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BUREAU OF SHIPS

TECHNICAL INSPECTION REPORT

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367456

⑥ OPERATION CROSSROADS.
U.S.S PENSACOLA (CA24).

TEST BAKER.

VOLUME 1 ~~U.S.~~ ⑧

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Director
Defense Atomic Support Agency
Washington, D. C. 20301

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DIRECTOR OF SHIP MATERIAL
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**BUREAU OF SHIPS GROUP
TECHNICAL INSPECTION REPORT**

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APPROVED

F.X. Forest,
Captain, USN.

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U.S.S. PENSACOLA (CA24)

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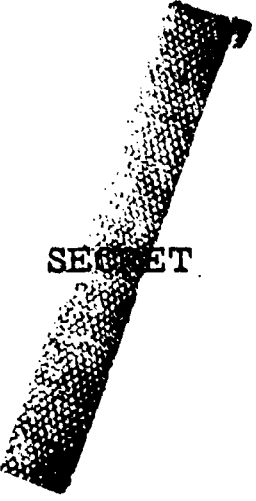
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U.S.S. PENSACOLA (CA 24)

SHIP CHARACTERISTICS

Building Yard: New York Naval Shipyard.

Commissioned: 6 February 1930.

HULL

Length Overall: 585 feet 8 inches.

Length on Waterline: 570 feet 0 inches.

Beam (extreme): 65 feet 3 inches.

Depth (molded at side, to main deck, amidships):
34 feet 1/4 inch.

Drafts at time of test: Fwd. 19 feet 9 inches.
Aft. 21 feet 0 inches.

Standard displacement: 9,100 tons.

Displacement at time of test: 12,160 tons.

MAIN PROPULSION PLANT

Main Engines: Four Sets of Turbines installed.

Type: Parsons. Mfg. by New York Navy Yard.

Reduction Gears: Four sets, single reduction. Mfg.
by De Laval.

Main Condensers: Four installed in ship.

Boilers: Eight installed in ship. Type: White-Foster.

Steam press. 300 psi gauge. Temp. 422° F.

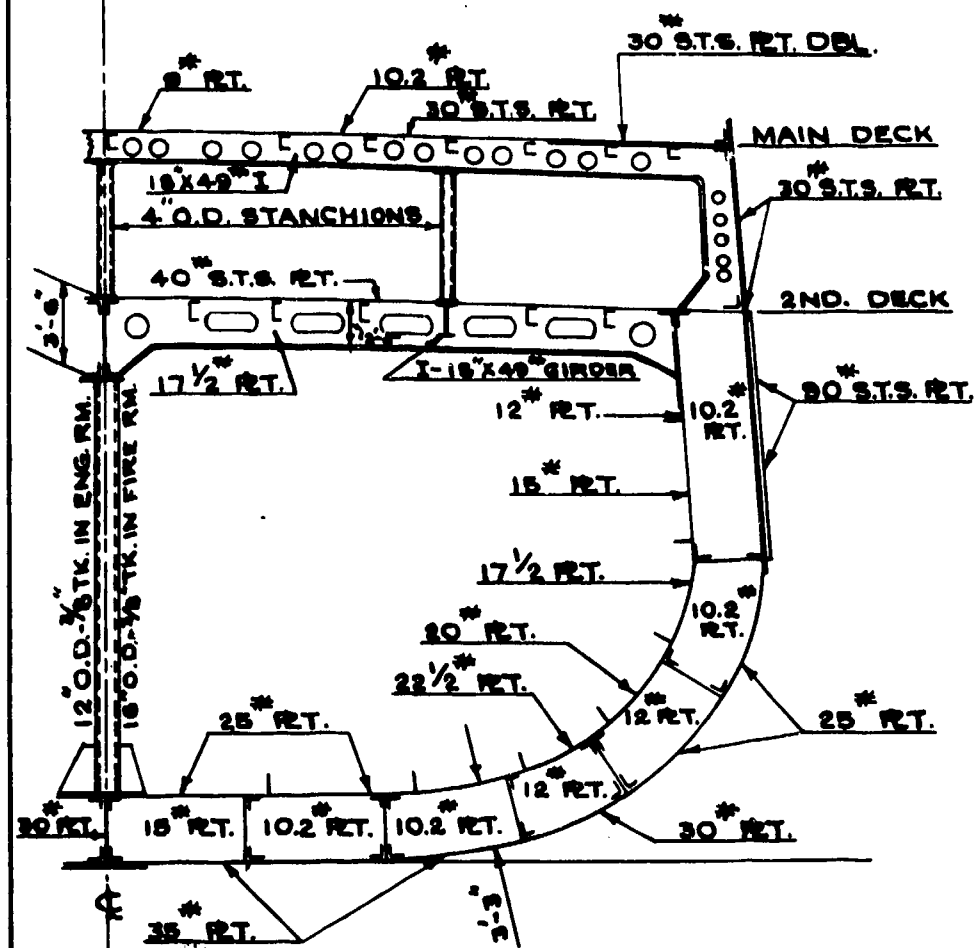
Propellers: Four installed in ship.

