10	12	12
BLADE	11	11	12	12
FLAGRA	15	13	12	12
	176	156	147	131

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Subj: Five Day Interim Report of Naval Medical Research Section, Test ABLE

It was noticed that most rats recovered were hyperactive at first, some later becoming lethargic. No damage was noted at first in the larger animals, but after a few hours those from the control ships became lethargic and refused to eat or drink. Blood counts made this period showed a decrease of white blood cells (leukopenic), particularly of Lymphocytes. There was some loss of fluid from the blood at first, which later was compensated for. On A + 2 deaths began to occur both in large animals and rats. More were noted on A + 3 and A + 4, and the peak is still to be reached.

From Japanese data it was expected that air blast would produce immediate death and radiation blast, both thermal and ionizing, would produce a large number of delayed deaths. These expectations are being fulfilled.

Approximately 90% of the test animals were recovered alive. Of this remaining 10% a few died because their water supply was destroyed, some were lost with the U.S.S. SAKAMA, and some were killed by secondary air blast injuries.

Flash burn was not an important cause of death or injury. A few animals showed singed hair and minor burns.

It is expected that most animals recovered from the U.S.S. NEVADA, U.S.S. INDEPENDENCE, U.S.S. ELLISON, U.S.S. CATRON, and U.S.S. SALT LAKE CITY will suffer severe radiation illness and most will die. It is expected that most of the remaining outer target ships will survive, with or without permanent injury.

From these observations we conclude tentatively that most personnel aboard ship would temporarily survive, the immediate effects of an atomic bomb blast of the type used in Test ABLE. Some would be able to operate ships, guns, and damage control mechanisms for a limited period of time, although probably with impaired efficiency. Some of these would sicken and die in a few days. The amount of exposure to radiation will determine the ultimate fate of the individual.

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MAJER  
Capt. (MC), USN.

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DIRECTOR OF SHIP MATERIAL  
JOINT TASK FORCE ONE  
OPERATION CROSSROADS

ELECTRONICS COORDINATING OFFICER, JOINT TASK FORCE ONE  
GROSS DAMAGE REPORT FOR TEST ABLE  
(ABLE PLUS FIVE DAYS)

6 JULY 1946  
(Date)

C. L. ENGLEMAN, Captain, USN

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Registered Number 20

Enclosure (F) to Director of Ship Material Serial 00174.

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CROSSROADS INSPECTION REPORT

TEST A

5 July 1946.

**From:** Electronics Coordinating Officer (014N).  
**To :** Director of Ship Material.  
**Subject:** Electronics Preliminary Gross Damage Report.

Submitted:

J.E. RICE,  
Comdr., USN

Approved:

C.L. ENGLEMAN,  
Captain, U.S.N.

**ABSTRACT:** Inspection by ECO personnel of all target vessels except U.S.S. SKATE and NAGATO shows that of 76 target vessels containing electronic equipment, 16 vessels (including those sunk) sustained major damage to electronic equipment, 17 additional vessels sustained minor damage, and the remaining 43 ships sustained no damage. Damage to antennas of radio and radar equipment accounted for over 90 per cent of the equipments reported inoperative. Vacuum tubes and other delicate components protected by enclosures generally remained undamaged. Major damage was confined to the area within 1000 yards of the blast center. Minor damage occurred between 1000 and 2500 yards. Electronic equipment on ships beyond 2500 yards generally remained undamaged. The air blast of the primary explosion accounted for the majority of all damage reported.

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ELECTRONICS PRELIMINARY GROSS DAMAGE REPORT

TEST A

A. ABSTRACT. Inspection by ECO personnel of all target vessels except U.S.S. SKATE and MAGATO shows that, of 76 target vessels containing electronic equipment, 16 vessels (including those sunk) sustained major damage to electronic equipment, 17 additional vessels sustained minor damage, and the remaining 43 vessels sustained no damage. Damage to antennas of radio and radar equipment accounted for over 90 per cent of the inoperative equipments. Vacuum tubes and other delicate components protected by enclosures generally remained undamaged. Major damage was confined to the area within 1000 yards of the blast center. Minor damage occurred between 1000 and 2500 yards. Electronic equipment on ships beyond 2500 yards remained undamaged. Air blast from the primary explosion accounted for the majority of all damage reported.

B. DAMAGE TO EQUIPMENT, GENERAL. Equipment under the cognizance of the Bureau of Ships, Bureau of Ordnance, Bureau of Aeronautics, and the U.S. Army was exposed on a total of 76 target vessels. In all, 3,835 items of electronic equipment were installed on these vessels, and 3,723 of these (97 per cent) were reported in operative condition prior to Test Able.

Major damage sustained by the electronic equipment of the ships (BuShips and BuOrd cognizance) was confined, for the most part, to the radio and radar antennas of vessels within 1,000 yards of the blast center. Minor damage was sustained out to a distance of 2,500 yards from the center, but vessels beyond this distance generally sustained no damage to electronic equipment. The distribution of damage in the target array, showing the name, and location of each target vessel and the overall condition of the electronic equipment thereon, is shown in Appendix A of this report. An inventory of all electronic equipment exposed, by types, is contained in Appendix B of this report.

Analysis of the ships whose electronic equipment sustained major damage reveals the following information: Of the eleven ships remaining afloat in this category, reports from seven ships show that 248 major items of electronic equipment were exposed. Of these, 165 equipments (67 per cent) were rendered inoperative by the blast.

The principal cause of damage was air blast from the atomic explosion itself. The effect of heat was limited to searing of the exterior surfaces of equipments and generally did not render the equipments inoperative.

C. DAMAGE TO COMPONENTS.

(1) Vacuum Tubes. Vacuum tubes of all types suffered far less damage than had been expected. Reports from all of the 69 vessels boardable and remaining afloat, show less than ten vacuum tubes smashed in nearly 3000 electronic equipments exposed. This preliminary figure may be raised when power is available for testing tubes showing no visible sign of damage. There is no evidence of tubes being affected by radioactivity. Numbers instances were reported of

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tubes jarred out of their sockets, but the majority of these were unharmed. In one case, spare tubes were sucked by blast from a shelf and dropped on a metal deck across the room, without damage. Damage to cathode ray tubes is reported in three cases, including changes in color due possibly to heat. The effect on magnetrons has not been determined as yet, but the external magnet of a magnetron was reported to have suffered decreased flux in one instance.

(2) Internal Wiring. Internal wiring of equipment suffered no severe damage. There are a few cases of severed soldered connections due to the heat or blast waves. Insulation of wiring in many cases was burned or scorched but generally not to the extent of making the equipment inoperative. The heat wave was of too short duration to affect wiring protected by metal covering.

(3) Plastic Knobs, Meter Faces. Considerable damage was done to plastic control knobs due to melting by the heat wave. Plastics in general did not withstand the heat and pressure wave. Numerous cases of meters being made inoperative by smashed windows were reported. Damage resulted from the pressure wave.

(4) Shock Mountings. Shock mountings did not withstand the blast pressure in several cases. The equipment, mostly receivers, was blown clear of shock mountings, but in most cases remained operative. Main frames of radars were twisted and bent and in some cases the equipment was blown clear of main frames, showing that large surfaces, exposed to the force of the blast, were subject to severe mechanical shock.

(5) Exposed Components: Of all electronic equipment, antennas, both radio and radar, received by far the most damage. This is to be expected, since they are placed in exposed positions as high on the superstructure as possible, in position to receive the brunt of the air pressure wave. Only minor damage was caused by the heat from the blast.

Radar dish-type or parabolic reflectors were particularly vulnerable, as would be expected because of their large, semi-flat surfaces. Many were blown completely away; others so badly bent that they damaged the associated dipoles.

Considerable damage was done to radar antenna mounts and pedestals but this damage was much less than that experienced by the antennas proper. Many antennas were made inoperative simply because the supporting masts were twisted, knocked off true, or blown down.

Many communications antennas were lost because their supporting masts were blown away or twisted to the point where the wire snapped. A large number, particularly of the stretched wire type, were lost because of broken insulators which permitted the wire to fall or be blown away. There were relatively few cases of the antenna wire being snapped due to air pressure alone. On several of the badly damaged ships all radio transmitting and receiving antennas were lost or severely damaged.

There were numerous cases of radar wave guides being dented, bent, or sheared off completely, particularly at the points where they pass through bulkheads. Considering the number exposed, however, wave guides weathered the storm remarkably well. Stand-off insulators and lead-in insulators in many instances were cracked or broken.

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Coaxial cables received only minor damage except in locations where they entered bulkheads.

(6) Radio Transmitters and Receivers. Damage to transmitter and receiver equipment was light even in those ships which received major topside damage. It is doubtful if the ships would have suffered serious communications inconvenience, except for the loss of exposed antennas. There were numerous cases of both transmitters and receivers being moved from their mountings, but in almost every case the equipment was not damaged and could have been restored to operating condition simply by returning to original position. This was particularly true of receivers.

(7) Loran. Little or no damage was experienced by Loran equipment, except for antennas which are covered under (6) above.

(8) Sonar. Preliminary inspection indicates that sonar equipment stood up remarkably well, little or no damage being reported.

D. DAMAGE TO BUORD EQUIPMENT (FIRE CONTROL RADAR). Of the 51 BuOrd radars aboard target vessels, 22 were rendered completely inoperable by the blast. One remained 20 per cent operable. The remaining 28 radars suffered no damage. Damage was due to the blast pressure which destroyed antennas or made them inoperative. Slight damage was done by heat but not sufficient to affect operability. Forty-seven per cent of all BuOrd radars were made completely inoperative due to antenna damage.

E. DAMAGE TO BUSHIPS EQUIPMENT. Since the large majority of all electronic equipment exposed is under BuShips cognizance, the general statements contained in paragraphs A, B, and C of this report apply substantially without modification to BuShips equipment. Blast damage to antennas rendered roughly 65 per cent of all BuShips radio and radar equipment inoperative in seven target ships sustaining heavy damage but remaining afloat. Equipment and components in shielded or protected locations escaped damage in nearly all instances except for displacement due to mechanical shock. In the majority of cases the equipment itself withstood the shock, although the mounting did not.

F. DAMAGE TO BUAER EQUIPMENT. The reports of loss of airborne electronic equipment were numerous because so many of the aircraft were lost. All aircraft on five vessels were lost altogether, and those on two others sank with the ships on which they were exposed. However, in cases where the aircraft survived, even in damaged condition, the electronics equipment contained within was judged by visual inspection to be but slightly damaged. On one vessel, both the aircraft and the airborne electronics equipment escaped damage, despite the fact that minor damage was caused to non-airborne electronic equipment on the same vessel. No conclusions could be drawn in the preliminary inspection concerning the causes of damage to airborne electronics equipment, but it was apparent that the shielding provided by the aircraft wings and fuselage protected the equipment from severe blast and heat damage, whenever the aircraft itself was not completely destroyed.

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G. DAMAGE TO SIGNAL CORPS EQUIPMENT. Signal Corps target material was exposed in seven locations. The following is a brief description of observations made on a quick superficial inspection trip. This is to be followed by inspection in detail.

(a) BIKINI ISLAND. Visible effects of the explosion, even under close scrutiny, altogether absent. Large items of radar and radio equipment were on this location.

(b) U.S.S. GASCONADE, APA-86. Large radar and radio showed very minor scorching and mechanical damage. Both operated perfectly.

(c) U.S.S. SARATOGA, CV-3. Large radar and radio, and numerous small items, showed minor scorching and mechanical damage. All items operable as found except one radio set burned by secondary fire.

(d) PRINZ EUGEN (IX-300). Unshielded radar was smashed moderately. Large radio, and small items, suffered small mechanical distortion and surface searing. All items either operable or easily repairable except large radar, which could be repaired with moderate effort. Gasoline engine-driven power units M7A1 and PE-95 both started and ran without difficulty.

(e) U.S.S. ARKANSAS, BB-33. Only small items of equipment were exposed here. All items were badly seared on the surface, with little heat penetration. The only extreme heat damage was the burning off of exposed nylon insulation on assault wire WD-1/TT. Mechanical damage was generally moderate, only a teletype being badly smashed. Wire communication equipment and small radios were operable or repairable. This equipment was offered very little shielding.

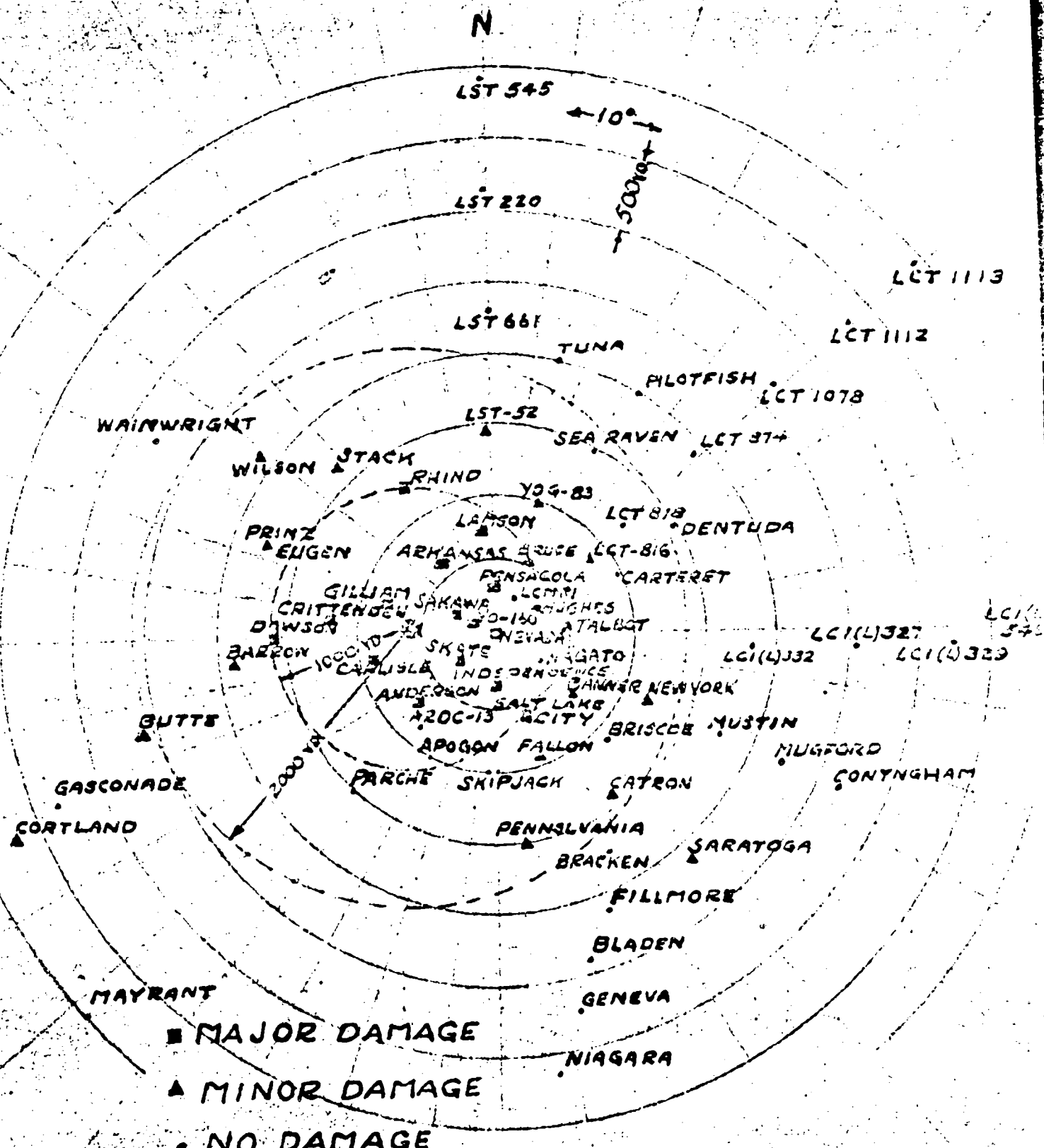
(f) U.S.S. INDEPENDENCE, CVL-22.

(1) The large radar and radio set were smashed beyond any reasonable expectancy of repair. The shelter and most of the components of radio set SCR-399 were carried away. The shelter of Radar Set SCR-584 was completely smashed in, the antenna structure was nowhere to be found, and the components were smashed and strewn about. Power units M7A1 and PE-95 appeared repairable on purely visual inspection.

(2) Small items were left on deck with the exception of the carrier repeater CF-3 which was hurled down the elevator opening, one wooden chest not yet found, and items fastened to the extension which was carried away. Small items were not badly smashed. A few were operable, a few repairable, and a few not worth the trouble of repair. Equipment not shielded.

(g) U.S.S. NEVADA, BB-36. Only small items of equipment were exposed here. Damage to this was superficial. Minor scorching and mechanical distortion are visible but all items are either operable or easily repairable. This equipment was one of the most impressive examples of shielding seen. It was efficiently shielded by the superstructure, Turret II, and an Ordnance medium tank.

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**TARGET SHIP ARRAY WITH  
SUMMARY OF ELECTRONIC  
DAMAGE**

APPENDIX A ENCLOSURE A

**CONFIDENTIAL**

RESTRICTED

INVENTORY OF ELECTRONIC EQUIPMENT EXPOSED  
IN TEST ABLE

(As reported on Form 13 and Form 51)

A. No listing.

B. Fire-Control Radar Equipment.

1. BuOrd Cognizance.

- 1 - Mk 3 (L band)
- 3 - Mk 3 Mod 1 (L band) - (1 inoperable)
- 8 - Mk 4 (L band)
- 1 - Mk 4 Mod 1 (L band)
- 1 - Mk 8 Mod 3 (S band)
- 4 - Mk 10 Mod 5 (S band)
- 4 - Mk 12 Mod 0 (L band)
- 1 - Mk 12 Mod 1 (L band)
- 6 - Mk 22 (X band)
- 10 - Mk 28 Mod 0 (S band)
- 7 - Mk 28 Mod 3 (S band)
- 2 - Mk 29 Mod 2 (X band)

Total: 48 - Fire control radars

C. Surface Search Radar Equipment.

1. BuShips Cognizance.

- 2 - SG (S band)
- 8 - SGa (S band)
- 24 - SG-1 (S band)
- 7 - SG-1B (S band)
- 1 - SG-2 (S band)
- 7 - SJ (S band)
- 2 - SN (S band)
- 5 - SO-1 (S band) - (1 inoperative)
- 3 - SQ (S band)
- 1 - SV (S band)
- 5 - ST (X-band submarine-range)

2. Army Cognizance.

- 1 - SGR-682 (S band)

Total: 66 - Surface Search Radars

D. Air Search and Airborne Radar Equipment (including fighter director radars)

1. BuShips Cognizance.

- 4 - SC-2 (P band)
- 6 - SC-3 (P band)
- 18 - SC-4 (P band)
- 1 - SC-5 (P band)
- 1 - SD (P band)
- 1 - SD-4 (P band)
- 1 - SD-5 (P band)
- 9 - SK (P band) - (1 inoperative)
- 2 - SM (Fighter-director S band)
- 2 - SP (Fighter-director S band)

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APPENDIX (B)

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2. BuAer Cognizance.

- 26 - AN/APB-4 Airborne search (2 inoperative)
- 9 - AN/APB-6 Night fighter (3 inoperative)

3. Army Cognizance.

- 5 - SCR-584 (3 band automatic tracking, gunfire control)

Total: 85 - Air search and airborne radars.

E. Radar Repeaters.

1. BuShips Cognizance.

- 39 - VC (2 inoperative)
- 44 - VD-2 (2 inoperative)
- 11 - VF
- 6 - VG

Total: 100 - Radar repeaters.

F. Radar Countermeasures Equipment.

1. BuShips Cognizance

- 6 - AN/SPA-1 Pulse Analyzer
- 2 - AN/APA-6 Pulse Analyzer.
- 7 - AN/SPR-1 Receiver
- 4 - AN/APR-5AX Receiver
- 1 - AN/APT-1 Transmitter
- 1 - AN/SPT-4 Transmitter
- 2 - AN/APQ-2 Transmitter
- 3 - DBM-1 E-F Direction Finder
- 3 - RDC-1 Receiver
- 2 - RDP Panoramic Adapter
- 2 - REC
- 4 - TDY Jamming transmitter (1 inoperative)

Total: 36 - Radar countermeasures equipment.

G. Radar and Radio Beacons.

1. BuShips Cognizance.

- 2 - AN/CPN-6 (X band beacon)
- 2 - IM Homing beacon
- 3 - YG Homing beacon

Total: 7 - Radar and radio beacons

H. I.F.F. Equipment.

1. BuOrd Cognizance.

- 3 - Mk 32 (fire control IFF)

2. BuShips Cognizance.

- 106 - BK transponder (18 inoperative)
- 9 - BL (1 inoperative)
- 33 - BM (3 inoperative)
- 59 - BN transponder (5 inoperative)
- 3 - BO transponder

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**3. BuAer Cognizance.**

- 7 - ABK transponders
  - 27 - AN/APX-1 transponders (1 inoperative)
  - 31 - AN/APX-2 Interrogator - responder
- Total: 277- I.F.F. Equipments.

**I. Communication Transmitters (Radio).**

**1. BuShips Cognizance.**

- 1 - TAB
- 1 - TAD
- 37 - TAJ
- 52 - TSK
- 28 - TEL
- 20 - TEM
- 2 - TBU
- 1 - TBW
- 1 - TCE
- 1 - TCK
- 1 - TCZ
- 1 - TD
- 35 - TDE
- 1 - TDM
- 31 - TDQ
- 1 - TKS

**2. BuAer Cognizance.**

- 1 - ATA
- 24 - AN/ART-13 (1 inoperative)
- 7 - GF-11

**3. Army Cognizance.**

- 5 - SCR-399

Total: 251 - Communication Transmitters

**J. Communication Receivers (Radio-including panoramic adapters).**

**1. BuShips Cognizance.**

- 2 - EC-639
- 32 - RAO
- 85 - RAK
- 89 - RAL
- 36 - RBA
- 58 - RBB (3 inoperative)
- 77 - RBC
- 39 - RBH (3 inoperative)
- 34 - RBK
- 20 - RBL
- 2 - RBM (1 inoperative)
- 92 - RBO (7 inoperative)
- 43 - RBS (1 inoperative)
- 4 - RBU Panoramic adapters
- 6 - RBV Panoramic adapters
- 4 - RBW Panoramic adapters

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- 34 - RCK
- 1 - RDK
- 3 - REE
- 3 - RPU

2. BuAer Cognizance.

- 1 - ARA
- 24 - ARE
- 35 - AN/ARC-5
- 64 - AN/ARR-2 Homing receiver
- 4 - BC-966A Homing receiver
- 14 - BC-1206C Homing receiver
- 7 - RU-16

Total: 813 - Communication Receivers

K. Communication Antennas.

1. BuShips Cognizance.

- 3 - Type 66053 Vertical antennas
- 3 - Type 66096 Antenna assemblies
- 4 - Type 66134 Antenna assemblies

Total: 10 - Communication antennas.

L. Radio Transmitter-Receivers (Radio).

1. BuShips Cognizance.

- 4 - 233A
- 11 - AN/ARC-1
- 4 - AN/ARC-4
- 18 - MAN (4 inoperative)
- 10 - MBF
- 12 - MN
- 1 - SCR-274
- 20 - SCR-506 (1 inoperative)
- 5 - SCR-510
- 14 - SCR-536
- 59 - SCR-606 (2 inoperative)
- 74 - SCR-610 (16 inoperative)
- 11 - SCR-624 (3 inoperative)
- 1 - SCR-694
- 58 - TDS
- 5 - TBX
- 3 - TBY
- 1 - TCD
- 1 - TDO (inoperative)
- 12 - TCY
- 21 - TCP
- 81 - TCS (11 inoperative)

2. BuAer Cognizance.

- 59 - AN/ARO-1
- 3 - AN/ARC-4

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APPENDIX (B)

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3. Army Cognizance.

5 - SCR-536

5 - SCR-694

Total: 498 - Radio Transmitter Receivers

II. Sonar Echo Ranging, Listening and Miscellaneous Equipment.

1. BuShips Cognizance.

5 - JP Listening Equipment

3 - QBF Echo ranging

3 - QCE Echo Ranging

2 - QCH Echo ranging

3 - QGE Echo ranging

5 - QJE Echo ranging

1 - QLA Echo ranging

1 - CC/JK Echo ranging and listening equipment

6 - TCM Echo ranging and listening equipment

1 - Type 55070 Range recorder

4 - Type 55134A Range recorder

1 - Type 55171 Range recorder

1 - DCDI Direction indicator

1 - DCRE Range estimator

3 - Bathythermographs

Total: 40 - Sonar Echo Ranging, Listening and Miscellaneous Equipment..

III. Sonar Echo Sounding Equipments and Altimeters.

1. BuShips Cognizance.

1 - NGI

1 - NJ

1 - NK (inoperative)

24 - 14- MI

3 - MLD

24 - MRC

2. BuAer Cognizance

24 - AN/APN-1 Altimeter

Total: 78 - Sonar Echo Sounding Equipments and Altimeters.

O. Loran Navigation Equipment.

1. BuShips Cognizance.

37 - DAS Equipments

Total: 37 - Loran Navigation Equipments.

P. Miscellaneous Communication Auxiliary Equipment.

1. BuShips Cognizance.

8 - Type 23032 Transmitter control panel

2 - Type 20131 Rectifier Power Unit

3 - Type 23034 Receiver Extension Panel

10 - Type 23073 Control Unit

1 - Type 23107 Dual Key Control

41 - Type 23135 Control Unit

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- 40 - Type 23146 Key-control panel (1 inoperative)
- 25 - Type 23172 Radiophone Unit
- 1 - Type 23183 Receiver Transfer Panel
- 19 - Type 23187 Receiver Transfer Panel
- 7 - Type 23188 Receiver Transfer Panel
- 2 - Type 23189 Receiver Transfer Panel
- 17 - Type 23190 Receiver Transfer Panel
- 1 - Type 23191 Receiver Transfer Panel
- 2 - Type 23193 Receiver Transfer Panel
- 6 - Type 23196 Transmitter Transfer Panel
- 1 - Type 23198 Transmitter Transfer Panel
- 17 - Type 23199 Transmitter Transfer Panel
- 2 - Type 23201 Transmitter Transfer Panel
- 2 - Type 23203 Transmitter Transfer Panel
- 15 - Type 23204 Transmitter Transfer Panel
- 3 - Type 23205 Radiophone Transfer Panel
- 2 - Type 23206 Radiophone Transfer Panel
- 8 - Type 23207 Radiophone Transfer Panel
- 9 - Type 23208 Radiophone Transfer Panel
- 1 - Type 23209 Radiophone Transfer Panel
- 61 - Type 23211 Radiophone Unit (1 inoperative)
- 3 - Type 23230 Remote Control Unit
- 11 - Type 23270 Remote Control Unit
- 1 - Type 23285 Remote Unit
- 1 - Type 23293 Receiver Transfer Panel
- 1 - Type 23404 Antenna Transfer Panel
- 1 - Type 23405 Antenna Transfer Panel
- 1 - Type 23407 Antenna Transfer Panel
- 16 - Type 23423 Radiophone Unit
- 2 - Type 23500 Radiophone Unit
- 1 - Type 24035 Selector switch
- 1 - Type 24205 Radiophone Selector Switch
- 1 - Type 24206 Disconnect Switch
- 4 - Type 24270 Disconnect Switch
- 9 - Type 28006A Receiver Protector Unit
- 1 - Type 46620 Speakeramplifier
- 20 - Type 49016 Head Telephone Assembly
- 18 - Type 49029 Jackbox
- 7 - Type 49063 Jackbox
- 1 - Type 49120 Concentric Jacks
- 1 - Type 49145 Loudspeaker Unit
- 230 - Type 49131C Loudspeaker Unit (4 inoperative)
- 82 - Type 49155 Loudspeaker Unit
- 1 - Type 49166 Loudspeaker (dual)
- 1 - Type 49181 Speaker Amplifier
- 3 - Type 49546 Loudspeaker Unit
- 60 - Type 49620 Units (Broadcast) (4 inoperative)
- 2 - Type 50055 Speaker Amplifier-Modulator
- 14 - Type 50064 Modulator Equipment
- 4 - Type 51008 Chest Microphone Assembly
- 3 - Type 51008 Chest Microphone Assembly
- 15 - Type 51019 Hand Telephone Assembly
- 1 - Type 51206 Hand Telephone Assembly
- 7 - Type 61019C Entrance Insulator
- 4 - Type 61022 Entrance Insulator

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- 1 - Type 61174B Pedestal Insulator
- 18 - Type 61175A Pedestal Insulator
- 4 - Type 61276A Entrance Insulator
- 3 - Type 61339 Pedestal Insulator
- 3 - Type 61471 Entrance Insulator
- 1 - Type 61479 Suspension Insulator
- 4 - Type 61494 Suspension Insulator
- 1 - Type 62060 Suspension Insulator
- 1 - Type 2133-2B Motor Generator
- 2 - Type 2133-2C Motor Generators
- 3 - Type 21029 Motor Generators
- 1 - Type 21202 Motor Generator
- 2 - Type 21677 Motor Generator
- 3 - Type 21956 Motor Generator
- 1 - Type 211014 Motor Generator
- 1 - Type 211016 Motor Generator
- 8 - 6V-SBM-175 A.H. Batteries
- 7 - 6V-SBM-100 A.H. Batteries
- 29 - 6V-SBM-50 A.H. Batteries

2. Army Cognizance.

- 5 - Chests of quartz crystals
- 5 - Chests of dry batteries
- 5 - Chests of wet batteries
- 5 - M-7 Power Unit (SCR-584)
- 5 - M-209 Converter
- 5 - PE-95 Power Unit (SCR-399)

3. BuAer Cognizance.

- 7 - ZB-3 Homing Adaptors (3 inoperative)

Total: 11069 - Miscellaneous communication auxiliary equipment

Q. Teletype Equipment.

1. Army Cognizance.

- 5 - TG-7 Teletypewriter

Total: 5 - Teletype Equipment

R. Test Equipment (including frequency meters).

1. BuShips Cognizance.

- 1 - 105 Wavemeter
- 7 - 202B Meter
- 1 - 241 DuMont Oscilloscope
- 1 - 606B Tube Tester
- 3 - 695 Megger
- 2 - 697 Weston Meter
- 1 - 785 Weston Meter
- 1 - 796 Weston Meter
- 2 - 804 Signal Generator
- 10 - Type 10223 Test Kit
- 8 - Type 60007 Test Kit
- 4 - Type 60018 Oscilloscope

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- 23 - Type 60ABM Frequency meter
- 1 - LD-2 Frequency Meter
- 41 - Type IM Frequency Meter
- 2 - Type LE Frequency Meter
- 3 - Type LP Signal Generator
- 21 - Type LE Frequency Meter
- 1 - Type LX Signal Generator
- 21 - Type QAA-2 Wavemeter (2 inoperative)
- 1 - Type QAE Analyzer
- 2 - Type QAO Wavemeter
- 15 - Type QAP Wavemeter
- 2 - Type QAW Tube Tester
- 1 - Type QAX Sound Monitor Test Set
- 16 - Type CBL Oscilloscope
- 1 - Type CEP V.T. - Volt-Ohm-M.A.
- 2 - Type CBT Oscilloscope
- 8 - Type CBQ Volt-Ohm-M.A. (1 inoperable)
- 16 - Type CBU Echo Box (S Band)
- 3 - Type OCD Signal Generator (Video) (1 inoperative)
- 1 - Type OCR Volt-Ohm-M.A.
- 2 - Type OD-3 Analyzer
- 3 - Type OD-6 Analyzer (1 inoperable)
- 16 - Type CE-12 Volt-Ohm Am.
- 6 - Type OQ Tube Tester
- 21 - Type OZ Tube Tester
- 1 - Type TS-13/AP
- 2 - Type TS-33/AP Frequency Meter
- 4 - Type TS-34/AP Oscilloscope
- 3 - Type TS-35/AP
- 3 - Type TS-182/UP Test Set
- 1 - Type SYE-15 Synchroscope

- 2. BuAer Cognizance.
- 4 - Type IM Frequency Meters

Total: 288 - Test Equipment

5. Telephone, Intercommunication and Amplifier Equipment.

- 1. BuShips Cognizance.
- 24 - MC Intercommunication Units
- 30 - NV-14 Intercommunication Units
- 2 - PAE-2 Portable Amplifier Units (1 inoperable)
- 2. BuAer Cognizance.
- 22 - EL-7 Interphone System
- 3. Army Cognizance.
- 5 - EK-8 Telephones
- 5 - TF-9 Telephones
- 5 - Repeaters
- 5 - ED-96 Switchboards
- 5 - CC-368 Cable Assemblies
- 5 - H-16/U Headsets
- 5 - TS-10 Handset

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5 - W110-B Samples-Wire

5 - WD-1/TT Samples-Wire

Total: 123 - Telephone, Intercommunication and Amplifier Equipment.

T. Direction Finding Equipment (Radio).

1. BuShips Cognizance.

1 - DAQ-1

1 - DP-12

2. BuAer Cognizance.

2 - DU

Total: 4 - Direction Finders

Total: 3835 - Number of Equipment Listed.

