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TECHNICAL INSPECTION REPORT

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...thority of Joint Chiefs of Staff (Action 15 Apr 49)
... Date ...

U. S. GOVERN... ...RY THROUGH
FROM DDC ...

... Agency
Washington, D. C. 20301

U.S.S. PENNSYLVANIA (BB38)

TEST ABLE

AD No. 366708

OPERATION CROSSROADS

DIRECTOR OF SHIP MATERIAL

CONFIDENTIAL JOINT TASK FORCE ONE

REG. NO.

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TECHNICAL INSPECTION REPORT

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John Bl[illegible] Capt Date 24 Apr 51
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FROM DDC. [illegible]

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

[redacted]

USS PENNSYLVANIA (BB38)

Page 1 of 95 Pages

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Downgraded at 12 year intervals;
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1 JAN 1965

TABLE OF CONTENTS

U.S.S. PENNSYLVANIA (BB 38)

SHIP CHARACTERISTICS

Building Yard: Newport News Shipbuilding Company.

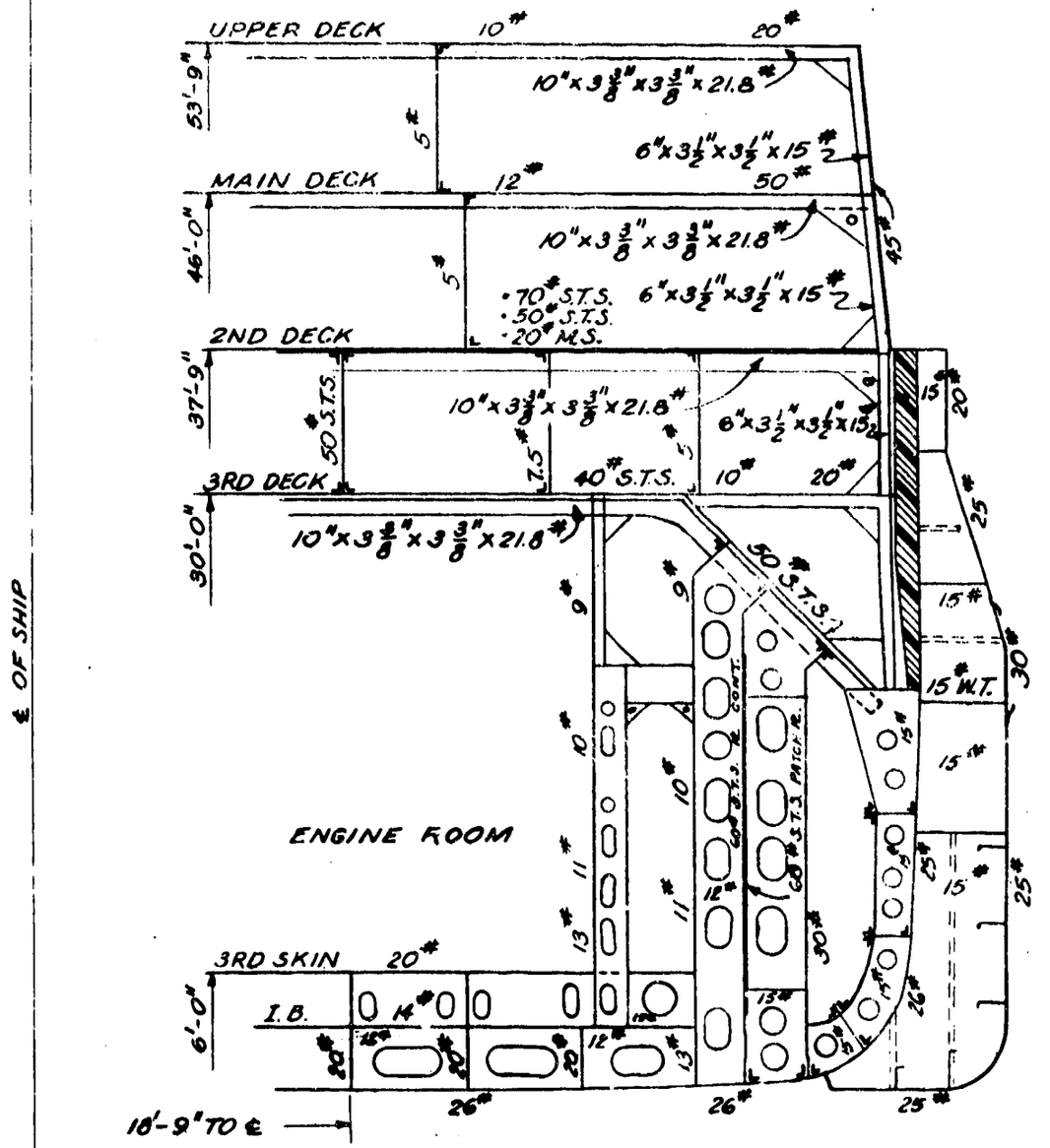
Commissioned: 12 June 1916.

HULL

Length Overall: 612 feet 3 inches.
Length on Waterline; 600 feet 0 inches.
Beam (extreme): 106 feet 3 inches.
Depth (molded at side, to main deck, amidships): 45-feet 1 inch.
Drafts at time of test: Fwd. 30 feet 3 inches.
Aft. 32 feet 3 inches.
Standard displacement: 33,100 tons.
Displacement at time of test: 37,260 tons.

MAIN PROPULSION PLANT

Main Engines: Westinghouse-Curtis turbines. Main high pressure ahead, and cruising. (starboard inboard).
Main high pressure ahead, and cruising. (port inboard).
Main low pressure ahead and astern, and H.P. astern (starboard-outboard.)
Main low pressure ahead and astern, and H.P. astern, (port - outboard).
Boilers: Five installed, type: White Forster express type, Mfg. by Babcock and Wilcox. One installed, type: Bu. of Eng'g. express, mfg by Norfolk Navy Yard.
Main Condensers: Two installed in ship. 14000 sq. ft. cooling surface. Mfg. by Newport News S.B. and D.D. Co,
Reduction Gears: Single reduction, Mfg by Westinghouse Electric and Mfg Co. One installed on each on H.P. a-head turbines and cruising turbines.
Propellers: Four installed in ship, 3 blades.
Main shafting: Four installed in ship. Line shaft O.D.= 12 1/4", I.D. = 7 1/2".
Turbo Generators: Four installed in ship, Mfg. by Westinghous Electric Co. 400 KW.



MIDSHIP SECTION
TEST A

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

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

There is no flooding, hence no change in drafts or list.

(b) Structural damage.

HULL

The light bulkheads in the after side of the foremast superstructure area, in general, are slightly dished. This is particularly true in confined passageways such as between frames 86 and 87 on the upper deck where the peripheral bulkheads are dished about two inches.

A vent intake duct at frame 80, port, which extends from the superstructure deck to the second deck, is bulged through out its length. The plating of smaller branches from this duct has been torn in several places.

Mushroom vent intakes at frame 60 on the upper deck are distorted.

MACHINERY

The stack was slightly dented and its outer casing pushed away about 1/8 inch from the main deck, port side. This does not impair operation.

ELECTRICAL

There was minor structural damage on topside, particularly in the vicinity of the galley and after side of bridge structure. This damage had little if any effect on electrical equipment.

(c) Other damage.

HULL

Operability of machinery, electrical equipment and ship control gear, including navigational equipment, is unimpaired.

Fire control equipment is operable except for the Mk. 14 sights and where damaged by heat from a fire in U. S. Army Quartermaster gear.

Gunnery equipment has not been affected.

The IFF is inoperable because the antennae are damaged. The Mk. 22 is out of commission because electrical wiring has been damaged by an adjacent fire. Other electronic equipment is operable.

MACHINERY

The casing panels of boilers 1, 5 and 6 are bulged and pulled apart at joints. Casing panels of boilers 2, 3 and 4 are slightly bulged. The two forward fresh water pumps were jarred out of alignment.

ELECTRICAL

1. Damage to electrical machinery and electrical elements of ship control, fire control and gunnery as a direct result of the bomb was negligible.

2. Cables to Mk. 57 gun director and Mk. 29 fire control radar located on port superstructure deck and 24 inch searchlight received secondary damage due to fire in Army Quartermaster gear displayed in this area for test.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

A directional flash heat radiating from about 220 degrees relative, scorched and blistered exposed paint. Two thicknesses of paint have been affected. In one place paint has been scorched by reflected heat. There is only slight scorching of decks and other horizontal surfaces.

Exposed signal halyards and life raft lines are scorched. Jute fenders on a U. S. Army amphibious truck at frame 40, port, appeared to be the most vulnerable type of cordage onboard.

MACHINERY

No evidence, except for scorched and blistered paint on exposed side of deck machinery.

ELECTRICAL

Radiant heat coming from 200° to 205° relative, blistered the paint on all exposed electrical cables and equipment located on the port and after side of superstructure. Other than damage to paint there was no adverse effect on this equipment.

(b) Fires and explosions.

HULL

The major fire started in the U. S. Army Quartermaster equipment stacked on wooden pallets between frames 60 and 80 on the port side of the superstructure deck. This equipment consisted of various types of clothing, mess, and outing equipment. This was provided with the standard quartermaster wrapping of waterproof paper and burlap. The debris from the fire has been disarranged by water

from the fire hose so that the point of original ignition cannot be determined, but it broke out about three hours after the burst. It was apparently intensified by the explosion of cans of methyl bromide, D.D.T., and aerosol. The fire spread to life rafts and cork float nets in the vicinity. Considerable damage was done to the wooden deck covering, but the steel deck is undamaged.

MACHINERY

No evidence.

ELECTRICAL

1. A fire originating in Army quartermaster gear displayed on port side of boat deck damaged cables to Mk. 57 gun director, Mk. 29 fire control radar and 24" searchlight.

2. There were no explosions except for one case of small cans of Methyl Bromide and two 5 gallon drums of insect spray in Army quartermaster gear, which caused no damage other than to intensify the fire.

(c) Shock.

HULL

There is no evidence of any damage resulting from shock.

MACHINERY

No evidence.

ELECTRICAL

There was some evidence of shock throughout the vessel. However, except for two fresh water pumps jarred out of alignment and a few lamps broken, electrical equipment was unaffected.

(d) Pressure.

HULL

Blast pressure from the same direction as the radiant flash heat is evidenced by the dishing of flat light metal bulkheads. Wherever the blast entered a pocket between bulkheads, the damage is more severe.

One empty locker on the superstructure deck is blown apart, apparently from internal pressure. This probably happened during rarifaction wave following the pressure wave.

Pressure caused distortion of all six boiler casings in varying degrees. Those with closed registers suffered somewhat greater damage than the two with open registers.

MACHINERY

Blast pressure caused all damage to the machinery installation except the misalignment of the forward fresh water pumps. This was apparently caused by whipping motion of the ship following the blast. The blast apparently came from near the port beam.

ELECTRICAL

This vessel was subjected to a pressure wave coming from 200° to 205° relative which caused minor structural damage, but had no appreciable effect on any electrical equipment. Slight distortion of a few cast aluminum enclosures, minor damage to starboard 24" searchlight and bending of the direction rod on wind direction and wind intensity transmitter, were the only effects on electrical equipment due to pressure.

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

HULL

Effects peculiar to the atom bomb are the long range of the blast, flash heat effects, and the spotty effects of the flash heat.

MACHINERY

A blast pressure sufficient to cause damage at this distance from an explosion is apparently peculiar to the atom bomb.

ELECTRICAL

Radiant heat and heavy blast pressure were the effects noted apparently peculiar to the atom bomb.

III. Effects of damage.

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

HULL

There is no effect on propulsion or ship control. There may have been some temporary adverse personnel effects from the jarring loose of excess dust and dirt.

MACHINERY

Boilers 1, 5 and 6 were made temporarily inoperable by damage to their casings. Repairs could have been made by the ship's force within a few hours. No other damage had any appreciable effect on operability of machinery. Ship control was not affected.

ELECTRICAL

The overall electrical installation suffered only negligible damage, all of which is within the capacity of the ship's force to repair in a relatively short time. Propulsion and ship control were unaffected from an electrical viewpoint.

(b) Effect on gunnery and fire control.

HULL

The operation of exposed gunnery and fire control stations would have been impaired by personnel casualties. The only material damage is to sights on 40mm directors and 20mm mounts.

MACHINERY

No comment.

ELECTRICAL

1. There was no electrical damage as a direct result of the bomb which had any adverse effects on gunnery or fire control.

2. Secondary damage due to fire in Army quartermaster gear did render the Mk. 29 fire control radar and Mk. 57 gun director on port superstructure inoperable.

(c) Effect on watertight integrity and stability.

HULL

There is no effect on the watertight integrity or stability.

MACHINERY

No comment.

ELECTRICAL

Electrical damage had no adverse effects on watertight integrity and stability.

(d) Effect on personnel and habitability.

HULL

There would have been some personnel casualties in exposed stations if the crew had been at general quarters.

The habitability of the ship is unimpaired.

MACHINERY

There would probably have been some personnel casualties among fireroom personnel if the ship had been steaming at the time of the test. Otherwise, it is not believed that personnel below decks would have been affected by the test. The test had no effect on habitability.

ELECTRICAL

1. Probable personnel casualties are estimated to be heavy in all exposed stations on topside, particularly on port side areas. Flash burns, blast damage and radiation sickness would be the principal causes of the casualties.

2. Habitability has not been impaired as a result of any electrical damage.

(e) Total effect on fighting efficiency.

HULL

The fighting efficiency of the ship would have been temporarily impaired by topside personnel casualties and by damage to sights on 40mm directors and 20mm mounts.