Main Shafts: Four installed in ship.

Turbo Generators: Four installed in ship. 250 K.W.

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TYPICAL MIDSHIP SECTION TEST B

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TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

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

Drafts before test B; Forward 20' - 1" aft 21' - 1"

List 1° Port.

Drafts after test B; Forward 20' - 4" aft 23' - 4"

List 3 1/2° Starboard.

The principal sources of flooding are a 2 inch cooling water line to the ice machinery room which broke in number 1 (starboard) shaft alley, and leakage through shaft stern tube glands.

No. 2 (starboard) shaft alley flooded through the stern tube and through opened rivets.

No. 3 (port) shaft alley partially flooded through the stern tube and weeps from adjacent fuel oil tanks.

No. 4 (port) shaft alley partially flooded through the stern tube.

The Ice Machine Room, D-301-E, partially flooded from No. 1 shaft alley through a leaky hatch.

The after engine room flooded with oil and water to a depth of 10 feet at the centerline (just below the upper gratings) from leakage through the four after bulkhead shaft glands and from leakage of oil tanks seams.

The after fire room flooded with oil and water to a depth of 10 feet from the after engine room through bulkhead shaft glands and electrical stuffing tubes.

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The forward engine room flooded with oil and water to a depth of 6 feet (about 2 feet above the lower level floor plates) from the after fire room through bulkhead shaft glands.

The forward fire room had 6 inches of oil and water in the bilges.

The fresh water pump room, A-508-E, partially flooded, presumably from fresh water tanks just forward or from the spare parts storeroom, A-506.

The aircraft small arms stowage, A-416-M, had 2 inches of water on the deck, presumably from the sprinkling system. A small amount of water accumulated in spaces below gun mounts during the decontamination washing of the ship.

It is believed that had personnel been on board, flooding could have been confined to shaft alleys.

General areas of flooding in way of electrical equipment were in forward engine room, after fire room and after gyro room.

(b) Structural damage.

HULL

Damage to the superstructure, except for directors and enclosed mounts is negligible. Some superstructure damage occurred to components already seriously distorted and weakened in test A.

Essentially no damage to hull plating above the waterline was observed. However, overall damage to this ship indicates that some leakage of the bottom shell may exist.

Above the second deck, damage is confined principally to structure previously seriously weakened during test A. In the well deck area, buckling of stanchions and failure of main deck girders was increased as a result of test B. Stanchions above the second deck,

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severely buckled in test A, were completely fractured in test B. Up-take bulkheads, damaged in test A, were further damaged in test B.

Structural and joiner bulkhead between the second deck and first platform are severely buckled in way of number two 8 inch mount due to violent vertical movement of the mount. The only other damage observed on the first platform is buckling of stanchions at frame 113 (between 3 and 4).

In the engineering spaces there is evidence of severe shock vibration. Structure foundations under condensers are deformed and rivets sheared, turbine casings are cracked, boiler saddles are slightly damaged, considerable brickwork is knocked down, gratings are displaced and moveable gear is severely disarranged. In both the forward and after firerooms, the 16" x 3/8" centerline column failed in tension after having been first severely wrinkled in compression. Longitudinal and transverse girders supporting the armored deck in way of the engineering spaces are severely buckled in the webs, principally in way of lighening holes.

MACHINERY

No data taken by Machinery Group.

ELECTRICAL

Damage appreciably affecting the electrical plant was essentially as follows:

1. The foundation securing bolts at the lower star-board corner of the ship's service switchboard in the forward engine room sheared off allowing one end of the switchboard to drop about 2 1/2 inches. Apparatus on the board was not damaged.

2. Supporting framework for ship's service generators in after engine room was bent.

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(c) Other damage.

HULL

No comment.

MACHINERY

All boilers were severely damaged, including damage to casings, brickwork and stacks. The foundations appear to have moved upward. Holding down bolts were bent and stretched. One soot blower on #8 boiler was knocked off. The main engines were damaged beyond repair with numerous cracks in bearing and foundation pedestals and supports and one crack in #1 astern turbine casing. No. 2 reduction gear sagged about 1/4 inch at its after end when the foundation casting broke. Damage to spring bearings of #4 main shaft indicates misalignment of the shaft. The main condenser foundations twisted slightly, #1 and #4 condensers dropped slightly. The condensers probably leak. Nearly all pumps had some damage to their foundations, this being especially heavy in the forward fireroom. The anchor windlass bedplate was cracked all the way across. There was considerable damage to piping throughout the ship. Both machinery shop lathes were knocked over. There were many items of comparatively minor damage.