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APPENDIX (B)

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DIRECTOR OF SHIP MATERIAL  
JOINT TASK FORCE ONE  
OPERATION CROSSROADS

BUREAU OF YARDS AND DOCKS GROUP  
GROSS DAMAGE REPORT FOR TEST ABLE  
(ABLE PLUS FIVE DAYS)

6 JULY 1946  
(Date)

R. LAMOREAUX, Commander, (CEC), USN

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840 080

16

Registered Number

Enclosure (G) to Director of Ship Material Serial 00174

~~SECRET~~

**CONFIDENTIAL**

JOINT TASK FORCE ONE  
USS WHARTON (AP 7)

All Crossroads  
OLAY/LR/lw

5 July 1946

CONFIDENTIAL:

From: Bureau of Yards & Docks Crossroads Representative.  
To: Director of Ship Material, Joint Task Force ONE.  
Subject: Preliminary Damage Report on ARDC-13, YOG-83, YO-160, and  
2 x 6 Pontoon Bridge Section.

1.  
below:

- (a) The several items of damage to the ARDC -13 are discussed
- (a) Cracking of the concrete hull and wing walls was noted on the top decks of the wing walls, both port and starboard faces of both wing walls, on the main deck, longitudinally near the center longitudinal water tight bulkhead, and on the port shell near the water line. In general, it is estimated that about 10% of the cracks were caused by the pressure wave, and 70% by the negative pressure wave.
- (b) The cracking is essentially minor and may readily be repaired. The crack near the water line allowed the slow leakage of water into the pontoon, in amount sufficient to increase the draft about 0.03 feet per hour, without any pumping. This leakage was allowed to continue for three and one-half days, at the end of which period, the draft of the dock had increased about three and one-half feet, with a list to port of about 8 degrees - ten minutes. The water subsequently was removed in eight hours, using a single 6-inch submersible pump.
- (c) A suspended catwalk between the tops of the wing wall was blown away, only one cable remaining in place. Timber walkways along the inboard edges of the tops of the wing walls were blown away, but the supporting framing timbers were largely intact. The steel ladders on the bow faces of the two wing walls carried away, but similar ladders on the stern faces were essentially untouched. A light plywood control house and signal bridge, together with the bulk of the light stanchion and cable safety railing at the top of the wing walls were blown away.

**CONFIDENTIAL**

ENCLOSURE (C)

-1-

840 087

**CONFIDENTIAL**

JOINT TASK FORCE ONE  
USS WHARTON (AP 7)

CONFIDENTIAL:

Subject: Preliminary Damage Report on ARDC-13, YOG-83, YO-160, and  
2 x 6 Pontoon Bridge Section.

-----

- (d) Timber exposed to the blast was charred to a depth of about 1/16 inch, but timber protected by the shadow of the superstructure appeared untouched. There was no evidence of calcination of the concrete, nor of fires or explosions on the dock itself. Vertical concrete faces exposed to the blast were darkened slightly by what appears to be a foreign material. In this connection, the shadow cast by interposed portions of the structure indicate that the blast occurred about 12 degrees forward of the port beam and at an elevation of about 14 degrees.
- (e) The machinery on the dock was limited to two 100 KW diesel engine driven generators. Their operation was not adversely affected by the blast. The glass faces of dials on the electrical control panel were not cracked, nor were light bulbs within the wing walls. The wiring has not yet been examined.
- (f) From recordings on scratch type deflection gages, it is apparent that there was a considerable movement back and forth of the wing walls relative to the pontoon. Such items of equipment as mess tables, galley tables, fly bulkheads, bunks and dry stores were in part torn loose from their moorings.
- (g) The effects of the test observed on the YOG-83 were negligible. Although the inspection of this craft has not been completed, it would appear that only superficial damage occurred to the superstructure, the hull, engines, pumps, valves, and piping were not affected, and there was no evidence of calcination of the concrete by the heat of the blast.
3. (a) There was no damage observed to the YO-160 from the main deck and below, although the subsequent fire in the area of the galley caused superficial scaling of the deck concrete. There was no evidence of calcination of the concrete by the heat of the blast. The heat was insufficient in degree or duration to fire the cargo tanks, in which small quantities of oil remained.

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ENCLOSURE (G)

**CONFIDENTIAL**

JOINT TASK FORCE ONE  
USS WHARTON (AP 7)

CONFIDENTIAL:

Subject: Preliminary Damage Report on ARDC-13, YOG-83, YO-160, and  
2 x 6 Pontoon Bridge Section.

-----

(b) The concrete and wooden superstructures were almost completely demolished by the blast. The poop deck was fractured and pushed downward over its entire area. The pilot house is missing, probably consumed by fire. Deck houses containing the power plant, pump engines, and line valves, were crushed in, and sections were scattered over the deck. The catwalks were ripped asunder and partially destroyed by fire. The after portion of the forecastle was crushed inward, but the forecastle deck was essentially intact.

(c) From measurements made on blast shadows noted on the fore castle deck, it has been estimated that the blast occurred about 70 degrees abaft the port beam.

4. The 2 by 6 pontoon bridge, moored to the stern of the ARDC-13, was structurally intact after the test. A small amount of dishing inward of the steel plates was noted between internal bracing. The bridge was turned over by the blast or subsequent wave action.

/s/ R. LAMOREAUX,

R. LAMOREAUX,  
Commander, (CEC), USN

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ENCLOSURE (G)

JOINT TASK FORCE ONE

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HUSANDA REPORT

Food, clothing and ship's store material stored below decks were not effected to any practical extent. Some food was mildly radioactive on the ARKANSAS and NEVADA, but still usable. Foods in tin or glass were entirely fit for consumption. Some danger exists in the consumption of unsealed foods such as fresh fruits and vegetables in topside lockers or flour in bins. The danger is not from the small amount retained radioactivity but from the possibility of bomb particles or dust residing on the food. Soda ash (laundry supplies) was found to be quite radioactive but activity subsided within forty-eight hours after the blast.

With the exception of the ARKANSAS' steam kettles which were bent and broken, all supply department facilities have been or can be restored as soon as water, electrical power and steam are reactivated.

Ships inspected were the NEVADA, ARKANSAS, CARTERET and SARATOGA.

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Enclosure (H)

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DIRECTOR OF SHIP MATERIAL  
JOINT TASK FORCE ONE  
OPERATION ~~CONFIDENTIAL~~

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BUREAU OF SUPPLIES AND ACCOUNTS GROUP  
GROSS DAMAGE REPORT FOR TEST ABLE  
(ABLE PLUS FIVE DAYS)

6 JULY 1946  
(Date)

O. W. FRASER, Lieutenant Commander,  
(SC), USN.

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Registered Number 16

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Enclosure (H) to Director of Ship Material Serial 00174.

840 054

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BUREAU OF SHIPS GROUP  
TECHNICAL INSPECTION REPORT

U. S. GOVERNMENT PRINTING OFFICE: 1964 O-348-000  
FROM USS. OTHER GOVERNMENTS AND FOREIGN COUNTRIES SHALL REQUEST THROUGH

Defense Support Agency  
Washington, D. C. 20301

APPROVED:

"This document contains information affecting the National  
Defense of the United States within the meaning of the  
Espionage Laws, Title 18, U. S. C., Section 793 and 794.  
Its transmission or the revelation of its contents in any  
manner to an unauthorized person is prohibited by law."

F.X. Forest,  
Captain, U.S.N.

USS CRITTENDEN (APA77)

Page 1 of 147 Pages

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1 JAN 1965  
GROUP 3 1 JAN 1965  
Downgraded at 5 year intervals;  
Not automatically declassified.

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### VOLUME II

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USS CRITTENDEN (APA77)

U.S.S. CRITTENDEN (APA 77)

SHIP CHARACTERISTICS

Building Yard: Consolidated Steel Corp.; Wilmington, California.

Commissioned: 17 January 1945.

HULL

Length Overall: 426 feet 0 inches.

Length on Waterline: 400 feet 0 inches.

Beam (extreme): 58 feet 0 inches.

Depth (molded to upper deck): 37 feet 0 inches.

Drafts at time of test: Fwd. 9 feet 6 inches.

Aft. 17 feet 6 inches.

Limiting displacement: 7,080 tons.

Displacement at time of test: 5,866 tons.

MAIN PROPULSION PLANT

Main Engines: Two sets of Westinghouse steam turbines, directly connected to Westinghouse main generators. Two main shaft motors.

Main Condensers: Two are installed in ship.

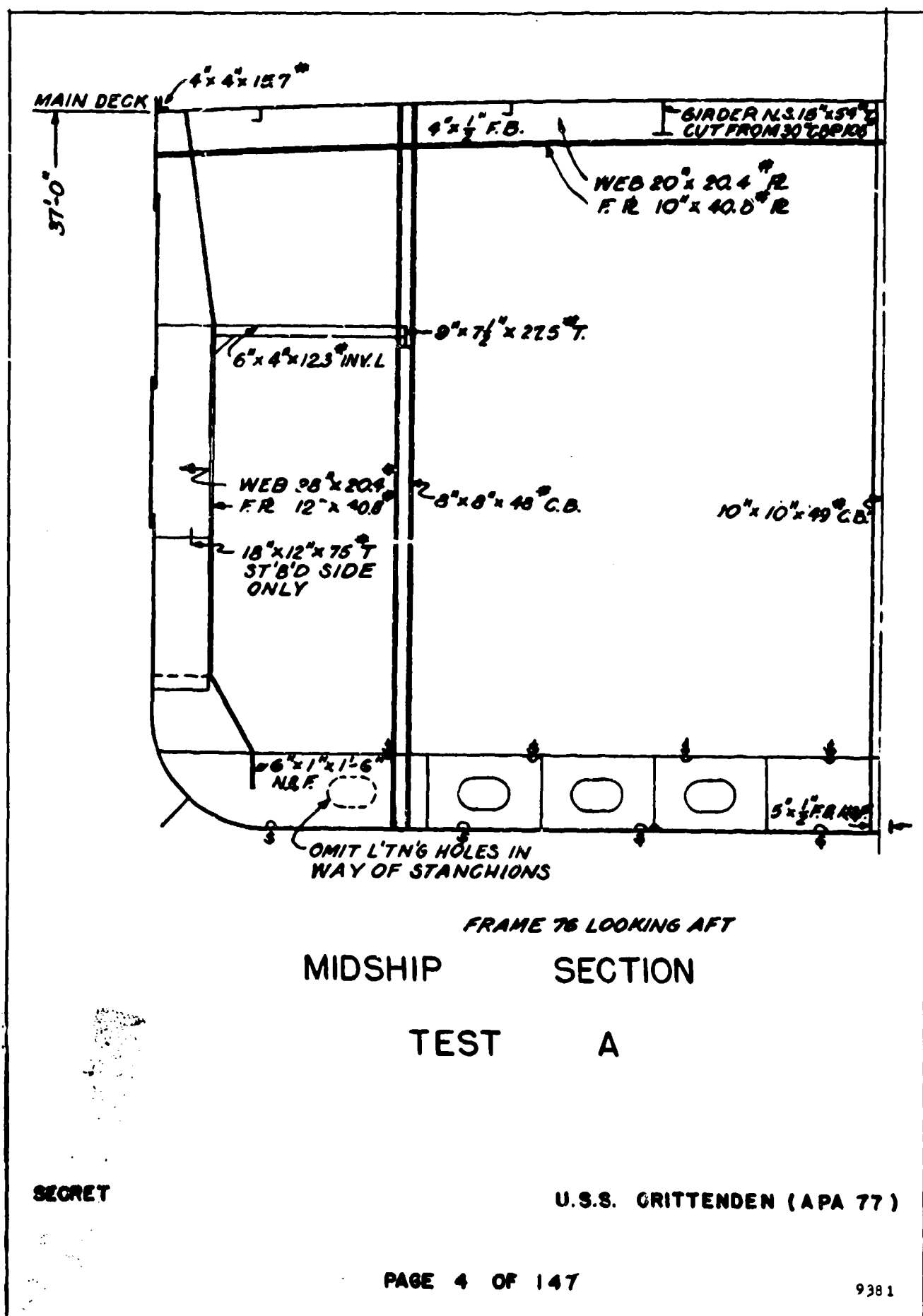
Boilers: Two Babcock and Wilcox Boilers are installed in ship. 450 psi gauge - 750° F.

Propellers: Two are installed.

Main Shafts: Two are installed in ship.

Ships Service Generators: Five are installed in ship. Two - 250 KW. - 450 V. - A.C., One - 150 KW. - 450 V. - A.C., and Two - 100 KW. - 120/240 V. D. C.

USS CRITTENDEN (APA77)



## OVERALL SUMMARY

(a) Drafts after Test; list; general areas of flooding, sources.

Drafts before and after Test:

(b) Structural Damage.

Major structural damage occurred in the forward and after cargo hatch areas and in the bridge structure. Distortion of structure is much more severe in the forward cargo hatch area than in the after cargo hatch area. In the forward hatch area, the longitudinal girders are deflected, spread, and tilted at the upper, main, and first platform deck levels. The upper deck in way of the forward cargo hatch is dished 20 inches, starboard, and 16 inches, port. The main deck and first platform in this area are deflected similarly but to a lesser degree. Deck dishing in way of the after cargo hatch reaches a maximum of six inches.

The forward face of the superstructure is badly dished, the bridge wings are lifted, and the bulwarks are torn. All weather bulkheads facing forward, port and starboard, are dished. Blast damage diminishes from forward to aft and from the topmasts downward. Blast damage to masts, booms, and boat davits is severe.

Damage to joiner bulkheads and furniture is considerable in the forward part of the superstructure, due principally to the distortion of the forward bulkhead of the bridge structure and its associated longitudinal bulkheads. The most serious structural

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damage in the superstructure occurs within the five frame spaces immediately aft of bulkhead 59.

Structural damage in interior spaces is negligible except in the cargo hatch areas. Bulkheads surrounding the hatch areas are moderately dished. Joiner bulkheads in these areas are damaged by pressure which came down through the cargo hatches. All hatch battens, strongbacks, and pontoon type hatch covers were blown into the holds with the exception of one pontoon cover at the main deck level in the after cargo hatch.

Essentially the only damage to the shell plating is a wrinkle at frames 45-48, starboard, which extends from the upper deck to below the waterline. This shell damage, together with the damage to decks and longitudinal girders in the forward cargo hatch area, constitutes a serious reduction in strength in way of the forward cargo hatch.

#### MACHINERY

The outer casings of both stacks were badly crushed. The inner casing of the after stack was considerably dished and was torn open on the forward side. Supports, both internal and external, of the after stack failed, leaving the stack in place but in a precarious position. Nos. 2 and 4 (port) Welin davits received severe structural damage.

#### ELECTRICAL

The ship received considerable structural damage as a result of this test. The only damage to the ship's electrical equipment due to this structural damage was a few cables cut when the bulkheads on which they were mounted gave way. Special electrical test equipment was damaged by falling hatch covers.

(c) Other damage.

#### HULL

Propulsion and auxiliary machinery are unaffected by the Test. Ship control is affected slightly by damage to instruments at the

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secondary conning station. Pilot house instruments remain essentially intact and steering machinery is unaffected. Fire control is reduced in effectiveness by a damaged 40 mm director foundation on the after deckhouse top. Gunnery and electrical equipment is essentially undamaged. Electronics equipment is unaffected except for carrying away of radio and radar antennae. Interior communications are undamaged.

### MACHINERY

No. 1 boiler casing seams were opened at the top where the boiler casing is welded onto the uptake. Both smoke periscope sight reflecting units were ruptured. The after stack was severely damaged. There was moderate damage to the uptakes. The forward starboard cargo winch was torn loose from its foundation. The port Welin davits (nos. 2 and 4) were severely damaged structurally. The electric controller of no. 3 Welin davit was torn loose from the bulkhead. The starboard side of the firemain loop was opened at three places just below the upper deck. There was a large amount of scattered minor damage to piping, electric drinking fountains, etc.

### ELECTRICAL

Principal electrical damage consisted of the following:

1. Both 24 inch searchlights and one 12 inch searchlight were demolished.
2. Approximately six lighting and fire alarm circuit cables for both cargo holds were ruptured.
3. Two gyro compass repeaters were missing and another repeater was knocked from its stand.
4. The port 6MC bull horn was missing.
5. The anemometer cups were blown off.
6. One boat davit controller was knocked off the

bulkhead.  
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7. A few lamps were broken.
8. A few sound powered telephones were rendered inoperable.
9. Special Bureau of Ships, code 660, test material in the forward cargo hold was damaged by falling hatch covers.

II. Forces evidenced and effects noted.

(a) Heat.

HULL

The heat wave struck the ship at an angle of approximately 350 degrees relative, and at an elevation of about 30 degrees.

Paint damage is confined principally to areas facing forward and to port and diminishes in severity from forward to aft and from the topmasts downward. A few athwartship surfaces facing aft have scorching about one foot inboard from the port side. Fire hoses are darkened and frayed. Manila rope appears dried out and wire rope boat falls appear to have all the grease burned.

MACHINERY

Paint on the port side of exposed machinery was badly scorched and blistered.

ELECTRICAL

Radiant heat from the port bow scorched paint on exposed electrical equipment and cables. This heat was not of sufficient duration to render any electrical equipment inoperable.

(b) Fires and Explosions.

HULL

No fires or explosions occurred on this ship.

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## MACHINERY

No evidence.

## ELECTRICAL

There was no evidence of fires or explosions.

(c) Shock.

## HULL

Effect of shock is slight. Pipe berths in troop berthing compartments aft are thrown from their hooks. Electric light globes and bulbs suffered little damage anywhere in the ship. Some equipment was thrown off bulkheads but this is attributable to either the direct effect of air blast or deflection of the structure. Breakage of a nipple on a boat fueling line and separation of pipe flanges in flushing and fire mains are the result of shock. No shock damage to machinery resulted from the test.

## MACHINERY

No evidence.

## ELECTRICAL

There was evidence that the vessel received considerable shock since some lamps, steamtight globes and fire alarm thermostats were broken.

(d) Pressure.

## HULL

Air blast pressure came from approximately 350 degrees relative, at an elevation of about 30 degrees. The areas most severely affected are the forward face of the bridge structure, the forward and after cargo hatch areas, and weather bulkheads facing forward and to port and starboard. In general, dishing of

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longitudinal weather bulkheads facing to starboard is as severe as dishing of bulkheads facing to port. Damage in the starboard main deck passageway is more severe than in the port passageway. Reflection of pressure from the forward face of the bridge structure into the forward cargo hatch area is apparent. The superstructure afforded considerable shielding of the after cargo hatch area.

Dishing of both 7 1/2 lb and 10 lb plating is general.

Top masts and booms proved particularly vulnerable to air blast. All cargo booms secured to the foremast and mainmast are badly bent or buckled.

The ship's speed would have been materially reduced pending repairs to the boiler casing in the forward machinery space. If the ship had been in heavy seas, she would be jeopardized because of serious reduction of strength in way of the forward hold.

#### MACHINERY

Blast pressure, and the whipping motion of the ship following the blast, are believed to have caused all of the damage to machinery. The blast came from the port side.

#### ELECTRICAL

This vessel was subjected to high pressures (air blast). This is evidenced by the searchlights, davit controller, and bull horn being blown from their mountings and by light metal bulkheads being carried away. Most of the electrical damage was a result of the air blast.

(e) Effects peculiar to the Atomic Bomb.

#### HULL

Exclusive of radiological features, the atomic bomb, at this range, presents a problem of large scale simultaneous exposure to heat, blast, pressure, and shock.

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## MACHINERY

A blast pressure of this magnitude is apparently peculiar to the Atom Bomb.

## ELECTRICAL

The loss of residual magnetism of #1 Ship Service generator may have been due to an atomic bomb effect.

### III. Results of Test on Target.

(a) Effect on machinery, electrical, and ship control.

## HULL

The effect of Test A on machinery and electrical equipment is negligible. Ship control is affected only to the extent of damage to instruments at the secondary conning station.

## MACHINERY

Both boilers could have continued in operation with an estimated reduction in efficiency of 50% forward, 25% aft. #1 boiler was repaired by the ship's force in about 2 hours and is now fully operable. The after stack was seriously weakened and would probably have fallen over if heavy weather had been encountered, in which case maximum load on the after boiler would be reduced to 50% or less of normal. Damage to the firemain considerably lessened the effectiveness of this system. Three of the four Welin davits were made inoperable and two are believed to be beyond repair. This reduces the ability of the vessel to lower boats by 75%.

## ELECTRICAL

Electrically, the damage which occurred as a result of the test had slight effect on the operation of the ship's electrical plant. All propulsion and boiler auxiliaries were operable. Had the #1 AC ship's service generator been operating at the time of the bomb explosion, it would not have lost its residual

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magnetism. Since the generator could be easily repaired by the ship's force and since there is a standby generator, the temporary loss of this generator would not affect the operation of the vessel. The most serious effect on the electric plant was the loss of both 24 inch searchlights which were damaged beyond repair. The loss of a few sound powered telephones, the port 6MC bull horn, the 12 inch signal searchlight, and the lighting cables would slightly impair the operation of the ship. The ship could be operated almost indefinitely without these items at only slightly reduced efficiency. Temporary lights could have been rigged by the ship's force to replace those lost.

Secondary ship's control was practically demolished. This control station is seldom used except when the primary control station is inoperable. The ship could therefore, continue to operate, controlled by the normal ship's control station.

(b) Effect on gunnery and fire control.

HULL

Gunnery appears essentially unaffected. Fire control is affected by dislocation of the 40mm director foundation on the after deck house top and by possible severance of electric cables interconnecting the fire control stations.

MACHINERY

No comment.

ELECTRICAL

The only damage to gunnery and fire control equipment was to that equipment secured to the masts. This consists of radar equipment which is covered by the electronics report.

(c) Effect on watertight integrity and stability.

HULL

Watertight integrity and stability are unaffected. No damage to main transverse bulkheads exists below the main deck.

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## MACHINERY

No comment.

## ELECTRICAL

Watertight integrity was not affected by damage to electrical equipment. No electrical equipment shifted sufficiently to affect stability.

(d) Effect on personnel and habitability.

## HULL

The commanding officer estimates that 50 percent of the topside personnel would be serious casualties from the effects of heat, blast, flying debris, and radioactivity and that 20 percent of personnel in the interior of the ship would suffer injuries. Some machinery space casualties could be expected from boiler flarebacks.

Habitability is affected, by damage to ventilation ducts in the forward and after cargo hatch spaces, by temporary disarrangement of berths and lockers, and by obstruction of passages by damaged joiner bulkheads.

## MACHINERY

It is estimated that there would have been few if any, casualties among personnel below decks. Habitability was slightly reduced temporarily by damage to piping and the general disarrangement of the ship.

## ELECTRICAL

The personnel on this vessel might have been affected by radioactivity, however, the extent of these effects is unknown. Disregarding radioactivity, it is considered that all exposed topside personnel would have been casualties due to the flash and air blast. There would also have been casualties around the cargo holds due to structure distortion and due to falling hatch covers. From an electrical standpoint, casualties might have resulted from electrical equipment such as the searchlights and the bull horn becoming missiles.

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Electrically, the only effect on habitability was the slight inconvenience due to the lighting failures.

(e) Effect on fighting efficiency.

HULL

Fighting efficiency is reduced by damage to the port after 40mm director foundation and by damage to radio and radar antennae. The ship could not carry out her mission in amphibious operations because of damage to all cargo booms and the inoperability of three of the four sets of boat davits.

MACHINERY

Damage to the Wellin davits, reducing the vessel's ability to lower boats, would seriously reduce her efficiency as a transport in certain tactical situations. It is to be noted that if the ship had her normal complement of boats aboard, many of these would have been wrecked. It is estimated that maximum speed was reduced to about 6 knots for 2 hours, and that after temporary repairs to the forward boiler speed could be built up to about 13 knots (16 knots is designed speed). It is estimated that approximately 25 days' work at a shipyard would be required to restore all machinery to normal operating condition.

ELECTRICAL

Due to personnel casualties and due to the damage to the vessel, its fighting efficiency was greatly reduced. Electrically, the effects were slight. Disembarkation would have been hampered by the loss of the davit controller, however, this damage could have been repaired by the ship's force in a few hours. Night cargo handling operations would have been hampered by the loss of the cargo lights. It is considered that the ship could operate electrically at approximately 90% efficiency.

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#### IV. General Summary.

##### HULL

This ship proved to be extremely vulnerable to the affects of air blast on topside structure, masts, booms, rigging, and cargo hatch areas. The discontinuity of structure in way of the cargo hatches is likely to contribute materially to reduction in local strength as a result of proximity to an air burst Atom Bomb.

##### MACHINERY

The CRITTENDEN was apparently near the edge of the lethal range of this type of attack for vessels of her type. A slightly greater amount of damage to the boilers and stacks would have immobilized the vessel.

##### ELECTRICAL

This vessel received the most damage of any of the transports that survived the first atomic bomb test. Although the ship's hull received considerable damage there was very little electrical damage. Part of the electrical damage that occurred was due to the failure of associated hull equipment.

#### V. Preliminary Recommendations.

##### HULL

(a) Increase in strength in way of cargo hatch areas is necessary and greater resistance to blast pressure is required for cargo hatch closures.

(b) Long spans between stowage cradles for cargo booms should be eliminated.

(c) Boat handling arrangements should be redesigned to eliminate broad surfaces exposed to blast pressure. Boats should be housed below the weather deck or in protective inclosures.

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(d) Top masts should be eliminated and radar and radio antennae should be replaceable by spares.

(e) Plating less than 10 lbs. in weight should not be used in structure exposed to air blast. Stacks should be of less projected area. Fire control and ship control stations should be spherical or cylindrical inclosures, preferable streamlined with the surrounding structure. Bridge wings should be eliminated.

(f) Life rafts, and loose topside gear in general, should be more securely attached to the ship's structure.

(g) Studies should be conducted to determine the most suitable paints for resisting heat.

#### MACHINERY

Stacks should be made more resistant to blast pressure.

Piping, especially main lines, should be so located that it is not likely to be damaged by deflection of decks and bulkheads.

#### ELECTRICAL

(a) It is recommended that consideration be given to the redesign of the 24 inch searchlights to give them more resistance to air blast. This is considered necessary to give them comparable strength to other electrical equipment.

(b) It is recommended that the gimbal and binnacle pins on gyro compass repeaters be lengthened to prevent the repeaters from being freed from their mounting stands.

(c) It is recommended that consideration be given to mounting equipment such as controllers on some sort of mounting pads or straps so that some bulkhead distortion can occur without damage to the equipment.

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(d) It is recommended that where possible, cable be run along beams instead of along light metal joiner bulkheads. It is considered that most of the damage to cables that occurred on this vessel could have been avoided if more consideration had been given to the routing of the cable.

(e) It is recommended that some means of pinning the 12 inch signal searchlights in their sockets be devised to prevent them from being jarred or blown from their sockets.

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# TECHNICAL INSPECTION REPORT

## SECTION I - HULL

### GENERAL SUMMARY OF HULL DAMAGE

#### I. Target Condition After Test.

##### (a) Drafts after test; list; general areas of flooding, sources.

No flooding occurred.

Drafts before and after test:

Forward, 9' 6"      Aft., 17' 6"      List, 0°

##### (b) Structural damage.

Major structural damage occurred in the forward and after cargo hatch areas and in the bridge structure. Distortion of structure is much more severe in the forward cargo hatch area than in the after cargo hatch area. In the forward hatch area, the longitudinal girders are deflected, spread, and tilted at the upper, main, and first platform deck levels. The upper deck in way of the forward cargo hatch is dished 20 inches, starboard, and 16 inches, port. The main deck and first platform in this area are deflected similarly but to a lesser degree. Deck dishing in way of the after cargo hatch reaches a maximum of six inches.

The forward face of the superstructure is badly dished, the bridge wings are lifted, and the bulwarks are torn. All weather bulkheads facing forward, port and starboard, are dished. Blast damage diminishes from forward to aft and from the topmasts downward. Blast damage to masts, booms, and boat davits is severe.

Damage to joiner bulkheads and furniture is considerable in the forward part of the superstructure, due principally to the distortion of the forward bulkhead of the bridge structure and its associated

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longitudinal bulkheads. The most serious structural damage in the superstructure occurs within the five frame spaces immediately aft of bulkhead 59.

Structural damage in interior spaces is negligible except in the cargo hatch areas. Bulkheads surrounding the hatch areas are moderately dished. Joiner bulkheads in these areas are damaged by pressure which came down through the cargo hatches. All hatch battens, strongbacks, and pontoon type hatch covers were blown into the holds with the exception of one pontoon cover at the main deck level in the after cargo hatch.

Essentially the only damage to the shell plating is a wrinkle at frames 45-48, starboard, which extends from the upper deck to below the waterline. This shell damage, together with the damage to decks and longitudinal girders in the forward cargo hatch area, constitutes a serious reduction in strength in way of the forward cargo hatch.

(c) Other damage.

Propulsion and auxiliary machinery are unaffected by the test. Ship control is affected slightly by damage to instruments at the secondary conning station. Pilot house instruments remain essentially intact and steering machinery is unaffected. Fire control is reduced in effectiveness by a damaged 40 mm director foundation on the after deckhouse top. Gunnery and electrical equipment is essentially undamaged. Electronics equipment is unaffected except for carrying away of radio and radar antennae. Interior communications are undamaged.

II. Forces Evidenced and Effects Noted.

(a) Heat.

The heat wave struck the ship at an angle of approximately 350 degrees relative, and at an elevation of about 30 degrees.

Paint damage is confined principally to areas facing forward and to port and diminishes in severity from forward to aft and from the topmasts downward. A few athwartship surfaces facing aft have scorching about one foot inboard from the port side. Fire hoses are darkened

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and frayed. Manila rope appears dried out and wire rope boat falls appear to have all the grease burned.

(b) Fires and explosions.

No fires or explosions occurred on this ship.

(c) Shock.

Effect of shock is slight. Pipe berths in troop berthing compartments aft are thrown from their hooks. Electric light globes and bulbs suffered little damage anywhere in the ship. Some equipment was thrown off bulkheads but this is attributable to either the direct effect of air blast or deflection of the structure. Breakage of a nipple on a boat fueling line and separation of pipe flanges in flushing and fire mains are the result of shock. No shock damage to machinery resulted from the test.

(d) Pressure.

Air blast pressure came from approximately 305 degrees relative, at an elevation of about 30 degrees. The areas most severely affected are the forward face of the bridge structure, the forward and after cargo hatch areas, and weather bulkheads facing forward and to port and starboard. In general, dishing of longitudinal weather bulkheads facing to starboard is as severe as dishing of bulkheads facing to port. Damage in the starboard main deck passageway is more severe than in the port passageway. Reflection of pressure from the forward face of the bridge structure into the forward cargo hatch area is apparent. The superstructure afforded considerable shielding of the after cargo hatch area.

Dishing of both 7-1/2 lb and 10 lb plating is general.

Top masts and booms proved particularly vulnerable to air blast. All cargo booms secured to the foremast and mainmast are badly bent or buckled.

The ship's speed would have been materially reduced pending repairs to the boiler casing in the forward machinery space.

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If the ship had been in heavy seas, she would be jeopardized because of serious reduction of strength in way of the forward hold.

- (e) Effects apparently peculiar to the atom bomb.

Exclusive of radiological features, the atomic bomb, at this range, presents a problem of large scale simultaneous exposure to heat, blast, pressure, and shock.

### III. Effects of Damage.

- (a) Effect on machinery, electrical and ship control.

The effect of Test A on machinery and electrical equipment is negligible. Ship control is affected only to the extent of damage to instruments at the secondary conning station.

- (b) Effect on gunnery and fire control.

Gunnery appears essentially unaffected. Fire control is affected by dislocation of the 40 mm director foundation on the after deck house top and by possible severance of electric cables interconnecting the fire control stations.

- (c) Effect on water-tight integrity and stability.

Water-tight integrity and stability are unaffected. No damage to main transverse bulkheads exists below the main deck.

- (d) Effect on personnel and habitability.

The commanding officer estimates that 50 percent of the topside personnel would be serious casualties from the effects of heat, blast, flying debris, and radioactivity and that 20 percent of personnel in the interior of the ship would suffer injuries. Some machinery space casualties could be expected from boiler flarebacks.

Habitability is affected, by damage to ventilation ducts in the forward and after cargo hatch spaces, by temporary disarrangement of berths and lockers, and by obstruction of passages by damaged joiner bulkheads.

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(e) Effect on fighting efficiency.

Fighting efficiency is reduced by damage to the port after 40 mm director foundation and by damage to radio and radar antennae. The ship could not carry out her mission in amphibious operations because of damage to all cargo booms and the inoperability of three of the four sets of boat davits.

IV. General Summary of Observers' Impressions and Conclusions.

This ship proved to be extremely vulnerable to the effects of air blast on topside structure, masts, booms, rigging, and cargo hatch areas. The discontinuity of structure in way of the cargo hatches is likely to contribute materially to reduction in local strength as a result of proximity to an air burst atomic bomb.

V. Preliminary General or Specific Recommendations of Inspection Group.

(a) Increase in strength in way of cargo hatch areas is necessary and greater resistance to blast pressure is required for cargo hatch closures.

(b) Long spans between stowage cradles for cargo booms should be eliminated.

(c) Boat handling arrangements should be redesigned to eliminate broad surfaces exposed to blast pressure. Boats should be housed below the weather deck or in protective inclosures.

(d) Top masts should be eliminated and radar and radio antennae should be replaceable by spares.