MACHINERY

Boiler power would have been reduced by about 50% and maximum speed to about 16 knots temporarily. The damaged boilers

could have been repaired by the ship's force within a few hours, after which full boiler power would be available. The test had no other effect on fighting efficiency, as far as machinery is concerned.

ELECTRICAL

Electrical damage directly attributable to the atom bomb had practically no effect on the fighting efficiency of this vessel.

IV. General Summary of Observers' Impressions and Conclusions.

HULL

Aside from the possible effects of radioactivity, damage is of a minor nature.

MACHINERY

The PENNSYLVANIA was apparently near the limiting range of serious damage to a vessel of her class. It is not believed that boilers of a modern battleship would have been damaged sufficiently to impair operability at the range at which the PENNSYLVANIA was exposed in Test A.

ELECTRICAL

This vessel was subjected to a flash of radiant heat which started fires in combustible materials, followed by an air blast pressure of sufficient magnitude to distort boiler casings, deflect light steel bulkheads and dish doors in topside structure. However, this damage was not severe enough to cause any appreciable change in the electrical installation except for the secondary damage to electric cable due to fire in Army quartermaster gear displayed on port side of boat deck for test.

V. Preliminary Recommendations.

HULL

Topside structure requires redesign, if material and personnel casualties are to be held to an acceptable level. Air lances should be used periodically to insure removal of dirt and dust from inaccessible locations. Cleaning of the ventilation system should be mandatory during every Navy Yard overhaul.

MACHINERY

Boiler casings should be made more resistant to blast pressure.

ELECTRICAL

None.

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.

There is no flooding, hence no change in drafts or list.

(b) Structural damage.

The light bulkheads in the after side of the foremast superstructure area, in general, are slightly dished. This is particularly true in confined passageways such as between frames 86 and 87 on the upper deck where the peripheral bulkheads are dished about two inches.

A vent intake duct at frame 80, port, which extends from the superstructure deck to the second deck, is bulged through out its length. The plating of smaller branches from this duct has been torn in several places.

Mushroom vent intakes at frame 60 on the upper deck are distorted.

(c) Other damage.

Operability of machinery, electrical equipment and ship control gear, including navigational equipment, is unimpaired.

Fire control equipment is operable except for the Mk. 14 sights and where damaged by heat from a fire in U.S. Army Quartermaster gear.

Gunnery equipment has not been affected.

The IFF is inoperable because the antennae are damaged. The Mk. 22 is out of commission because electrical wiring has been damaged by an adjacent fire. Other electronic equipment is inoperable.

II. Forces Evidenced and Effects Noted.

(a) Heat.

A directional flash heat radiating from about 220° relative, scorched and blistered exposed paint. Two thicknesses of paint have been affected. In one place paint has been scorched by reflected heat. There is only slight scorching of decks and other horizontal surfaces.

Exposed signal halyards and life raft lines are scorched. Jute fenders on a U.S. Army amphibious truck at frame 40, port, appeared to be the most vulnerable type of cordage onboard.

(b) Fires and explosions.

The major fire started in the U.S. Army Quartermaster equipment stacked on wooden pallets between frames 60 and 80 on the port side of the superstructure deck. This equipment consisted of various types of clothing, mess, and outing equipment. This was provided with the standard quartermaster wrapping of waterproof paper and burlap. The debris from the fire has been disarranged by water from the fire hose so that the point of original ignition cannot be determined, but it broke out about three hours after the burst. It was apparently intensified by the explosion of cans of methyl bromide, D.D.T., and aerosol. The fire spread to life rafts and cork float nets in the vicinity. Considerable damage was done to the wooden deck covering, but the steel deck is undamaged.

(c) Shock.

There is no evidence of any damage resulting from shock.

(d) Pressure.

Blast pressure from the same direction as the radiant flash heat is evidenced by the dishing of flat light metal bulkheads. Wherever the blast entered a pocket between bulkheads, the damage is more severe.

One empty locker on the superstructure deck is blown apart, apparently from internal pressure. This probably happened during the rarifaction wave following the pressure wave.

Pressure caused distortion of all six boiler casings in varying degrees. Those with closed registers suffered somewhat greater damage than the two with open registers.

(e) Effects apparently peculiar to the atom bomb.

Effects peculiar to the atom bomb are the long range of the blast, flash heat effects, and the spotty effects of the flash heat.

III. Effects of Damage.

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

There is no effect on propulsion or ship control. There may have been some temporary adverse personnel effects from the jarring loose of excess dust and dirt.

(b) Effect on gunnery and fire control.

The operation of exposed gunnery and fire control stations would have been impaired by personnel casualties. The only material damage is to sights on 40 mm directors and 20 mm mounts.

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

There is no effect on the water-tight integrity or stability.

(d) Effect on personnel and habitability.

There would have been some personnel casualties in exposed stations if the crew had been at general quarters.

The habitability of the ship is unimpaired.

(e) Effect on fighting efficiency.

The fighting efficiency of the ship would have been temporarily impaired by topside personnel casualties and by damage to sights on 40mm directors and 20mm mounts.

IV. General Summary of Observers' Impressions and Conclusions.

Aside from the possible effects of radioactiv y, damage is of a minor nature.

V. Preliminary General or Specific Recommendations of Inspection Group.

Topside structure requires redesign, if material and personnel casualties are to be held to an acceptable level. Air lances should be used periodically to insure removal of dirt and dust from inaccessible locations. Cleaning of the ventilation system should be mandatory during every Navy Yard overhaul period.

VI. Instructions for loading the vessel specified the following:

ITEM	LOADING
Fuel Oil	50%
Diesel Oil	50%
Ammunition	50%
Potable and reserve feed water	Full Load
Salt water ballast	1630 Tons
Gasoline	50%

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.

DETAILED DESCRIPTION OF HULL DAMAGE

A. General Description of Hull Damage.

(a) Overall condition of vessel.

The damage is of a minor nature. General views of the exterior are shown on pages 53 to 62, inclusive.

(b) General area of hull damage.

Damage is largely confined to the superstructure.

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

Dishing of bulkheads in the superstructure has been caused by blast pressure. Scorched paint has been caused by the radiant flash heat. Damage to the boiler casings has been caused by blast pressure.

(d) Principal areas of flooding.

There is no flooding.

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

Strength, buoyancy, and operability are unaffected.

B. Superstructure.

The athwartship bulkheads in the bridge area are dished up to two inches. Bulkhead stiffeners are bent to conform with the bulkheads. Three air port rings are partially torn from the bulkheads as a result of the bulkhead dishing.

Longitudinal bulkheads on the port side of the bridge area are dished from 1/2 to 1-3/4 inches. The bulkheads in this area are

10 pound mild steel and 1/4 inch brass. The bulkhead stiffeners are 1/2 inch by 3-inch mild steel angles except those in the RCM shack (Emergency Cabin Platform, frame 67) which are 1/4 inch by 2-inch brass channels. Quick acting doors are dished to conform with bulkheads but are not otherwise damaged.

Wire screens for fireroom uptakes in the superstructure deck are dished in.

The fire on the port side of the superstructure deck between frames 60 and 70 has burned the paint on the after side of the amidships deck housing, the Mk 57 director tower at frame 78, and the port 5 inch gun mount at frame 82. The heat does not appear to have warped the structure in this area.

One life raft on the outboard side of Nos. 8, 5, inch gun mount has been blown off by the blast.

Gear lockers on the port side of the superstructure deck are dished. One has been blown open apparently by relative internal pressure during the rarifaction wave.

The outer plating of the smoke stack is dished both port and starboard to a height of 20 feet above the superstructure deck. The maximum dish is four inches.

Two RBH-1 radio receivers in Flag Radio, in the foremast structure, have been wrenched from their "shockproof" mountings and thrown on the deck. One set is working. The other is out of commission but its damage is of a minor nature.

One 1-1/2 inch drain line from the incinerator and a flushing line to the bridge are damaged.

The transverse passageway at frame 87 on the upper deck formed a trap for the blast. Bulkheads around the periphery of this passageway are bulged generally about two inches. The longitudinal bulkhead that is the port extremity of the passageway is pulled away from the overhead.

(b) Causes of damage.

Damage is due to blast pressure, to radiant flash heat, and to the fire in the superstructure deck.

(c) Evidence of fire in the superstructure.

U.S. Army Quartermaster gear supplied wit h the standard quartermaster wrapping of waterproof paper and burlap was stored on the port side of the superstructure deck. Fire broke out in this gear about three hours after the burst. The type of material that first ignited cannot be determined. The wooden deck covering is generally burned on the port side between frames 60 and 80. Paint on structures and equipment nearby is burned. Cables and transformers in the radio tower at frame 70 on the port side are damaged by the heat. Standard life rafts hanging nearby are partially burned. Some cans of methyl bromide, DDT, and serosol spray stored nearby were blown open and all have lost their contents. (Photos 1808-10, 9, 12, pages 63, 64, and 65).

There is no evidence of any other fire.

(d) Estimate of relative effectiveness against heat and blast.

Flat surfaces normal, or nearly so, to the blast seem more susceptible to blast damage than do rounded surfaces.

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

No recommendations.

C. Turrets, Guns and Directors.

(a) Protected Mounts.

1. General condition, including operability, if known.

Outside painted surfaces of armor boxes and barbettes are slightly scorched from radiated heat but there is no indication that flame reached the interior of the turrets. One canvas gun

port buckler on turret 4 has a seam ripped from the blast. But there is no evidence of scorching on either the canvas or leather bucklers. The turrets are otherwise undamaged and the operability is not affected.

2. Effectiveness of installed turrets or shields.

Satisfactory.

(b) Unprotected Mounts.

1. General condition, including operability, if known.

Except for a slight scorching of the exterior surfaces the mounts are undamaged and the operability is not affected.

2. Effectiveness and sufficiency of crew shelters.

The crews do not have sufficient protection from the heat of the bomb under the conditions of this test.

(c) Directors and Rangefinders (In 14" turrets).

1. General condition, including operability, if known.

No damage.

2. Condition of instruments therein.

No damage.

(d) Constructive criticism of design or construction of mounts, directors, foundations, and shelters.

No comment.

D. Torpedo Mounts, Depth Charge Gear.

Not Applicable.

E. Weather Deck.

(a) General condition of deck and causes of damage.

Weather decks are slightly scorched where not shielded from the explosion. The wooden deck covering has been burned by the fire in the quartermaster gear stowed on the port side of the superstructure deck between frames 60 and 70. The steel deck is apparently unaffected. Deck deflection gage readings are tabulated on pages 67 and 68.

(b) Usability of deck in damaged condition.

The usability of the deck is unimpaired.

(c) Condition of equipment and fittings.

Three life rafts are missing. Four have been burned by the quartermaster gear fire.

The airplane handling gear and catapult were out of commission prior to the test.

F. Exterior Hull. (above water line).

No damage.

G. Interior Compartments (above armor deck).

(a) Damage to structure and causes.

There is no damage to structures.

(b) Damage to joiner bulkheads.

There is no damage to joiner bulkheads.

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

There is no damage to access closures or fittings.

(d) Condition of equipment within compartments.

There is no damage to equipment within compartments.

(e) Evidences of fires.

There is no evidence of fire.

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

Several ventilation ducts are blown open at the seams and joints where the ducts turn. Inspection plates are blown off. Baker-type valves are distorted so that they cannot be opened. Tare-type vent covers are blown off where no other valve is in the line. Able-type valves gave no trouble.

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

There is no reduction in watertight subdivision, habitability or utility.

H. Armor Decks and Miscellaneous Armor.

(a) Damage to armor deck and causes.

There is no damage to the armor deck.

(b) Protection afforded spaces below.

Complete protection is afforded to spaces below, except at the uptakes.

(c) Condition around openings.

The uptake bulkheads to the after distribution and blower room, C-202-6, are bulged. Riveted seams have failed. The bulkheads are of 10 pound plate.

(d) Condition of connections to vertical armor.

There is no visual damage to connections of vertical armor.

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

(a) Interior inspection of underwater hull.

There is a slight additional wrinkling and buckling of bulkheads and decks in the area of prior torpedo damage on the starboard side, aft.

(b) Damage to joiner bulkheads and causes.

There is no damage to joiner bulkheads.

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

There is no damage to access closures.

(d) Condition of equipment within compartments.

Pressure caused distortion of all six boiler casings in varying degrees. Those with closed registers suffered somewhat greater damage than the two with open registers.

(e) Flooding.

There is no flooding.

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

There is no damage in way of piping or cables.

One tare-type vent cover has been blown off in A-516-M-P crews space on the 3rd deck, port side, between bulkheads 48 and 60. A second has been blown off in the after distribution room, C-401, on the first platform between bulkheads 78 and 84.

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

There is no reduction in watertight subdivision, habitability or utility of spaces.

J. Underwater Hull.

No damage is known or suspected.

K. Tanks.

No damage.

L. Flooding.

None.

M. Ventilation.

(a) Damage to ventilation system and causes.

Ventilation screens are blown in on the top side of vent trunks leading from the superstructure deck to the engineering spaces. Several ventilation ducts above the armor deck are blown open at the seams and joints where ducts turn. Inspection plates are blown off. Baker-type valves are distorted so that they cannot be opened. Tare-type vent covers have been blown off where there are no other valves in the line. Able-type valves gave no trouble.

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

There is some evidence of blast at the end of vent ducts.

(c) Evidence that ventilation system allowed progressive flooding.

The system did not allow progressive flooding.

(d) Constructive criticism of design and construction of system.

No comment.