(e) Plating less than 10 lbs in weight should not be used in structure exposed to air blast. Stacks should be of less projected area. Fire control and ship control stations should be spherical or cylindrical inclosures, preferable streamlined with the surrounding structure. Bridge wings should be eliminated.

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(f) Life rafts, and loose topside gear in general, should be more securely attached to the ships structure.

(g) Studies should be conducted to determine the most suitable paints for resisting heat.

VI. Instructions for loading the vessel specified the following:

ITEM	LOADING
Fuel Oil	95%
Diesel Oil	95%
Ammunition	100%
Potable and reserve feed water	95%
Salt water ballast	None

Details of the actual quantities of the various items aboard are included in Report 7, Stability Inspection Report, submitted by the ship's force in accordance with "Instructions to Target Vessels for Tests and Observations by Ship's Force" issued by the Director of Ships Material. This report is available for inspection in the Bureau of Ships Crossroads Files.

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## DETAILED DESCRIPTION OF HULL DAMAGE

### A. General Description of Hull Damage.

#### (a) Overall condition of vessel.

This ship suffered major structural damage in the forward and after cargo hatch areas and on the forward bulkhead of the bridge structure. Considerable reduction in longitudinal strength is considered to have resulted from damage in way of the forward cargo hold.

The starboard shell plates are buckled between frames 45 and 48 from the upper deck to below the waterline. The upper deck is dished approximately 20-inches, starboard, and 16-inches, port, in way of the forward cargo hatch. The hatch coamings are severely deflected and tilted. Similar damage, to a lesser degree, occurs on the main deck and first platform levels in the forward cargo hatch area. Damage in the after cargo hatch area is much less than in the forward hatch area. The upper deck is dished approximately six inches on the starboard side of the after cargo hatch. Distortion of hatch girders is much less severe in the after cargo hatch area.

All exposed superstructure bulkheads, stacks, and masts are damaged. Failure of cargo booms and boat davits would prevent the ship from carrying out her assigned functions.

The pressure from the blast came from about 350 degrees relative and an elevation of about 30 degrees. The forward bulkhead of the bridge structure apparently reflected the blast into the forward cargo hatch area. Conversely, the amidship superstructure partially shielded the after cargo hatch area.

General photographs of the exterior are shown on page 2 to page 17 inclusive. Principal damage is shown on diagram, page 82.

#### (b) General areas of hull damage.

Regions of major structural damage are the forward and after cargo hatch areas, the bridge structure, the superstructure

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immediately aft of the bridges, the port and starboard main deck weather passageways, and the starboard shell plating forward. Hatch battens, strong backs, and pontoon covers, were blown into both cargo holds.

In the forward cargo hatch area, the upper, main and first platform decks are dished (photos 1907-5, 6, 1891-2, 3, pages 18, 19, 20 and 21). The intensity of deck dishing diminishes downward and is more severe along the starboard side of the hatch openings. In the after cargo hatch area, dishing of the main deck is slight, (photos 1907-11, 12, pages 22 and 23). In both forward and after cargo hatch areas, deflection and tilting of hatch coaming girders occurs. Web columns supporting these girders are severely strained. In the superstructure, damage to longitudinal bulkheads is most severe in way of the five frame spaces immediately aft of bulkhead 59, as the result of deflection of the forward face of the bridge structure. In the main deck weather passageways, longitudinal and transverse bulkheads and doors are dished. Damage is more severe on the starboard side (photos 1819-1, 2, 1908-8, pages 24, 25, and 26). The starboard shell plating, frames 45-48, is buckled from the upper deck to below the waterline (photos 1901-8, 9, pages 27 and 28).

(c) Apparent causes of hull damage in each area.

All hull damage is considered to be the result of air blast.

(d) Principal areas of flooding with sources.

No flooding occurred.

(e) Residual strength, buoyancy, and effect of general condition of hull operability.

Longitudinal strength is seriously affected by failure of the upper flange of the ship's girder in way of the forward cargo hold as evidenced by deflection of the upper, main, and first platform decks, and by distortion of the hatch girders. Buckling of the starboard shell plating in way of the forward hold is further evidence of reduction in longitudinal strength.

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Buoyancy is unaffected. Propulsion is not affected. Operability is seriously affected by failure of boat davits, cargo booms, radio and radar antennae, halyards, and fire control equipment. Ship control is somewhat affected by wrecking of the emergency steering station equipment at frame 90 on the signal bridge level.

B. Superstructure.

(a) Description of damage.

Bridge area, general.

The entire forward face of the bridge structure is severely dished and all bulwarks are torn or distorted, (photos 1960-3, 4, 2102-1, 2, 1903-3, 4, 5, 6, 8, 9, pages 31, 32, 33, 34, 35, 36, 37, and 38). The signal bridge and navigating bridge port wings are lifted. The signal bridge is separated 10-inches from its supporting stanchions and the navigating bridge a lesser amount (photos 1960-4, 1901-7, pages 30 and 39). Moderate dishing of weather decks and exposed bulkheads is general in all superstructure areas. Stiffness of decks and longitudinal bulkheads served to divide dishing of the bridge structure forward face (bulkhead 59) into fairly well defined panels. Decks and longitudinal bulkheads were not sufficiently rigid to totally resist distortion due to longitudinal end thrust caused by blast pressure on bulkhead 59. As a result, the plating of the signal bridge, navigating bridge, and deckhouse top is severely wrinkled and longitudinal bulkheads are buckled. The most severe wrinkling of decks and bulkheads occurs within the five frame spaces immediately aft of bulkhead 59. Further wrinkling is in evidence on the navigating deck aft of bulkhead 88, due principally to heavy dishing of the bulkhead. The dishing of decks and bulkheads exposed to the weather caused a general buckling of the triangular plate brackets connecting the deck girders with bulkhead stiffeners. The amount of bracket buckling diminishes from forward to aft and is most severe in the forward part of the superstructure. Distortion of railings and ladders in the superstructure is general. Damage to joiner bulkheads and furniture is general and is most severe in the forward part of the superstructure. Damage to light structure apparently was much reduced by having all weather access closures dogged shut before the test.

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### Signal bridge level

The bulwarks at frame 59 are distorted and bent aft six inches at the top edge (photo 1961-6, page 40). The port 20 mm gun bulwark failed over a two foot length in way of the deck edge weld. The entire port wing is bent upward, with a maximum lift of 10-inches at the outboard edge. In the area immediately aft of the forward bulwark, the deck is wrinkled to a maximum depth of four inches. The signal bridge deck plating, generally, is dished from 1/2 inch to 1-inch in panels defined by the centerline longitudinal and supporting transverse bulkheads underneath. The port and starboard sheet metal flag bags were blown overboard. Pipe railings are distorted (photo 2058-8, page 41). The centerline walkway connecting the forward portion of the signal bridge level with the emergency steering station is separated from bulkhead 88 by failure of welds connecting the walkway with brackets on bulkhead 88 (photo 1904-9, page 69). Immediately aft of bulkhead 88 the signal bridge level is wrinkled to a depth of four inches over a fore and aft distance of four feet, due to blast pressure against bulkhead 88. At the emergency ship control station, located between frame 88 and the after stack, the master compass pedestal (wooden) is broken off by blast. The gyro repeater and telegraph pedestals are damaged. A part of this damage is due to contact with the port 24-inch searchlight. It was blown off its platform on the forward stack at frame 71 and landed on the signal bridge level at frame 90, starboard (photos 1904-6, page 52). The forward bulkhead of the radio direction finder house is moderately dished. The sky lookout tub (7-1/2" lb. plate) at frame 100, port, is severely distorted by blast (photos 1904-8, 1962-6, 1922-3 pages 49, 127, and 129).

### Stacks.

The outer casing of both stacks is severely buckled. The after stack is more severely damaged (forward stack, photos. 2058-9, 1904-4, 1961-3, 2058-10, 1904-5, 1878-6, 1817-7, pages 42, 43, 44, 45, 46, 47 and 48); after stack, photos 1904-8, 1878-4, 5, 1904-6, 1878-7, pages 49, 50, 51, 52 and 53). The searchlight platforms on the forward stack are out of line due to distortion of the stack casing in way of connections to the platform and platform bracing. The port 24-inch searchlight was blown aft, landing on the signal bridge level at

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frame 90, starboard, in the emergency steering station (photo 1904-8, page 52). The reflector from this searchlight landed on the upper deck, forward. The starboard 24-inch searchlight is demolished, and its pedestal is broken (photos 1901-5, 1922-5, pages 54 and 55). The railings on both searchlight platforms are distorted by blast. The after stack is severely torn in way of the access closure on its forward face. Tears and impending tears are prominent in both stacks at the corners of rectangular coamings around closures and louvers. A portion of the inner casing of the after stack is severed with a 4" x 18" tear. The outer casing connection is torn in the deck weld (photos 1904-8, 2058-11, pages 49 and 56).

#### Navigating bridge level.

The port and starboard forward bulwarks of the navigating bridge are dished in about 1-inch. Both bulwarks are sheared along the vertical stiffener, located six inches outboard of the pilot house (photos. 2102-2, 1903-4, 5, 6, 8, 1904-12, 1905-1, 7, 8, 2058-6, pages 32, 34, 35, 36, 37, 57, 58, 59, 60 and 61). The deck just aft of the forward bulwarks, port and starboard, is dished a maximum of 8-inches, between frames 59 and 60, due primarily to the pushing in of the forward face of the bridge structure (photos 1905-7, page 59). From frames 60 to 65, the deck is wrinkled to a maximum depth of 3-inches. The pilot house, port and starboard bulkheads are moderately dished (photo 1905-9, page 62). The forward bulkhead is severely damaged. This bulkhead is dished to a maximum depth of 12-inches. All 3" x 4" angle stiffeners are tripped. Three stiffeners have failed in tension at mid-height in way of holes for cable clips. One vertical butt weld failed (photos 2102-2, 1903-4, 1905-2, 4, 10, pages 32, 34, 63, 64 and 65). Evidence of lack of weld penetration exists in the weld failure of the STS bulkhead. Inside the pilot house, just aft of the forward bulkhead, the deck is severely buckled and torn (photos 1905-3, 2058-3, 4, pages 66, 67 and 68). The 9" x 11" centerline "T" longitudinal under the signal bridge punched through the pilot house forward bulkhead. The outboard walkways on the navigating bridge level are dished approximately 1/4 inch between frames and the deck is dished. All pilot house instruments remain operable, although some glass is broken. Light globes are intact except where struck by flying objects. Bulkhead 88, the forward face of the 20 mm ready service room, on the navigating deck, is severely dished and buckled throughout its entire area though partially shielded from the blast by the forward portion of the bridge structure (photos 1904-9, 11, pages 69 and 70).

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### Superstructure deck.

Bulkhead 59, between the superstructure deck and the navigating bridge, is moderately dished. The starboard forward bulwark is dished aft. Stanchions supporting the navigating bridge are bent (photo 1903-4, 8, pages 34 and 37). The port forward bulwark is laid aft sharply and sheared along its inboard stanchion (photos 1960-4, 1903-6, 8, 9, 10, 11, pages 30, 36, 37, 38, 71, and 72). The port forward bulwark is also torn along the stiffener adjacent to the captains' cabin. The forward outboard stanchion, supporting the navigating bridge, is torn away. The next stanchion aft is separated at its upper weld connection to the navigating bridge (photos 1960-4, page 30). The sounding machine on the port wing of the superstructure deck is knocked down and demolished. The starboard longitudinal bulkhead of the division commanders cabin is severely buckled, frames 59-61 (photo 1906-1, page 73). The longitudinal bulkhead between the division commander's cabin and the captains pantry is crumpled adjacent to bulkhead 59, (photo 1906-3, page 74). Similarly, the port forward corner of the captains' pantry is crumpled by deflection of bulkhead 59 (photo 1906-2, port 75). Bulkheads and equipment in the captain's pantry are demolished. The port longitudinal bulkhead of the captain's cabin is severely buckled and opened to the weather (photos 1903-10, 12, 1904-2, pages 71, 76 and 77). Dishing of the port bulkhead of the captain's cabin caused severe damage to the transverse bulkhead and door separating the cabin from the captain's stateroom. The deck is severely buckled between frames 59 and 60. The port and starboard wings at the superstructure deck level are dished to a 3-inch maximum, principally due to end thrust caused by the blast pressure on bulkhead 59. This effect is more severe on the port wing. The outboard walkways are deflected approximately 1/4 inch between frames and the deck house sides are dished. Connecting brackets have tripped (photo 1906-5, page 78). The sheetmetal motion picture booth at frame 107 is badly dished on all sides. (photo 1906-11, page 79 ).

### Top of blower house.

Structure and equipment on the blower house top exhibits effects of blast pressure. This damage is confined principally to the port side, where the 40 mm director tub is slightly distorted and the life raft stowage is disarranged (photos 1960-9, 7, 1962-4, pages 80, 81 and 82).

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### Top of after deckhouse.

The after deckhouse top is dished a maximum of 1-1/2-inches over an area approximately 10-feet square on the starboard side, midway between the centerline and the deck edge. On the port side, the deck dished lightly between frames 142-145. On the port side forward, the house top plating is buckled downward approximately 8-inches underneath and just aft of the high director tub. This deflection is the result of a strong couple exerted by the director tub pipe bracing (4-1/2" O.D. pipe) resisting the sternward push of the blast wave on the high tub. The two forward pipe braces and the central tube to the tub are pulled out of their welds to the house top. The two after pipe brace welds are cracked halfway around their periphery on the forward side, leaving the tub structure barely self supporting, (photos 1907-1, 1961-10, pages 83 and 84). A hawser reel with line, located on the port side with a vertical axis, is blown down aft. The central support (3-1/2" O.D. pipe) tore a petal of plating from the house top. At frames 130-134, starboard, life raft supports are carried away (photos 1961-10, 1906-8, pages 84 and 85). Deck gear locker, ready boxes, and sheet metal on the after deckhouse are dished by blast. The speed light shield is blown off, but the light itself is undamaged. Smoke generators are damaged beyond use.

### Masts and rigging.

The jack staff is bent to starboard and aft making an angle of approximately 45 degrees with the horizontal (photo 1921-11, page 86). The flag staff is also bent slightly. The stub mast located on the forward edge of the forward stack is bent aft. On this mast signal yardarms are badly damaged and halyards and radio antennae are down (photos 1904-7, 1922-8, pages 87 and 88). The fore topmast is bent aft sharply and slightly to starboard just above the foremast platform. The port and starboard cargo booms, stowed vertically by the foremast, are bent aft sharply just above the platform at the juncture of the upper boom sections. Absence of damage to the major portion of these cargo booms apparently is due to shielding and reflection phenomena associated with location of the booms relative to the foremast, (photos 1959-8, 1962-1, 1921-10, pages 89, 90 and 91).

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The main topmast is bent aft sharply just above the main mast platform. The port cargo boom, stowed vertically by the mainmast, is bent just below the boom midsection. Similarly, the starboard cargo boom buckled sharply on the forward side just below the midsection (photos 1959-7, 1905-11, 1922-2, 1906-9, 1961-12, 1921-12 1906-12, pages 92, 93, 94, 95, 96, 97 and 98). Radar equipment on both the foremast and mainmast is damaged beyond repair. The SC-4 radar on the mainmast fell off and landed on the after deckhouse top. Halyards, radio antennae, yardarm blinker lights, anemometer, range lights, and other equipment attached to the fore and main masts are destroyed.

(b) Causes of damage in each area.

All damage in superstructure areas is considered to be due to the air blast. The effect of shielding and of restraints offered by the complexity of hull structure, greatly influenced the degree of distortion resulting from the blast pressure.

(c) Evidences of fire in superstructure.

There is no evidence of fire in the superstructure.

(d) Estimate of relative effectiveness against blast of various plating thicknesses, shaped surfaces, STS.

Light sheet metal offers essentially no resistance to blast. MS plating, up to and including 10 lbs in weight is dished where directly exposed to blast pressure. Gun tubs of 10 lb weight suffered negligible distortion.

Rails, stanchions, booms and masts do not effectively resist distortion, though having curved surfaces. Damage to these elements is an inertia effect and is due to the acceleration imparted to relatively large masses having insufficient support to prevent bending or buckling at their critical sections. Panels of STS plating apparently do not show superior resistance to dishing as evidenced by distortion of the forward face of the bridge structure. Plating of 7-1/2 lbs weight, as in superstructure weather bulkheads and stacks, appears especially vulnerable to blast pressure.

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(e) Constructive criticism of superstructure design or construction including important fittings and equipment.

Superstructure plating should not be less than 10 lbs. in weight. Square corners should be eliminated as far as practicable. This applies both to deck houses and to weather access closures.

Overhangs should be eliminated.

Stacks should of less projected area, constructed of not less than 10 lb. plate, and be more securely connected to the ships structure.

Doors and door frames should be made less vulnerable to blast pressure. Bulkheads should be reinforced adjacent to door frames to more effectively resist local distortion due to effects of mass.

The design and arrangement of masts and booms should be studied for greater resistance against blast, vibration, and inertia effects. Cradling of booms requires special attention. Long spans between cradles should be avoided.

Spars, rigging, and antennae should be reduced to a minimum. Radar devices should be made retractable or should have provisions for rapid replacement of spares.

C. Turrets, Guns and Directors.

(a & b) Protected and unprotected mounts.

All guns operate satisfactorily except in alignment. One 20 mm gun is temporarily inoperative due to obstruction by a bent STS shield on the gun used for protection of the gunner. All 20mm guns had been removed except one at each corner of the navigating deck level. The forward, port, and the after, starboard, 40mm guns were removed before the test.

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preventing application of blast pressure against the relatively broad vertical inboard surfaces of the hatch girders. Similar distortion of hatch edge girders occurs at the main deck and first platform levels to a lesser degree.

It is apparent that pressure exerted athwartships by the hatch girders caused the compression buckles in the upper deck plating and tended to increase the amount of deck deflection. The vertical component of blast pressure caused dishing, both local and general. But it could not by itself, have caused buckling of the deck. It is believed that buckling due to edge compression of the deck plating was initiated prior to dishing, inasmuch as the deck, in a dished condition, could not have furnished sufficient lateral resistance to cause buckling. The more severe damage to the starboard side apparently is partly due to the reflection of pressure from the forward face of the bridge structure. The detailed pattern of the upper deck deflection is provided by the deck survey made after Test A, (photos 1961-5, 1819-4, 2101-7, 9, 1817-10, 9, 2086-9, 10, 2101-10, 1960-1, 2, 2101-12, pages 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112 and 113). The pontoon covers for the forward cargo hatch are damaged. (photos 1891-5, 6, 7, 8, 9, pages 114, 115, 116, 117 and 118).

The 5' x 7' ammunition hatch at frames 56-58-1/2 on the upper deck centerline, is severely damaged. The hatch cover was blown inward and landed at the bottom of the ammunition trunk. Blast pressure on the hatch cover and on the sides of the relatively high coaming caused the coaming to collapse inward (photos 1817-11, 1901-6, 1961-1, pages 119, 120 and 121). Pressure reflected from the forward side of the bridge structure at frame 59 probably contributed to failure of this hatch.

Upper deck damage in way of the after cargo hatch is much less than that in way of the forward cargo hatch. The upper deck is dished a maximum of 6-inches abreast the starboard side of No. 2 cargo hatch. Distortion of hatch girders occurred to a lesser degree than in the forward cargo hatch area but is in evidence at both upper and main deck levels (photos 1907-11, 12, pages 22 and 23). Shielding by the superstructure apparently prevented the after cargo hatch area from being severely damaged.

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The upper deck aft of the after deckhouse is in good condition except for areas of slight local dishing. The deck is dished approximately 1-5/9 inches, frames 150-158 starboard, between the bitts and the 5 inch gun mount (photo 1908-11, page 122). A slight dish exists on the port side also abreast the gun mount. The deck is dished about 1/2 inch at the centerline abreast the after wildcat.

Bulkhead 59, between the upper and superstructure decks is dished about four inches. Upper deck longitudinal weather bulkheads, port and starboard, are lightly dished. Watertight doors and door frames generally, are dished and the dogs are bent. A number of doors exposed to blast pressure had to be opened with crowbars. Doors on the starboard side of the ship appear to be as heavily damaged as doors on the port side. The two heavy doors to the starboard side of the wardroom were blown off their hinges and into the wardroom, causing damage to furniture (photo 1959-11, page 124). The double doors to the carpenter shop, port side, frame 131, received similar damage (photo 1906-10, page 125).

The forward bulkhead of the after deckhouse is dished aft approximately 1 inch and the forward port corner is distorted (photo 1906-10, page 125).

In the main deck weather passageways, longitudinal and transverse bulkheads are dished. Doors and door frames are damaged. The port passageway area seems to have been shielded by the upper deck and consequently suffered much less damage than the starboard passageway area. The port passageway, bulkhead 122, is dished and the doors to the gear locker, outboard, and to the after troop berthing, are moderately dished (photo 1819-1, page 24). Dishing of the starboard passageway bulkhead is negligible from frame 59 to frame 67 and is severe from frame 100 to 110 and 116 to 122 (photo 1908-10, page 126). The forward bulkhead (59) is intact but the door is dished. The two doors in the starboard after bulkhead 122 are torn off their hinges. The bulkhead and door frames are severely dished (photos 1819-2, 1908-8, page 25 and 26). Recordings of scratch gages installed under the upper deck are in Appendix , page 91.

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(b) Usability of deck in damaged condition.

Usability of weather decks is not seriously affected.

(c) Condition of equipment and fittings.

The boat handling gear and the cargo booms are seriously damaged (see Item B, Superstructure for boom damage). All boat davits are out of commission, except the forward starboard davit which is operable. The forward davit of the port after pair is completely out of its roller track. The after davit of this pair is distorted (photos 1982-6, 1904-10, 1922-3, 4, 1882-6, 1922-7, 1882-7, 1922-6, 1959-9, 10, pages 127, 128, 129, 130, 131, 132, 133, 134, 135 and 136). Continued rolling of the ship undoubtedly would have had a disastrous effect on the damaged port after davits and associated deck-house structure. Damage to miscellaneous equipment exposed to air blast is as follows:

1. Bow lookout chair demolished and hawse pipe covers blown overboard.
2. Telephone handset ripped out of box on forecastle.
3. Potato locker on upper deck at frames 20-23 severely dished on all sides.
4. Hold-down bolts on starboard forward deck winch failed due to depression of the deck in way of the winch foundations (photos 1960-2, 1882-9, pages 112 and 137).
5. No. 5 cargo winch capstan shaft bent.
6. Hold-down bolts of ventilator, frame 55, upper deck, starboard, sheared off and ventilator blown overboard. Hold-down bolts loosened on port ventilator (photos 1817-10, 2101-10, pages 106 and 110).
7. Fire hose at station 01-29-2 cut off at plug and hose rack bent.

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8. No. 3 davit controller box blown off bulkhead.
9. Magazine sprinkler boxes distorted and glass broken.
10. Life rafts blown about and overboard, or damaged by falling debris. Only 6 good rafts remain out of an original 46.
11. Forward port boat boom knocked out of stowage bracket.
12. All top side canvas ripped and torn. The three layers over the forward cargo hatch were shredded and blown into the hold.
13. Paravane after hold-down bands broken loose from pad eyes.
14. Three P-500 pumps demolished on deck.
15. Four steel jacks ladders damaged beyond repair.
16. Port side debarkation net ripped and torn beyond use. (The starboard net remained intact).
17. Port 6MC bull horn blown overboard and starboard horn demolished; flood lights demolished.
18. Spare 40 MM gun barrel boxes dished in on all sides.
19. Taffrail long blown off port side and lost.
20. Several stays and guys failed in the turnbuckle bolt threads.
21. Smoke generators on after deckhouse top damaged beyond repair.
22. Both airplanes, one on the upper deck starboard abreast the after cargo hatch and the other in the after hold, are severely damaged by falling debris (photo 1961-8, 11, 1908-1, pages 138, 139 and 140).
23. Two test bombs, one 350 lb and one 500 lb were knocked clear of their stowage pad eyes on the upper deck and rolled into the depression to port and starboard of the forward cargo hatch (photos 2086-10, 1960-1 pages 109 and 111).

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24. Pipe lifelines are damaged (photos 1960-8, page 141).

F. Exterior Hull. (above waterline)

(a) Condition of exterior hull plating and causes of damage.

The exterior hull is essentially undamaged except for a set of buckles in the starboard shell plating between frames 45-48 and slight waves in the plating near frame 30. The buckles at frames 45-48 extend from the upper deck to below the waterline (photos 1901-8, 10, pages 27 and 142). These buckles are associated with the failure of the ships girders as the upper deck dished and longitudinal girders distorted in this area. The cause of the damage was the air blast loading of the upper deck and vertical surfaces.

(b) Condition of exterior hull fittings and causes of damage.

Boat booms and light hull fittings are damaged by the air blast.

(c) Details of any impairment of sheer strake.

The starboard shell plate is buckled between frames 45 and 48. The sheer strake has two buckles at this location which are about 1-1/2 and 3-inches deep.

(d) Condition of side armor.

Not Applicable.

G. Interior Compartments (above w.l.).

(a) Damage to structure and causes.

In the forward cargo hatch area, the starboard side of the main deck is dished approximately 6-inches (photos 1907-5, 1891-3, 1817-12, 1907-8, 9, 2086-4,5,8, 2101-1, 2, 4, 5, pages 18, 21, 143, 144, 145, 146, 147, 148, 149, 150, 151 and 152). Stress patterns are clearly indicated in paint cracking (photos 1889-1, 1891-10, 11, 12,

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2156-1, 2, pages 153, 154, 155, 156, 157 and 158). The port side has negligible dishing. This area was shielded by the semi-structural port longitudinal bulkhead of the hatch opening. The bulkhead is dished outboard approximately four inches (photos 1817-12, 2101-5, 6, 1960-5 pages 143, 152, 159 and 160).

The first platform deck to port and starboard of the forward cargo hatch is dished approximately three inches (photos 1907-5, 6, pages 18 and 19). The hatch edge longitudinal girders are deflected at the main deck level, starboard and at the first platform level port and starboard (photos 1907-5, 6, 1891-2, 3, 2101-1, 5, pages 18, 19, 20, 21, 149 and 152). Deflection of these girders severely strained the web columns at bulkheads 40 and 56 and caused web buckling in both columns and girders (photos 1907-5, 6, 1891-2, 3, 2086-8, 2101-1, 5, 1890-8, 2086-2, 1890-9, 12, 1907-10, 2086-3, 2171-11, pages 18, 19, 20, 21, 148, 149, 152, 161, 162, 163, 164, 165, 166 and 167). At bulkhead 56, starboard, the welded connection of the column to the main deck is cracked at the flange and web (photos 1890-8, 2086-2, pages 161 and 162). Bulkhead 40, between the main and upper deck is dished forward (photo 1908-3, page 168). Intermittent welds on stiffeners on the forward side are fractured (photos 2086-6, page 169). Deflection of the upper deck around frame 27, port and starboard, resulted in distortion of bulkhead 27 between the main and upper decks and severely strained the port and starboard web columns on the after side of the bulkhead (photos 2171-9, 10, pages 170 and 171). Distortion of deck beam brackets at the shell, port and starboard, is general. This effect is most severe in the cargo hatch area but extends forward to bulkhead 27 (photos 1907-8, 7, 1890-11, 7, 2101-3, pages 144, 172, 173, 174 and 175. Damage to interior bulkheads on the main deck is superficial. Bulkhead 59, starboard, is buckled adjacent to the passageway longitudinal bulkhead, and in compartments B-101-E and B-102-L.

Interior damage in the after cargo hatch area is similar but much lighter than the forward damage. The main deck to starboard of the cargo hatch is dished a maximum of 1-inch. The starboard hatch edge girder is deflected downward, (photo 1907-12, page 23, and is buckled adjacent to the supporting columns at bulkheads 108 and 124. The column webs are buckled slightly. Weld

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failures occurred under the main deck in way of column web buckling (photos 1908-6, 7, pages 176 and 177). The semi-structural longitudinal bulkhead between the main and upper decks at the port edge of the cargo hatch is slightly dished outboard. Bulkhead 124, between the main and upper decks, is dished aft approximately six inches. The stiffeners are tripped. The centerline stiffener is pulled away from its intermittent welds along the upper third of its length (photo 1908-2, page 178).

In the main deck troop berthing space, frames 124 to 135, the port stanchion (3/4" O.D. pipe) is bent aft approximately 1-1/4-inches, (photo 1908-9, page 179), and the starboard stanchion bent aft approximately 2-1/4-inches. The top and bottom connections of the stanchions are intact. In the troop washroom on the main deck. The starboard bulkhead is dished approximately 3/8 of an inch between frames 154 and 158. The longitudinal bulkhead of the starboard main deck passageway is severely dished inboard between frames 100-110 and 116-122, with the most severe dishing in the after section. On the inboard side of this bulkhead eleven of the fifteen beam brackets under the upper deck are slightly buckled.

(b) Damage to joiner bulkheads and causes.

Damage to joiner bulkheads is moderate except in the bridge structure and occurred primarily in main deck areas exposed to the blast that entered the cargo hatches. This damage is confined to the port side in way of the ships office, aft, and the port passageway, forward.

(c) Details of damage to access closures and fittings.

Except for cargo hatch covers, damage to interior closures and fittings other than those in joiner bulkheads is negligible. In the after cargo hatch, the three after, main deck, pontoon type hatch covers were blown into the hold (photos 1907-12, 1908-5, pages 23 and 180). The forward pontoon is severely dished but remains in place (photo 1907-11, page 22). The two starboard hinge pins are bent and all four hinge pads are pulled out of their welds. The strongbacks 18" x 7-1/2" I-beam, 3/8" web and 1/2" flange, were blown from the upper deck level and landed in the hold. A typical shear failure at the end of a strongback is shown in photo 1908-4 on page 181. Typical

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damage to hatch battens is shown in photo 1907-3 on page 182.

(d) Condition of equipment within compartments.

Berths and lockers are disarranged in both the forward and after main deck cargo hatch area (photos 2086-5, 2101-1, and 2, pages 147, 149 and 150). Disarrangement of berths is general in after troop berthing spaces on the main deck and below (photo 1908-12, page 183). Lighting fixtures in the forward cargo hatch area have damaged supports, but light globes and bulbs are, in general, unbroken. Special equipment (diesel generators, electric panels, etc.), located in the forward hold was damaged by falling hatch covers and strongbacks (photos 1960-6, 1901-1, 3, 4, pages 184, 196, 192 and 189). An airplane in the after hold was damaged in a similar fashion (photo 1961-11, 1908-1, pages 139 and 140).

(e) Evidence of fire.

There is no evidence of fire.

(f) Damage in way of piping, cables, ventilation ducts, etc..

Damage to cable and piping is, in general, slight. It consists of distortion in way of dished decks. On the fire and flushing system some pipe flanges are separated (photo 2086-3, page 166). On the main deck, starboard, in way of the forward cargo hatch ventilation ducts are collapsed and the seams are opened (photos 2086-5, 2101-1, 2, 4, pages 147, 149, 150 and 151). On the first platform level the damage is less and principally confined to separation of duct joints (photos 1907-7, 2086-7, pages 172 and 185). Similar damage to ventilation ducts occurred in the after cargo hatch area.

(g) Estimate of reduction in watertight subdivision habitability and utility of compartments.

There is no reduction in watertight subdivision. Habitability and utility of compartments exclusive of the cargo hatch areas is temporarily slightly reduced. Habitability of cargo hatch area berthing spaces is temporarily reduced due to ventilation duct damage.

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H. Armor Decks and Miscellaneous Armor.

Not Applicable.

I. Interior Compartments (below w.l.).

(a, b & c) Damage to structural and joiner bulkheads, access closures and causes.

No structural damage occurred below the waterline except to No. 1 uptake in the forward machinery space. Welded seams were fractured where the vertical section rises from the boiler. These seams were rewelded and the boiler lighted off satisfactorily. Damage to this uptake is believed to have been due to blast pressure coming down the stack.

(d) Damage to equipment within compartments.

No damage to machinery or equipment occurred except that both smoke periscope mirror holders in the engine rooms fractured at the aluminum welded joints. Equipment stowed in both holds was damaged by falling hatch pontoons and strongbacks.

(e) Flooding.

No flooding occurred.

(f) Damage in way of piping, cables, ventilation ducts, etc..

No damage.

(g) Estimate of reduction in watertight subdivision, habitability or utility of spaces.

No reduction in watertight subdivision, habitability or utility.

J. Underwater Hull.

No damage is known to have occurred to any part of the underwater hull, rudder, struts, propeller shafts, or stern tubes stuffing glands except in way of the starboard shell, frames 45 to 48, where the plating is buckled.

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K. Tanks.

No damage.

L. Flooding.

No flooding occurred in this ship.

M. Ventilation (exclusive of blowers).

(a) Damage to ventilation ducts and causes.

Damage to ventilation ducts is severe in the forward and after cargo hatch areas. The most extensive damage occurs on the main deck level, abreast the starboard side of the forward cargo hatch. (photos 2086-5, 2101-1, 2, 4, 1907-7, 2086-7, pages 147, 149, 150, 151, 172 and 185). On the upper deck at frame 55, the starboard ventilator hold down bolts sheared off and the ventilator was blown overboard; the port ventilator, opposite suffered loosening of hold down bolts.

(b) Evidence that the ventilation system conducted heat, blast, fire, or smoke below decks.