N. Ship Control.

No damage.

O. Fire Control.

(a) Damage to fire control stations and causes.

The Mk. 14 gunsight of the after port and starboard Mk. 51 directors are damaged and rendered inoperable by heat and blast.

All Mk. 63's of the fire control system are inoperable. One of the two Mk. 51's of the fire control system is also inoperable.

(b) List of stations having insufficient protection and estimated affect on fighting efficiency of the loss of each.

The following stations are insufficiently protected:

1. 40MM mounts.
2. Mark 51 directors.
3. 20MM mounts.

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

No comment.

P. Ammunition Behavior.

Ready service ammunition is unaffected. Magazines are unaffected. Stowage protection is adequate.

Gasoline stowage is unaffected.

Q. Ammunition Handling.

Ammunition handling equipment is unaffected.

R. Strength.

There is no evidence of any damage that would affect the ship's strength.

S. Miscellaneous.

No comment.

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 stack was slightly dented and its outer casing pushed away about 1/8 inch from the main deck, port side. This does not impair operation.

(c) Other damage.

The casing panels of boilers Nos. 1, 5, and 6 are bulged and pulled apart at joints. Casing panels of boilers Nos. 2, 3 and 4, are slightly bulged. The two forward fresh water pumps were jarred out of alignment.

II. Forces Evidenced and Effects Noted.

(a) Heat.

No evidence, except for scorched and blistered paint on exposed side of deck machinery.

(b) Fires and explosions.

No evidence.

(c) Shock.

No evidence.

(d) Pressure.

Blast pressure caused all damage to the machinery installation except the misalignment of the forward fresh water pumps. This was apparently caused by whipping motion of the ship following the blast. The blast apparently came from near the port beam.

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

A blast pressure sufficient to cause damage at this distance from an explosion is apparently peculiar to the atom bomb.

III. Effects of Damage.

(a) Effect on machinery and ship control.

Boilers Nos. 1, 5 and 6 were made temporarily inoperable by damage to their casings. Repairs could have been made by the Ship's Force within a few hours. No other damage had any appreciable effect on operability of machinery. Ship control was not affected.

(b) Effect on gunnery and fire control.

No comment.

(c) Effect on watertight integrity and stability.

No comment.

(d) Effect on personnel and habitability.

There would probably have been some personnel casualties among fireroom personnel if the ship had been steaming at the time of the test. Otherwise, it is not believed that personnel below decks would have been affected by the test. The test had no effect on habitability.

(e) Total effect on fighting efficiency.

Boiler power would have been reduced about 50% and maximum speed to about 16 knots temporarily. The damaged

boilers could have been repaired by the ship's force within a few hours, after which full boiler power would be available. The test had no other effect on fighting efficiency, as far as machinery is concerned.

IV. General Summary of Observers' Impressions and Conclusions.

The PENNSYLVANIA was apparently near the limiting range of serious damage to a vessel of her class. It is not believed that boilers of a modern battleship would have been damaged sufficiently to impair operability at the range at which the PENNSYLVANIA was exposed in Test A.

V. Preliminary Recommendations.

Boiler casings should be made more resistant to blast pressure.

DETAILED DESCRIPTION OF MACHINERY DAMAGE

A. General Description of Machinery Damage.

(a) Overall condition.

Casing panels were pulled apart and bulged on boilers Nos. 1, 5 and 6. There was slight bulging of the casing panels of boilers Nos. 2, 3 and 4. The stack was slightly dented and pulled away from the main deck, port side, up to a maximum of about 1/8 inch.

(b) Areas of major damage.

No. 1 fireroom.

(c) Primary causes of damage.

Blast pressure.

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

Some personnel casualties would probably have occurred in the firerooms if they had been in operation. The ship might have been without boiler power for a few minutes, after which she could have resumed steaming but at reduced speed.

Boilers Nos. 1, 5 and 6 were made inoperable by the damage to their casings. They could have been repaired by the ship's force within a few hours, after which normal operation could have been resumed.

B. Boilers.

(a) Air casings.

No appreciable damage to the air casings of boilers Nos. 2, 3 and 4 resulted from the blast. There was slight

bulging of side casings on these boilers, resulting in inconsequential air leakage through the joints. These boilers were operable without repairs.

On boilers No. 1 and 6 the outboard and the inboard side casings were bulged sufficiently to cause toggle bolts to slip from their slots. The casing panels were displaced leaving openings up to 1 1/2 inches wide. This damage could be repaired by the ship's force, and the boilers returned to service, in approximately three hours.

On boiler No. 5 the backwall was bulged, leaving an opening 1/4 inch wide at connection where the wall fits around the steam drum. No appreciable damage to the side casings on this boiler occurred Repairs of this boiler could be accomplished by the ship's force within about four hours.

The burner registers on boilers No. 5 and 6 were open at the time of the blast.

(b) External fittings.

The external fittings on the boilers are undamaged.

(c) Fuel oil burner assemblies.

The fuel oil burner assemblies on the boilers sustained no apparent damage. All pressure fittings are intact, and no distortion or disarrangement of the air doors is apparent.

(d) Brickwork and furnaces.

With the exception of slight spalling of the plastic fronts of the boilers, no damage was sustained by the brickwork and furnaces.

(e) Steam and water drums.

The steam drums and water drums on all boilers are undamaged. Hydrostatic tests indicate no change in the tightness of the boilers.

Boilers No.1,2 and 5 were left under hydrostatic pressure of 300 lbs/sq.in. at 1200, on 30 june 1946. Upon

return of the crew at 1530, on 3 July 1946, the pressure remaining on these boilers was as follows:

1. Boiler No. 1, 35 lbs./sq. in.
2. Boiler No. 2, 65 lbs./sq. in.
3. Boiler No. 5, 60 lbs./sq. in.

HYDROSTATIC TESTS

Boiler No. 1.

	Before Test A.	After Test A.
Initial Pressure	387 1/2 lbs./sq. in.	387 1/2 lbs./sq. in.
Pressure remaining after:		
30 minutes	371 lbs./sq.in.	300 lbs./sq. in.
24 hours	256 lbs./sq. in.	155 lbs./sq. in.

Boiler No. 2.

Initial Pressure	387 1/2 lbs./sq. in.	387 1/2 lbs./sq. in.
Pressure remaining after:		
30 minutes	367 lbs./sq. in.	361 lbs./sq. in.
24 hours	255 lbs./sq. in.	265 lbs./sq. in.

Boiler No. 5.

Initial Pressure	387 1/2 lbs./sq. in.	387 1/2 lbs./sq. in.
Pressure remaining after:		
30 minutes	376 lbs./sq. in.	370 lbs./sq. in.
24 hours	260 lbs./sq. in.	280 lbs./sq. in.

(f) Tubes.

The tubes are undamaged. See (e) above.

(g) Foundations.

Undamaged.

(h) Stack and uptakes.

The outer stack was slightly dished in several places, port and starboard. The function of the stack was not impaired. The drain line from the incinerator on the starboard side of the stack was ruptured.

C. Blowers.

Undamaged. All units turn freely by hand. No defects were observed. Three units have been operated by steam at normal operating speed and pressure.

D. Fuel Oil Equipment.

Undamaged. All fuel oil equipment has been in service since Test A. No damage was observed.

E. Boiler Feedwater Equipment.

Undamaged. All feedwater equipment has been in service since Test A, and functions normally.

F. Main Turbines.

Undamaged. Turbines No. 1 and 2 were inoperable before Test A. Their condition was not changed by the test. Turbines No. 3 and 4 were operated ahead and astern after Test A.

BEARING LEAD DATA

STARBOARD H. P. TURBINE - FORWARD BEARING

Forward lead	Before Test A	After Test A	Difference
Port	.007	.006	.001
Top	.005	.005	.000
Starboard	.007	.006	.001
Center lead			
Port	.008	.0065	.0015
Top	.007	.007	.000
Starboard	.0085	.005	.0035
After lead			
Port	.009	.006	.003
Top	.009	.0085	.0005
Starboard	.005	.0045	.0005

STARBOARD H. P. TURBINE - AFTER BEARING

Forward lead			
Port	.005	.004	.001
Top	.007	.007	.000
Starboard	.006	.006	.000
Center lead			
Port	.005	.005	.000
Top	.007	.007	.000
Starboard	.005	.005	.000
After lead			
Port	.006	.005	.001
Top	.007	.007	.000
Starboard	.005	.005	.000

L. P. AHEAD TURBINE - FORWARD BEARING

Forward lead	Before Test A	After Test A	Difference
Port	.0125	.012	.0005
Top	.032	.027	.005
Starboard	.015	.014	.001
Center lead			
Port	.018	.017	.001
Top	.0275	.023	.0045
Starboard	.011	.009	.002
After lead			
Port	.021	.019	.002
Top	.032	.0235	.0085
Starboard	.009	.0075	.0015

L. P. AHEAD TURBINE - AFTER BEARING

Forward lead			
Port	.0175	.0165	.001
Top	.031	.021	.010
Starboard	.018	.011	.007
Center lead			
Port	.014	.014	.000
Top	.029	.023	.006
Starboard	.016	.0125	.0035
After lead			
Port	.014	.014	.000
Top	.032	.029	.003
Starboard	.0175	.011	.0065

G. Reduction Gears.

Undamaged. Reduction gears No. 3 and 4 were operated after Test A, incident to operation of the main turbines. They are satisfactory.

H. Shafting and Bearings.

Undamaged. Shafting and bearings were checked while the shafts were being turned, and functioned normally.

I. Lubrication System.

Undamaged. All parts of the system have been operated under service conditions and no defects have been found.

J. Condensers and Air Ejectors.

Undamaged. Main and auxiliary condensers that were operable before Test A have been operated since the test, and functioned normally.

K. Pumps.

The two forward fresh water pumps were thrown out of alignment by whipping motion of the ship following the blast. There is no other damage to pumps, all of which have been operated satisfactorily since Test A.

L. Auxiliary Generators (Turbine and Gears).

Undamaged. All turbo-generators have been operated under load and found satisfactory.

M. Propellers.

The propellers were inspected by divers after Test A. They were not damaged.

N. Distilling Plant.

Undamaged. The main distilling plant was placed in operation immediately after Test A, and functions normally.

Visual inspection of the emergency distilling plant reveals no damage.

O. Refrigerating Plant.

Undamaged. The refrigerating plant was placed in operation immediately after Test A, and functions normally.

P. Winches, Windlasses and Capstans.

Undamaged. The anchor windlass was operated under service conditions satisfactorily while hauling in and laying out about 10 fathoms of chain. All winches operable before the test were operated under service conditions after the test. The after starboard winch and after capstan were inoperable before Test A but their condition was not changed by the test.

Q. Steering Engine.

Undamaged. The steering gear has been operated by steam since Test A. The electric steering was inoperable before Test A. Its condition was not changed by the test.

R. Elevators, Ammunition Hoists, Etc.

Undamaged. The boat and airplane crane was inoperable before the test. Its condition was not changed by Test A. The ammunition hoists were operated after Test A, and functioned normally.

S. Ventilation (Machinery).

Undamaged. All ventilation machinery was operated after Test A, and functioned normally.

T. Air Compressors.

Undamaged. All compressors were operated satisfactorily after Test A.

U. Diesels (Generators and Boats).

Undamaged. The diesel generators were operated after Test A, and functioned normally.

V. Piping.

Undamaged. All piping was tested at normal working pressures after Test A. Performance was normal.

W. Miscellaneous.

Undamaged. Laundry, galley, and machine shop equipment was operated after Test A, and functioned normally.

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.

Drafts after test, and list - not observed. Flooding - none.

(b) Structural damage.

There was minor structural damage on topside, particularly in the vicinity of the galley and after side of bridge structure. This damage had little if any effect on electrical equipment.

(c) Other damage.

Damage to electrical machinery and electrical elements of ship control, fire control and gunnery as a direct result of the bomb was negligible.

Cables to Mk. 57 gun director and Mk. 29 fire control radar located on port superstructure deck and 24" searchlight received secondary damage due to fire in Army quartermaster gear displayed in this area for test.

II. Forces Evidenced and Effects Noted.

(a) Heat.

Radiant heat coming from 200° to 205° relative, blistered the paint on all exposed electrical cables and equipment located on the port and after side of superstructure. Other than damage to paint there was no adverse effects on this equipment.

(b) Fires and explosions.

A fire originating in Army quartermaster gear displayed on port side of boat deck damaged cables to Mk 57 gun director, Mk 29 fire control radar and 24" searchlight.

There were no explosions except for one case of small cans of Methyl Bromide and two 5 gal. drums of insect spray in Army quartermaster gear, which caused no damage other than to intensify the fire.

(c) Shock.

There was some evidence of shock throughout the vessel. However, except for two fresh water pumps jarred out of alignment and a few lamps broken, electrical equipment was unaffected.

(d) Pressure.

This vessel was subjected to a pressure wave coming from 200° to 205° relative which caused minor structural damage, but had no appreciable effect on any electrical equipment. Slight distortion of a few cast aluminum enclosures, minor damage to starboard 24" searchlight and bending of the direction rod on wind direction and wind intensity transmitter, were the only effects on electrical equipment due to pressure.

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

Radiant heat and heavy blast pressure were the effects noted apparently peculiar to the atom bomb.

III. Effects of Damage.

(a) Effect on propulsion and ship control.

The overall electrical installation suffered only negligible damage, all of which is within the capacity of the ship's

force to repair in a relatively short time. Propulsion and ship control were unaffected from an electrical viewpoint.

(b) Effect on gunnery and fire control.

There was no electrical damage as a direct result of the bomb which had any adverse effects on gunnery or fire control.