None.

(c) Evidence that ventilation ducts allowed progressive flooding.

No flooding occurred.

(d) Constructive criticism.

No comment.

N. Ship Control.

(a) Damage to ship control stations and causes.

Damage to pilot house instruments is slight although the forward face of the pilot house is severely dished by direct exposure

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to air blast (photos 1905-10, 2058-4, pages 65 and 68). There is no damage to equipment in the chart room, although the forward and port bulkheads are damaged (photo 1905-5, page 186). The secondary conning station located on the signal bridge level forward of the after stack suffered severe damage due partly to air blast and partly to the 24-inch searchlight which was blown off the port side of the forward stack, (photo 1904-6, page 52). Gyro repeaters, port and starboard, were blown overboard from the navigating bridge wings and from the signal bridge. The CIC, gyro compass, and interior communications equipment appears to be in satisfactory condition. The steering gear was not affected.

(b) Constructive criticism of ship control systems.

The secondary conning station on the signal bridge level should be provided with a splinter proof shield sufficient to protect instruments and personnel from blast and pressure effects.

O. Fire Control.

(a) Damage of fire control stations and causes.

The fire control station on the signal bridge is nearly 100 percent operable except for possible severance of electrical connections with other control stations. The port 40MM director on the after deckhouse top is inoperable due to severe aftward tilt of the director tub foundations (photos 1961-10, 1906-10, pages 84 and 125).

(b) Constructive criticism of location and arrangement of stations.

The commanding officer states that the forward fire control station on the signal bridge is considered to be in the best available location, particularly from an AA point of view but that the present station could be greatly improved by installation of an inverted, curved shield streamlined with the surrounding structure, for protection to personnel.

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P. Ammunition Behavior.

(a) Ready service ammunition, location, protection, behavior under heat and blast.

No damage occurred to ready service boxes or to ready ammunition. Several 40MM cartridges were knocked out of stowage clips in gun tubs.

(b) Magazines; location, protection, forces involved, behavior.

No damage occurred to ammunition in clipping rooms or magazines. Two test bombs exposed on the upper deck by the forward cargo hatch were blown from their temporary moorings but were otherwise undamaged.

(c) List of stowages which are insufficiently protected and effects on ship survival of explosion of each stowage.

None.

(d) Behavior of gasoline stowage.

No damage occurred.

Q. Ammunition Handling.

(a) Condition and operability of ammunition handling equipment.

The 5-inch ammunition hoists are operable. Passing scuttles are operable in all magazines. No damage is known to have occurred to any ammunition handling device.

(b) Evidence that any ammunition handling device contributed to passing of heat fire, blast, or flooding water.

No evidence was found that devices permitted heat, fire, blast or water to pass.

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(c) Constructive criticism of design and construction of ammunition handling devices.

No comment.

R. Strength.

(a) Permanent hog or sag.

No evidence exists of any hog or sag.

(b) Shear strains in hull plating.

The starboard shell plating is severely wrinkled, frames 45-48, from the upper deck to below the water (photos 1901-8, 9, pages 27 and 28).

(c) Evidence of transverse or racking strains.

Due to the fact that the ship received the air blast on the port side forward, there is possibility that wrinkling of the starboard shell plating is due to compressive stress. It appears, however, that this wrinkling is associated with the reduction in the strength at the forward quarter point due to the damaged decks and longitudinal girders in way of the forward cargo hatch at the upper, main, and first platform deck levels.

(d) Details of local failures in way of structural discontinuities.

In way of the forward cargo hatch, the upper deck is dished 20-inches, starboard, and 16-inches, port. The main deck and first platform in this area are similarly dished, though less severely. The forward cargo hatch longitudinal girders are spread, tilted, and severely deflected. The web columns at the girder ends are severely strained. Similar damage to a lesser degree, occurs in way of the after cargo hatch.

(e) Evidence of panel deflection under blast.

The most outstanding example of panel deflection in

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this ship occurs in damage to bulkhead 59, the forward face of the bridge structure (photos 1960-3, 2102-2, pages 29 and 32). Dishing of weather bulkheads facing forward is severe, but diminishes in magnitude toward the after part of the vessel. Dishing of weather bulkheads facing to port and starboard is general. In some locations it is nearly as severe on the starboard side as on the port. The longitudinal bulkheads in the main deck passageways are dished, more severely on the starboard side than on the port.

(f) Turret, machinery and gun foundations.

Main and auxiliary machinery foundations were undamaged. Gun foundations were undamaged.

S. Miscellaneous.

Paint damage is confined principally to areas facing forward and to port and diminishes in severity from forward to aft and from the topmast down to the waterline. Scorching is more prevalent than blistering (photos 1960-12, 1817-8, pages 187 and 188). The entire port side shows signs of change in the color of the paint. A section of bulkhead was cut from the upper deck bulkhead frame 25, port and sent to Naval Material Laboratory for analysis of paint. The white numerals on the port bow and the yellow frame numbers along the port side are obliterated. A few athwartship surfaces facing aft have scorching about one foot inboard from the port side. General effects of paint scorching are shown in photos 1960-12, 1817-8, pages 187 and 188.

No manila lines, cables, wires, canvas or other equipment is burned. Fire hoses are darkened and frayed. Manila rope appeared dried out and wire rope boat falls appeared to have had all the grease dried out by the heat.

The commanding officer's comments on heat effects to paint is as follows:

Oil based paint appeared to be burned off more than any other. White enamel held up satisfactorily; it was only necessary to wipe off the soot and the painted bow numerals, for which this paint

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was used, were as good as new. Paint with a plain white base used for numerals on frames, was burned off. This was also used on the draft numerals. Anchor black appeared as if the heat had melted some of the tar base.

The yellow chromate was burned off.

Red iron oxide, and ships own mixed red lead held up well when used as paint. The parts of the deck on which these were used lost the top blue gray deck paint from the heat, leaving only the red iron oxide and red lead underneath.

A maximum-minimum thermometer on the upper deck forward registered a temperature of 95°, indicating that the duration of the flash heat was too short to influence this instrument.

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# TECHNICAL INSPECTION REPORT

## SECTION II - MACHINERY

### GENERAL SUMMARY OF MACHINERY DAMAGE

#### I. Target Condition After Test.

##### (a) Drafts after test; list; general areas of flooding, sources.

No data taken by machinery group.

##### (b) Structural damage.

The outer casings of both stacks were badly crushed. The inner casing of the after stack was considerably dished and was torn open on the forward side. Supports, both internal and external, of the after stack failed, leaving the stack in place but in a precarious position. Nos. 2 and 4 (port) Welin davits received severe structural damage.

##### (c) Other damage.

No. 1 boiler casing seams were opened at the top where the boiler casing is welded onto the uptake. Both smoke periscope sight reflecting units were ruptured. The after stack was severely damaged. There was moderate damage to the uptakes. The forward starboard cargo winch was torn loose from its foundation. The port Welin davits (nos. 2 and 4) were severely damaged structurally. The electric controller of No. 3 Welin davit was torn loose from the bulkhead. The starboard side of the firemain loop was opened and three places just below the upper deck. There was a large amount of scattered minor damage to piping, electric drinking fountains, etc..

#### II. Forces Evidenced and Effects Noted.

##### (a) Heat.

Paint on the port side of exposed machinery was badly scorched and blistered.

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(b) Fires and explosions.

No evidence.

(c) Shock.

No evidence.

(d) Pressure.

Blast pressure, and the whipping motion of the ship following the blast, are believed to have caused all of the damage to machinery. The blast came from the port side.

(e) Effects apparently peculiar to the atom bomb.

A blast pressure of this magnitude is apparently peculiar to the atom bomb.

III. Effects of Damage.

(a) Effect on machinery and ship control.

Both boilers could have continued in operation with an estimated reduction in efficiency of 50% forward, 25% aft. #1 boiler was repaired by the ship's force in about 2 hours and is now fully operable. The after stack was seriously weakened and would probably have fallen over if heavy weather had been encountered, in which case maximum load on the after boiler would be reduced to 50% or less of normal. Damage to the firemain considerably lessened the effectiveness of this system. Three of the four Welin davits were made inoperable and two are believed to be beyond repair. This reduces the ability of the vessel to lower boats by 75%.

(b) Effect on gunnery and fire control.

No comment.

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(c) Effect on water-tight integrity and stability.

No comment.

(d) Effect on personnel and habitability.

It is estimated that there would have been few if any, casualties among personnel below decks. Habitability was slightly reduced temporarily by damage to piping and the general disarrangement of the ship.

(e) Total effect on fighting efficiency.

Damage to the Welin davits, reducing the vessel's ability to lower boats, would seriously reduce her efficiency as a transport in certain tactical situations. It is to be noted that if the ship had her normal complement of boats aboard, many of these would have been wrecked. It is estimated that maximum speed was reduced to about 8 knots for 2 hours, and that after temporary repairs to the forward boiler speed could be built up to about 13 knots (16 knots is designed speed). It is estimated that approximately 25 days' work at a shipyard would be required to restore all machinery to normal operating condition.

#### IV. General Summary.

The CRITTENDEN was apparently near the edge of the lethal range of this type of attack for vessels of her type. A slightly greater amount of damage to the boilers and stacks would have immobilized the vessel.

#### V. Preliminary Recommendation.

Stacks should be made more resistant to blast pressure.

Piping, especially main lines, should be so located that it is not likely to be damaged by deflection of decks and bulkheads.

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## DETAILED DESCRIPTION OF MACHINERY DAMAGE

### A. General Description of Machinery Damage.

#### (a) Overall condition.

Boiler number one was damaged but could be repaired by the ship's force within two hours. Both stacks were damaged, the after one severely. However, in an emergency both boilers could have been steamed with some reduction in efficiency. There were three failures in the firemain at flanges, and numerous failures in piping connected to the firemain. The latter are of only local significance. All Welin davits except number one were severely damaged.

#### (b) Areas of major damage.

Major damage was confined to areas where the direct effect of the blast pressure could be felt. Damage below decks was minor except for the firemain on the main deck starboard, and this damage was caused by deflection of the deck overhead by the blast pressure.

#### (c) Primary cause of damage in each area of major damage.

All significant damage was caused by blast pressure. Damage to the firemain was, in most cases, caused by deflection of decks and bulkheads resulting from the blast pressure.

#### (d) Effect of target test on overall operation of machinery plant.

Both boilers could have continued in operation with an estimated reduction in efficiency of 50% in the forward boiler and 25% aft. Boiler number one could have been repaired to restore full operation in approximately two hours. The after stack was seriously weakened and might have fallen over if heavy weather had been encountered. Otherwise, operation of the after boiler could be continued.

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There might have been some personnel casualties in the enginerooms because of blast pressure coming through light engineroom doors. It is estimated that, under war conditions, the ship's force could make temporary repairs to number one boiler in about two hours and to the firemain and after stack within 48 hours. Three of the four Welin davits are inoperable. One of them could be repaired by a tender in about four days, the other two are beyond economical repair.

B. Boilers.

(a) Air Casings.

Boiler #1 - The vertical seams on the starboard forward and starboard after corner of the outer casings were split apart at the upper edge of the casing (where it is welded onto the uptake), the splits being about 4" long and about 1/4" wide at the upper end. The welded seam around the top of the casing, where it joints the uptake, was evidently pulled apart slightly, as a small amount of smoke came through this seam all around the casing when the boiler was first lighted off after the test. As the boiler heated up, this seam closed by expansion of metal and the flow of smoke ceased. The ship's force welded the splits in the casing.

Boiler #2 - No damage to casing.

(b) External Fittings.

Both smoke periscopes failed at the reflection unit where the periscope shaft leaves the boiler casing and is bent through 90° to the vertical. This is an aluminum casting with a threaded boss at each end, a mirror in the middle, and a piece of 1/8" glass plate mounted in the top boss. Blast pressure blew out these bosses. The periscope of #1 boiler had the boss broken all the way around. That of #2 boiler had the boss broken about 1/3 of the way around the periphery. The glass plates were undamaged. At the point of rupture the aluminum is about 1/8" thick.

(c) Fuel Oil Burner Assemblies.

No damage.

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(d) Brickwork and Furnaces.

No damage.

(e) Steam and Water Drums and Headers.

No damage.

(f) Tubes.

No damage.

(g) Foundations.

No damage.

(h) Stacks and Uptakes.

Forward stack and uptakes - The outer stack casing was badly bent and crushed in. (See photo 1878-6; page 47). This does not affect operation. The inner casing is undamaged. The inner and outer casings of the uptakes are braced by staybolts. Near the bottom of the uptake there were a number of holes in the inner casing. These holes appear to have been torn in the casing by the staybolts during vertical relative motion between inner and outer uptake casings. Six holes were found in the starboard side of this casing and three in the after side. These holes are 1/2" to 3/4" in diameter. It is probable that similar holes exist farther up the casing in areas inaccessible for inspection.

After stack and uptakes - The after stack has a tear in the outer casing at bottom of the access door (forward end of stack, reached from superstructure deck) extending about 3 feet around the stack to starboard of the door opening, and about 4 inches to port. (See photos 1878-4, 5; pages 50 and 51.) From this point the outer casing is flattened and pushed in against the inner casing across the entire forward end of the stack almost up to its top. The sides and after end of the outer stack casing are badly crumpled and bent, and there are several small tears. A number of stays and braces inside the outer stack casing are broken, some are bent. (See photo 1878-7; page 53).

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The galley smoke stack is a 12'' brass pipe passing up between the inner and outer casings of the after stack. It was broken apart at the forward side in a horizontal line about six feet above the main deck, the rupture extending about half-way around the pipe. Above this rupture the pipe was flattened for most of its length, the walls of the pipe being now about two inches apart. The steel atmospheric exhaust pipe, outboard of the galley smokepipe and against the outer stack casing, was not damaged.

There is a tear in the inner casing about 18'' long and about 8'' wide at the widest point, with its axis horizontal. This tear is about 3' above the superstructure deck on the forward side of the casing, somewhat to port of the centerline. It was apparently caused by the outer casing and galley smokepipe being pushed against it.

In the uptakes of #2 boiler, five holes similar to those described above for #1 uptake were found. These were all on the starboard side of the uptake and were smaller than those in the forward uptake, the largest being about 1/2'' in diameter. There may be similar holes higher up in the uptakes.

(i) General Notes.

When the crew evacuated the ship at 0340 on 1 July, #1 boiler was left with 450 lbs/sq. in. steam pressure and #2 with 450 lbs/sq. in. hydrostatic pressure. When the crew returned on the morning of 4 July there was no pressure in either boiler. Boiler #2 was full of water with no evidence of leakage.

Boiler #1 was tested hydrostatically after Test A with results similar to those before the test. It was lighted off on 5 July and has been in use since with no defects other than those noted above. Boiler #2 was lighted off and tested under steam (450 lbs/sq. in.) on 11 July. No defects were found other than those noted above.

Results of Hydrostatic tests on #2 Boiler.

Before Test A

Initial Pressure 450 lbs.

Time required for pressure to drop 100 lbs - - - - 4 hours

Time required for pressure to drop to 0 - - - - 10 hours

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## After Test A

Initial Pressure 450 lbs.

Time required for pressure to drop:

150 lbs.	- - - - -	5 minutes
250 lbs.	- - - - -	10 minutes
300 lbs.	- - - - -	15 minutes
325 lbs.	- - - - -	20 minutes
350 lbs.	- - - - -	30 minutes
400 lbs.	- - - - -	19 hours

Repairs had been made on this boiler between tests, such as renewing leaking gaskets. All pressure leaks were through leaking valves.

Test A had no effect on the pressure parts of the boilers on this vessel.

### C. Blowers.

Undamaged. All four blowers have been operated at approximately 1/2 full load since Test A.

### D. Fuel Oil Equipment.

Undamaged. All equipment has been operated under service conditions since Test A.

### E. Boiler Feedwater Equipment.

Undamaged. All equipment has been operated under service conditions since Test A.

### F. Main Propulsion Machinery.

Undamaged. The main turbines have been operated at no load for five hours, and have been used while the ship shifted berth since Test A. They have been operated in both directions.

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G. Reduction Gears.

Not Applicable.

H. Shafting and Bearings.

Undamaged. Shafting and bearings were checked while the ship was underway.

I. Lubrication System.

Undamaged. All equipment has been operated under service conditions since Test A.

J. Condensers and Air Ejectors.

Undamaged. All condensers have been operated under service conditions with a vacuum of 29-1/2" since Test A.

K. Pumps.

Undamaged. All pumps have been operated under service conditions Since Test A.

L. Auxiliary Generators (Turbines and Gears).

Undamaged. All generators have been operated at rated load since Test A.

M. Propellers.

Undamaged. The propellers were checked while the ship was underway.

N. Distilling Plant.

Undamaged. The plant has been operated since Test A with the same capacity and quality of water as before the test.

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O. Refrigeration Plant.

Undamaged. There were numerous freon leaks before Test A. They were not increased by the test.

P. Winches, Windlasses and Capstans.

1. The forward starboard cargo winch was torn loose from its foundation as shown in photograph 1882-9, page 137. All foundation bolts on the right hand side and two on left hand side are missing.

2. It is believed that the damage was caused by the deck being dished in about three feet below normal just aft of this winch. Other than the fact that the foundation is ruined, the winch appears in good condition.

3. There was no other damage to equipment under this heading.

Q. Steering Engine.

1. The wheel on after deck house steering stand was bent aft on the starboard side. Since the wheel was covered by a canvas cover, it is believed that this provided sufficient surface for the blast to inflict the damage. It is believed that had the canvas cover not been provided, no damage would have occurred to the wheel as the spokes are relatively small and offer comparatively little resistance. Similar damage has been observed on other APA's.

2. The steering engine was undamaged. Both units have been operated from all stations since Test A.

R. Elevators, Ammunition Hoists, Etc.

1. Undamaged, except for davits (see below).

2. Both ammunition hoists and the gasoline hoist have been operated under service conditions since Test A.

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3. Davit #2 - The forward and after heads were bent aft. The after trackway is bent and twisted as shown in photograph 1882-7; page 133.

4. Davit #4 - Both heads were torn out of the trackway and broken loose from the strong back which was thrown inboard against the superstructure. Both trackways are twisted and bent. (See photograph 1882-6; page 131).

5. Davit #3 - The electrical controller was torn loose from the bulkhead. This prevents operation of the davit.

6. Davit #1 was undamaged.

S. Ventilation (Machinery).

No damage to machinery. A few vent sets are inoperable because of structural damage.

T. Compressed Air Plant.

Undamaged. The air compressor has been operated under service conditions since Test A.

U. Diesels (Generators and Boats).

No damage. The diesel generator and diesel fire pump have been operated under service conditions since Test A.

V. Piping Systems.

Damage occurred in the piping systems as noted below.

(a) Main Steam.

No damage.

(b) Auxiliary Steam.

No damage.

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(c) Auxiliary Exhaust.

No damage.

(d) Condensate and Feedwater.

No damage.

(e) Fuel.

No damage.

(f) Lub Oil.

No damage.

(g) Firemain, sprinkling and Water Curtain.

1. A flanged connection in the 6" main in #1 hold, frame 40, starboard, parted. The deck to which this section is secured by hangers was pushed down about 18" in this area. The flange is about 4" aft of the forward bulkhead. All bolts except the two at the top were pulled and bent, the two bottom ones were broken. The after flange was bent. The four hangers aft of this flange each had the inboard bolt broken. The fifth flange, about 2 feet forward of the expansion joint in the after bulkhead of the hold (frame 50) was undamaged.

2. A similar failure occurred in #2 hold, frame 118, starboard, at the flange just aft of the forward bulkhead of the hold. This failure was apparently caused by hatch cover panels falling on the flange. In this case the pipe hangers aft of the parted flange were not damaged.

3. In troop compartment C-102-L, main deck, the flange in the 6" main just aft of the bulkhead, frame 140, starboard, failed. Nothing fell on this flange and the deck over it is not appreciably distorted. All except the 2 or 3 top bolts pulled loose. The after flange was pulled away from the forward one about 3/8" at the bottom, and was bent and broken away from the pipe at the weld. This failure appears to have been caused by whipping motion of the vessel after the blast.

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4. At frame 17, main deck, port, a screwed union connection from the fire main to a 1-1/2" riser to the flushing system was broken. This connection was previously badly corroded.

5. At frame 40, port, first platform, the flange of a fireplug riser failed. The bolts pulled loose. The flange was not damaged. This is believed to have been caused by deflection of the bulkhead to which the riser was strapped.

6. A similar failure occurred at frame 56, port, main deck. In this case the deck 4 feet above the flange was defected.

7. There were numerous small leaks in small piping connected to the firemain. In most cases the affected fittings were already badly corroded.

(h) Condenser Circulating Water.

No damage.

(i) Drain.

No damage.

(j) Compressed Air.

No damage.

(k) Hydraulic.

No damage.

(l) Gasoline.

No damage.

(m) Other Systems.

1. All four diesel boat filling valves, in the vicinity of the Welin davits, main deck, failed. At #1 station, frame 84, starboard,

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the 1-1/2 inch screwed nipple broke near the lower end of the threaded portion. At #3 station, frame 104, starboard, the 1-1/2" steel screwed fitting pulled off and the valve was blown over the side. At #2 and #4 stations there were small leaks.

2. Screwed fittings in the diesel oil lines to the galley ranges leaked before Test A. Some increase in these leaks was noted after Test A.

3. There were numerous leaks in hot and cold fresh water piping throughout the ship.

4. The diaphragm of the whistle was apparently ruptured. An attempt to blow it resulted only in blowing out a cloud of water and steam. Piping to the whistle was not damaged.

W. Miscellaneous.

Several electric drinking fountains had their casings torn off and one or two had considerable mechanical damage. Otherwise there was no damage to miscellaneous equipment. Galley, laundry, machine shop and ice cream equipment have been operated under service conditions since Test A.

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# TECHNICAL INSPECTION REPORT

## SECTION III - ELECTRICAL

### GENERAL SUMMARY OF ELECTRICAL DAMAGE

#### I. Target Condition After Test.

##### (a) Drafts after test; list; general areas of flooding, sources.

The drafts and list were not observed. No flooding occurred.

##### (b) Structural damage.

The ship received considerable structural damage as a result of this test. The only damage to the ship's electrical equipment due to this structural damage was a few cables cut when the bulkheads on which they were mounted gave way. Special electrical test equipment was damaged by falling hatch covers.

##### (c) Other damage.

Principal electrical damage consisted of the following:

1. Both 24 inch searchlights and one 12 inch searchlight were demolished.
2. Approximately six lighting and fire alarm circuit cables for both cargo holds were ruptured.
3. Two gyro compass repeaters were missing and another repeater was knocked from its stand.
4. The port 3 MC bull horn was missing.
5. The anemometer cups were blown off.

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6. One boat davit controller was knocked off the bulkhead.
7. A few lamps were broken.
8. A few sound powered telephones were rendered inoperable.
9. Special Bureau of Ships, (Code 660), test material in the forward cargo hold was damaged by falling hatch covers.

## II. Forces Evidenced and Effects Noted.

### (a) Heat.

Radiant heat from the port bow scorched paint on exposed electrical equipment and cables. This heat was not of sufficient duration to render any electrical equipment inoperable.

### (b) Fires and explosions.

There was no evidence of fires or explosions.

### (c) Shock.

There was evidence that the vessel received considerable shock since some lamps, steamtight globes and fire alarm thermostats were broken.

### (d) Pressure.

This vessel was subjected to high pressures (air blast). This is evidenced by the searchlights, davit controller, and bull horn being blown from their mountings and by light metal bulkheads being carried away. Most of the electrical damage was a result of the air blast.

### (e) Any effects apparently peculiar to the atom bomb.

The loss of residual magnetism of #1 Ship Service generator may have been due to an atomic bomb effect.

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### III. Effects of Damage.

#### (a) Effect on propulsion and ship control.

Electrically, the damage which occurred as a result of the test had slight effect on the operation of the ship's electrical plant. All propulsion and boiler auxiliaries were operable. Had the #1 AC ship's service generator been operating at the time of the bomb explosion, it would not have lost its residual magnetism. Since the generator could be easily repaired by the ship's force and since there is a standby generator, the temporary loss of this generator would not affect the operation of the vessel. The most serious effect on the electric plant was the loss of both 24-inch searchlights which were damaged beyond repair. The loss of a few sound powered telephones the port 6 MC bull horn, the 12" signal searchlight, and the lighting cables would slightly impair the operation of the ship. The ship could be operated almost indefinitely without these items at only slightly reduced efficiency. Temporary lights could have been rigged by the ship's force to replace those lost.

Secondary ship's control was practically demolished. This control station is seldom used except when the primary control station is inoperable. The ship could therefore, continue to operate, controlled by the normal ship's control station.

#### (b) Effect on gunnery and fire control.

The only damage to gunnery and fire control equipment was to that equipment secured to the masts. This consists of radar equipment which is covered by the electronics report.

#### (c) Effect on watertight integrity and stability.

Watertight integrity was not affected by damage to electrical equipment. No electrical equipment shifted sufficiently to affect stability.

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(a) Effect on personnel and habitability.

The personnel on this vessel might have been affected by radioactivity, however, the extent of these effects is unknown. Disregarding radioactivity, it is considered that all exposed topside personnel would have been casualties due to the flash and air blast. There would also have been casualties around the cargo holds due to structure distortion and due to falling hatch covers. From an electrical standpoint, casualties might have resulted from electrical equipment such as the searchlights and the bull horn becoming missiles.

Electrically, the only effect on habitability was the slight inconvenience due to the lighting failures.

(e) Total effect on fighting efficiency.

Due to personnel casualties and due to the damage to the vessel, its fighting efficiency was greatly reduced. Electrically, the effects were slight. Disembarkation would have been hampered by the loss of the davit controller, however, this damage could have been repaired by the ship's force in a few hours. Night cargo handling operations would have been hampered by the loss of the cargo lights. It is considered that the ship could operate electrically at approximately 90% efficiency.

IV. General Summary of Observers' Impressions and Conclusions.

This vessel received the most damage of any of the transports that survived the first atomic bomb test. Although the ship's hull received considerable damage there was very little electrical damage. Part of the electrical damage that occurred was due to the failure of associated hull equipment.

V. Any Preliminary General or Specific Recommendations of the Inspecting Group.

(a) It is recommended that consideration be given to the redesign of the 24" searchlights to give them more resistance to air

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blast. This is considered necessary to give them comparable strength to other electrical equipment.

(b) It is recommended that the gimbal and binnacle pins on gyro compass repeaters be lengthened to prevent the repeaters from being freed from their mounting stands.

(c) It is recommended that consideration be given to mounting equipment such as controllers on some sort of mounting pads or straps so that some bulkhead distortion can occur without damage to the equipment.

(d) It is recommended that where possible, cable be run along beams instead of along light metal joiner bulkheads. It is considered that most of the damage to cables that occurred on this vessel could have been avoided if more consideration had been given to the routing of the cable.

(e) It is recommended that some means of pinning the 12" signal searchlights in their sockets be devised to prevent them from being jarred or blown from their sockets.

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## DETAILED DESCRIPTION OF ELECTRICAL DAMAGE

### A. General Description of Electrical Damage.

#### (a) Overall condition.

Damage to electrical equipment as follows resulted from the test:

1. Approximately six lighting cables were cut by distorted or blown-out bulkheads. Fire alarm cables in both forward and after holds were ruptured.
2. A few lamps were broken.
3. Two 24" searchlights and one 12" searchlight were demolished.
4. Two gyro compass repeaters were missing and one repeater was knocked from its stand.
5. A few sound powered telephones were inoperative.
6. The port 6 MC bull horn was missing.
7. Anemometer cups were blown off.
8. One boat davit controller was knocked off the bulkhead.
9. Special Bureau of Ships, (Code 660), test material in the forward hold was damaged by falling hatch covers.

#### (b) Areas of major damage.

The areas of major damage were exposed locations topside and in and around the #1 and #2 cargo holds.

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(c) Primary causes of damage in each area of major damage.

The primary cause of damage to this vessel was air blast. The secondary cause was missiles (such as the searchlights and hatch covers). There was also slight damage due to radiant heat and due to shock.

(d) Effect of target test on overall operation of electric plant.

1. The exciter for the #1 AC ship's service generator lost its residual magnetism and had to be flashed with a 24 volt battery before it would build up again. All other ship's service equipment was undamaged and operable so there was very little effect on the overall operation of the electric plant. The ship's force was able to readily repair the damage.

2. All electrical engine and boiler auxiliaries were operable after the test.

3. All electrical propulsion equipment was operable after the test.

4. All communications equipment was operable except for the port bull horn, one 12" signal searchlight, both 24" searchlights, and a few sound powered telephones.

5. Only damage to fire control equipment was to that equipment secured to the masts. This damage was to radar equipment which is covered by the Section IV - Electronics of this report.

6. There was no electrical damage which rendered ventilation equipment inoperative. One ventilation set was rendered inoperative due to mechanical damage to the motor mounting support base.

7. The 24" searchlights were damaged beyond repair. All cargo flood lights were demolished. One 12" signal searchlight was blown over the side. Another had its bulb broken but was operable when the bulb was replaced. Some lighting circuits were damaged but it is considered that the ship's force could have jury rigged sufficient lights for temporary service without serious difficulty.

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(e) Types of equipment most affected.

Searchlights and cable were the types of equipment most affected.

B. Electric Propulsion Rotating Equipment.

There was no damage to electric propulsion rotating equipment reported. All equipment operated satisfactorily after the test.

C. Electric Propulsion Control Equipment.

There was no damage reported to electric propulsion control equipment. All equipment operated satisfactorily after the test.

D. Generators - Ships Service.

(a) The 5.5 KW, 120 V. DC, Westinghouse Electric Corporation exciter for the ship's service turbo-generator set located in the #1 engine room lost its residual magnetism so that voltage would not build up when the set was started up after the test. It was necessary to flash the generator field with a 24 volt battery before the exciter would build up voltage. After the field was flashed, the set operated satisfactorily.

Comments.

The reason for this casualty is not known, it being the only casualty of this type reported on all the vessels in the test. The other two identical sets on this vessel were unaffected. There is the possibility that this casualty was a result of shock. It is considered that the casualty would not have occurred if the set had been operating at the time of the blast.

(b) The special Code 660 - 400 KW 450V AC turbo-generator set, item 12E1, installed in the forward hold was hit by falling hatch covers, see photograph 1901-4; page 189. These hatch covers are

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estimated to weigh approximately 2000 pounds each. They bent the generator frame and knocked the end bell off the exciter. See photographs 1949-6 and 12; pages 190 and 191. The set did not appear to have moved on its base and does not appear to have suffered damage from any source other than from the falling debris.

(c) The special code 660 - 60 KW, 450 VAC Diesel generator set Item 12E3, installed in the forward hold was hit by falling hatch covers. The generator frame was broken on the engine end of the set. See photograph 1901-1; page 196, showing debris on generator and cracked frame. The generator control panel which was mounted on the generator frame was knocked off and completely demolished. See photograph 1949-11; page 199, showing remains of the generator control panel. Photographs 1949-3, 4; pages 197 and 198, show the set after the debris has been cleared away.

(d) The special Code 660 - 300 KW, 120/240 VDC, Diesel generator Item 12E2, installed in the forward cargo hold was hit by falling hatch covers. See photograph 1901-3; page 192. The diesel manifold was knocked off and the generator brush cover plate was crushed down against the brush rigging. See photographs 1948-11, 1949-1; pages 193, and 194.

#### Comments And Recommendations.

The damage to the generator sets due to the falling hatch covers cannot be considered to be representative of what happens to generator sets during the explosion of atomic bombs since generator sets are not normally installed in cargo holds. The sets were installed for the purpose of determining how these sets of modern Navy design would compare with the normal ships generator sets. The difference in conditions caused by the loose cargo hatch covers was not foreseen. Although this test gave very little information as to how these special sets stand up to the direct effects of the bomb blast, it emphasizes strongly the fact that much damage may be caused to equipment by loose gear becoming missiles. It is recommended that consideration be given to more adequate stowage of loose gear particularly spare parts.

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E. Generators - Emergency.

No damage was reported to the emergency generator. This generator was running at the time of the explosion and continued to run until the set was out of fuel.

F. Switchboards, Distribution and Transfer Panels.

No damage was reported to any switchboards or to any distribution or transfer panels normally installed on the vessel.

The special Bureau of Ships, Code 860, CV9 class control bench board, Item 12E5, located in the forward cargo hold was hit by falling hatch covers. See photograph 1949-10; page 195, showing dent in the panel. All of the equipment on the board appeared to still be in good operating condition. The voltage regulator and instrument missing in the photograph were missing before the test.

G. Wiring, Wiring Equipment and Wireways.

(a) Cable.

1. Six cables were severed when the bulkhead gave way at frame 109 on the main deck, stbd. side. These cables supplied lighting and fire alarm circuits in the after cargo hold.

2. Lighting cable frame 116 on the main deck, stbd side was severed by a missile when the hatch cover was carried away by the blast.

3. Director shield in breaking loose at frame 25 on the 02 level stbd side cut one sound powered and one call bell cable.

4. Radiant heat burned the paint off 60% of all cables on the foremast and mainmast. The armor and insulation on these cables appear very slightly affected.

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(b) Wiring equipment.

1. One 10 amp S and R box located at frame 116 on the main deck, stbd side was damaged when hit by a missile. The cover was bent and screws sheared.