Secondary damage due to fire in Army quartermaster gear did render the Mk 29 fire control radar and Mk 57 gun director on port superstructure inoperable.

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

Electrical damage had no adverse effects on water-tight integrity and stability.

(d) Effect on personnel and habitability.

Probably casualties are estimated to be heavy in all exposed stations on topside, particularly on port side areas. Flash burns, blast damage and radiation sickness would be the principal causes of the casualties.

Habitability has not been impaired as a result of any electrical damage.

(e) Total effect on fighting efficiency.

Electrical damage directly attributable to the atom bomb had practically no effect on the fighting efficiency of this vessel.

IV. General Summary of Observers' Impressions and Conclusions.

This vessel was subjected to a flash of radiant heat which started fires in combustable materials, followed by an air blast pressure of sufficient magnitude to distort boiler casings, deflect light

steel bulkheads and dish doors in topside structure. However, this damage was not severe enough to cause any appreciable change in the electrical installation except for the secondary damage to electric cable due to fire in Army quartermaster gear displayed on port side of boat deck for test.

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

None.

DETAILED DESCRIPTION OF ELECTRICAL DAMAGE

A. General Description of Electrical Damage.

(a) Overall condition.

The main and emergency generating plant, distribution switchboards, power and lighting distribution panels and motor driven engine and boiler auxiliaries were undamaged and operable. Two motor driven fresh water pumps of obsolete design were jarred out of alignment, the motors were undamaged.

Cables to a Mk 57 gun director and Mk 29 fire control radar located on the superstructure, port side amid ship and 24" searchlight were damaged by fire originating in Army quartermaster gear displayed in this area for test.

The covers on a few cast aluminum enclosures of electrical equipment located in areas of maximum structural damage were slightly distorted, and the direction rod for the wind direction and intensity transmitter was bent as a result of blast pressure. There was no damage to the interior of these units.

(b) Areas of major damage.

There were no areas of major damage. Minor damage occurred on the port and after side of bridge structure and port side of boat deck amidship.

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

Radiant heat and blast pressure.

Fire originating in Army quartermaster gear displayed for test between frames 63 to 80 on port side of boat deck.

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

1. Ship's service generator plant - undamaged and operable.

2. Engine and boiler auxiliaries - undamaged and operable.

3. Electrical propulsion - not applicable.

4. Communications - undamaged and operable, except for minor damage to starboard 24" searchlight and direction rod for wind direction and intensity transmitter.

5. Fire control circuits - secondary damage to fire in the Army quartermaster gear rendered the Mk 29 fire control radar and Mk 57 gun director on port side of superstructure amid inoperable.

6. Ventilation - undamaged and operable.

7. Lighting - there was no damage to any lighting equipment, except for several lamps broken throughout the ship.

(e) Types of equipment most affected.

Cast aluminum enclosures exposed to blast pressure, especially searchlights.

B. Electric Propulsion Rotating Equipment.

Not applicable.

C. Electric Propulsion Control Equipment.

Not applicable.

D. Generators - Ships Service.

Undamaged and operable.

E. Generators - Emergency.

Undamaged and operable.

F. Switchboards, Distribution and Transfer Panels.

Undamaged and operable. Fuses in power panel No. 4 located in ward room frame 108 port side of main deck were jarred out of their clips. The required fuse retainers never had been installed.

G. Wiring, Wiring Equipment and Wireways.

(a) Cable.

The cables to Mk 57 gun director and Mk 29 fire control radar located at frame 80 on superstructure deck, port side and 24" searchlight received secondary damage due to fire in Army quarter master gear displayed on boat deck for test.

(b) Wireway supports.

Undamaged.

(c) Wiring equipment.

Undamaged.

H. Transformers.

(a) Framework and mountings.

Undamaged.

(b) Electrical connections.

The ship's service power, lighting and I.C. transformers were undamaged and operable.

Two transformers located in Mk 28 radar control station frame 80 on port side of superstructure deck for radar supply received secondary damage due to heat from fire outside of station in Army quartermaster gear displayed for test.

I. Submarine Propelling Batteries.

Not applicable.

J. Portable Batteries.

Undamaged.

K. Motors, Motor Generator Sets and Motor Controllers.

(a) Rotating Equipment.

Two fresh water pumps of obsolete design were jarred out of alignment. The motors were undamaged. All other units were undamaged and operable.

(b) Control Equipment.

Undamaged and operable.

L. Lighting Equipment.

(a) Lamps.

Several lamps below main deck were broken. The rough service type installed for test were undamaged.

M. Searchlights.

The turn table was loose and door hinge broken (cast aluminum) on the starboard 24" searchlight due to blast pressure.

N. Degaussing Equipment.

Undamaged.

O. Gyro Compass Equipment.

(a) Master gyro.

Undamaged.

(b) Repeaters.

The door in the port bearing repeater stand, Mk 7, Mod. 1 located on navigating bridge was distorted by blast pressure and could not be secured.

P. Sound Powered Telephones.

Undamaged.

Q. Ship's Service Telephones.

The cover on a Type "C" automatic telephone located on port side of navigating bridge was distorted due to blast pressure. There was no damage to the interior.

R. Announcing Systems.

Undamaged and operable.

S. Telegraphs.

Undamaged and operable.

T. Indicating Systems.

The direction rod for wind direction and intensity transmitter located on starboard yard arm, was bent about 30° out of line. The transmitter was undamaged and operable. There was no other damage to indicating systems.

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

Undamaged and operable.

V. F.C. Switchboard.

Undamaged and operable.

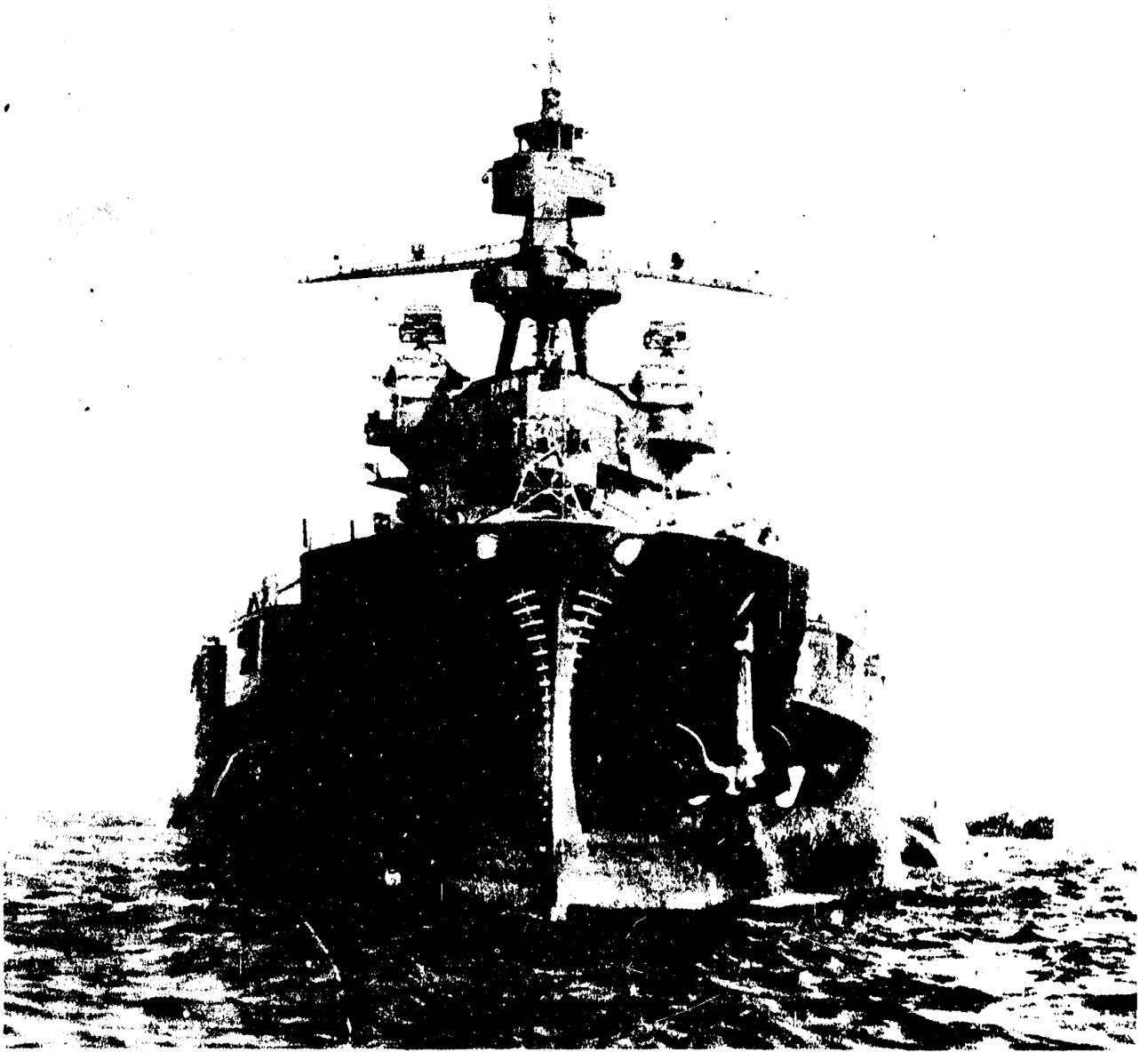
W. Special Materials (Bureau of Ships Code 660).

Undamaged.