2. One deck riser in the navigation bridge was broken by impact from the forward bulkhead which was dished in by the blast. No damage resulted to the cable.

H. Transformers.

There was no damage reported to transformers installed on this vessel.

I. Submarine Propelling Batteries.

Not Applicable.

J. Portable Batteries.

There was no damage reported to portable batteries installed on this vessel.

K. Motors, Motor Generator Sets and Motor Controllers.

(a) The motor for the propeller type fan located at frame 58, port side, main deck was not operable since the mounting support for the motor was so twisted that the set was out of line. There was no apparent damage to the motor, however, there is the possibility that the shaft or frame was sprung due to the twisted mounting.

(b) The motor for the Welin davit located on the 01 deck at frame 105 port side had the paint burned due to the radiant heat of the blast. The motor appeared to be otherwise undamaged, however, it was not tested since the davit was smashed. See photograph 1882-6; page 101, showing mechanical damage to davit.

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(c) The special Code 660 - 75 KW, 450 V AC, 230 V DC motor-generator set, Item 12E4, located in the forward cargo hold was hit by falling hatch covers. See photographs 1901-2; page 200, showing the set covered with debris. The commutator was scored and knocked out of true. The shaft appeared to be bent. See photograph 1949-7; page 201, showing the set after the debris had been removed.

(d) A Westinghouse Electric Corporation Size 1, 2 speed two winding class HI shockproof ventilation fan motor controller located in the O3 deck passageway at frame 93 port has its enclosure slightly bent due to the distortion of the bulkhead. The controller operated satisfactorily after the test.

(e) The enclosure door of the anchor windlass controller was dished due to the blast. This damage was insufficient to affect the operation of the controller.

(f) The General Electric Company Type Cr 5431-D31Y Welin davit controller located on the main deck at frame 105, starboard side, was knocked off the bulkhead by the blast. The four 1/2 inch mounting bolts were broken in tension. One arc chute was broken. This arc chute damage can probably be attributed to the impact of the controller striking the deck. The power and control leads to the controller were pulled in two. The controller appeared operable if the cables were reconnected and the arc chute replaced.

#### Recommendations.

The controller was mounted solidly on the bulkhead. The bulkhead appeared to be slightly dished. It is considered that control equipment should not be mounted solidly on the bulkhead but should be mounted on straps or on built-up pads so that some distortion of the bulkhead can occur without damage to the controller. In connection with the breaking of the arc chute, this is a commercial low shock controller. It is considered that Navy HI shockproof contactors would not have been damaged by the fall.

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(g) The Cutler-Hammer, Bulletin 6968ED21, size 1, 2 speed Two winding ventilating fan controller located in the crews quarters, port side of the #1 cargo hold had its case distorted due to being hit by a water curtain valve reach rod. Although the case was distorted the controller still operated satisfactorily.

(h) The controllers for the two port Welin davits had their enclosure doors dished inward due to the blast. The controllers appeared operable, however, they were not tested, due to the failure of the mechanical portion of the davit.

#### L. Lighting Equipment.

(a) Missiles from the forward and after cargo hatch covers in carrying away and shock being transmitted from the deck above caused considerable damage to the lamps, reflectors and fixtures in the compartments below. Approximately seven 12 inch reflectors were broken.

(b) Approximately 50% of all running and anchor lights were broken or carried away by the air blast.

(c) All four of the cargo handling lights were demolished by the air blast - two at frame 127 one port and one starboard and two at frame 59 one port and one starboard.

(d) In addition to the above the following rough service lamps were broken - One in the CIC room frame 63; 03 deck - one in the Captain's pantry frame 62; 02 deck - one in the radio direction finder room frame 80; 04 deck - others probably were broken but were replaced prior to this inspection.

#### M. Searchlights.

(a) The 12" signalling searchlight located on the port signal bridge was lifted out of its mounting socket and was missing. Socket appeared to be undamaged.

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## Recommendations.

It is recommended that these searchlights be pinned in their sockets to prevent their becoming missiles. It was noted that some of these 12" searchlights had provision for being held in place, however, the holding nut had been removed and lost in all cases noted. Since these lights are frequently moved from one location to another, a method to prevent careless loss of the holding down device should be provided.

(b) The 12" signalling searchlight located aft of the aft stack at frame 103 had the strap to which the socket was welded bent so that the light had a list of approximately 20°. The incandescent bulb was broken. The searchlight operated satisfactorily after the bulb was replaced.

(c) The port General Electric Company 24" searchlight, Navy model 93013, was carried away by the blast and landed in the Secondary Control Station on the deck below. Ref. photograph 1904-6 page 52 . The bolts holding the searchlight yoke to the flange were sheared. Ref. photograph 1876-6; page 47 , showing distortion of the searchlight mounting platform.

(d) The starboard 24" searchlight, Navy Model 93013, was smashed against the railing. See photographs, 1904-5, 1901-5 and 1922-5; pages 46 , 54 , and 55 . The glass was broken and the searchlight interior was gutted. The reflector was on the deck below approximately 50 feet forward of the searchlight and in the direction from which the blast came. The bolts holding the flange to the yoke were broken.

## N. Degaussing Equipment.

The binnacle for the magnetic compass at the secondary control station carried away due to the blast or due to being struck by the falling searchlight. (See Item M). See photograph 1904-6, page 52 . The cable to the degaussing compensating coils and control box parted. The coils and control box appeared to be undamaged.

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O. Gyro Compass Equipment.

(a) Both the port and starboard pelorus on the navigation bridge were damaged. The repeaters and gimbal rings were missing and the binnacle stands were bent. It is considered that the air blast dislodged the repeaters and the stands were bent when struck by the bridge shield which was distorted by the air blast. Hull photograph 1903-5; page 35, shows the starboard stand and 1903-6; page 36, shows the port stand.

(b) Hull photographs 1904-6, 8; pages 52 and 49, show the secondary control station on the 04 level and the damage to the pelorus located there. The repeater dial window was cracked, the repeater was free of the gimbal ring, the gimbal ring was loose from the binnacle and the binnacle was torn from its column. There were numerous cases on ships in this test where the repeaters and gimbal rings were dislodged by the air blast due to temporary distortion of the gimbal ring and loosened binnacle pins which are of the non-locking type, but this is the only case where the binnacle yoke was torn from the column and it is believed that this is due to the fact that only one of the six studs was in place. This stud had pulled through the flange on the stand.

(c) The glass was broken on the Dead Reckoning Tracer located in the Chart house at frame 64, centerline, on the 03 level.

Recommendation.

It is believed a great deal of the damage to the pelorus repeaters could be eliminated by lengthening the gimbal pins which hold the repeater and by the use of threaded binnacle pins with lock nuts.

P. Sound Powered Telephones.

(a) One RCA Type MI-2045-E head set was left exposed, at frame 25 on the 02 deck, starboard side. It was scorched by the radiant heat, the diaphragms were distorted by the air blast and the transmitter mouth piece was broken from impact with a director shield.

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(b) One RCA Type MI-2040-A hand set located in a cabinet without a cover at frame 25, 01 deck on the port side was scorched by the radiant heat, the transmitter and receiver diaphragms were distorted and the handset bracket was bent by the air blast. Had the cover been on the cabinet, this damage would not have occurred.

(c) Telephone Jack Box at frame 59, centerline, on the 04 level, had its paint badly burned by the radiant heat. Other jack boxes in exposed locations were scorched to a lesser degree.

(d) One hand set cabinet RCA Type MI-2025 located at frame 128 01 deck on the port side was bent by the air blast and the hand set inside was rendered inoperable due to distortion of the receiver diaphragm. The operability of this hand set prior to the test is not definitely known. See Hull photograph 1906-10; page 125 .

Q. Ship's Service Telephones.

Not Applicable.

R. Announcing Systems.

(a) The tripod mounted reproducer for the PAB system was damaged in falling and from being hit by a missile. One speaker magnet and diaphragm assembly were destroyed due to the missile. Examination of another speaker showed the voice coil and diaphragm undamaged although mounted exposed at frame 59, centerline, on the 04 level pointing directly into the blast. Minor changes in the reproducer wiring would allow operation at reduced output.

(b) The port 6 MC bull horn mounted on the port wing of the signal bridge at frame 61, 04 level was blown over the side by the blast, examination disclosed failure of the foundation welds. The foundation welds were also cracked on the starboard bull horn. Hull photographs, 1903-4 and 1959-9; pages 34 , and 135 , shows the starboard bull horn and the method used in mounting which was also used on the port. The starboard bull horn was tested and found operable.

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(c) Two IMC reproducers were struck by missiles bending their horns, one located at frame 64 on the starboard side of the 03 deck and one located on the centerline frame 59, 03 level. Both reproducers were tested and found still operable. Hull photographs, 1903-8 and 4; pages 37, and 34, show the reproducer at frame 59 and indicate the pressure it withstood without damage to its diaphragm.

(d) The intercommunication unit suspended from the overhead in the chart house frame 64, on the 03 deck, was found hanging by one of its four mounting brackets. The welds failed on the other three. The unit is still operable.

#### S. Telegraphs.

There was no damage to telegraphs reported on this vessel.

#### T. Indicating Systems.

(a) The anemometer cups were carried away by the air blast.

(b) The following "Pilot Marine Corporation Mod. SRIRA1" rudder angle indicators were damaged:

1. One located at the secondary control station had its dial window and dial broken. Its base was distorted and two of the foundation bolts were sheared when the indicator was hit by a missile. See photographs 1904-6, 8; pages 52, and 49.

2. One located on the bridge, frame 59, centerline, on the 03 level had its dial window cracked by the air blast.

3. One located at the after steering station, frame 140, centerline, 02 level, also had its dial window cracked by the air blast.

(c) The fire alarm circuit for the after cargo hold was rendered inoperable due to the supply cable being severed when a bulk-head gave way at frame 109 on the starboard side of the main deck.

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The fire alarm circuit for the forward cargo hold was disabled due to one thermostat fixture completely carrying away leaving the cable dead ended and due to another thermostat breaking.

U. I.C. and A.C.O. Switchboards.

There was no damage reported to I.C. and A.C.O. switchboards.

V. F.C. Switchboards.

There was no damage reported to F.C. Switchboards.

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APPENDIX

SHIP DAMAGE DIAGRAM

TEST ABLE

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USS CF IT TENDEN (APA77)

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SC 4 RADAR SCREEN FELL TO TOP  
OF AFTER DECK HOUSE

SC 4  
ANT

PORT 24° S  
STBD. SEA

ALL DAVITS OUT OF GEAR  
THE FORWARD STBD. DAM

STACK INNER CASING TORN

DECK TORN AT CONNECTION  
TO STACK.

DIRECTOR TUB FOUNDATION PULLED FROM  
CONNECTION TO HOUSE TOP AND TILTED AFT.

HAWSER REEL TILTED

DECK DISHED 6" STBD. IN  
WAY OF CARGO HATCH.

DECK DISHED 1 5/8" STBD. FRS. 150-155

DECK DISHED 1/2" AT 6

CARPENTER SHOP DOORS  
BLOWN OFF, PORT.

PORT CARGO BOOM BENT

STAFF BENT

BULKHEAD DISHED 1"

STANCHIONS BUCKLED

DECK DISHED SLIGHTLY

BHD. 154 DISHED 6"

MAIN DECK DISHED 1" STBD.  
THREE PONTOON TYPE HATCH  
COVERS THROWN INTO HOLD.

COLUMNS STRAINED

STBD. PASSAGEWAY BHD  
FRS. 100-110 & 115-122  
(DAMAGE MUCH LESS)

DRAFT AFT 17'-6" BEFORE  
& AFTER TEST A

170 165 160 155 150 145 140 135 130 125 120 115 110 105 100 95

A.P.

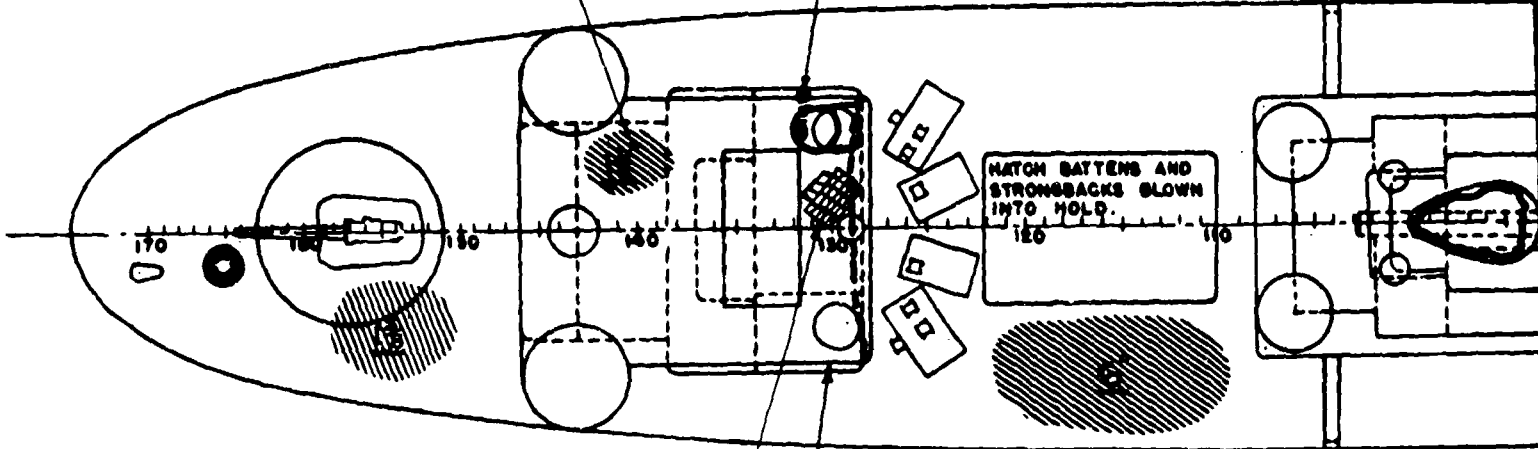
HOUSE TOP BUCKLED DOWN 6" FROM PRESSURE  
EXERTED BY DIRECTOR TUB FOUNDATION.

HOUSE TOP DISHED 1 1/2"

HATCH BATTENS AND  
STRONGBACKS BLOWN  
INTO HOLD.

SC 4 RADAR SCREEN

LIFE RAFT SUPPORTS CARRIED AWAY.  
(ONLY 6 RAFTS OUT OF 45 REMAINED  
ON BOARD OR UNDAAGED)



SC 4 RADAR SCREEN FELL TO TOP  
OF AFTER DECK HOUSE

SIGN  
ANT

PORT 24° S  
STBD. SEA

ALL DAVITS OUT OF COME  
THE FORWARD STBD. DAV

STACK INNER CASING TORN

DECK TORN AT CONNECTION  
TO STACK.

DIRECTOR TUB FOUNDATION PULLED FROM  
CONNECTION TO HOUSE TOP AND TILTED AFT.

HAWSER REEL TILTED

DECK DISHED 6" STBD. IN  
WAY OF CARGO MATCH.

PORT CARGO BOOM BENT

BULKHEAD DISHED 1"

STANCHIONS BUCKLED

SHD. 22 DISH

CARPENTER SHOP DOORS  
BLOWN OFF, PORT.

DECK DISHED 1 5/8" STBD. FRG. 180-188

DECK DISHED 1/2" AT 6

STAFF BENT

DECK DISHED SLIGHTLY

SHD. 184 DISHED 6"

MAIN DECK DISHED 1" STBD.  
THREE PONTOON TYPE MATCH  
COVERS THROWN INTO HOLD.

COLUMNS STRAINED

STBD. PASSAGEWAY SHD  
FRG. 100-110 & 116-122  
(DAMAGE MUCH LESS)

DRAFT AFT 17'-6" BEFORE  
& AFTER TEST A

A.P.

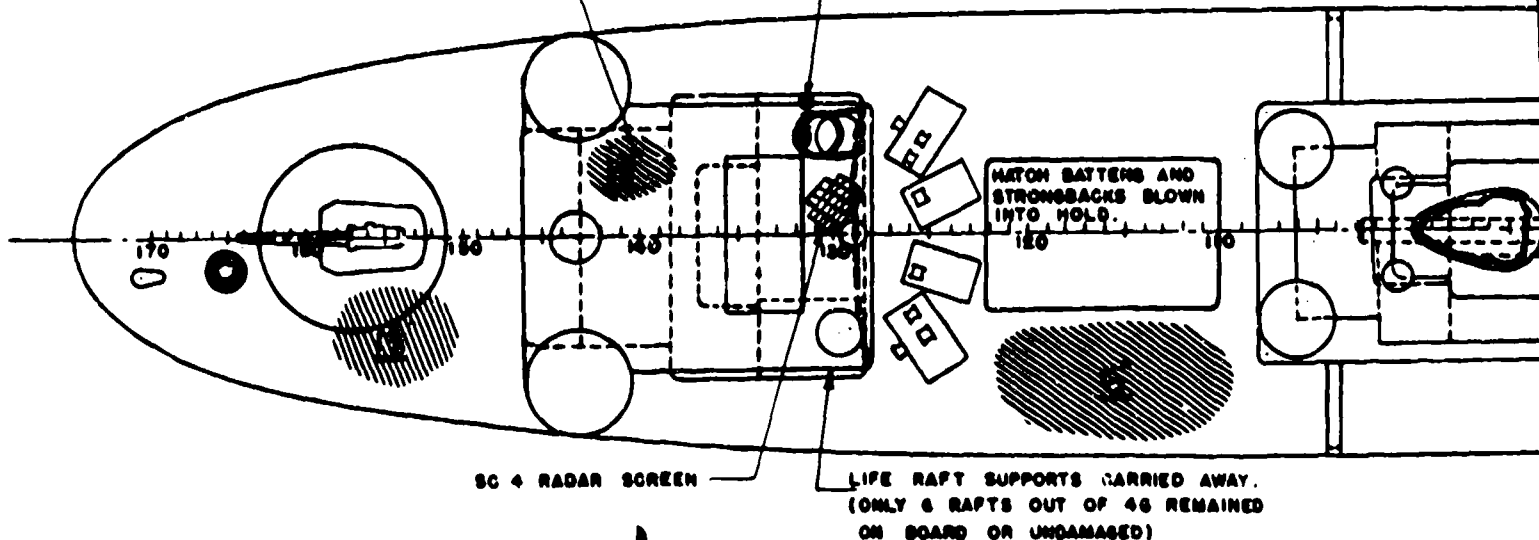
HOUSE TOP BUCKLED DOWN 6" FROM PRESSURE  
EXERTED BY DIRECTOR TUB FOUNDATION.

HOUSE TOP DISHED 1 1/2"

MATCH BATTERS AND  
STRONGBACKS BLOWN  
INTO HOLD.

SC 4 RADAR SCREEN

LIFE RAFT SUPPORTS CARRIED AWAY.  
(ONLY 6 RAFTS OUT OF 48 REMAINED  
ON BOARD OR UNDAMAGED)



SIGNAL MAST BENT, YARD ARMS DAMAGED,  
ANTENNAE AND MASTYARDS DOWN.

PORT 24" SEARCHLIGHT BLOWN OFF AND  
STBD. SEARCHLIGHT DEMOLISHED.

ALL DAVITS OUT OF COMMISSION EXCEPT  
THE FORWARD STBD. DAVITS.

HINGE TORN

SECTION

MASTER COMPASS  
PEDESTAL BROKEN OFF

BHD. 28 DISHED

W.R. DOORS BLOWN OFF,  
STBD.

ENTIRE FORWARD FACE OF BRIDGE  
STRUCTURE DISHED, BULKHEADS TORN,  
BRIDGE WINGS LIFTED, DECKS AND  
STRUCTURAL BHDS. BUCKLED,  
FURNITURE AND JOINER BHDS  
DEMOLISHED. (MOST SEVERE DAMAGE  
IN BRIDGE STRUCTURE OCCURRED  
FRS. 60-64, P. & S.)

RADAR EQUIPMENT DAMAGE

FORE TOPMAST AND BOTH

AMMUNITION MATCH COVER

MATCH COAMINGS TILTED

DECK DISHED 20" STBD.

DECK DISHED 8", P. & S.

DIRECTOR TUB DIS  
AND LIFE RAFTS

MAIN DECK DISHED 6" STBD.

1ST. PLATF. DISHED 3" P. & S.

STBD. PASSAGEWAY BHD. SEVERELY DISHED  
FRS. 100-110 & 116-122 AND DOORS DAMAGED.  
(DAMAGE MUCH LESS SEVERE IN PORT PASSAGEWAY)

MAGAZINE

STBD. SHELL BUCKLED,  
FRS. 45-46

COLUMNS AND BRACKETS SEVERELY  
STRAINED AND WESS BUCKLED AT  
BHD. 40 & 56.

MATCH COVER FROM UPPER DECK  
LANDED HERE.

MATCH GIRDERS DISTORTED. ALL  
TYPE MATCH COVERS AT MAIN DECK  
FIRST PLATFORM THROWN INTO M

PRESSURE  
ATION.

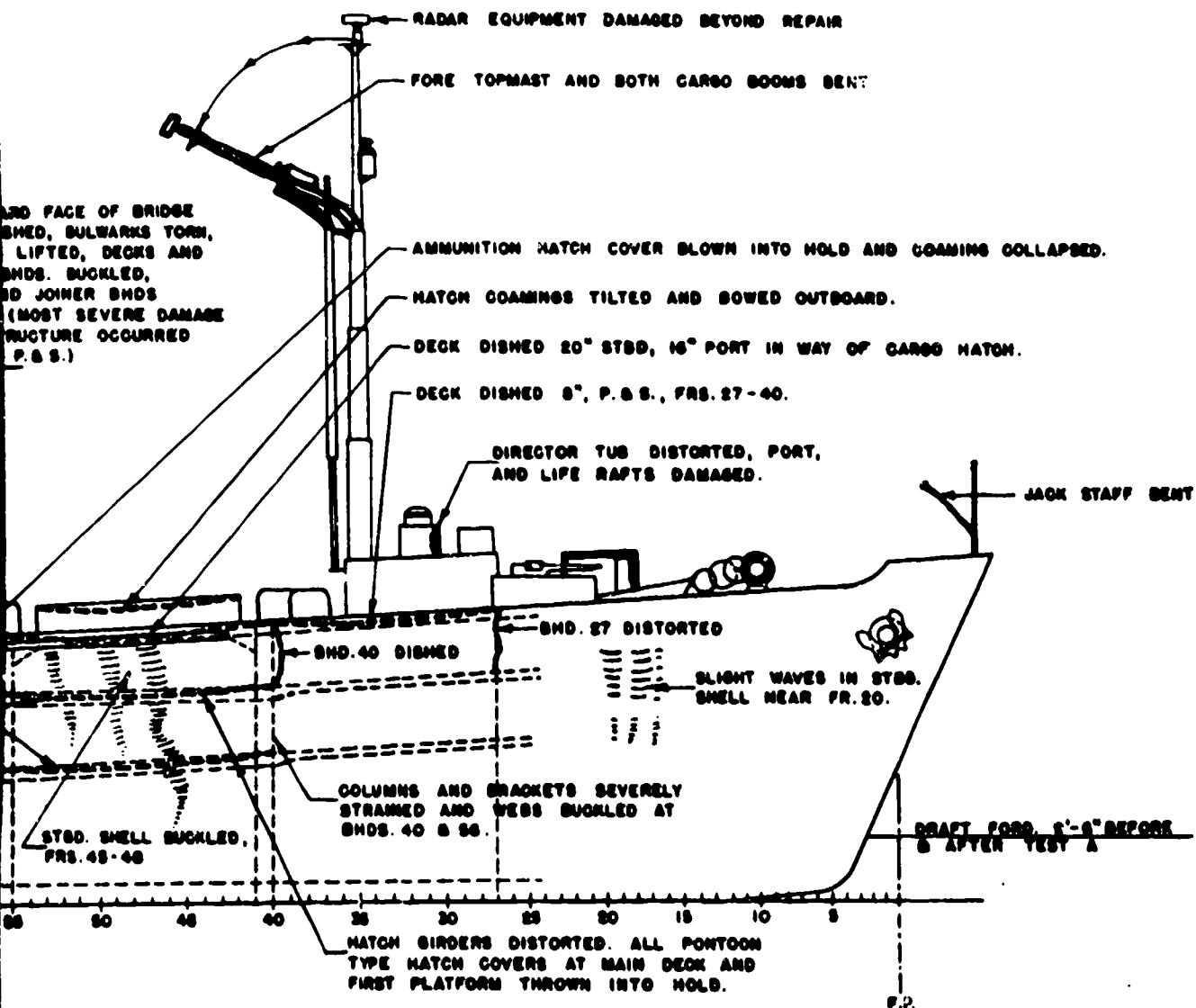
COAMINGS DISTORTED

MATCH BATTENS AND  
STRONGBACKS BLOWN  
INTO HOLD.

VENTILATOR BLOWN OVERBOARD

WING HOLD-DOWN BOLTS FAILED

2

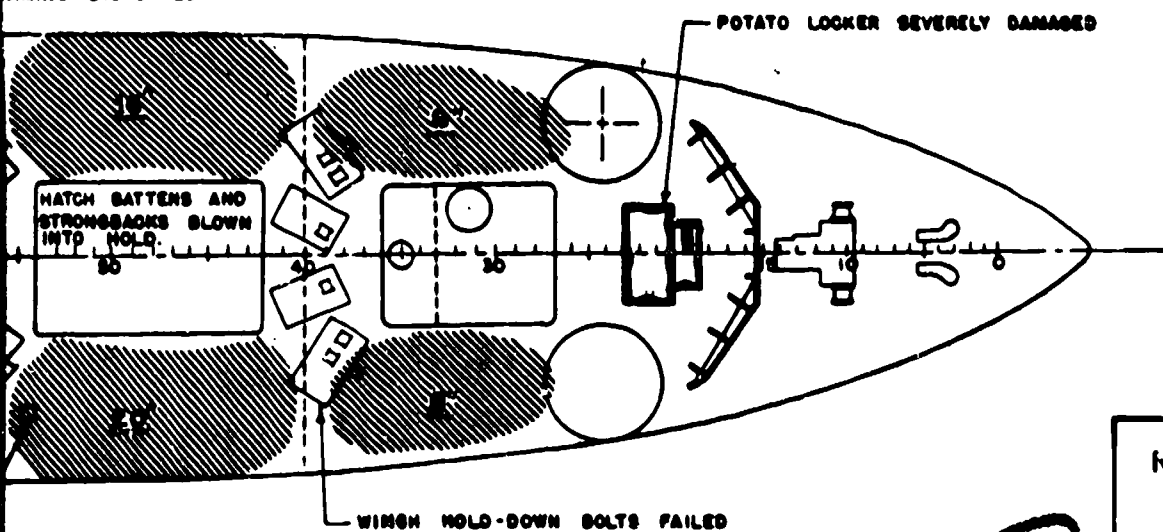


# LEGEND



DECK DEFLECTION

AMING DISTORTED



SECRET

NAVY DEPT. BUREAU OF SHIPS

DAMAGE  
TEST A

U.S.S. CRITTENDEN

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25W

3

APPENDIX

SHIP MEASUREMENT DATA

TEST ABLE

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USS CRITTENDEN (APA77)

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APPENDIX  
SHIP MEASUREMENT DATA

A. General Considerations.

A deck survey method was developed to determine the twist and longitudinal bending of each target vessel's hull girder resulting from an air or underwater burst of the atomic bomb. The procedure is as follows:

1. Select transverse sections. The maximum number of transverse sections used on any ship was six.
2. At each transverse section, select stations at which rod readings are to be taken. Center punch these stations in the deck. A minimum of five stations were used at each transverse section.
3. Establish throughout the length of the ship, by use of a surveyor's transit, a reference plane approximately parallel to the deck.
4. Take rod readings at every station on each transverse section.
5. Plot rod readings relative to a straight line representing the reference plane.
  - (a) Readings at each transverse section are plotted in order to obtain the configuration of individual sections and also to establish the relationship between sections.
  - (b) Readings at desired distances from the centerline are plotted in order to establish sheer lines. On most ships the actual readings are corrected for changes in sections resulting from local damage.
6. Repeat steps 3, 4 and 5 after the test using the stations established in steps 1 and 2.

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7. Superimpose the after test plots on the before test plots in order to compare the conditions existing at the times of the two surveys.

The reference planes used in the before test and after test surveys are not necessarily parallel. Their relationship can not be accurately determined because bench marks established before the test may be affected by local damage or by changes in hull alignment. Therefore it is possible only to determine relative movement of any one section. The reference planes are disregarded after completion of the initial plots.

Twist of the hull girder is determined by superimposing one after test transverse section on the similar before test section and comparing and configurations of the remaining sections. Hog and sag is determined by superimposing before and after test plots of sheer.

The camber curves indicated in all plots are faired lines and do not show local deformation which may exist between the five station points.

B. Measurements.

1. The before test survey of the upper deck of the USS CRITTENDEN was conducted at Pearl Harbor Navy Yard on March 16, 1946, and the after test survey was conducted at Bikini Atoll on July 11, 1946. Both surveys were conducted as outlined in paragraph "A". Superimposing the plots of the two surveys indicated no change in the ships girder.

2. Local deformation of the upper deck and main decks occurred in way of the forward cargo hatch and in way of the after hatch at the main deck level. These deformations were recorded and shown on pages 87 through 90. Although the coaming around the forward cargo hatch moved downward a maximum of 6-inches it remained a boundary for the dishing of the deck plating between the coaming and the port and starboard deck edges, see page 88. The port and starboard deck edges remained unchanged. As shown

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on pages 88 , and 89 , the upper deck also dished, a maximum of 10-inches, between frames 30 and 40. It is evident that the dishing of the upper deck would have been continuous had not the rigidity of transverse bulkhead 40 below divided this area. The superstructure bulkhead at frame 59 formed the aft boundary for the upper deck dishing around the forward cargo hatch.

2. The main deck between frames 40 and 56, compartment A-104-L, was dished a maximum of 26-inches. This is a greater deflection than recorded on the upper deck, maximum of 22-inches. As shown on page 90 , the starboard side of the main deck was dished considerably more than the port side. This difference is accounted for by the two longitudinal bulkheads, forming the passage A-104-LT, retarding the blast, the starboard side was open to the blast.

3. Dishing of the main deck aft between frames 108 and 124, compartment B-102-L was not as serious as that recorded in way of the forward cargo hatch. A maximum of 8-3/8" deflection was recorded at the starboard side coaming of the cargo hatch near frame 116, page 87 . The position of the main dishing is located similar to the dishing recorded in the forward compartment to starboard.

#### C. Deck Deflection Scratch Gages.

Six gages were installed to record movement of the upper deck. Locations and readings of these gages are tabulated on page 91 .

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USS CRITTENDEN (APA77)

**FRAME SPACING 2'-6"**

LONG'L. BHD.

NO.2 CARGO HATCH  
30'-0" X 18'-0"

BHD. 124

LONG'L. BHD.

MAIN DECK  
PLAN VIEW

PACING 2'-6"

3'L. BHD.

30 HATCH  
"X 18'-0"

118

114

112

7/8"

1 1/8"

2 3/8"

3"

3 1/2"

4 1/4"

4 3/4"

4"

2 3/4"

6 3/8"

6 1/4"

7 3/4"

7"

6 1/2"

5 1/4"

3 1/2"

6 7/8"

6 1/4"

4 7/8"

2 3/8"

4 1/8"

3 1/4"

1 3/4"

1 1/4"

TRUNK

BHD. 108

CL OF SHIP

FORWARD

NOTE:

D  
O  
P  
B

3'L. BHD.