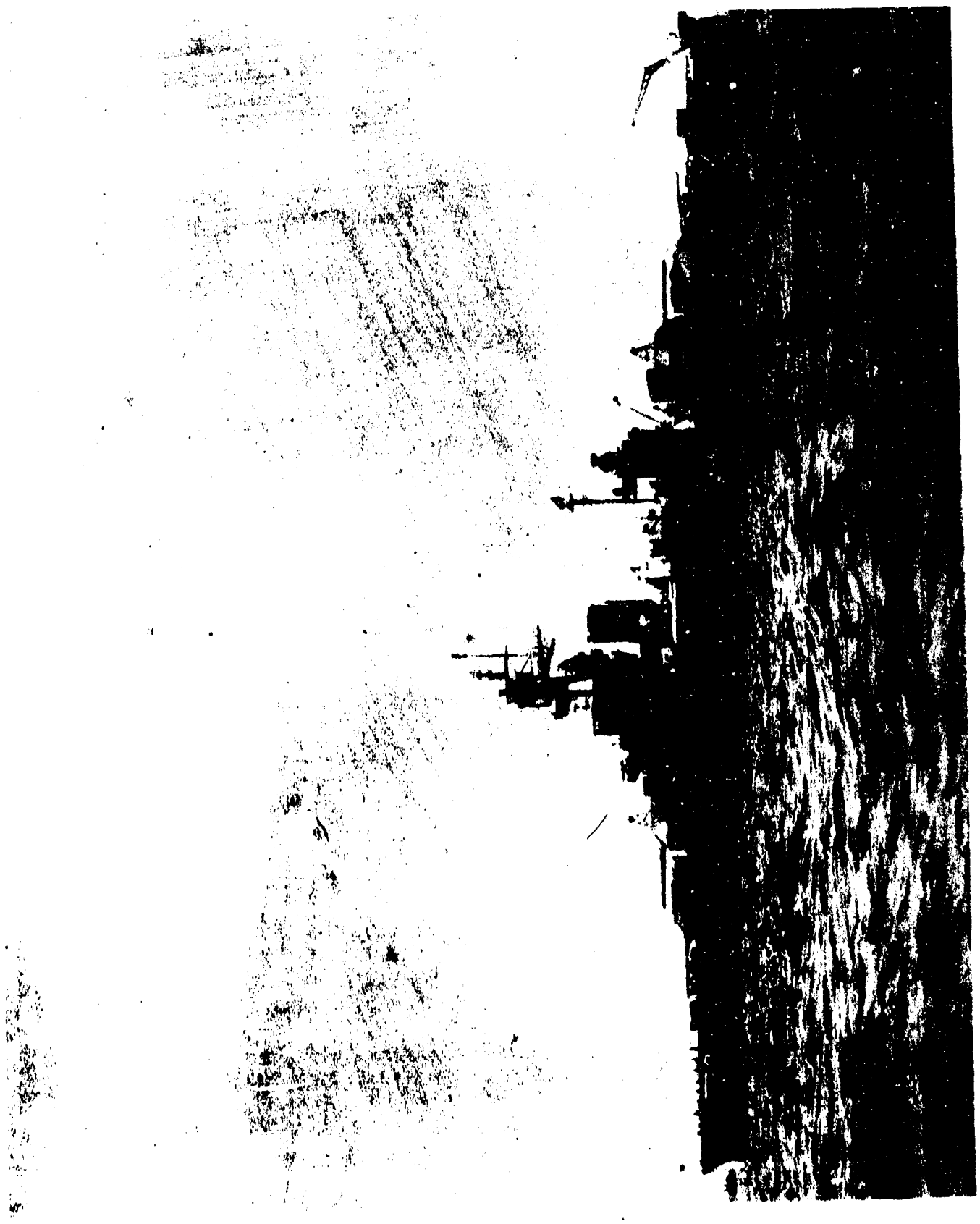
SECTION IV

PHOTOGRAPHS

TEST ABLE

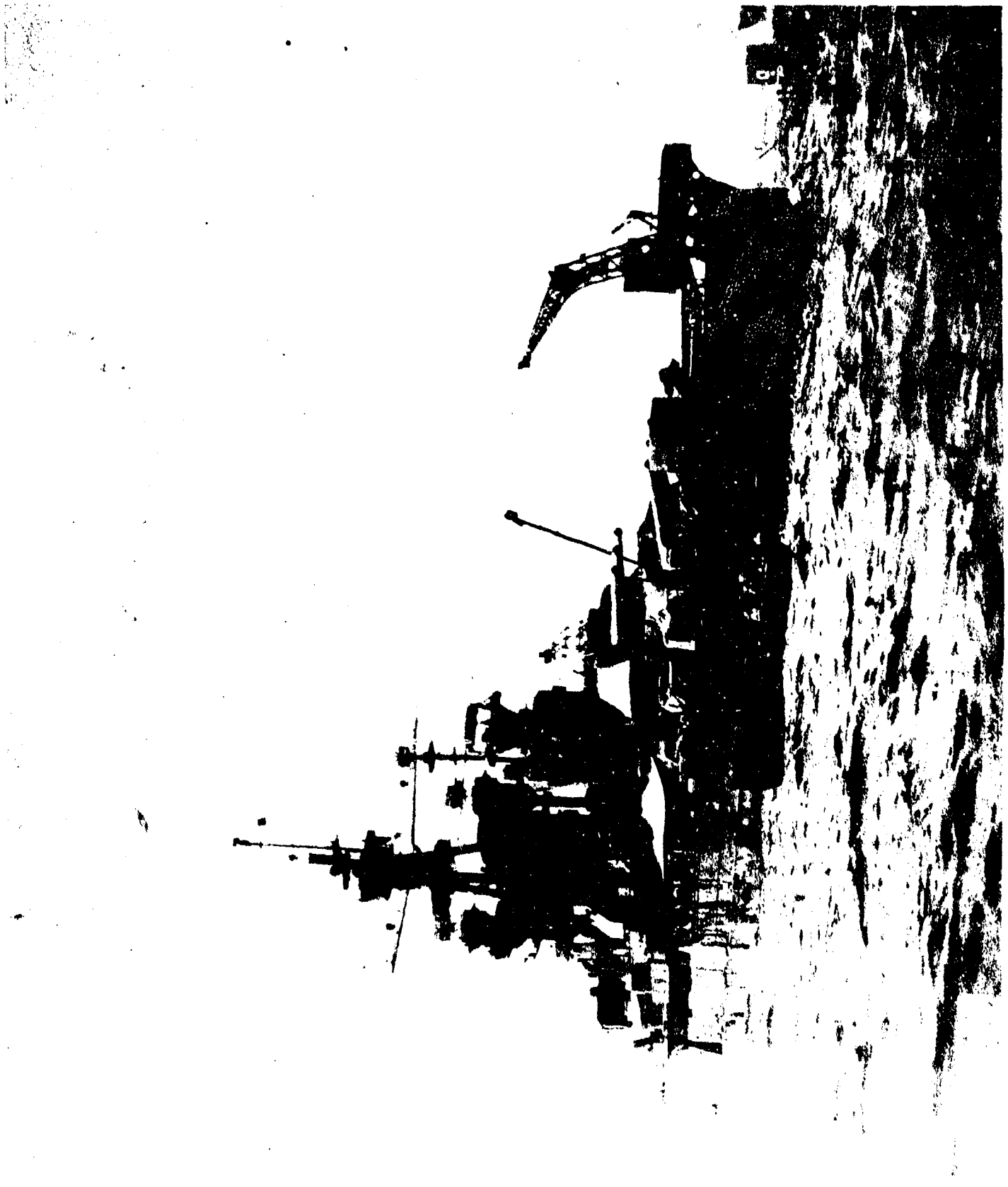


AA-CR-227-91-66. General view of bow from dead ahead after Test A.

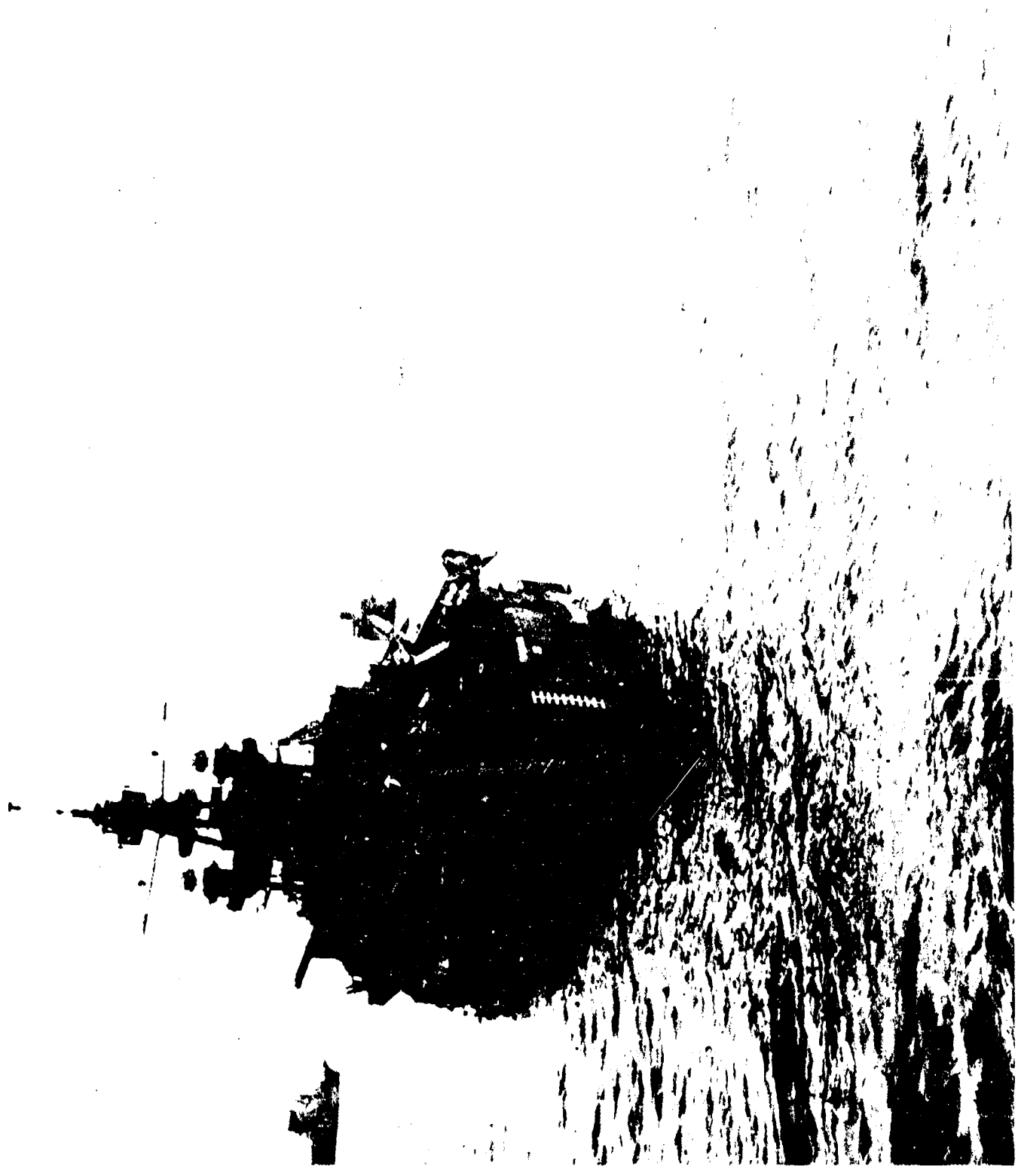


AA-CR-227-91-68. General view from off port beam after Test A.

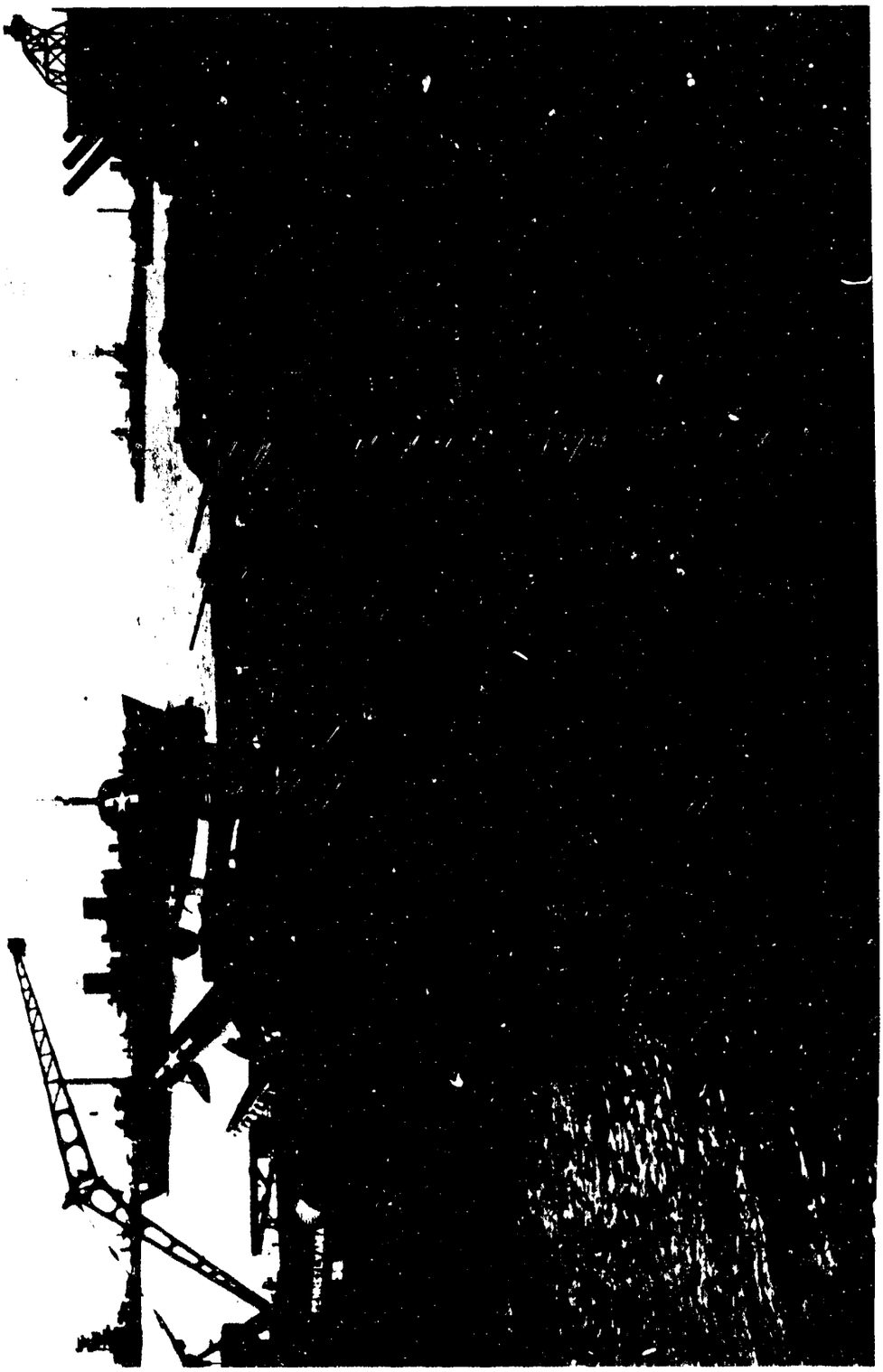
AA-CR-62-1808-11. Looking aft and to starboard at port stern.



AA-CR-227-91-61. General view from off port quarter after Test A.



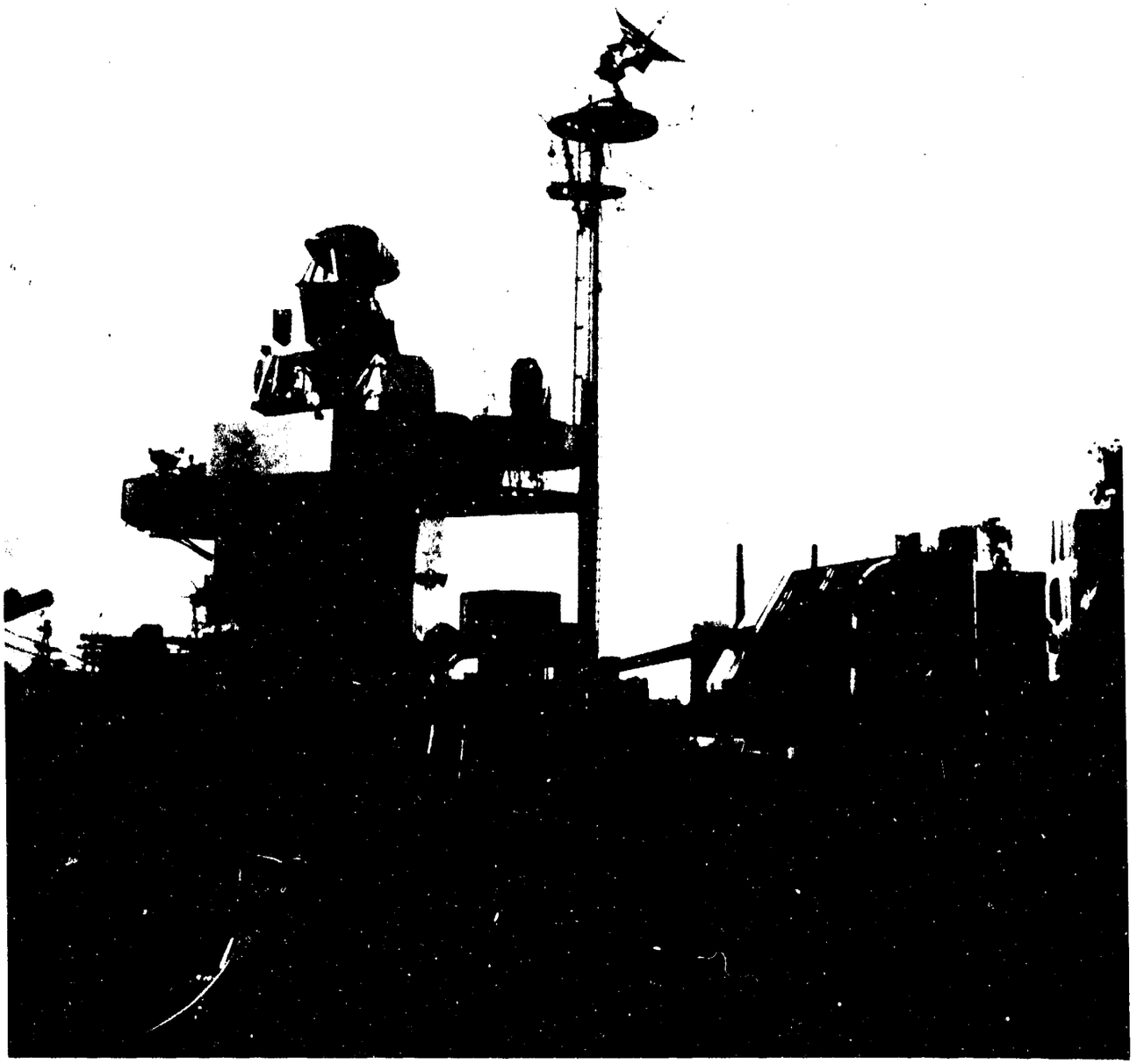
AA-CR-62-1831-5. General view from the stern after Test A.