DECK

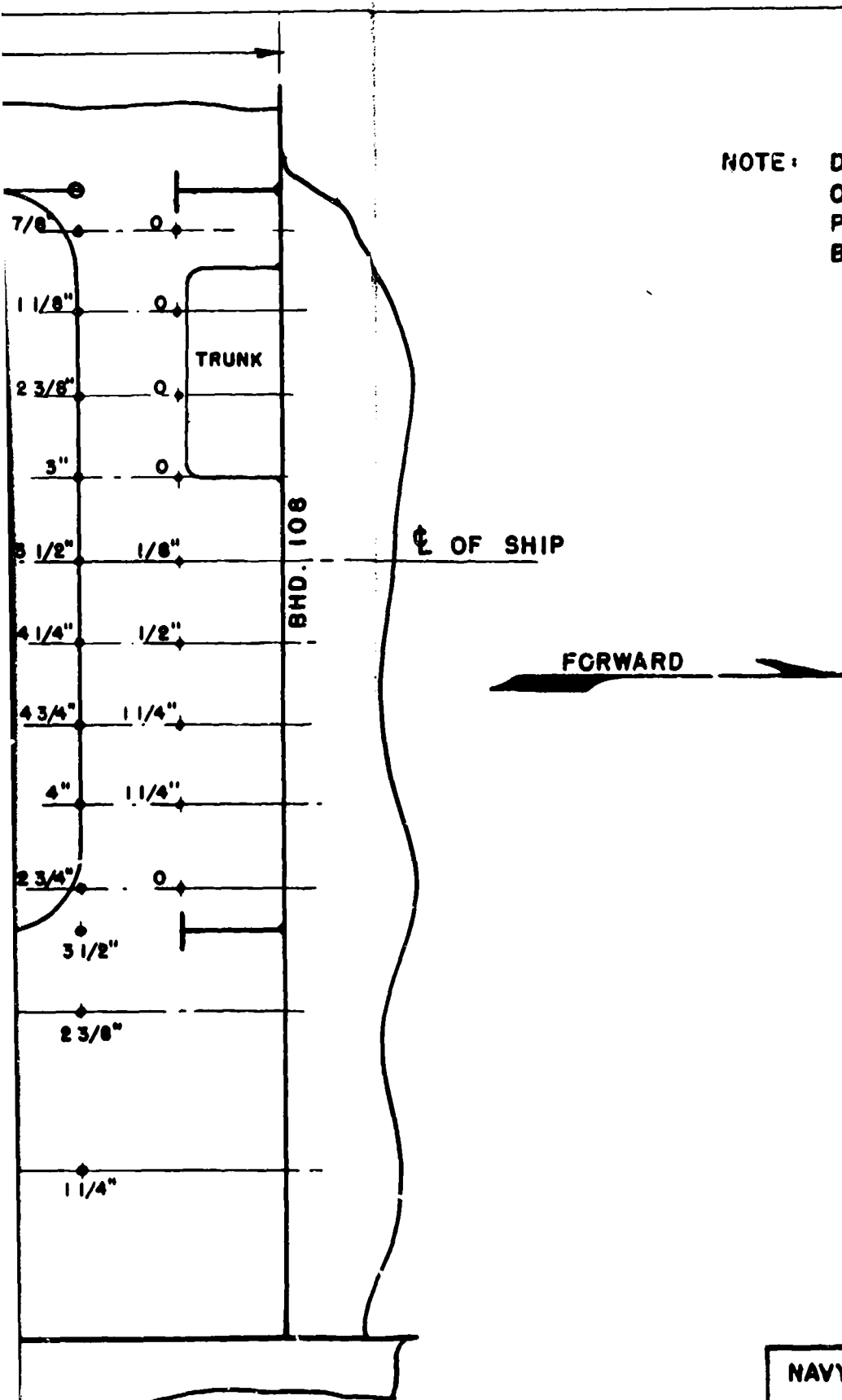
VIEW

2

NAVY

U.S.S.

NOTE: DECK DEFLECTION MEASUREMENTS  
OBTAINED BY MEASURING TO DECK  
PLATE FROM CHALK LINE STRETCHED  
BETWEEN BHDS. 108 AND 124.



SECRET

NAVY DEPT.

BUREAU OF SHIPS

DECK DEFLECTION  
MAIN DECK, AFT HOLD  
TEST A

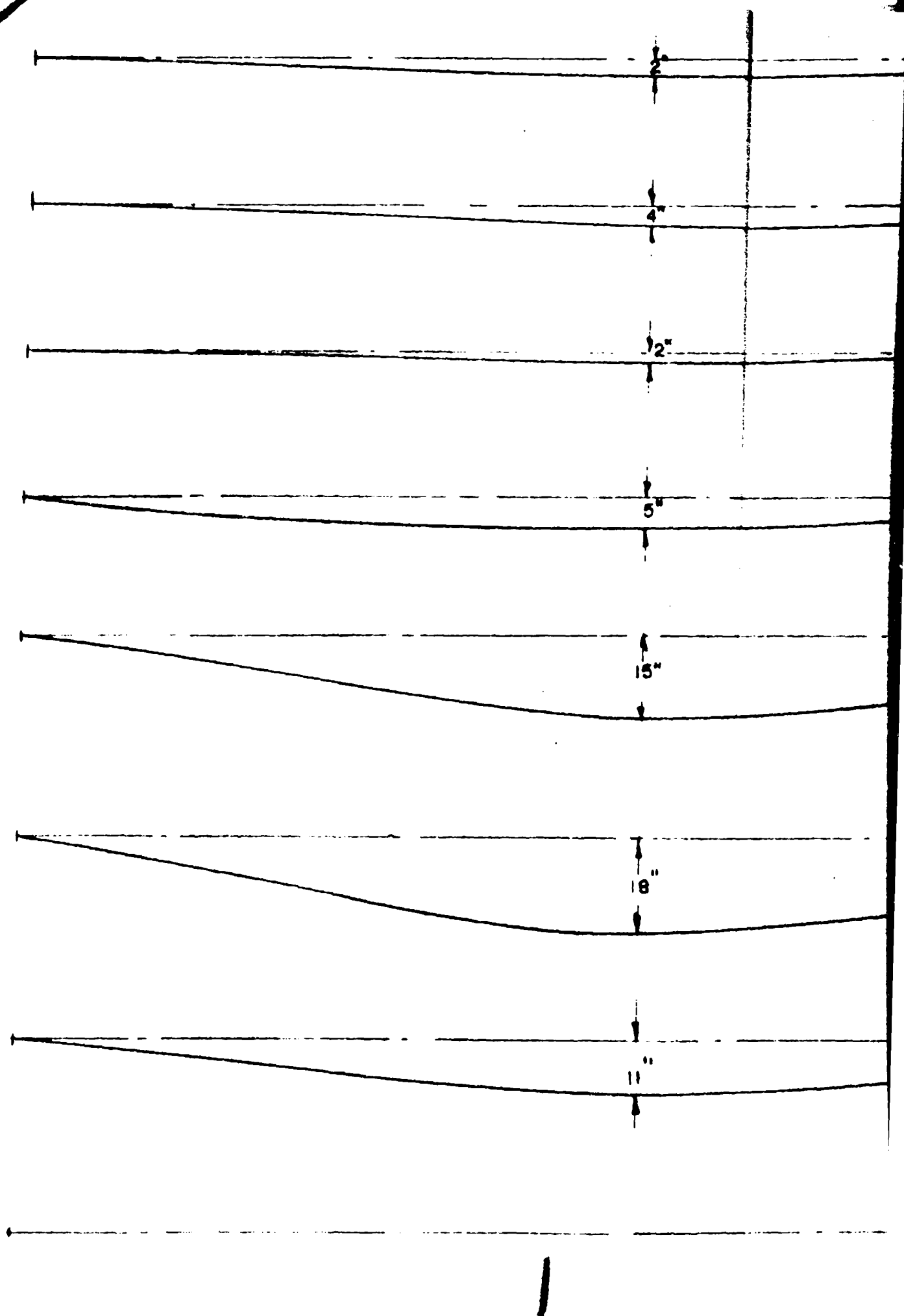
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PORT



FRAME 30

FRAME 34

FRAME 38

FRAME 42

FRAME 46

NO. 1 CARGO HATCH

FRAME 50

FRAME 54

FRAME 58

2

TRANSVERSE SECTIONS — LOOK

30

16

TCH

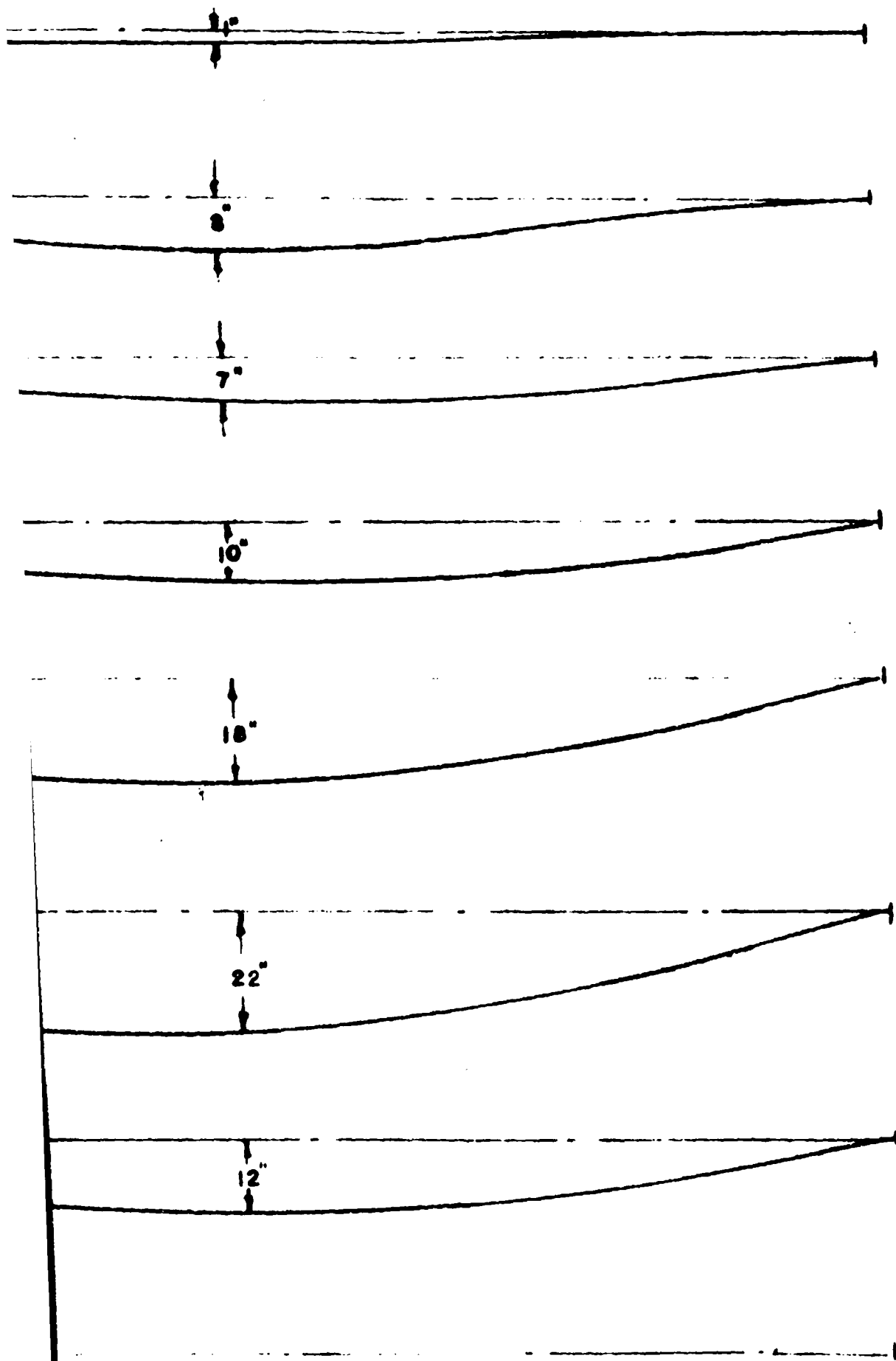
30

14

NO CHANGE

3

LOOKING FORWARD



STBD.

4

NAVY DEPT.
TRANSVERSE
UPPER
U.S.S. CRITTENDEN
PH

STBD.

\_\_\_\_\_ BEFORE TEST

\_\_\_\_\_ AFTER TEST

SECRET

NAVY DEPT.

BUREAU OF SHIPS

TRANSVERSE SECTIONS

UPPER DECK, FORWARD

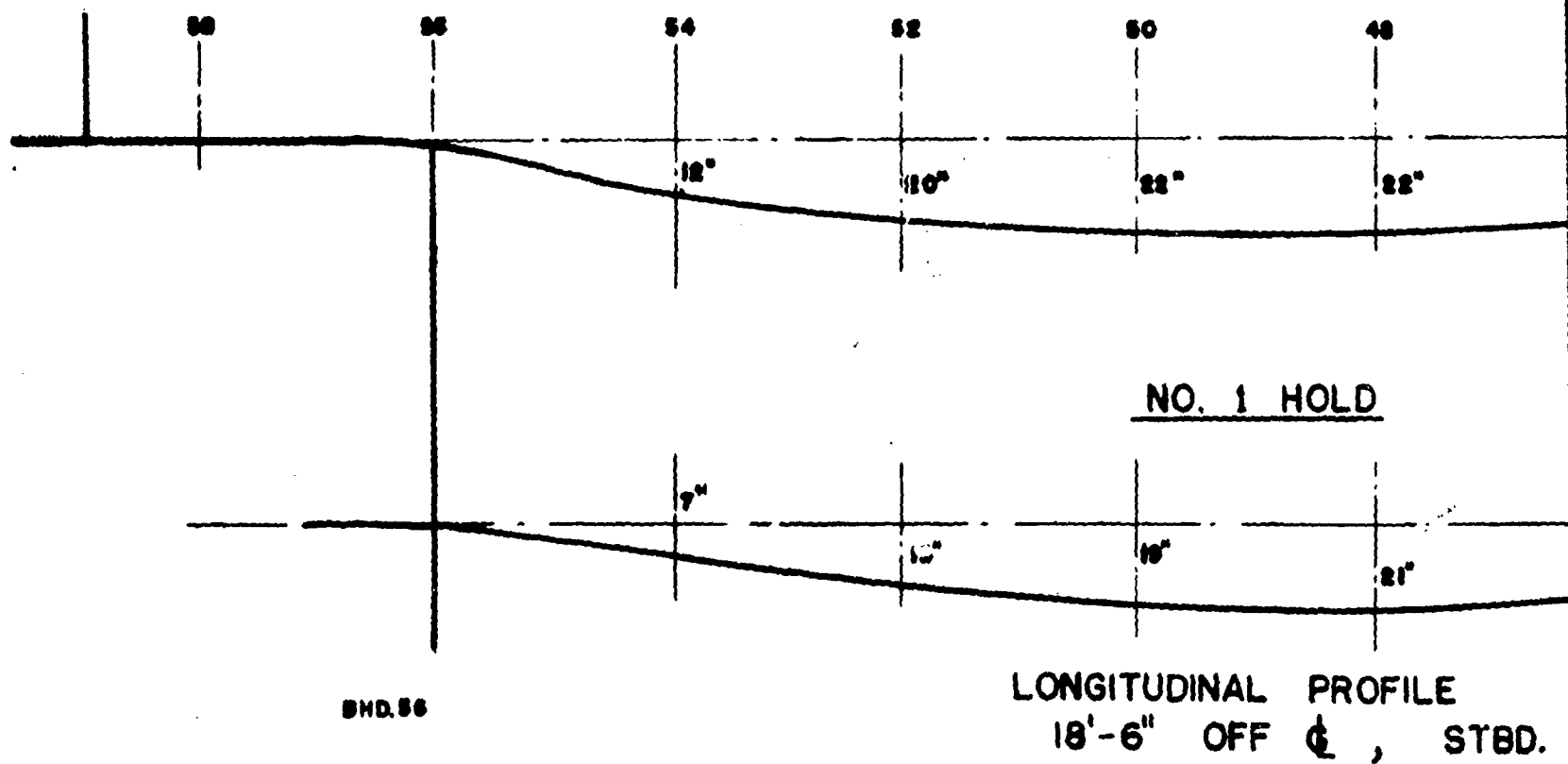
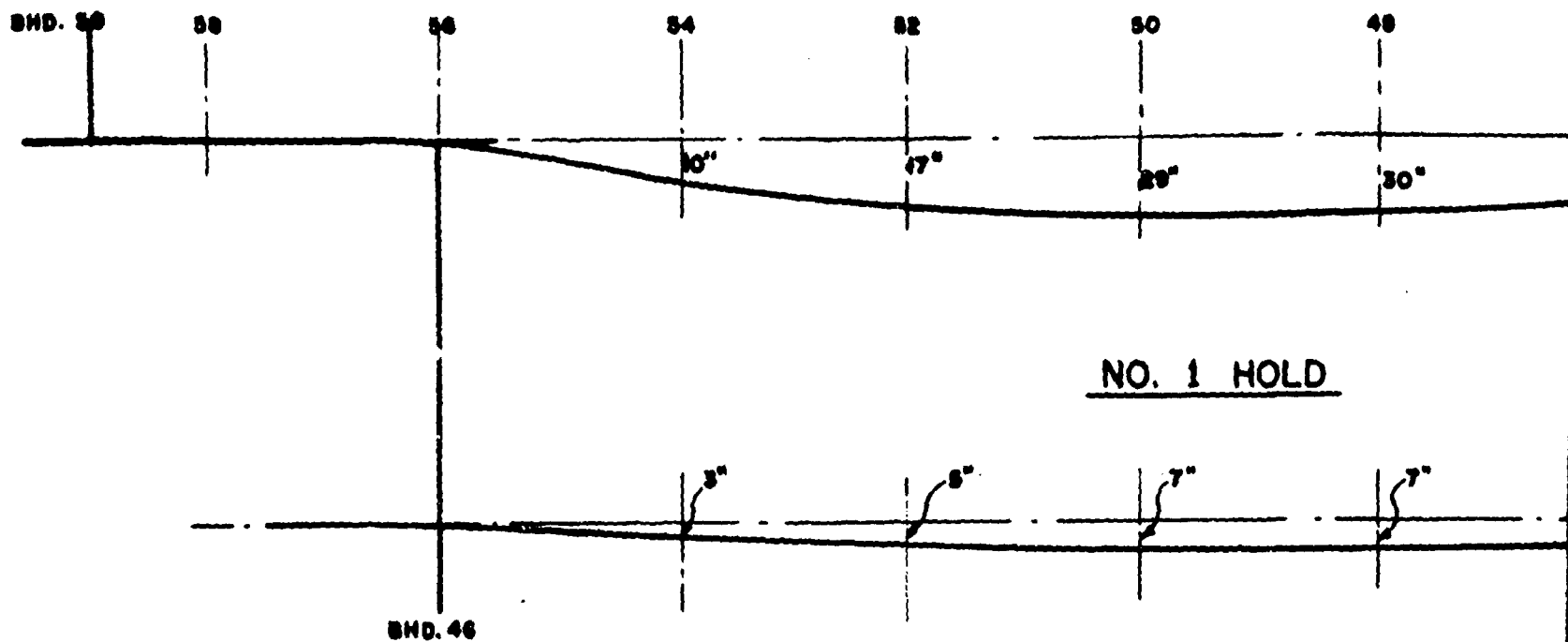
TEST A

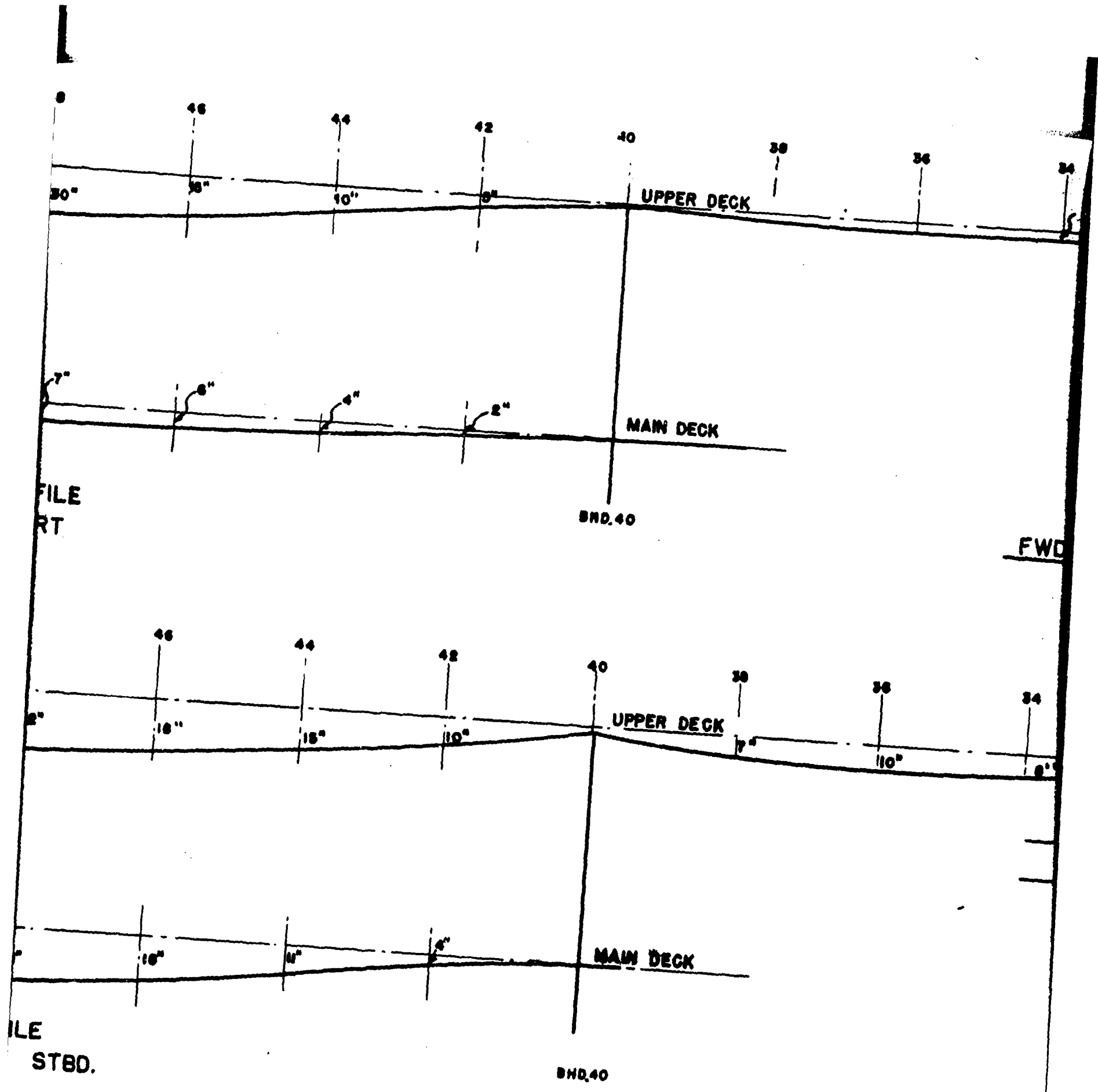
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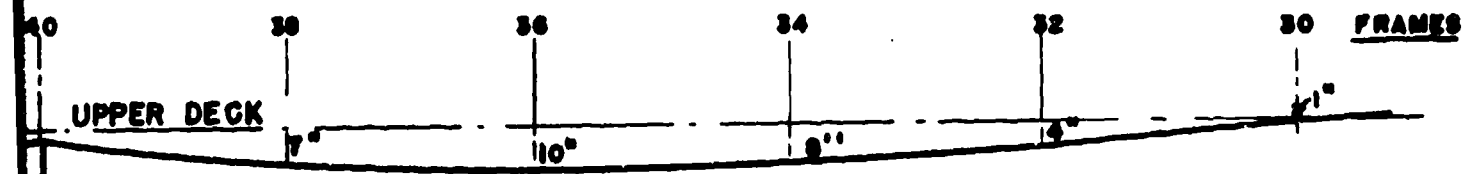


2



MAIN DECK

0.40 FWD



\_\_\_\_\_ BEFORE TEST  
 \_\_\_\_\_ AFTER TEST

MAIN DECK

0.40

2

3

SECRET	
NAVY DEPT.	BUREAU OF SHIPS
LONGITUDINAL SECTIONS	
UPPER AND MAIN DECK	
(FORWARD)	
USS CRITTENDEN	APA (77)
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2"

5"

4"

3"

PORT

1

FRAME 42

FRAME 46

FRAME 48

LONG'L BHD. BETWEEN MAIN AND  
UPPER DECK, PORT SIDE ONLY.

FRAME 50

NO. 1 CARGO HATCH.

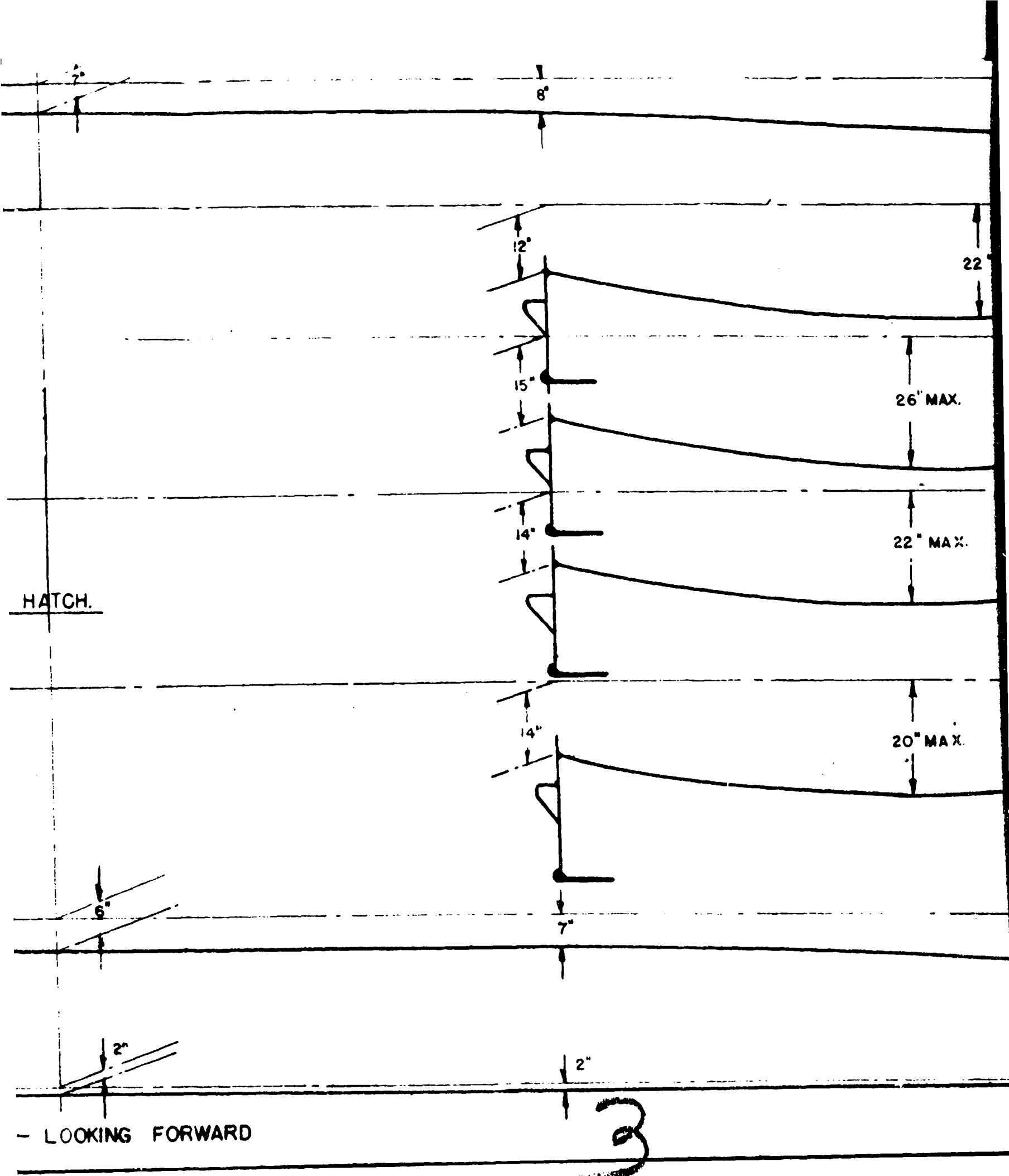
FRAME 52

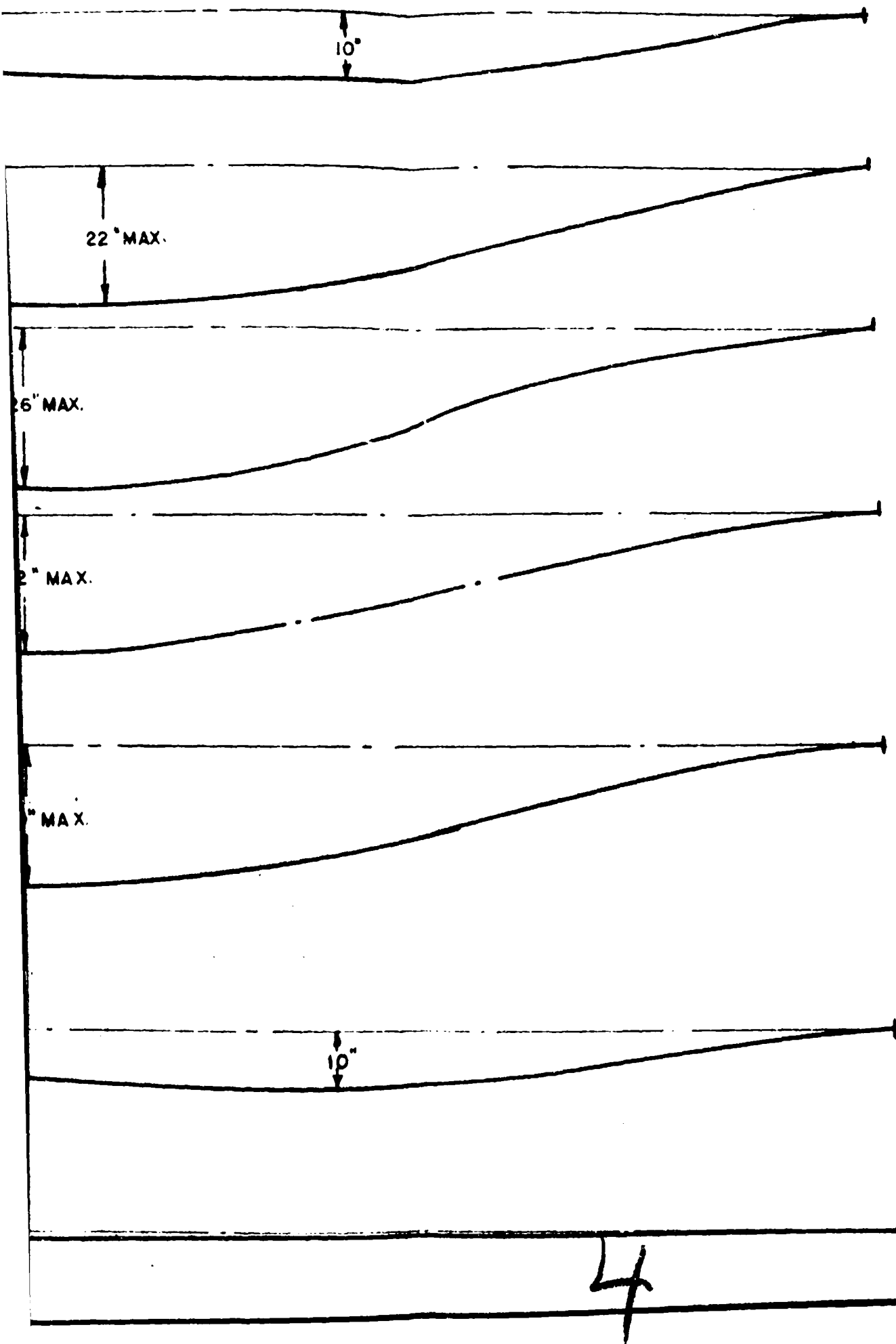
FRAME 54

FRAME 56

2

MAIN DECK - LOOKING FORWARD





STBD.

NAVY DEPT.

TRANSVE  
MAIN DI

USS CRITTENDE

4

STBD.

\_\_\_\_\_ BEFORE TEST

\_\_\_\_\_ AFTER TEST

5

SECRET

NAVY DEPT.

BUREAU OF SHIPS

TRANSVERSE SECTIONS

MAIN DECK, FORWARD

TEST A

USS CRITTENDEN

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4

## SHIP USS CRITTENDEN (APA 77) TEST A

NOTE: READING ARE IN FEET, INCHES AND THIRTY - SECONDS OF AN INCH

9381

APPENDIX

COMMANDING OFFICERS REPORT

TEST ABLE

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REPORT # 11

COMMANDING OFFICERS REPORT

PART A - GENERAL SUMMARY

I. Target Condition After Test.

- (a) Draft forward 9 - 6 Draft aft 17- 6 List: None  
General areas flooding - none.
- (b) Structural damage.

Superstructure: Both topmasts bent backward and slightly to starboard, at point just below crow's nest. The forward topmast is bent 80 degrees, the after topmast 110 degrees. The forward side of the mast is broken at each bend. All radar gear, navigational lights, electrical circuits, radio antennas, and phone circuits on both masts broken, carried away, or damaged beyond repair. Forward stay has broken and carried away from foremast, leaving only two stays on each side of mast.

Booms secured to the masts are bent and distorted beyond repair or safe use. All rigging and ground tackle strained, broken, distorted, or otherwise damaged beyond repair. Replacement would be necessary if the ship were to operate.

Davits are bent or distorted beyond safe use except the forward starboard davit is now in operation. Wire on this davit requires renewal.

Smokestacks are badly dished in and distorted in various sections; guys and stays carried away. #2 stack is in worse condition with part of inside stack severed and closed off by the outside shell plating. On the forward (#1) stack the signal mast with antennas, siren diaphragm, and 24" searchlights have been demolished. Whistle has been repaired and is operable.

Liferafts carried away overboard or flung about upper deck of ship. Less than half the original 46 rafts remain in useful condition; remainder lost overboard.

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USS CRITTENDEN (APA77)

Cargo hatches are distorted at coamings, which are bent outboard. This permitted all hatch covers and pontoons to fall down on gear below, seriously damaging one plane in after hold and electrical test equipment in forward hold. Only one hinged pontoon and I beam remained at #2 hatch, in position.

Watertight doors, ports, and hatches about the ship are generally distorted, except the battle ports. Doors and hatches topside are dished in, dogs bent, or frames distorted. Crowbars were necessary to open many outside doors. Airplane on starboard side #2 was damaged beyond repair. Both planes jetisoned.

Bulkheads topside are all dished in at varying degrees. Principally around doors, and on forcs'le. Forward topside structures suffered most damage particularly at frame 59. This latter bulkhead was dished in toward aft to about 18". The bulkhead was broken in several locations, notably in the pilot house where a welded seam was split open vertically for about six feet with about three inches split. Bulkheads below decks and inside the upper superstructure were only slightly damaged. The most serious damage being around number one and two cargo hatches where sheathing, furniture, bunks, and lockers were thrown around and in many cases blocking the passageways.

Decking topside was pushed downward by the pressure, buckling supporting I beams, and distorting piping. Here again most the damage was suffered around number one hatch with a slight amount aft around #2. No breaks were observed in the decks although several places seemed to have experienced considerable movement up and down.

Hull above the water line appears to be in good condition. Inside inspection has todate revealed no damage to the interior of the hull. The results of the pressure can be observed on the outside hull at frames 10 - 20 portside between the upper and main decks. There are dents in the starboard bow at frames 40 - 45 but a close examination indicates that these must have been caused by tugs of the boarding parties. The inside plating and frames are also distorted by these outside dents. No leaks in the hull can be found as a result of the test.

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Ventilators as a whole received little damage. The ventilation system in #1 and #2 holds received the most damage and is out of operation. The ventilation system throughout the rest of the ship is operable.

(c) Operability.

In general all machinery on the ship is operable except deck winch #6 which has bent shaft, and davit winches #2, 3, and 4. Gasoline hoist in number 2 hold is out of order.

Electrical equipment is operating and satisfactory except the davits and winches noted above, and the circuits to the both masts.

Ship control equipment is satisfactory except as noted under Navigation.

Fire control equipment is satisfactory except those few items listed in the detail part of the report.

Gunnery equipment is operating satisfactorily except the alignment of the guns and minor detailed deflections listed in the more specific damage section of this report.

Electronics equipment is operating satisfactorily except for the fathometer, and the radar. Radar on both mast and connections thereto were demolished. CIC equipment is being tested and so far appears operable provided it had the complete equipment to fill out the set.

Navigation equipment for conning the ship was little damaged. The following gear remains: One standard compass, one steering repeater in pilot house, one on bridge, and one topside on signal bridge. The stand on the outside of the bridge is so bent that the accuracy of the bearings might be questioned, but rough checks indicate it is not out more than a degree. Gyro error obtained and checks.

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USS CRITTENDEN (APA77)

(d) Heat.

No excessive heat was recorded. Traces of excess heat (which was apparently very short duration) was noted on the side of the ship towards the blast, the masts, and certain forward parts of the superstructure that were exposed direct-to the rays. This is covered more in detail under Part II. The maximum and minimum thermometers outside the magazines showed no change in their normal readings, except the after magazines which, due to no ventilation slightly exceeded their normal readings. This was the result of the sun heat.

Fires; no trace of any fire could be observed.

Personnel casualties - none.

II. Forces Evidenced and Effects Noted.

(a) Heat.

Effects of heat were noticed, starting at the waterline to the top of both masts. The effects became progressively worse as their altitude increased. At the ships bow very little heat effect was observed below the hawsepipes. Commencing with the upper deck, paint was blistered and removed in spots. This ranged from a very slight area on the starboard bow to an increasing area around to port. The entire port side showed signs of a change in color of the paint. The numerals (white) on the bow were obliterated by burned paint and soot, and the frame numbers (yellow) were similarly eliminated. The heat blast appeared to have struck the ship at the water line from an angle of about 20 degrees on the port bow, and expanded rapidly as it rose to the upper decks. The starboard side of the ship was clear of heat evidence except for the unshielded small amount on the bow, and a part of the forward bridge structure at bulkhead 59. There was no evidence of heat inside the ship.

Significant behavior of equipment; no manila lines, cables, wires, canvas or other equipment appeared to have burned. A small amount of manila left exposed on the forecastle seemed to have changed color a little but no trace of burning could be found; merely

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USS CRITTENDEN (APA 77)

a darker color. Fire hoses were also darkened. Some fire hoses (expose 1) were badly frayed as if they had whipped up and down in their brackets. Also some were blown off at their connection to the fire plug. The metal connection remained but the hose was gone, as if torn lose. The most appreciable results of any heat were observed on the forward side of the foremast and the bridge superstructure forward. Equipment on those locations showed the same amount of heat effect.

(b) Fires and explosions.

None.

(c & d) Shock and pressure.

It is difficult to determine whether most of the damage received was actually the result of shock or pressure. My own opinion is that pressure was the predominant cause, and any results of shock might have been due to fracture or sudden distortion to other structure. Exposed instruments such as those on the forward bulkhead of the pilot house, were not seriously damaged. The glass on one instrument was broken due to distortion of its face, but all instruments are operating. The heavy glass ports were fractured and held in place by their battle ports, but even the light globes in the forward part of the ship were undamaged except by structural causes when something hit them, flying debris, etc. The 24" searchlight that was blown off the forward stack was a result of blast effect. Both searchlights on #1 stack were demolished. The general direction of the blast or pressure appeared to be from the port bow. There seemed to be, however, a distinct difference between what appeared to be instantaneous blast or pressure, and a more steady pressure that was exerted on the outside structure. As an example, the port searchlight was blown 50 feet through the air, but a chair in the Captain's cabin which is many times lighter than the searchlight, but protected from the blast, was squeezed so quickly by the closing of the corner of the bulkhead that the chair was not moved more than an inch. The original estimate that the blast and heat must have been about 45 degrees on the port bow has been revised. It is believed that it must have been about 25 degrees on the port bow and that the ship swung around by the blast, presented more of its port side to

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the remainder of the explosion. It appears quite significant that the superstructure of the ship was fractured in several places, mostly at frame 59, in the bridge structure. Maximum damage occurred between frame 35 to 59. Very few fractures were observed elsewhere. This same section of the bridge, bulkhead 59, experienced irregular tearing of the forward metal shield on both wings of the bridge. The metal was ripped down its vertical depth to the deck and the shield itself almost flattened out to the deck, almost horizontally. At this location the tack and seam welding (apparently machine work) held better than the metal itself. At a few places electric fans and similar objects fell off the bulkheads. Lockers and bunks were knocked loose, magazine sprinkler control boxes damaged, and some medical first aid lockers damaged. This might have been due to either blast or shock but the shock results were far in the minority.

(e) Effects apparently peculiar to the Atom Bomb.

The most noteworthy observation to make was the seeming lack of concussion effect. No electric light globes could be found inoperative except those damaged as described above. Light bulbs two feet from bulkhead 59 were undamaged. Two raw eggs on the wardroom pantry shelf were undamaged, but the electric fan right above them was knocked off the bulkhead. Wherever the ship was well closed up, the effect of the bomb was minimized. Glass ware was undamaged except where it received the full force of the blast such as the glass ports in the pilot house.

The boilers and engines are undamaged. The bricks in the incinerator were knocked loose and the incinerator is out of order. Pressure generated by the explosion appeared to exert a downward and sidewise force simultaneously, which increased in intensity as it rose but decreased in intensity as it expanded towards the stern of the ship. When shielded by another piece of structure, the result of the explosion was greatly lessened. As an example; the forward part of number 1 stack was moderately damaged, being protected by the 03 structure, but #2 stack was severely damaged its entire height, where it had no protection from the blast. Low heavy objects (like deck winches) did not seem to suffer. A cargo net hanging over the port side was demolished whereas the same type and in the same place on the starboard side was undamaged and is still in use.

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USS CHITTENDEN (APA77)

All topside watertight doors show about the same pressure effects on the same levels. Although the starboard side was the protected side, the doors on that side were damaged as much, if not more than those on the port side. The two heavy doors to the starboard side of the wardroom were blown off their hinges. Similarly two WT doors on the main deck aft, starboard side, were blown off their hinges also. The two heavy doors to the carpenter shop, port side aft, received the same damage. It was quite evident that wherever structural strength was lacking (such as around doors and hatches) the material suffered severe damage. Boat gripes (wire wrapped with canvas) were themselves wrapped around their davit strongbacks several times. Ladders were twisted once or even twice, around themselves; that is, the lighter ladders like the one on #2 stack, etc. Canvas covers, and tarpaulins were ripped and torn beyond repair. This gave the effect of damage received from a typhoon. A hollow piece of pipe about 3" in diameter, was observed to be bent 180 degrees by the blast and then another turn of about 150 degrees almost back on itself. There was no other object near it that could have caused the same degree of distortion. The force of the blast was sudden and swift; the pressure almost equally so.

### III. Results of the Test on the Target.

#### (a) Effect on propulsion and ship control.

Effect on propulsion and ship control was negligible. The ship got underway twice after the explosion, to shift berths and was able to use own engines without difficulty. Necessary navigational aids were the only equipment missing. Secondary control station midships has a few instruments damaged, such as the compass, repeater, and telegraph to pilot house, which was caused by the falling searchlight from #1 stack. The amount of boiler power might be reduced by part of the uptake in #2 stack being closed off, but that could be easily corrected. At present, with minor structural repairs, the ship would experience no difficulty in steaming both of its engine rooms and equipment.

#### (b) Effect on gunnery and fire control.

Guns are operative except for minor damage caused locally, as listed in the detailed damage report. Except for misalign-

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ment they could be operated with little difficulty. Magazines and ammunition are undamaged except for the bulkheads and doors of the clipping rooms which are dished in like all other topside doors and bulkheads. Test bombs were knocked out of their location on the focsle, but were undamaged. Test ammunition, including rockets, were undamaged. Fire control equipment is all operative except as noted above, plus certain phones and connections blown overboard or otherwise damaged beyond use by debris or structural effect. Three of the four legs supporting the after director tower were pulled loose from the deck. Circuits to the fore and maintops were demolished. Smoke generators on the after deck house were damaged beyond repair.

(c) Effect on watertight integrity and stability.

Watertight integrity of the hull has not been effected. On and above the main deck, however, the watertight integrity has been seriously affected. All doors, hatches, and openings topside require repairs to make them watertight; particularly Nos. 1 and 2 holds. For test B as many as possible of these places will be shored up to prevent a large accumulation of water from breaking through. Most of the battle ports appear to be satisfactory and can close sufficiently tight to prevent flooding. Some ports on the main deck, inboard were blown out, but the overhang of the ship should assist these somewhat. Holes in bulkhead 59 will have to be welded closed. In rough weather the ship would not be safe for operation in its present condition, as it would be subject to progressive flooding. Once flooded its stability would be affected. With no boats on board the stability would be improved, but the masts and stacks must be reguyed, and sections cut off, to prevent their falling over and affecting the stability. Loose and damaged davits on the port side should be removed as a serious set of rolls would break them loose with disastrous effects. Considerable weight was removed from #1 and 2 hatches when it was necessary to jettison the damaged pontoons and hatch covers. The test electrical equipment in number 1 hold still furnishes a little ballast. The ship at present has 100% ammunition and fuel. As the fuel is used up the stability will naturally be more sensitive at sea. The cargo booms will require more secure fastenings because the old brackets supporting them have been broken and all running gear is inoperative. With their present damage it would

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be better to jetison the booms if it were not desired to take any chances with their carrying away and affecting the stability. Separate recommendations are being submitted, if it is desired to sail the ship back to a shipyard, in order to make it seaworthy with a minimum amount of work.

(d) Effect on personnel and habitability.

With the present low personnel allowance, and the excess troop passenger spaces available, the destruction of lockers and bunks has not seriously affected the habitability, although it has inconvenienced the personnel. All living spaces (except one compartment outboard of #2 hold) had to be abandoned around #1 and 2 holds. For normal peace time allowance of personnel, and as a passenger carrier, the habitability of the ship would not be satisfactory without replacement of lockers and bunks, and structural repairs. The use of cots is possible in emergency but they are not a satisfactory substitute for bunks on this type of ship due to its roll and pitch. The sanitary system is now working but for two days after return to the ship trouble was experienced with the flushing system due to separation of pipes at the flanges, etc. The same thing occurred to the fire main. After cutting out certain sections and blanking off the flanges, habitability was eventually established two days after reboarding. An additional feature that had to be considered in this climate was the icebox situation. Considerable trouble had been experienced with the ice boxes since departure from Pearl. Whether any damage to them resulted from the A test is questionable, but the situation was worse on the return to the ship because the whole plant had not been operated for four days. The tender is now attempting to rectify the trouble. Pending work completion on the ice box, supplies were obtained in small quantities from the evacuation ship BEXAR.

The effect the bomb would have on personnel is purely conjecture. Based on an observation as to what it did to equipment, etc., it is safe to guess that personnel casualties would have been heavy, especially those topside or exposed. Persons inside the ship would possibly escape danger, except from flying debris. Those exposed would experience several types of damage; blown overboard,

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burned, or struck by debris, etc., for it would seem that when life rafts can be knocked around the topsides and blown overboard, human beings would experience similar fate unless protected by superstructure. Personnel on the fantail might survive without damage, even though the flagstaff was bent downwards about 30 degrees. Food and water were found not to be contaminated.

(e) Effect on fighting efficiency.

It is estimated that the fighting efficiency of the ship would have been reduced as follows; (note that this does not include radiological effects. These would add to the loss.).

50% of the armament would require immediate repairs. although minor repairs, they would require man power.

50% of the personnel topside would be serious casualties. 20% more would suffer casualties around the interior of the ship and in exposed places shielded from the bomb blast.

25% maneuverability of the ship would be lost. Maximum speed would be limited to ten knots instead of sixteen. It is believed further that if boats had been carried on board all of them would have been damaged beyond ready availability. Possibly one or two might have survived serious damage. This opinion is based on what happened to the davits. As far as fulfilling its mission as an Attack Transport, it is considered that the ship would be useless except as a hotel until its rigging, booms, hatches, and davits were cleared of debris and rigged ready for safe operation. This would also require satisfactory jury rigged antennas, halyards, rigging, etc. With a war-time allowance repairs might be satisfactorily accomplished within three days; one day being required to clear the ship of debris in order to get through passageways, etc. Another day to restore living conditions such as plumbing, fresh water, fire main, etc., and a third day to clean up. From the radiological viewpoint additional days might be required. This is a most important feature when it is realized that this ship remained hot for four days before it could be boarded. Rain washed down the decks and the radiological material collected in practically every wrinkle in the decks. This required washing down frequently to clear the decks.

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#### IV. General Summary of Observers Impressions and Conclusions.

The CRITTENDEN at the time of the test, was anchored in berth 159 BIKINI with 105 fathoms of chain to the port anchor and 45 fathoms of chain to the starboard anchor with a tight moor. The GILLIAM was 400 yards on the starboard or port bow (depending on the wind) and the CARLISLE was on the starboard beam when the wind was from 085 true. Distance to the CARLISLE was also about 400 yards. From comparison of damage to nearby ships it must be assumed that the bomb hit within 700 yards of the ship in the direction of the GILLIAM. If the ship was headed about 110, which seemed to be true wind that date, then the bomb dropped about 30 degrees on the port bow. The mission of the ship as result of the A test has been nullified as an attack transport until repairs can be effected, especially to booms, davits, and hatches, including the winches operating with same.

#### V. Preliminary General or Specific Recommendations.

This part can be briefly divided into personnel and material.

##### (a) Personnel.

Those topside that are required for ship control, gunnery and deck operations must be reduced to a minimum number. All exposed personnel must try to keep themselves shielded by bulkheads or heavy machinery when warned of an attack. If debris can be avoided a position prone on the deck should be the best defense against being swept off one's feet. Protective clothing should be worn to avoid receiving the radiological dust that appears to settle over the ship. Ports and all air openings practicable should be closed, similar to a gas attack. The safety precautions laid down for tests A and B appear to be a good guide for personnel expecting atomic bomb attack.

##### (b) Material.

It is recommended that the topmasts (foremast and mainmast) be designed with reduced heights for this type of ship. If the radar equipment were to be placed where the booms end when

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secured in an upright position, it is believed that sufficient results will be obtained by the radar.

Stays and Guys held up well except for one or two. Those that did carry away did so at the turnbuckle threaded bolts. This indicates that stronger bolts would have held. No fracture of wires or cables was observed.

Life Rafts broke loose from their holding down clamps or bridles and ended up all over the ship or overboard. A wider (and metal) band or strap would have held up much better and would not have cut into the life rafts themselves.

Topside parts, especially the superstructure of the ship must be streamlined. Eliminate square corners where possible. It is particularly noticeable that no gun tubs received damage except one. Eliminate breaks in the superstructure of the ship. Join up sections where possible. As an example, the forward deck structure on the focsle of this ship had all four bulkheads pressed in (Spud locker). The next deck structure aft also had all bulkheads pushed inward. It was difficult to force open the door to the clipping room. If these two structures had been joined there would have been two less bulkheads damaged, besides according a stronger structure.

Deck and bulkhead plating should be thicker. Where 3/16 is used it should be increased to 1/4" and where 1/4" is used it should be increased to 5/16". These ships are extremely light anyway, too much so for their mission; a few extra pounds of heavier sheet plating would improve their condition all around.

Piping: Use less rigid connections at the flanges; particularly for flushing water and the fire main. If necessary use the same system for suspension of piping as is used for the steam line in the engine rooms.

Davits are weak and easily distorted. Any single one or combination of the following suggestions could be used: Use of hinges to lower the davits down flat in order that they will not be subjected to the blast. Build davits into the streamlining of the ship. Use hydraulic system for raising and lowering davits out of the skin of the ship.

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Do away with davits and substitute cranes two aft and two forward, so they can plumb the two cargo hatches and at the same time handle the boats. This would do away with the present boat booms and davits which now require considerable rigging and work and which were damaged badly during the attack.

Door frames; were exceptionally weak for the attack, and should be strengthened.

Canvas covers; remove all covers before an attack as they become very radio active. Use metal coverings over canvas hoses. Use stronger metal boxes over magazine sprinkling system.

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### SECTION III

#### PART C - INSPECTION REPORT

#### SECTION A - HULL

##### A. General Description of Hull Damage.

###### (a) Overall condition of vessel.

Fair; the hull appears to be seaworthy, the superstructure, masts and stacks are not seaworthy. The tops of the cargo holds are not seaworthy for rough weather. The engineering plant is satisfactory. The ship can operate in normal weather conditions.

###### (b) General areas of hull damage.

None except a few dents on starboard side between frames 20 and 45, just below the upper deck beading. Other damage to the hull is not noticeable.

###### (c) Apparent causes of hull damage.

A very slight showing of the frame work on the port side forward might indicate a small pressure effect from the blast. The indentations on the starboard side between frames 20 and 45 might have been caused by the boarding party tugs, or by the pressure exerted on the port bow by the blast. There are indications that it might be due to both.

###### (d) Principal areas of flooding.

None.

###### (e) Residual strength, etc.

No apparent change. It will be difficult to determine this until the ship encounters rough weather.

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B. Superstructure (exclusive of gun mounts).

(a) Description of damage (giving important dimensions).

1. Bridge area: entire forward bulkhead (frame 59) pushed aft, except at deck, about 18' beginning at the 02 deck for a distance of 2' at the 02 deck. The worse section is the forward part of the pilot house; here the plating at the welded seam just to the right of the ship's centerline is ruptured vertically for a distance of 6' and about 3' wide. Both wings of the bridge structure on the 02 and 03 decks have their forward plates ripped vertically downward to the deck and are forced aft and horizontal to the deck. Gyro repeater stands on both wings of the navigating bridge were badly distorted and off their centerline. The repeaters themselves were blown overboard. The sounding machine on the wing of the 02 deck was knocked down and demolished (portside of ship). Cargo lights located on the forward part of bulkhead 59 were demolished. All except one glass port in the pilot house were demolished or damaged beyond repair. All instruments on the inside of the pilot house and on the forward bulkhead were, however, undamaged and the clock was still running on arrival of the first boarding team ABLE. The fathometer was out of order. There was no way to determine if the remote PPI scope was operative, due to damaged masts. The fathometer was later repaired by ship's force so it could be used in an emergency. Electric lights on the overhead were undamaged. Also on the wings of the bridge superstructure the stanchions supporting the 20mm guns on the 03 deck, and the stanchions supporting the 02 deck were severed. Temporary makeshift stanchions have been installed as an emergency measure to prevent the wings of the 03 deck from dropping. All doors and bulkheads around the bridge superstructure have been dished in or distorted depending upon the amount they were exposed to the blast. Both doors to the pilot house cannot be closed without forcing shut. The lower port ladder aft of the bridge structure is undamaged. The ladder from the 01 to the 02 deck was blown down. The ladder from the 02 to the 03 deck was loosened. Temporary emergency cabin (constructed out of sheet metal) blown overboard (portside). Port forward corner of Captain's cabin on 01 deck broken and fractured; exposed to outside of weather conditions. Captain's pantry badly damaged as

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well as equipment therein. Forward part of Division Commander's cabin also damaged, but not as much as other side. Bulkhead 59 on 03 deck pushed in and backwards. Splinter shield in front of Fire Control station is fractured at centerline. Both signal flag bags demolished and blown overboard. CIC room undamaged. Chart house undamaged. Radio room suffered only one antenna switch casualty. Switch was knocked off overhead.

2. Amidship Deckhouse and Stacks: No severe damage was suffered by the amidship section of the superstructure, except the usual dishing in of the doors and bulkheads. This also applies to the Radio direction finder shack. Overhead of the midship section above compartment B-0309M is badly distorted by the downward pressure. Frame 88 bulkhead is particularly pushed in, leaving door badly jammed to clipping room. The port after lookout tub forward side has been pushed in. Rails (hand) around 03 deck are badly bent. The following special damage to the midship control station was noted: Compass binnacle dismounted by blast and falling searchlight (from #2 stack). Rudder steering indicator damaged beyond repair. Course steering indicator satisfactory. Engine order telegraph seems satisfactory. Gyro repeater stand and repeater damaged and may be repaired if required.

Stacks: Both badly damaged; #2 stack is the worse damaged. #1 smoke-stack forward part is pushed in about 1' for about a height of 10 vertical feet at about 4' above deck, the metal in forward part of stack is fractured for about 6". Port side of stack under searchlight platform is pushed inward about 1'. Searchlight (port) is blown off platform and demolished light landed about 50' farther aft at midship control station. After part of stack (streamlined part), is squeezed together until two lower blower vents are almost together. Starboard searchlight is still on its platform, but demolished; its reflector landed on forecastle. Signal mast and yardarms bent backward 90 degrees and resting on top of stack. Damaged beyond repair. Halyards and radio antennae demolished. #1 stack still has two guys supporting it, but stack would fall if ship rolled. Inside of stack not badly damaged. Whistle still operates but siren diaphragm broken. Forward stack casing opened at welded seams just above boiler in #1 Engine Room. Ship's force rewelded on reboarding ship in order that boiler could be steamed. Top of smoke-

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stack not damaged, #2 smokestack, forward part, is pushed back in and aft about 5', and fractured across the bottom of stack. Various fractures also occurred in the welded seams joining stack and deck 03, superstructure. Entire stack leans aft and to starboard, being held up at present by two guys. After section (streamlined part) of stack is squeezed together similar to #1 stack. Stack badly distorted in all sections. Inside part of stack is exposed to weather, with part of outside shell severing the inside uptake. Galley uptake (charley noble) severed at 03 deck and exhausts, with main uptake, into incinerator room. Incinerator bricks broken and incinerator out of order. Ladder on port side of #2 stack twisted around itself once and bent beyond repair. If subjected to the rolling of the ship, #2 stack would carry away. It is believed that boiler power of #2 boiler might be affected unless stack obstruction is removed. At present boiler can be used for auxiliary purposes.

3. After deck house: Forward bulkhead is pushed in about 1' and badly fractured and distorted, particularly at forward port corner. 40mm gun director tub tower port side, is severed from three of its forward supporting legs, and pushed over and aft about 30 degrees. Decking on after deckhouse is bent and dented in a few places, from the blast but nothing of particular note. Ready boxes, spare 40mm gun barrel boxes, and other light sheet metal objects are all dented inward from pressure. Screen speed light shield knocked off light but light itself undamaged. Smoke generators damaged beyond use, unless rebuilt. All radio antennas and insulators broken. Radio 3 however, is undamaged. All connections with mainmast are down. Large doors to carpenter shop (portside) in after Jeckhouse, are blown off. Other doors and bulkheads affected similar to rest of ship but on a diminished scale. Empty oil drums in stowage are all caved in.

(b) Causes of Damage in each area: These can be subdivided into the following important headings.

1. Blast: instantaneous damage such as caused holes to be torn in the sheathings, bulkheads, etc., to rip canvas, and blow a searchlight fifty feet from its position. This effect was very noticeable on exposed objects without adequate protection around them.

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2. Pressure; a rapid sidewise and downward force exerted on the ship topside, and increasing in its effect with altitude. Subsequently a bending or distortion of other parts of the ship resulted from the transmission of the pressure through intermediary points, such as piping, bulkheads, beams, etc.

3. Debris; flying objects which struck other objects and parts of the ship causing damage to those parts, or to the flying objects themselves.

4. Heat; effects were very light and not generally noticeable except on the forward part of the masts' and sides of the ship, as well as part of the superstructure, where it blistered paint, left shadows, or otherwise left its mark. Some of the plastic name plates over doors were melted where exposed to the direct rays of heat; others were undamaged.

5. Radioactivity; Geiger counter showed that the worse effects were on the topside of the ship where the particles of radioactive matter settled in dips, hollows, and breakers in the plating. The ship was considered to "hot" to reboard for 4 days after the test. When boarding was finally accomplished, it was necessary to wash away all spots where the water had drained and collected, leaving later a dried residue of radioactive matter. It was two days before these places lost their "hot" characteristics; ie: 6 July. Where holes were blown in the superstructure, and in #1 and 2 cargo holds, radioactive matter entered the inside of the ship. This was a very negligible quantity, however.

(c) Evidence of fire.

None.

(d) Estimate of relative effectiveness against heat and blast, of:

1. Various plating thicknesses: Light sheet metal (particularly inside sheathing) was damaged severely. Heavier metal such as 1/4" plating, was damaged only by blast when the plating was exposed to the burst or pressure. Also if the plating constituted a flat surface it suffered more than when in a spherical or circular shape. One exception were the life line stanchions, jackstaff, flagstaff, and signal mast which were all bent by the explosion in spite of

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the little surface they presented. The thicker the metal the better it withstood the blast.

2. Various shaped surfaces; Round surfaces escaped major damage. Gun and lookout tubs were in general undamaged. Only one lookout tube suffered damage, the metal sides being pushed in. This was on the O3 superstructure and near #2 stack where the worse effect of the blast appeared to be felt. Flat surfaces invariably suffered result of both pressure and blast whether exposed or not.

3. STS compared with MS: Assuming the gun tub splinter proof metal is specially treated steel, and that lookout tubs are mild steel, it can be stated that STS steel is superior to the MS steel under atomic pressures and blasts. No damage occurred to the various splinter shielding.

4. Aluminum materials; only two of these were observed damaged. These were the top right angle mirror holder sections of the smoke periscopes in the engine rooms. Both fractured at the aluminum welded joints. Considering their state of protection in the spaces, it would appear that aluminum welds would not be satisfactory as withstanding atomic blasts.

(e) Constructive criticism of superstructure design or construction; including important fittings and equipment;

It was noted generally that frames around doors, hatches, and the athwartships bulkheads, the topmasts, and the stacks, all of which suffered the most damages, would require reenforcing if it is desired to withstand the effects of the blasts. Whereever a fore and aft frame support was used the bulkhead forward of that support seemed to withstand the pressure or shock. This was especially true at bulkhead 59 topside where the greatest pressure was exerted and that bulkhead there were no fractures or serious distortions where the bulkhead was strengthened by a fore and aft stiffener. Exposed fittings were generally unsatisfactory if of weak construction. One example was the bracket which held the wing (STS) metal shields on the 20mm guns and used for the protection of the gunner. The shields withstood the blast but the bracket weakened and bent, when

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pressure was exerted on the shields. This bent one shield back (which would have killed the gunner) and temporarily made the gun inoperative. A considerable number of brackets on bulkheads were rusted and promptly carried away as a result of the blast. The desire to keep down topside weights is recognized, but the atomic bomb will mean that more thought and care must be put into stronger and more durable metals.

C. Turrets, Guns, and Directors.

(a) Protected mounts.

1. General condition, including operability; gun protection for personnel on this ship consists of splinter proof shields or gun tubs. The 40 and 20mm guns or mounts were not damaged except the 20mm gun mentioned above. When the ship was "stripped" at Terminal Island Naval Shipyard, the forward port and after starboard 40mm guns were removed. Also all 20mm guns were removed except one on each corner of the O3 superstructure. All these guns will operate if necessary, and have not been damaged sufficiently to prevent their use. The actual firing of the guns can not be tested of course until an opportunity is offered, but with the exception of their alignment no difficulty is anticipated. Gun sights require checking.

2. Effectiveness of installed turrets or shields; the splinter protecting shields or gun tubs resisted all damage except as otherwise noted above. It is considered that the present installations are satisfactory except for minor alterations as will be proposed later in this report.

(b) Unprotected mounts; the 5"/38 AA gun is the only unprotected gun on the ship.

1. General conditions including operability; the 5" AA gun was partly shielded from the blast, due to the gun's position close to the after deckhouse superstructure which partly shielded it. The gun accordingly received no damage. Canvas in the vicinity, however, was ripped to pieces. The flagstaff aft of the gun was bent 30 degrees lower than its previous position. To all intent and purposes and without any opportunity to test the firing of same, it is considered that this gun will operate satisfactorily at the present time.

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2. Effectiveness and sufficiency of crew shelters; these are considered insufficient for the atomic bomb attack. Gun crews particularly must have better protection from blast and radiological materials, or mater. Other persons can run for shelter when warned of an air attack which might mean an atomic or other type of bombing. If the gun crews are to remain on their stations, modification in our present protective devices is required.

(c) Rangefinders and directors.

1. General condition and operability; as a result of the test it is believed that the directors are satisfactory except in alignment and that the rangefinders are operable. The following minor defects exist: Mk14 mod 8 sights require adjusting and overhaul by a firecontrolman. The director tube (40mm) for gun #44, is out of alignment and hence so is director. The test blast knocked the tub stands off 3 of their supports close to the deck with the result that the tower is leaning aft from the vertical about 25 degrees. Battery for the rangefinder was torn loose.

2. Condition of instruments; same as above.

(d) Constructive criticism of design or construction of mounts, directors, foundations, etc.

As mentioned above, there appears to be a decided need for more protection to exposed personnel, and improved mechanical devices to secure parts to mounts, etc. The side shields (splinter protection) on the 20mm guns should be rounded off instead of being flatwings. The 40mm and 5" guns should have STS splinter shields of spherical (or at least some curved surface) surfaces. It is not considered that a splinter proof tub around the 5" gun is practicable, nor is it necessary. A turret mount might help, but this gun is so well protected by the after superstructure that it is not believed advisable to add more unnecessary weight. More emphasis must be placed on a better welding/adhesion for brackets and legs supporting tubs or other objects to prevent their being severed by the atomic blast. If a light strong splinter proof metal can be produced, it is considered that such a metal or plating would be highly desirable.

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to install around the gun, either in a dome arrangement, turret type, or merely a surface so curved as to minimize the effects of the blast. It must be remembered that with the atomic bomb the danger from shell fire, bombs or shrapnel is far less than radiological effects or blast of the atomic bomb.

D. Torpedo Mounts - Depth Charges Gear.

None.

E. Weather Deck.

(a) General conditions of deck - causes of damage.

The most severely damaged weather decking was that forward of frame 59, particularly that section on both sides of the focsle between frames 33 and 59. This deck has been pushed downward about 18'' with the maximum dent at about frame 55. The following damage on the focsle, although not to the decking, will illustrate the force of the blast and pressure to which the decking was subjected. Jackstaff bent aft 45 degrees, metal specimen and forward anchor light brackets blown clear of ship. Lookout chair in bow, demolished. Forward guy to foremast (jackstay) carried away at bolt into turnbuckle. Paint was blasted off the blast tower, forward side of foremast, and other exposed higher surfaces on the focsle. Small 5 gallon test tin and 55 gallon test drums were collapsed. Hawse pipe covers blown clear of ship. Life buoys and rafts scattered about the focsle and over the side. Most damage to rafts was caused by canvas straps carrying away and broken gratings with loss of emergency gear; paddles broken, etc. Dent in topside of anchor windlass control box. Windlass operates. Ladder on forward side of spud locker bent to starboard. Sound telephone on bulkhead ripped out of box. Swab rack aft of blast tower, split a little but usable. Life raft grating just behind swab rack suffered worse damage with broken grating. Top of hatch to forward fire pump room dished in. Door and gratings (metal) blown off after side of spud locker. Metal box inside was crushed. Locker itself has all bulkheads pushed in from pressure. The after-section of shield around 40mm tub port side was scorched inside the tub. Top of hatch to paint locker trunk dished in.