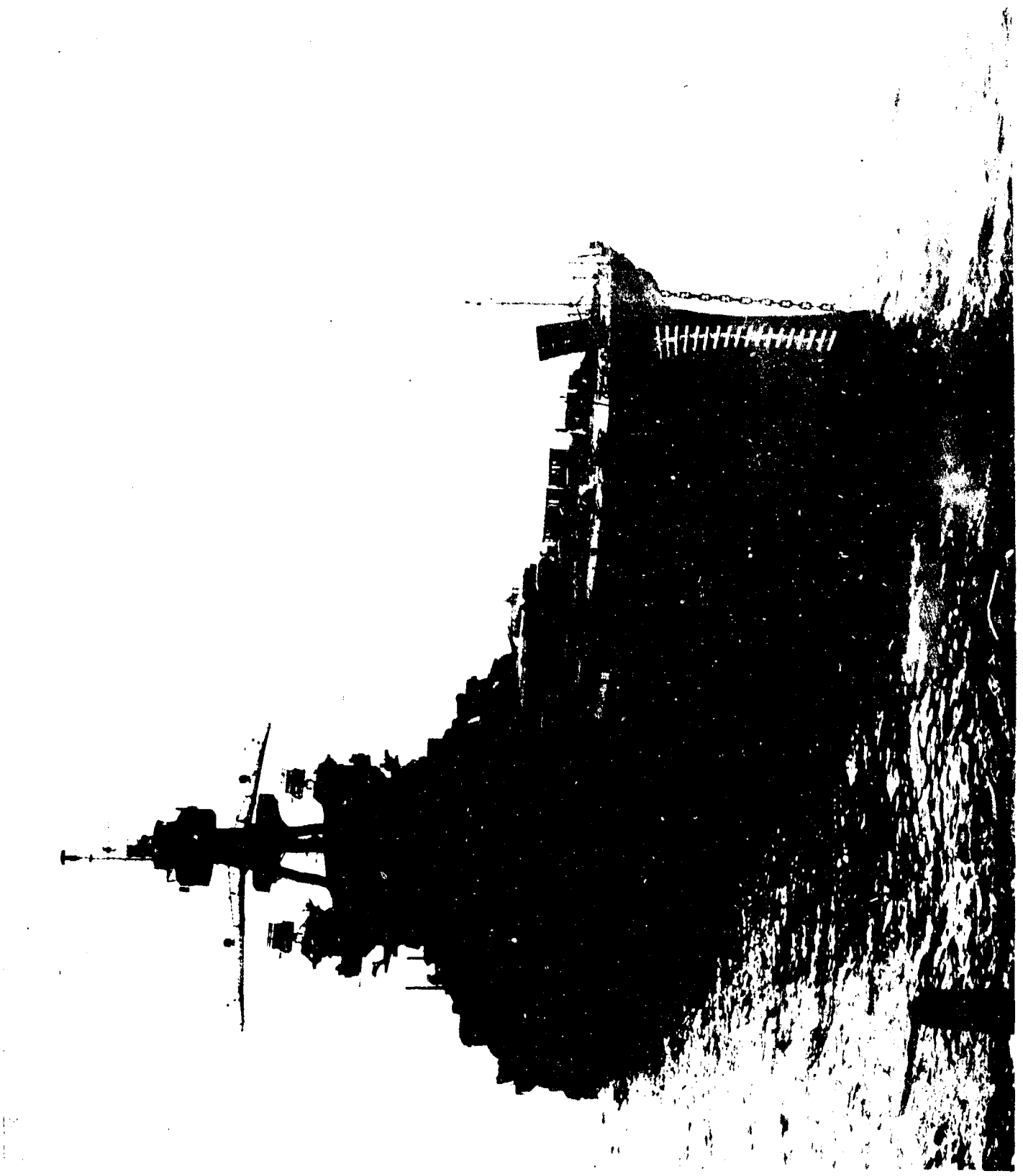
AA-CR-62-1831-4. Looking to port at starboard stern. Note displaced and damaged planes.

AA-CR-62-1831-2. Looking aft and to port at starboard stern after Test A.

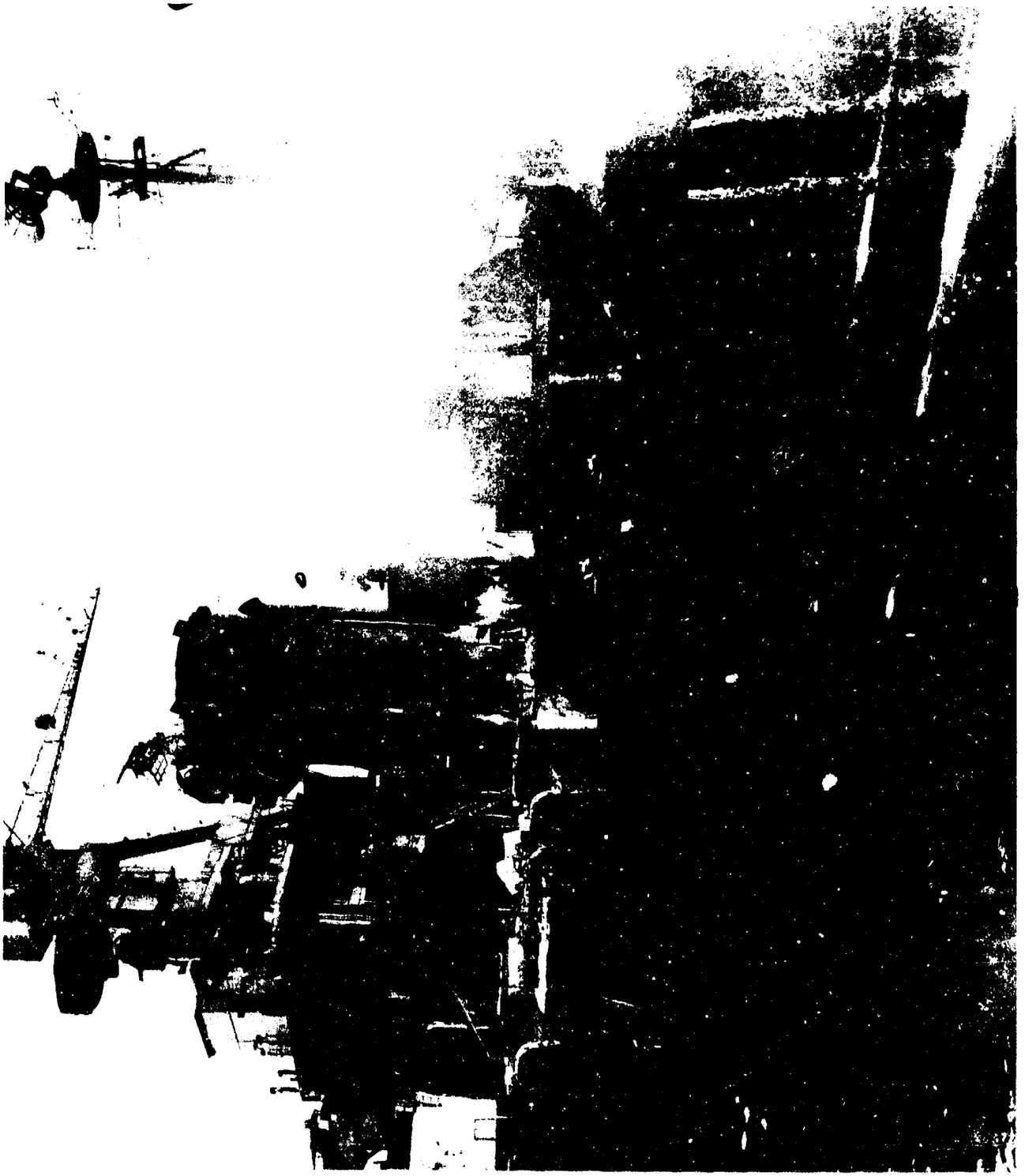
AA-CR-227-91-64. General view from off starboard beam after Test A.



AA-CR-62-1831-3. Looking at mainmast area, frame 85, starboard side.

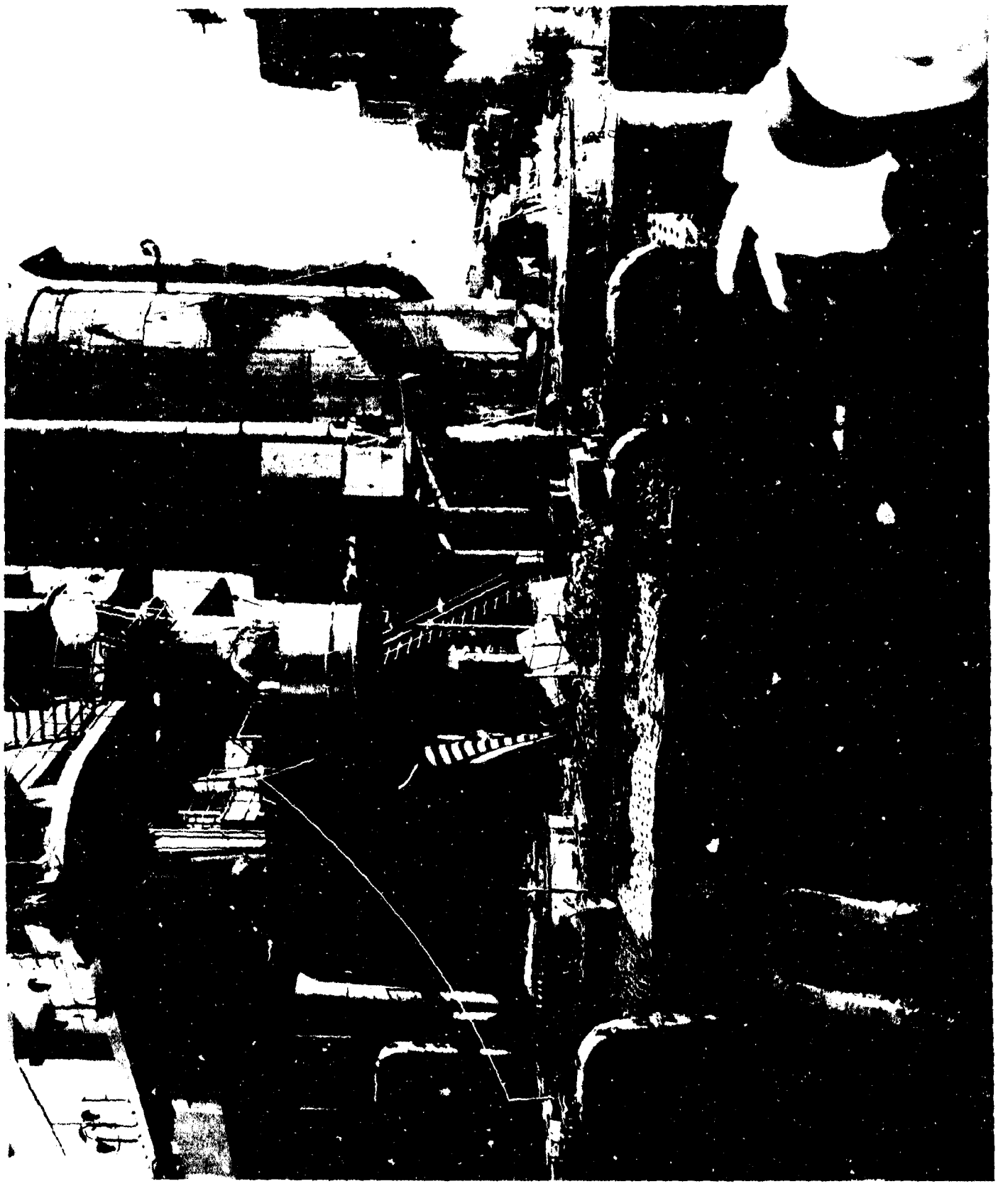


AA-CR-62-1831-1. General view from off starboard bow after Test A.



AA-CR-62-1808-10. General view of fire on port side. Fire being put out by tug.

AA-CR-62-1808-9. Looking aft and to starboard at area of fire in U.S. Army Quartermaster gear on the superstructure deck.



AA-CR-62-1808-12. Looking to starboard and forward at area of fire in U.S. Army Quartermaster gear on supers ructure deck after fire is out.

APPENDIX

SHIP MEASUREMENT DIAGRAM

TEST AB LE

SECRET

DECK DEFLECTION GAGES

SHIP USS PENNSYLVANIA (BB-38) TEST A

LOCATION			MAXIMUM COMP.	MAXIMUM EXP.	PERMANENT SET		REMARKS
FR. NO.	DECK	DIST. OFF ℄			DISTANCE	EXP. / COMP.	
25	Main	Port	0-0-7/16	None	None	None	None
25	Main	Stbd.	0-0-1/8	None	None	None	None
25	Main	Stbd.	0-0-1/2	None	None	None	None
40	Main	Port	0-0-9/16	None	None	None	None
40	Main	Stbd.	0-0-5/8	0-0-1/8	None	None	None
89	2nd	Centerline	0-0-1/16	None	None	None	None
96	2nd	Port	0-0-9/16	None	None	None	None
96	2nd	Stbd.	0-0-5/8	0-0-3/16	0-0-2	Comp.	None
96	2nd	Stbd.	0-0-1/4	None	None	None	None
100	2nd	Centerline	0-0-1/8	None	None	None	None

SECRET

DECK DEFLECTION GAGES

SHIP USS PENNSYLVANIA (BB-38) TEST A

LOCATION			MAXIMUM COMP.	MAXIMUM EXP.	PERMANENT SET		REMARKS
FR. NO.	DECK	DIST. OFF ℄			DISTANCE	EXP. / COMP.	
112	2nd	Port	0-0-5/8	0-0-3/16	0-0-1/16	Comp.	None
112	2nd	Stbd.	0-0-3/16	None	None	None	None

APPENDIX

COMMANDING OFFICERS REPORT

TEST ABLE

TECHNICAL INSPECTION REPORT

PART A - GENERAL SUMMARY

I. Target condition after test.

(a) There was no change in draft, no change in list or trim and no flooding. Normal rudder post leakage resulted in about 14" of water in the tiller room.

(b) There is no major structural damage. Minor damage from blast occurred as follows: Boiler casings distorted, flat bulkheads dished in the vicinity of the galley and on the after side of bridge structures, ventilator screens dished, stack dented, and ventilation ducts distorted.

(c) Operability of machinery, electrical equipment, and ship control gear including navigational equipment is unimpaired. Fire control equipment is operable except Mark 15 sights and where damaged by heat from fire in Army Quartermaster gear. Gunnery equipment is operable except gear which was inoperative before the test as a result of torpedo damage. Electronic gear is operable except I.F.F. which is inoperative due to antenna damage, and Mark 22 radar for which leads were damaged by heat from fire.

(d) No areas on the ship were overheated after the test. No fires were burning except that reported in II (b), which was out when personnel returned on board. It is considered that personnel casualties from blast, flash heat and blinding from intense light would have been heavy on the port side in all exposed stations. On the starboard side and wherever personnel would have been shielded by ships structure, casualties should have been reduced. It is considered that there would have been very few personnel casualties in unexposed stations except in the fire rooms where casualties from flarebacks were possible. A detailed estimate of personnel casualties is not considered

practicable since the final fate of the animals from this vessel is not known and since no animals were located on the port quarter where the most severe exposure occurred.

II. Forces evidenced and effects noted.

(a) A very directional flash heat from 200° to 205° relative is evident on the port side and on the after side of all structures above the main deck. This flash heat evidence consists of a deposit of black soot like material. In some places it appears to be a deposit on top of good paint, in other places the paint underneath seems to have been scorched and in still other places the paint underneath has blistered. The spots of scorched and blistered paint are scattered and there appears to be no symmetry of location nor any reason for their existence. (Samples scraped from various locations have been delivered to Captain Forrest of the staff of the Director of Ship Material.)

(b) The only fire which occurred was the burning of a large portion of the Army Quartermaster gear on the port side of the boat deck. This fire broke out over three hours after Mike hour and was apparently intensified by the explosion of cans of DDT on display. The fire spread to life rafts and cork float nets in the vicinity. Considerable damage was done to the wooden deck, but no damage to the steel deck.

(c) There is no evidence of any damage resulting from shock.

(d) There is evidence of blast pressure from the same direction as the flash heat noted in II (a), such evidence being the dishing of flat light metal bulkheads. One deck locker on the boat deck was blown apart as though from internal pressure. Since nothing was stowed in this locker which could have caused an internal pressure it is assumed that this is the one piece of evidence of the existence of a vacuum. This result may have been produced by the sudden release of external pressure. In general the type of damage to structures from blast pressure is exactly comparable to that which might result from main

battery gun blast, but somewhat greater. It is of interest that wherever the blast entered a pocket between bulkheads the damage increased. This was particularly true in the pocket between the after galley bulkhead and the potato peeling shack. There is a possibility that the air or gas forced into this space expanded to cause greater structural damage. Pressure caused distortion of all six boiler casings in varying amounts. Those with closed registers suffered somewhat greater damage than the two with open registers. It is questionable whether any appreciable damage would have occurred if the boilers had been steaming under air pressure. A flareback is probable, but any estimate of intensity would be guess work. It is not believed that casualties in the fire rooms would have been inevitable.

(e) Effects apparently peculiar to the atom bomb.

1. Long range of blast and flash heat effects.

2. Spotty effects of the varying degrees of flash heat.

3. Radioactivity in ships structure. This was only discovered on the port side, with the largest Geiger counter reading occurring on the port quarter near the stern and at the skin of the ship. The value here was stated by the radiological monitor to be about 1/100 th of the allowable value for personnel exposure. This reading was taken about 1400 on Able plus one day.

4. Shakedown of dirt from inaccessible overhead locations and blowing out of dirt from ventilation ducts was much greater than anyone aboard has previously experienced. This occurred on weather decks, in compartments on all decks above the armored deck and in engineering spaces particularly the engine rooms and fire rooms. In places this layer of dirt covered the decks to a depth of an inch or more. From the distribution of this accummulation of dirt it is believed that the entire ship may have been severely shaken before or as the blast of air arrived. If this be true the shake affected the structure above

the armored deck to a greater extent than that portion below the armored deck. It is considered that dirt would have been present in the air in compartments below decks in sufficient quantity to cause:

1. Reduced visibility.
2. Difficulty in breathing.
3. Adverse effects on operating machinery.
4. Possible explosions and fires from ignition by electrical sparks.

III. Results of Test on Target.

(a) No effect on propulsion and ship control except from possible flarebacks in fire rooms and possible adverse effects from excess dust and dirt. No permanent effect.

(b) Exposed gunnery and fire control stations would have been out of commission pending replacement of a large percentage of personnel. Material condition not affected except for sights on close range weapons.

(c) Effect on watertight integrity and stability - None.

(d) Probably personnel casualties would have been heavy in exposed stations on the port side, less in starboard stations and light below decks. Habitability not seriously impaired.

(e) Fighting efficiency would have been temporarily disrupted due to topside personnel casualties.

IV. The damage resulting from a single atom bomb under the test conditions is perhaps somewhat less than might have been expected. The result from a pattern of these bombs might well be an entirely different story since there is no certainty that the extent of damage would merely be increased in proportion to the number of bombs used.

V. The entire structure of ships above the armored deck or water line as appropriate requires redesign if material and personnel casualties are to be held to an acceptable value. Air lances should be used periodically to insure removal of dirt and dust from inaccessible locations. Cleaning of ventilation system should be mandatory during every Navy Yard overhaul period.

PART C - INSPECTION REPORT

SECTION I - HULL

A. General Description of Hull Damage.

(a) No change.
(b) None.
(c) No damage.
(d) None.
(e) None.

B. Superstructure (exclusive of gun-mounts).

(a) Description of damage, giving important dimensions:

1. The bridge area suffered minor damage only. The athwartship bulkheads in the bridge area show dishing of from 1/2" to 2". Bulkhead stiffeners were bent to conform with bulkheads, and about three were cracked where rivets and welded seams were present. These stiffeners are not strength members. Three air port rings were partially blown from bulkheads in this area, apparently from the dishing of bulkheads rather than from the blast itself. Longitudinal bulkheads on the port side of bridge area show dishing of about 1/2" to 1-3/4". Bulkhead stiffeners in this area were also bent to conform with bulkheads, but none were cracked. The bulkheads in this area that show dishing are of 1/4" mild steel and 1/4" brass in the vicinity of the navigation bridge. The bulkhead stiffeners in this same area are 1/2" by 3" mild steel angle except those in the RCM shack which are 1/4" by 2" brass channel. Wire screens for fire room uptakes on superstructure deck were dished in. Some quick acting doors in the bridge area were dished to conform with bulkheads, but none were blown off or through the knife edges. These doors are of 1/8" to 1/4" plate.

2. In the midship deckhouse and stack area the MK57 director tower on the port superdeck, frame 78, and the after bulkheads from the deck level to about ten feet were badly

burned due to the Army Quartermaster gear that burned completely. Bulkheads are still intact and do not show excessive warpage from heat. The forward side of the 5" gun mount frame 82 port side of superstructure deck burned due to the same fire. Paint on this is badly blistered, but no visual damage to armor plate is in evidence. Life rafts and nets in this area were destroyed by the fire. One life raft on the outboard side of 5" mount number 8 was evidently blown off by the bomb blast as no evidence of fire is present and the raft has not been found. Gear lockers on the port side of the superdeck were dished in and one was opened, evidently by the vacuum of the blast.

The outer shell plating of the smoke stack is dished in several places both port and starboard, and the starboard forward side is dished from the deck level to about 10 ft. in height covering an area 4 ft. wide and 2-1/4 in deep. The starboard center area is dished from the deck level to about 20 ft. in height covering a section 8 ft. to 4 ft. wide and 1/2 in. to 4 in. deep. The starboard after side is dished from the deck level to a height of about 15 ft. covering an area of from 4 ft. to 1 ft. wide and 2 in. deep; also from the top of the stack down about 3 ft. between the stack frames. The port side center is dished from the deck level to a height of about 20 ft. covering an area of from 8 ft. to 1 ft. wide and about 6 in. deep. The drain line for the incinerator on the starboard side of the stack was ruptured.

3. The mainmast port side shows slight dishing of bulkheads, and the airport on the 04 deck, frame 63 has rivets torn loose. The 40 mm. gun foundation supports from the main to the superdeck show slight dishing on the port side.

(b) The cause of the damage in each area were from the concussion of the blast itself except that which was in the vicinity of the Army Quartermaster fire.

(c) None.

(d) Estimate of relative effectiveness against heat and blast of:

1. The effectiveness against various plating thicknesses is impossible to estimate due to a lack of sufficient heat being present.

2. The flat surfaces broadside to or nearly so the blast showed evidence of considerable pressure, while the rounded surfaces except the smoke stack as mentioned above showed little evidence of the blast.

3. Estimate impossible.

4. None.

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

No comments.

C. Turrets, Guns, and Directors.

(a) Protected mounts.

1. In general, all protected mounts seemed to have suffered little damage from the detonation of the bomb. All equipment is operable, and in the same condition as prior to the test. There was evidence of heat on the shield of 5"/38 mount #8, caused by the fire which burned the Army QM equipment located nearby. The only visible results were to blister the paint on the outside of the shield.

2. Shields and turrets appeared to have satisfactorily resisted the heat and blast. Exposed powder was not affected.

(b) Unprotected Mounts.

1. Generally, all mounts were unaffected. Those in the path of the blast had some scorched paint, but there were no indications of damage. All equipment was operable.

2. Those of the crew who were exposed would probably not have been completely protected by the shields installed.

(c) Directors and Range-finders.

1. Directors and range-finders were in operating condition with no effects noted. Those optics in the path of the blast were undamaged, beyond a light coating of smudge, perhaps a product of the explosion.

2. Instruments inside the directors were unaffected.

(d) Consistent with the aim of increasing the arcs of fire of 40mm mounts to the maximum, the bulwarks seem to be as effective as could be hoped for. Installation of shields to protect the loaders, the pointer, and trainer would entail too great an increase in topside weight for the added protection afforded.

D. Torpedo Mounts, Depth Charge Gear.

(a) Not applicable.

(b) Not applicable.

E. Weather Deck.

(a) General condition of deck and cause of damage.

Weather decks show slight signs of heat, but are not burned except on the superstructure deck in way of Army QM gear in this area. The wooden deck is badly burned, but the steel deck is in good shape.

(b) Usability of deck in damaged condition.

Fully usable.

(c) Condition of equipment and fittings.

1. No damage.

2. No boats on board.

Boat booms and winches - no damage.

Liferafts - three lost. Four burned from QM gear fire.

3. The airplane handling gear is out of commission due to torpedo damage in 1945.

4. The catapult is out of commission due to torpedo damage in 1945.

F. Exterior Hull (above waterline).

(a) No damage.
(b) No damage.
(c) No damage.
(d) No inspection made.

G. Interior Compartments (above waterline or armor deck, if fitted.)

(a) Damage to structure and causes.

The after bulkhead of Flag Radio was blown in several inches. It is not apparent whether this was from the bomb blast or some local explosion on the boat deck.