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Door 01-27-1 jammed inward. Forward bulkhead to 40mm clipping room also dished in. One foamite can on bulkhead #27 knocked off rack and demolished. Door to A-0102 (companionway) dished in and name plate over door burned off. Door just forward of this was blown off hinges. Fire hose at cut-out I-27-2 (fire station 01-29-2) blown off at plug. Spare piece of hose was scorched beyond safe use. Hose holden bent. Ventilator cover 01-32-2 dished in. After ladder port side forward deckhouse (from forecastle to top of house) bent aft. Metal rack on bulkhead for helmet stowage, crushed together. After holding down straps on both paravanes carried away, but paravanes remained bolted to deck and were undamaged. Spare 40mm gun barrel metal boxes were bent inward on all sides. Port life line stanchions bent aft and inboard. Two guys or stays to foremast still remained on each side. Port boat boom broken loose from securing bracket. Steam tight globe broken but inside electric light bulb still intact. Starboard boom appears satisfactory except where hit by tug. Army portable announcing equipment stowed on 03 deck, was blown down on to the forecastle, (1 box only). #1 and #2 hatch coaming badly distorted, bent outwards. Test bombs located port and starboard sides at frames 45 and 40 respectively, were undamaged except torn loose from securing padeyes. Fins on bombs slight bent from rolling around deck. Holding down bolts on starboard forward deck winch sheared off at base due to depression made in deck. Both boat skids #1 hatch damaged. Starboard one was blown out on deck. Port ventilation frame 55 (pl-55-2) was sheared off at deck, leaving hole into #1 hold compartment. Starboard ventilator undamaged except where holding down bolts loosened. Troop ammunition hold hatch cover to trunk A-405M was blown in and ended up in bottom of trunk. Similar action had happened to all hatch covers and pontoons to the cargo hatches. All other weather decks sustained only minor damage. #2 hatch and the topside superstructure of the 03 deck are the main exceptions, particularly above B-0309M. The chief cause of damage to the decks was principally the pressure, and partly as a result of the transmission of stresses through frames, etc.

(b) Usability of decks in damaged condition.

They are usable; however, the forecastle deck and top of B-0309 are considered to be the most hazardous for rough weather because the structures and their deformations have not been tested subject to normal sea conditions.

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(c) Condition of equipment and fittings.

1. Mooring and towing fittings; Satisfactory.

2. Boats and boat handling; unsatisfactory. Only one davit is operable (starboard forward davit), and its durability is questioned until a satisfactory test can be conducted. Falls will require overhaul. Two boats could be carried at this davit if too much operation is not required. Other davits and boat booms are not operable. The starboard after davit might be made operable with minor repairs to electrical apparatus and safety test made on davit. The starboard davits would require considerable overhaul with crane services. They are distorted and the after one has collapsed and fallen out of its tracks. It is supported by the superstructure bulkhead at present, and blocks the passageway along the O2 deck port side. One boat which was carried on the evacuation ship still remained operable. All other boats were turned into the boat pool BIKINI.

3. Airplane handling gear, etc.; only boat booms used on this type ship and they are not operable.

4. Barriers, arresting gear, etc.; does not apply.

F. Exterior Hull (above water line).

(a) Condition of exterior hull plating and causes of damage; as described in preceding items, the hull exterior appears to be in good condition. The only damage that could be ascertained was a trace of pressure indication on the port side where faint outlines of the ship's frames and strakes may be observed. This can only be observed under close scrutiny. On the starboard side there are two separate indentions, one of which appears to have been the result of boarding tugs coming alongside, and the other which might be from the same causes or from the result of the bow of the ship being forced to starboard. I am inclined to favor the tug causes because there are no other indications to show that this damage is a result of the test. Both indentations are between frames 20 and 45, and along the main deck strake, although the damage is vertical.

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(b) Condition of exterior hull fittings.

None observed.

(c) Details of any impairment or sheer strakes.

None observed.

(d) Condition of side armor belt.

Does not apply to this ship.

G. Interior Compartments (above water line or armor deck).

(a) Damage to structures and causes.

The primary damage resulted around #1 and 2 hatches. Other miscellaneous damage was of minor nature and is detailed as follows in later sections of this report. The damage to the hatch coamings was indirectly responsible for much more interior damage than would normally have been expected. When the downward pressure was exerted on the cargo hatches, it was strong enough to double in two of the hatch covers. These gave way and their weight, plus the instantaneous pressure on the decking, forced the hatch coamings to bulge and this in turn permitted the hatch pontoons below them, to fall to the bottom of the hatches. In number 1 hatch the debris damaged the test electrical equipment installed at PEARL. In number 2 hatch the airplane was demolished. The distortion of the main deck around these two hatches damaged considerable amount of sheathing and miscellaneous equipment. The dropping of the hatch and pontoon covers left the compartments adjacent to them wide open and exposed to the blast of the bomb. Accordingly more damage resulted inside the ship than would have been the case if the ship had remained closed up. The same remarks apply to the troop ammunition hatch just aft #1 hold.

(b) Damage to bulkheads (joiner) and causes.

Very few places were observed with this type of damage. Most of it was distorted metal due to transmission of the stresses through some other medium.

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(c) Details of damage to access closures and fittings.

This damage has been described in general throughout this report, but certain details are being added. All watertight doors exposed to the blast were pushed inward and all those on the exposed part of 01, 02, and 03 decks had their frames so distorted that it was impossible to open the doors without the use of a sledge hammer, crowbar, or beam. None of the doors when once opened could be closed. Two doors remained closed. Ventilation damage will be covered later. Escape hatches were similarly treated as for the watertight doors.

(d) Condition of equipment within the compartments.

Equipment was damaged wherever it was subjected to unrestricted pressures. Lightweight sheathing around #1 and 2 hatches was bent, fractured, separated and otherwise distorted. Likewise the lockers, bunk stanchions, magazine sprinkler boxes, first aid boxes, and furniture. Most of the damage was done by the movement of the decks and bulkheads, the remainder by debris. The two large doors on the starboard side of the wardroom were hurled into the wardroom and cut off one of the tables as well as banging up the furniture pretty generally. Even office equipment in the damaged parts received its share of damage. The ship's offices suffered considerable damage but not enough to prevent their use. However, here like in other places, the damage was received where closures had been opened by the explosion, this seemed to let in the blast of air that did the damage.

(e) Evidence of fire.

None.

(f) Damage in way of piping, cables, ventilation ducts, etc.

On first boarding the ship it was observed that several pipe connections had been broken. As soon as pressure was placed on the fire main and flushing system, a considerable amount of water started leaking at various connections. Flanges were tightened with a little success but several large ones could not be

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repaired. In such cases the particular section was blanked off or by-passed. Eventually the only section that was cut out was on the starboard side of #1 hold where the fire main had been forced apart due to distortion of the overhead. At present the system operates satisfactorily at anchor but it is doubtful as to how much vibration it would stand at sea.

Electric cables were in general, undamaged. Cables running up the foremast and mainmast were the only ones damaged severely. Others had a few loose connections as a result of equipment being displaced etc. A detailed report of these will be found under the electrical section.

Ventilation ducts as a whole acted very satisfactorily. The ducts around #1 and 2 holds were the only portion of the system that were badly damaged. The most severely damaged part of the system occurred on the main deck port side at frame 56 where the entire blower trunk and vent duct was blasted wide open. On both sides of the hatch the ducts were knocked down and no ventilation operates on that section of the deck. Topside on the upper deck, the same vent trunk was struck hard enough to knock out its bolts to the decking but sufficient number held to keep the trunk upright. On the other side of the deck the trunk was blown overboard. At present the ventilation system is adequate for present operations. Although distorted, the system around #2 hold is operable.

(g) Estimate of reduction in watertight division, utility, etc.

None estimated at present.

#### H. Armor Decks.

Not applicable for this type of ship.

#### I. Interior Compartments (below water line).

(a) Damage to superstructure and causes.

Not applicable to compartments below water line.

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(b) Damage to joiner bulkheads and causes.

None.

(c) Details of damage to access closures and causes.

None.

(d) Condition of Equipment within compartments.

Satisfactory, except as noted in other subheads.

(e) Flooding.

None.

(f) Damage in way of piping, cables, and vent ducts.

None below water line.

(g) Estimate of reduction in watertight subdivision and utility of spaces.

No change.

J. Underwater Hull.

(a) Interior inspection of underwater hull.

Results satisfactory.

(b) Effect of damage on buoyancy, operability, maneuverability, etc.

None observed and none considered likely.

(c) Any known or suspected damage to:

1. Shafts and propellers. None.

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2. Struts. None.

3. Rudder. None.

4. External keel. None.

(d) Details of impairment of keel structure.

None observed.

#### K. Tanks.

(a) Condition of tanks in areas of damage.

None observed and none believed damaged.

(b) Contamination of tanks and liquids.

1. Extent and cause if known. None.

2. Effect on ship's operability. None.

(c) Damage (known or suspected) to torpedo defense system.

None.

#### L. Flooding.

(a) Description of major flooding areas.

None.

(b) Sources of flooding.

1. Opened boundaries. None.

2. Damage or poorly designed system, such as access closures or fittings, ventilation ducts, piping, wiring, etc. None.

(c) List of compartments believed to have flooded slowly so as to be susceptible to damage control.

None.

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M. Ventilation (exclusive of blowers).

(a) Damage to ventilation system and causes.

1. Ducts. It is noteworthy that no damage occurred to ventilation ducts anywhere in the ship except near the cargo hatches where the system was exposed to the blast by the opened hatches. Even though doors to the blower rooms were dished in, and hatches and doors to compartments similarly affected throughout the ship were likewise under pressure, no part of the system was affected in these sections of the ship. In the spaces around number 1 hold the ducts that were protected with lagging suffered the least damage and could have been used again had not the unlagged sections been badly distorted or demolished by falling debris. The only ducts that were exposed to the outside blast and damaged, were those vents on the focsle aft frame 55 and the one on the main deck outboard and aft of the garbage grinder compartment. The latter can be reassembled when time permits. The vent on the port side of the focsle can be welded when the bolts carried away, but the ducts in the compartment below are demolished. The vent on the starboard side of the focsle at frame 55 was blown overboard and left only the opening in the deck. Its counterpart in the compartment below was also destroyed. Vents (particularly vertical ones) exposed topside should be secured better at the deck.

2. Closures. the same comment as above as above applies to the closures.

3. Effect on habitability. The only effects were those around #1 cargo hold. In confined atmosphere, such as rough weather in the tropics, the lack of ventilation in that area would be noticeable. At present its effect is negligible.

(b) Evidences that ventilation system conducted heat blast, fire, or smoke below decks.

None could be observed.

(c) Evidence that ventilation system allowed progressive flooding. None.

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- (d) Constructive criticism of design and construction of system.

Vents and trunks exposed to the outside explosions should be secured by better means to the hull or deck or bulkheads. Ducts through compartments should be lagged as well as possible, everywhere, and not secured to too many places that might be subject to distortion or pressure.

N. Ship Control.

- (a) Damage to ship control stations and causes.

1. Bridge area.

Although the forward bulkhead of the bridge structure was badly damaged, it seems remarkable that the instruments suffered so little. Two days after rehabilitation, all ship control instruments were tested and the ship actually turned over its screws with all hands stationed at their underway stations, and no difficulty with ship control was experienced. No repairs were necessary to accomplish this. The only ship control instruments, in the bridge area that were damaged were the two gyro repeaters in the ends of the bridge wings. Both stands of these instruments were knocked off the centerline and the repeater connections and repeaters damaged beyond repair. Above the bridge on the 03 deck, the single repeater at the fire control station remained operative even though it was near a bulkhead that was split by the force of the blast.

2. CIC room.

No damage was observed; radar however was inoperative due to connections with masts being severed.

3. Gyro-Compass.

No damage; and is operative.

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4. Steering gear.

No damage; and is operative.

5. Interior communications.

Satisfactory for ship control.

(b) Constructive criticism of the ship control system.

1. Layout and arrangement.

Considered satisfactory, except as in comments below.

2. Location with respect to protection.

It will be noted that the comments above applied to the bridge area only. As regards the midship secondary control station on top the superstructure of the O3 deck, it is considered that this station should have more protection. This is not recommended so much for protection of personnel as for both personnel and equipment. It is difficult to determine what damage resulted to this station directly from the explosion because the 24" searchlight landed in the middle of it. From a close analysis it seems that more damage was caused by the searchlight as all instruments were demolished except two. It is therefore recommended that a small weight splinter proof shield be installed around this equipment so as not to block the conning view, but sufficient to protect both personnel and equipment from direct blast and pressure effects. The smoke stacks provide some protection except from the beam. This control station at present is inoperative. The control station on the after deck house is still operative as it was protected by the smoke pot stowage and other shields around that area, such as gun tubs, etc. It seems unusual that the after station was not affected when the smoke generators just a few feet aft were piled up in one corner and damaged beyond use. No additional protection is considered necessary for the after station.

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O. Fire Control.

(a) Damage to fire control stations and causes.

1. Directors and elevated control stations.

The fire control station on top of the bridge structure was not badly damaged, and is almost 100% operative except that there is no way at present to determine if the severance of the connection with the fore and main tops is having any effect on communications with the other stations. Due to all the connection boxes etc., being on the forward bulkhead which was split by the blast, a few repairs were necessary, but nothing of a serious nature.

2. Plot rooms and protected spaces.

Not applicable.

(b) List of stations having insufficient protection and estimated effect on fighting efficiency of the loss of each.

The fire control station on this ship is only slightly protected by bulkhead 59. If this station is eliminated there is no other suitable station available to operate, as control personnel at this post would suffer severe casualties unless more protection is provided from blast and radioactivity.

(c) Constructive criticism of location and arrangement of stations.

The location is considered to be in the best available spot, particularly from the AA control viewpoint. However the present station could be greatly improved by the addition of a parabolic or similar type (inverted) metal shield installed in sections around the control station and on top of the present shield so as to provide protection to the entire human body, and still retain the clear visual overhead and surrounding view. The curve of the additional protection could be fitted in with the streamlining recommended for topside superstructures.

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P. Ammunition Behavior. Note: This ship carries 100% ammunition.

(a) Ready service ammunition, location, protection, behavior, and heat and blast effect.

1. Main battery.

Not applicable.

2. Secondary battery, 5"/38 AA.

No damage to ready service boxes or ammunition. One s.p. sample broken in 5" powder box.

3. 40mm, 20mm, and other.

40mm (gun 41) ammunition in rack around inside of gun tub was shaken up a little. One cartridge knocked out of holding down clips on rack, and was lying flat on its side in same rack. Canvas cover torn off. A few other cartridges knocked loose from clips but did not change position. This gun was forward on the starboard side and partly shielded from the blast. 40mm (gun 44) starboard side aft; ammunition undamaged and not moved. Canvas cover torn off tub.

20mm ammunition in ready boxes undamaged. Canvas protective covers torn off all boxes. Boxes dished in a little from pressure. No other caliber guns are installed.

(b) Magazines, location, protection, forces involved, behavior.

1. Main battery powder and projectiles.

Not applicable.

2. Secondary battery.

5" AA in C-305-306M. One 5" projectile on deck in C-305M where it had fallen. Powder cans in C-306 were

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shaken up but had not fallen out of racks. No damage to ammunition.

3. 40mm; 20mm; others; doors of 40mm magazines.

A-0101M clipping room had door forced in and jammed and thermometer broken. Ammunition not damaged or disturbed. Likewise there was no damage in A404M, C-0104M, C-302M. 20mm magazines; both doors jammed on B-0309M clipping room. Forward bulkhead was dished in aft thus displacing ammunition cans on back side thereof. No damage to ammunition. Sprinkler system damaged due to distortion of overhead. One 20mm magazine fallen to flooring of deck. No damage to C-0104M (clipping room), or C-302M small arms ammunition stowage.

(c) List of stowages which are insufficiently protected and efforts on ship survival of explosion of each stowage.

None.

(d) Behavior of gasoline stowage facilities.

Satisfactory.

Q. Ammunition Handling.

(a) Condition and operability of ammunition handling devices.

1. Main battery hoists.

Not applicable.

2. Secondary battery hoists.

5'' hoist operable and no damage.

3. Passing scuttles.

Operable in all magazines.

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4. Bomb and torpedo elevators.

Not applicable.

- (b) Evidences that any ammunition handling devices contributed to passing of heat, fire, blast or flooding water.

None.

- (c) Constructive criticism of design and construction of ammunition handling devices.

None considered necessary or desirable as all such devices work satisfactorily.

R. Strength.

- (a) Permanent hog or sag.

1. Hull evidence.

None visible to the naked eye. It is possible that the engineers who made the original measurements may have found either or both after the test.

2. Superstructure expansion joints, etc.

Only one observed was the one on top of the 03 superstructure deck, amidships. This is not a true expansion joint but illustrated the amount the deck moved fore and aft, about six inches.

3. Local evidences of longitudinal stresses.

Traces were evident in the deck plating around #1 hatch particularly. Also the paint on the pontoons in the hatches, and the beams that fell into the hatches showed the stress marks in the painted surfaces. These were photographed by the various boarding members of DSM.

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(b) Shear strains in hull plating.

None observed.

(c) Evidences of transverse or racking strains.

None observed except for the possibility of the indentations on the starboard bow at frame 30 to 45 being caused by same.

(d) Details of any local failures in way of structural discontinuities.

It is difficult to determine which failures were caused by which causes. As an example; was the failure of the smoke stacks due to structural failure of the stack, or was the failure a simultaneous one caused by the blast. Actually no failure of materials could be definitely traced to structural failures.

(e) Evidence of panel deflection under blast.

None observed.

(f) Turret, machinery and gun foundations.

No turrets, machinery and gun foundations unaffected, according to available measurements. See engineering report for additional information.

S. Miscellaneous.

(a) Evidence of heat damage variations under various colors of camouflouge painting.

Oil based paint appeared to be burned off more than any other. White enamel held up satisfactorily. It was only necessary to wipe off the soot and the painted bow numerals (for which this paint was used) were as good as new.

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Paint with a plain white base used for numerals on frames, was burned off. This was also used on the draft numerals. Anchor black with an asphalt base appeared to the naked eye as if the heat of the blast had melted some of the tar base. The yellow zinc chromate was burned off. Red iron oxide, and ship's own mixed redlead held up well when used as paint. The parts of the deck on which these were used, lost the top bluegray deck paint from the heat, leaving only the red iron oxide and redlead underneath. On the superstructure the heat left shadows on the paint where the areas were shielded. Description of the loss of paint on the masts, etc., was described in the first part of this report.

(b) Other miscellaneous effects or conditions noted during inspection.

As a matter of record it should be reported that three canvas tarpaulins were used on each of number 1 and 2 cargo hatches for the test. These tarps were securely fastened in three thicknesses in the usual manner over the hatch covers. The reboarding parties found these covers torn in small pieces lying at the bottom of the hatches and mixed in with the debris.

Boat gripes and safety lines were found wrapped around the davit strongbacks. Metal jacob's ladders left over the side of the ship had been whipped to pieces as well as any ropes or lines that were left hanging and exposed.

Wire that remained wrapped with canvas or otherwise covered during the test was in good condition later. Exposed wire, however, such as boat falls etc., seemed to have all the grease extracted from the wire by the heat. The same appeared to be true of any exposed manila rope, which looked dried out.

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## SECTION B - MACHINERY

### A. General Description of Machinery Damage.

#### (a) Overall condition.

Satisfactory; no specific damage observed.

#### (b) Areas of major damage.

None.

#### (c) Primary causes of damage in each area of major damage.

None.

#### (d) Effect of target test on overall operation of machinery plant.

None.

### B. Boilers.

No damage.

### C. Blowers.

No damage.

### D. Fuel Oil Equipment.

No damage.

### E. Boiler Feedwater Equipment.

No damage.

### F. Main Turbines.

No damage.

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G. Reduction Gears. Note: None on main turbines of this vessel.  
The following data is for turbo generator sets.

No damage.

H. Shafting and Bearings.

No damage.

I. Lubrication System.

No damage.

J. Condensers and Air Ejectors.

No damage.

K. Pumps.

No damage.

L. Auxiliary Generators, (Turbine and Gears).

No damage.

M. Propellers.

Topside inspection only, available. Propellers  
appear satisfactory and undamaged.

N. Distilling Plant.

No damage.

O. Refrigeration Plant.

No damage.

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P. Winches, Windlasses, and Capstan.

(a) Foundations and Bodplates.

No damage except to those of number 1 cargo winch, forward. This winch has all but four bolts missing, sheered off by the deck being distorted underneath the winch. The latter is therefore inoperative.

(b) Motors.

No damage.

(c) Brakes and brake lining.

No damage.

(d) Gearing.

No damage.

(e) Hydraulic systems.

None.

(f) Drums, bearings and shafting.

Number 5 cargo winch has bent shaft on capstan. Boat winches 2, 3, 4, can not be tested due to condition of davits and falls.

(g) Fittings, wildcats, valves, etc.

In general all fittings etc., appear to be intact except the controller box of #3 boat davit which was blown off bulkhead.

Q. Steering Engine.

No damage.

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R. Elevators, Ammunition Hoists, Etc.

(a) Machinery foundations.

No damage.

(b) Motors and gearing.

No damage except to package gasoline hoist. This motor is not operating. Time and personnel shortage has not yet permitted a thorough check to determine the difficulty. No outward evidence of damage exists, and it may be electrical trouble.

(c) Hydraulic systems.

No damage.

(d) Guide rails, dredger chains, etc.

No damage.

(e) Elevator platforms.

No damage.

(f) Brakes and brake lining.

No damage.

(g) Control systems and follow-up gear.

No damage.

(h) Miscellaneous.

Hoist in B-03-9M sprinkling system is distorted so that hatch cannot be opened all the way.

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S. Ventilation (Machinery).

(a) Fans and motors.

Damage to only one as covered below.

(b) Foundations and mountings.

Fan and motor at frame 58 port side was damaged by blast. Foundation was distorted on exhaust blower, and sleathing around blower ripped off. Ducts torn down and system is inoperative.

(c) Heaters.

No damage observed although no test has been available.

(d) Miscellaneous.

No observed damage to valves and thormostats, or other connections.

T. Air Compressors.

No damage.

U. Diesels (Generators, and Boats).

No damage.

V. Piping.

(a) Main steam.

No damage.

(b) Auxiliary steam.

No damage.

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(c) Auxiliary exhaust.

No damage.

(d) Condensate and feedwater.

No damage.

(e) Fuel and feedwater.

No damage.

(f) Lub oil.

No damage.

(g) Firemain, sprinkling and water curtains.

No damage in Engineering spaces; No sprinkling or water curtain system is in the Engineering spaces. Water curtain control damaged in compartment #1 hatch port side, bulkhead 58 as covered in first part of report.

(h) Condenser circulating water.

No damage.

(i) Drain.

No damage.

(j) Compressed air.

No damage.

(k) Hydraulic.

No damage.

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(l) Gasoline.

No damage and none on board.

(m) Other systems.

Diesel oil not damaged.

W. Miscellaneous.

(a) Machinery not included in the above groups.

1. Uptakes: Upon reboarding, #1 uptake in the engine room was found to have fractured at the welded seams around the horizontal part where the vertical section rises from the boiler. This damage was definitely caused by the blast. The seam was rewelded and the boiler lighted off satisfactorily.

2. Smoke periscopes: damaged by the blast as covered in the section under aluminum.

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## SECTION C - ELECTRICAL

### A. General Description of Electrical Damage.

#### (a) Overall condition.

Generally very satisfactory, with not much damage, except as noted below.

#### (b) Areas of major damage.

Superstructure decks, masts and holds.

#### (c) Primary causes of damage in each area of major damage.

Combined pressure and blast. Minor damage was caused by distortion of connections as a result of the blast and pressure.

#### (d) Operability of the electric plant.

Ship service generator plant: No. 1 ships service generator lost its residual magnetism; reason unknown. It required 24 volts to reestablish same.

Engine and boiler auxiliaries: No damage.

Electrical propulsion: No damage.

Communications: generally satisfactory; minor damages received. One bull horn on port side at bridge, blown overboard. Both 24" searchlights demolished. One 12" searchlight blown over the side.

Fire control circuits: No damage except to those originally secured to the masts. These have been demolished.

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Ventilation: One panel and motor damaged at frame 58 main deck, port side by #1 hold. Set inoperative.

Lighting: In general undamaged, Navigation light circuits and fixtures damaged on masts. #2 cargo hold lighting system ruptured at branch box frame 110 main deck, starboard side.

(c) Types of Equipment most affected.

Switchboards and switch gear: No damage.

Rotating machinery: No damage.

Motor controllers: Only one damaged was #3 Wellin Davit control panel. This was found lying on the main deck port side, near original bulkhead position. Supply cable had been jerked out but otherwise the control panel appears operable. See #6 under sub-heading (d).

Cables and supports: A few were broken on each mast. One cable ruptured between control panel and #2 wellin davit. Cable in area #2 hold ruptured.

B. Electric Propulsion Rotating Equipment (Propulsion Motors, Generator, Submarine Auxiliary Generators, Exciters, Motor Gen. Sets).

No damage.

C. Electric Propulsion Control Equipment (Propulsion Control Cubicles, Transfer Switch Panels, Controllers, For. Motor Gen. Sets).

No damage.

D. Generators - Ships Service.

No damage.

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E. Generators - Emergency.

No damage.

F. Switchboards - Distribution and Transfer Panels (Ships Service, Emergency, Battery Charging, Lighting and Test Switchboards, Power and Lighting Distribution Panels, Submarine Torpedo Heating and Hydrogen Burning Panels: Transfer Panels, De-gaussing Panels:

No damage.

G. Wiring, Wiring Equipment, and Wireways.

No damage.

H. Transformers (Lighting and I.C.).

No damage.

I. Submarine Propelling Batteries.

Not applicable.

J. Portable Batteries.

No damage.

K. Motors, Motor Generator sets, and Motor Controllers (Motor and Controllers For Engine Room Auxiliaries, Steering Gear, Deck Auxiliaries, Air Condition, Refrigeration, Ventilation, Distilling Equipment Motor Generator Sets For Lighting: Welding Degaussing Battery Charging, Interior Communications Etc.

(a) Rotating Equipment.

Framework and mounting: Mounting for ventilation motor distorted at frame 58 main deck port side.

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Commitator or ship rings: Does not apply.

Brushes and brush rigging: Does not apply.

Bearings: No damage.

Speed regulators: Does not apply.

(b) Control equipment.

Framework and mounting: Mounting for #3 wellin davit broken at bolts, and panel cover is slightly distorted. Mounting for ventilation motor controller and cover distorted.

Electrical connections and wiring: No comment.

Contactors switches and relays: No damage.

Rheostats and resistors: No damage.

Insulating materials: No damage.

Pilot circuit devices: No damage.

Brakes: No damage.

L. Lighting Equipment.

(a) Lamps (Rough service high impact and fluorescent lights).

Several rough service lamps were broken in the forward part of the ship. It is difficult to determine the cause for the breakage as some was due to distortion of the bulkheads, transmission of the blast and pressure, etc. As most of the breakage occurred around #1 and 2 cargo holds, it must be assumed that the same force which broke sheathing bent beams, etc., also demolished lamps.

(b) Reflectors.

Same remarks as above apply.

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(c) Fixture mounts.

Very little damaged.

(d) Shock mounts (U strap type and plate type).

No damage.

(e) Pendent lamp holders.

Do not apply to this ship.

(f) Lamp globes.

Only three broken due to falling debris etc.

M. Searchlights (36'', 24'', 12'' and 8'').

(a) Framework and mountings.

Framework and mountings on both 24'' searchlights were destroyed beyond repair, by the blast. The port 24'' was blown 50' aft and clear of its searchlight platform. The mounting on #3 12'' signal light was bent from the blast. #1 twelve inch signal light was blown overboard.

(b) Front glass.

Glass broken on both 24'' searchlights. Other 12'' undamaged, except as noted above.

(c) Shutter and operating mechanism.

Demolished on the 24'' lights.

(d) Locks and brakes.

Jammed and inoperative on #1 24''; demolished on the other.

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(e) Arc lamp feed rods.

Broken on both 24'' lights.

(f) Incandescent lamps.

No damage, except one lost.

(g) Rheostats.

No damage.

N. Degaussing Equipment.

(a) Compass compensating coils and control boxes.

Magnetic compass at secondary control station was dislocated, breaking cable to compensating coils.

(b) Connection boxes.

No damage.

(c) Heading switches and relays.

No damage.

O. Gyro Compass Equipment.

(a) Master.

No apparent damage received.

(b) Repeaters.

Port and starboard wing (bridge) bearing repeaters were blown overboard by the blast. Stands were bent out of alignment with center line. Repeater at secondary control station was damaged and hanging by its cable; Zeke and inner gimbal ring distorted.

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(c) DRT and DRA.

No damage observed but instruments have not been tested under simulated operating conditions due to lack of available opportunity.

P. Sound Powered Telephones.

(a) Headsets.

None damaged except those in masts at lookout stations.

(b) Handsets.

One on forward bulkhead superstructure on focsle, damaged when ripped out of box.

(c) Jack and switch boxes.

No damage.

(d) Stowage.

No damage.

Q. Ships Service Telephones.

Do not apply to this ship.

R. Announcing Systems.

(a) Portable (PAM and PAB).

No damage.

(b) Amplifier racks.

No damage.

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(c) Control racks.

No damage.

(d) Transmitting station.

Decimeter broken at fire control station.

(e) Reproducers.

No damage.

(f) Inter communicating units.

No damage.

Note: The loss of the port bullhorn and inoperative status that circuit was covered in previous item. Starboard bullhorn is operable.

S. Telegraphs.

No damage.

T. Indicating Systems.

Anemometer indicator on starboard wing of bridge demolished. Instrument itself damaged when mast bent over. Circuit broken to topmast. Rudder angle indicator at secondary control station damaged; face and meter smashed when searchlight hit same.

U. I. C. and A. C. O. Switchboards.

No damage.

V. F. C. Switchboards.

No damage.

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## SECTION D - ELECTRONICS

### A. General Description of Electronic Damage.

#### (a) Overall condition.

The general condition of all Electronics gear can be described as satisfactory except for radar. No severe damage was experienced by radio equipment except the antennas. The loss of the two radars on both topmasts, makes the radar inoperative.

#### (b) Areas of major damage.

Topside wherever equipment was exposed; such as all antennas, and the masts.

#### (c) Primary cause of damage in each area.

The force of the blast did considerable whipping of all wires, and ropes. This plus the falling topmasts, was sufficient to sever all wire antennas. The metal antennas were distorted by the blast or by falling debris. Radar equipment was damaged by both the blast and the falling topmasts also.

#### (d) Operability of Electronic equipment..

By means of jury rigged antenna, the radio equipment can be operated provided not too much power or antenna length is required. The radar is not and cannot operate due to the gear on the topmasts having been damaged beyond repair or use. The fathometer was damaged and did not operate for awhile. Repairs by the technician were successful, however and it now operates. Whether it will continue to do so is a matter of conjecture.

Radar: The SC-4 assembly mounted on the main-topmast was bent **back** by the blast and when the mast (top section) was forced back to a 120 degree angle the radar antenna dropped off and landed on the after deck house. The SG-1 antenna mounted on the foretop was similarly treated except that the radar antenna is still secured, although part of it is missing. All circuits to

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the topmasts have been severed and sections are missing. The BN IFF and the ABK antennas broke loose from their coaxial cables and at present are very insecurely mounted. The VD remote PPI unit in the wheelhouse was knocked loose from its base, but appears to be undamaged, although there are no facilities to test same due to the loss of the antennas.

Radio: All receivers are operable. All transmitters will operate if provided with proper antennas. Three transmitters will contain bad tubes, (1 each). The SCR-624 receiver mounted on the forward bulkhead of the wheelhouse, was knocked loose by the blast on bulkhead 59, but can be repaired.

Sonar: The ship has no sonar equipment, the nearest thing to that type being the fathometer. The NMC fathometer chassis was knocked loose from its support by the distortion of the forward bulkhead in the pilot or wheel house. Its source of power was also severed. Repairs have since made it operable.

Loran: Ship has no Loran gear.

Other apparatus: Radar control rooms appeared to be intact and could undoubtedly operate if the facilities were available.

(c) Types of equipment most effected.

The most exposed equipment, irrespective to type, was the most affected. In this case it was the radar antenna on each topmast, and the radio antennas connected with the masts and signal yardarms. The manner in which the other electronic gear withstood the blast is considered to be a very creditable showing.

U. S. S. CRITTENDEN (APA77)



Defense Special Weapons Agency  
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Alexandria, Virginia 22310-3398

TRC

18 April 1997

MEMORANDUM FOR DEFENSE TECHNICAL INFORMATION CENTER  
ATTENTION: OMI/Mr. William Bush (Security)

SUBJECT: Declassification of Reports

The Defense Special Weapons Agency has reviewed and declassified the following reports:

*AD-367489* XRD-133-Volume 1  
U.S.S. Gasconade (APA 85), Test Baker, Volume 1, Operation Crossroads, Bureau of Ships Group, Technical Inspection Report, Director of Ship Material, Joint Task Force One. Approved by F. X. Forest, Captain, U.S.N., 77 pages.

*AD-367486* XRD-130-Volume 1  
U.S.S. Fallon (APA81), Test Baker, Volume 1, Operation Crossroads, Bureau of Ships AGroup, Technical Inspection Report, Director of Ship Material, Joint Task Force One. Approved by F. X. Forest, Captain, U.S.N., 78 pages.

*AD-377460* XRD-213  
Director of Ship Material, Joint Task Force One, Operation Crossroads, Gross Damage Report, Test Able, dated 6 July 1946.

The DTIC accession number was not available. This office is not sure if DTIC was on distribution for the cited reports.

However, the reports are now **approved for public release; distribution statement "A"** now applies.

*Arldith Jarrett*  
ARDITH JARRETT  
Chief, Technical Resource Center