(b) The athwartships bulkheads in crews galley upper deck frame 86 were dished in. The starboard bulkhead of the galley passageway, frame 86 to 87 was dished in and ruptured at the top. The bulkheads forward of the potato-peeler were dished in near frame 87 while the port bulkhead of the potato-peeler room was bulged. These bulkheads are the boundaries of an air pocket from the main deck.

(c) No remarks.

(d) Condition of equipment within compartments.

All the drawers in the cabinet facing forward in Tran Eleven on the superdeck were thrown out on deck. Two RBH-1 radio receivers in Flag Radio in the foremast structure were wrenched from their "shock-proof" mountings and thrown on deck. One set is working the other temporarily out of commission with only minor damage.

(e) Evidence of fire.

None outside of the Army QM fire.

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

One 1-1/2 in. drain line to the incinerator and a flushing line to bridge area were damaged, no other damage has been found. Ventilation screens were blown in on vent trunks on the top side of the superstructure deck leading to the engineering spaces. Several ventilation ducts above the armor deck were blown open at the seams and joints where vent ducts turned. Inspection plates were blown off and baker-type valves were warped so that they could not be opened. Tare-type vent covers were blown off where no other valve was in the line. Able type valves gave no trouble.

(g) It is estimated that the habitability of all compartments was unimpaired.

H. Armor Deck.

(a) Damage to armor deck and causes of damage.

None.

(b) Protection afforded spaces below.

Complete protection from the blast itself, but unknown for radioactivity.

(c) Condition around openings.

1. Hatches - no damage.

2. Gratings - no damage.

3. Uptake bulkheads.

The uptake bulkheads to after distribution and blower room C-202-C exhaust were bulged and rivets were pulled through the bulkhead, this trunk is flat-bottomed with small ducts leading from it on the sides, bulkheads are of 1/4 in. plate where rivets were pulled through. No other trunks that terminate in this were damaged.

4, No damage was noted to the barbettes except for slight areas of scorched paint.

(d) Condition of connections to vertical armor.

No visual damage.

I. Interior Compartments (below waterline).

(a) Damage to structure and causes.

Slight additional wrinkling and buckling of bulkheads and decks in way of torpedo damaged area were noted, no other structural damage has been found.

(b) Damage to joiner bulkheads and causes - None.

(c) Details of damage to access closures and causes - None.

(d) Condition of equipment within compartments - No damage.

(e) Flooding - None.

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

No damage in way of piping or cables has been found. One tare-type vent cover was blown off on the third deck in a living compartment (A-516-M-P) and one in after distribution (C-401); there was no evidence of fire or heat in either of these areas.

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

None.

J. Underwater Hull.

(a) Interior inspection of underwater hull - No visual damage.

(b) Effect of damage on buoyancy, operability, maneuverability.

None.

(c) Any known or suspected damage to:

1. Shafts and propellers - None.

2. Struts - None.

3. Rudder - None.

NOTE: These three items were inspected by a diver on 6 July 1946 and found to be intact and undamaged.

4. The external keels are believed to be undamaged, but have not been inspected by a diver to date.

(d) Details of impairment of keel structure - None suspected.

K. Tanks.

(a) No damage.
(b) None.
(c) Damage to torpedo defense stations - None.

L. Flooding.

No flooding.

M. Ventilation (exclusive of blowers).

(a) Damage to ventilation system and causes.

See Item G (f).

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

There was no evidence of heat, but some evidence of blast at the end of vent ducts and no fire.

(c) Evidences that ventilation system allowed progressive flooding - None.

(d) Constructive criticism of design and construction of system.

Vent system is of old type running below third deck and is not used today.

N. Ship Control.

(a) Damage to ship control stations and causes - None.

(b) Constructive criticism of ship control systems.

No comments.

O. Fire Control.

(a) Damage to fire control stations and causes.

1. Directors with the exception of exposed Mk 51's were unaffected by the bomb. The Mk 51's that were in the path of the blast showed very slight effects of heat, with small areas of scorched paint. the Mk 14 and 15 gunsights were damaged by heat, all Mk 15 sights being inoperative.

2. Plotting rooms and all enclosed spaces(turrets and mounts).

No damage.

(b) The following stations might be considered as insufficiently protected, since some exposed personnel there might have been injured. However, the equipment itself remained operable, and with replacement of personnel, would become 100% effective again.

1. 40 mm. mounts.

2. Mk 51 directors.

3. 20 mm. mounts.

(c) Constructive criticism of location and arrangement of stations:

No comments.

P. Ammunition Behavior.

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

1. Exposed bags of 14"/45 powder in the trays, with breeches open, were not affected.

2. 5"/38 ammunition in the trays, hoists, and upper handling rooms was not affected.

3. 40 mm. and 20 mm. ammunition in clipping rooms and ready service lockers were not affected.

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

1. Main battery powder magazines and projectile stowage showed no evidence of heat. Maximum temperature recorded was 90°F.

2. 5"/38 magazines and projectile stowages were not affected. Maximum temperature recorded was 92°F.

3. 40 mm., 20 mm., and small arms magazines were not affected.

4. The bomb locker showed no evidence of heat.

(c) No comment.

(d) Normal.

Q. Ammunition Handling.

All equipment intact.

R. Strength.

No visual evidence of structural damage.

S. Miscellaneous.

Not Applicable.

SECTION II - MACHINERY

A. General Description of Machinery Damage.

(a) Overall condition - Good.
(b) None.
(c) None.
(d) No appreciable effects noted.

B. Boilers.

(a) Air casings.

#1 Boiler.

The outboard casing was bulged out 4" at second seam up from the mud drum. The toggle bolts failed to hold seam resulting in an open crack 1-1/2" wide. The inboard casing was bulged 1-1/2" at third seam up from mud drum leaving a very small crack.

#2 Boiler.

The outboard and inboard casings were bulged out 1" at third seam up from the mud drum, but no open cracks were in evidence. Small air leak from loose gasket developed.

#3 Boiler.

The outboard and inboard casings were bulged out 1" at third seam up from the mud drum. No open cracks or air leaks were in evidence.

#4 Boiler.

The outboard and inboard casings were bulged out 1" at third seam up from the mud drum. No open cracks or air leaks were in evidence.

#5 Boiler.

The back wall was bulged out 1/4" around the steam drum. No open cracks or air leaks were in evidence.

#6 Boiler.

The outboard and inboard casings were bulged out 1/2" at third seam up from the mud drum. No open cracks or air leaks were in evidence.

(b) No visible damage has been found in the external fittings. No. 3 boiler has steamed since test with no damage indicated.

(c) No visible damage.

(d) No damage.

(e) No damage - All boilers given satisfactory hydrostatic test since t e blast.

(f) No damage.

C. Blowers.

(a) to (f) All blowers operated by steam or jacked over by hand - No damage.

D. Fuel oil equipment.

No damage.

E. Boiler feedwater equipment.

Entire feed system tested satisfactorily. No damage.

F. Main Turbines.

Main turbine tested with steam by spinning ahead and astern. No apparent damage.

G. Reduction gears.

No apparent damage was indicated when tested with the main turbines.

H. Shafting and Bearings.

No apparent damage was indicated when tested with the main turbines.

I. Lubrication system.

Completely tested; no damage.

J. Condensers and air ejectors.

Completely tested; no damage.

K. Pumps.

All pumps operated by steam or jacked by hand. No damage.

L. Aux. Generators Turbine and Gears).

All generators operated under load. No damage.

M. Propellers.

No change.

N. Distilling Plant.

Distilling plant operated and found to be normal. No damage.

O. Refrigerating plant.

Operation normal. No damage.

P. Winches, Windlasses, and Capstans.

Tested satisfactorily after test.

Q. Steering engine.

Tested satisfactorily after test.

R. Elevators, ammunition hoists, etc..

Operation normal. No damage.

S. Ventilation (Machinery)

All ventilation machinery tested, operation normal. No damage.

T. Air Compressors.

All air compressors operated. No damage.

U. Diesels (Generators and Boats).

Diesel generator operated normal. No damage. The ships boats were not aboard for the test.

V. Piping.

All piping inspected and tested with pressure. No damage. Slight leak at one flanged joint in auxiliary steam line.

SECTION III - ELECTRICAL

A. General Description of Electrical Damage.

(a) Good.
(b) None.
(c) None.
(d) No change.
(e) None.

B. Electric Propulsion Rotating Equipment.

Not Applicable.

C. Electric Propulsion Control Equipment.

Not Applicable.

D. Generators - Ships Service.

All generators operated with load. No damage.

E. Generators - Emergency.

Diesel generator operated with load. No damage.

F. Switchboards, etc.

All switchboards, distribution panels, and battery charging panels inspected and energized. No damage.

G. Wiring, Wiring Equipment, and Wireways.

No visible damage noted except as caused by fire in Army Q M equipment.

H. Transformers (Lighting and I.C.)

All transformers energized. No damage.

I. Submarine Propelling Batteries.

Not Applicable.

J. Portable Batteries.

All batteries inspected. No damage.

K. Motors, Motor Generator Sets, and Motor Controllers, etc.

All motors operated and found to be undamaged.

L. Lighting Equipment.

No damage noted to any lighting equipment. An un-noticeable number of light bulbs were knocked out.

M. Searchlights.

One hinge was broken on the mirror door of the starboard 24" signal searchlight. No other damage was noted.

N. Degaussing Equipment.

No damage.

O. Gyro Compass Equipment.

All compass equipment has been operated since the test with no damage noted.

P. Sound Powered Telephones.

Twenty per cent of the sound powered telephones have been tested. No damage has been found.

Q. Ships Service Telephones.

No trouble has been experienced with the telephone system since the test. The system has been in constant use.

R. Announcing Systems.

No trouble has been experienced with the announcing equipment since the test. Equipment has been in constant use.

S. Telegraphs.

All systems have been tested satisfactorily. No damage.

T. Indicating Systems.

The starboard wind direction indicator pointer was bent about 15°. No other damage was noted.

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

Inspected and energized. No damage.

V. F.C. Switchboards.

Inspected and energized. No damage.

SECTION IV - ELECTRONICS

A. General Description of Electronics Damage.

(a) In general the damage to electronic equipment appears to be slight and is confined to a few of the units only. Damage was caused by either shock of the blast or from heat from the fire started on deck. Probably only the Mk 29 port radar suffered a total loss, this being due to the fire of Army equipment on the superdeck.

(b) The Mk 57 director and the Mk 29 radar located on the port side of the superdeck was subjected to intense heat from the fire of life rafts and Army QM equipment on deck, therefore this loss would be classed as secondary damage. Maximum temperatures around this equipment were unknown, but samples of Army aluminum equipment in the vicinity show evidence of having been molten. The units inside the director tower are intact, but have been subjected to considerable heat and smoke. Paint on the units is a burned-brownish color rather than the original grey, and the plexi-glass over the indicator was burned a brownish color. The tubes and components inside the radar units are covered with a soot-like film. Sections of cable around the inside of the towers are melted. It is believed the installation is a total loss.

(c) Primary cause of major damage was fire as noted above.

(d) Operability of Electronics Equipment:

1. Radar

(a) The Mk 22, on the port Mk 37 director had its external cables from transmitter subjected to heat, probably from fire on boat deck. Ship's force can repair.

(b) The Mk 28 Mod 2 aft port (#262) and the Mk 10 Mod 5 on port Mk 50 had antenna caps scorched, but were undamaged otherwise.

(c) The Mk 8, on the Mk 34 director, showed evidence of fire, but the equipment was intact and undamaged.

(d) The SQ radar in sky forward had its front panel protective cover blown open at the top, and one of the legs supporting the unit blown loose from base.

(e) The air search radars were intact and apparently undamaged, however, the SP antenna was blown around 90° in azimuth and tilted up approximately 30° by blast.

(f) All the radar repeaters were intact and apparently undamaged.

(g) The RCM equipment was intact and apparently undamaged. The TDY antenna in sky forward was blown around 90°, but remained undamaged.

(h) The IFF equipment was intact and apparently undamaged except the top section of the BM antenna on the mainmast was blown off.

2. Radio.

(a) Two RBH-1 receivers in Flag Radio were thrown to the deck by the blast. One operable, the other temporarily inoperable, but later repaired some minor connection having been loose.

(b) No damage to transmitters.

(c) One spare receiving antenna was broken at nav-bridge level.

3. Sonar - None.

4. Loran - No damage.

5. Fathometer - No damage.

6. Radio direction finder - None.

(e) Not Applicable.

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Classification (Changed to _____)
By Authority of Joint Chiefs of Staff (Action 15 Apr 49)
By _____ Date _____

CONFIDENTIAL

Defense Special Weapons Agency
6801 Telegraph Road
Alexandria, Virginia 22310-3398

TRC

4 April 1997

MEMORANDUM TO DEFENSE TECHNICAL INFORMATION CENTER
ATTN: OMI/Mr Bill Bush

SUBJECT: Declassification of Documents

The following is a list of documents that have been declassified and the distribution statement changed to Statement A, Approved for Public Release.

XRD-41, AD-366731
XRD-42, AD-366732
XRD-40, AD-366730
XRD-39, AD-366729
XRD-38, AD-366728
XRD-34, AD-366720
XRD-13, AD-366725
XRD-8, AD-366699
XRD-5, AD-366697
XRD-6, AD-366698
XRD-21, AD-366708
XRD-27, AD-366714
XRD-22, AD-366709
XRD-26, AD-366713
XRD-28, AD-366715
XRD-29, AD-366727
XRD-36, AD-366722

If you have any questions, please call me at 703-325-1034.

Ardith Jarrett

ARDITH JARRETT
Chief, Technical Resource Center