Damage to boilers would have been more severe if they had not already been damaged in test A, because blast pressure could vent out the ruptured casings of #1 - 4 boilers, and because the uptakes of boilers #6 and 8 were blanked off after test A, preventing blast pressure from entering them.

ELECTRICAL

Significant damage to electrical equipment was as follows:

1. Gyro compass suspension springs and supporting gimbels distorted. Compass was rendered inoperable.
2. Vacuum tubes for general announcing system control equipment damaged. Control is inoperable.

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3. Ship's service telephone switchboard selector switches broken. Switchboard inoperable.

4. Several vent sets inoperable due to damaged casings.

5. A number of storage batteries damaged beyond repair.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

There is no evidence of heat.

MACHINERY

There was no evidence of damage due to heat.

ELECTRICAL

There was no evidence of damage due to heat.

(b) Fires and explosions.

HULL

There are no evidences of fire or explosion, but personnel casualties in engineering spaces would have been high due to boiler flarebacks and shock.

MACHINERY

There was no evidence of fires or explosions.

ELECTRICAL

There was no evidence of damage due to fires or explosions.

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(c) Shock.

HULL

The underwater pressure from test B struck this ship at an angle of approximately 357 degrees relative, or essentially from dead ahead. There is evidence of tremendous shock in main battery mounts, in engineering spaces, and to a lesser extent throughout the vessel.

The centerline stanchions in both the forward and after firerooms are fractured and second deck girders in the engineering spaces are buckled in the webs due to inertia of the armored (second) deck.

MACHINERY

Most of the damage was done by an underwater shock of very high magnitude. Effects of this shock were apparent throughout the ship, particularly in the machinery spaces.

Boilers are moved on their foundations, a large amount of brickwork is knocked down, numerous pedestals and other machinery supports are cracked. The casings of numbers 1 and 4 astern turbines are cracked and condenser supports are distorted. Moveable gear is thrown about, powder cans and batteries in magazines are dislodged and projectile stowages in mounts are disarranged.

ELECTRICAL

Damage was evidenced by sheared switchboard support bolts, damaged gyro compass, dislocated storage batteries and bent generator supports.

(d) Pressure.

HULL

Blast pressure in test B caused negligible damage to superstructure. Additional deflection of weather deck areas pre-

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viously weakened by test A in due primarily to wave action and to upward acceleration of the ship. The ship was affected by underwater explosion pressure, followed by one or more very large sharp waves.

MACHINERY

A blast pressure of considerable magnitude is evidenced by the fact that damage to uptakes and boiler casings remaining from test A was increased. Temporary repair work to the casings of boilers #5 and #7 was blown out. It is possible that undamaged boilers would have suffered more from blast pressure than these did (see I (c) above).

ELECTRICAL

There was no evidence of damage due to pressure.

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

HULL

Effects noted peculiar to the atom bomb are wave phenomena and a high degree of contamination by radioactivity. It is estimated that personnel casualties above the second deck would have been extremely high due to radiological effects. Radioactivity was carried below decks by blowing out of boiler casings and to some degree by water coming down ventilation ducts from topside intakes.

MACHINERY

An underwater shock of this magnitude is believed to be peculiar to the atom bomb.

ELECTRICAL

There were no effects noted which were considered peculiar to the atom bomb.

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III. Effects of Damage.

(a) Effect on propulsion and ship control.

HULL

The machinery plant was completely wrecked as an operating plant. Emergency repairs would have been ineffective even with control of flooding; repairs would require a lengthy shipyard overhaul. Machine shop equipment is wrecked. Ship control was lost through absence of power of any kind. Diesel power (from forward generator only) might have been restored within a short time if undamaged starting batteries had been available.

MACHINERY

The machinery plant as a whole is inoperable. Many units are damaged beyond repair. Diesel generators could not be operated as the starting batteries were knocked out of their racks and damaged, and the diesel engines themselves may be damaged. Propulsion and ship control were destroyed, and could not be restored by the ship's force.

ELECTRICAL

Ship propulsion was not affected by electrical damage.

Ship control was slightly affected by the loss of the gyro and the general announcing system.

(b) Effect on gunnery and fire control.

HULL

Gunnery and fire control was affected by loss of power and by inoperability of all protected mounts, directors, and rangefinders, and of electronic equipment in the bridge area, due to shock. Damage to powder cans, disarrangement of ammunition stowages, and leakage of powder fumes in magazines would have affected the rate of firing.

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MACHINERY

No comment.

ELECTRICAL

Gunnery and fire control were somewhat affected by the loss of the gyro.

(c) Effect on watertight integrity and stability.

HULL

Watertight integrity was reduced slightly by loosening of shaft stuffing glands, due to shock. Flooding of the power plant could have been prevented had personnel been aboard. It is estimated that the ship took on 920 tons of water and listed 3 1/2 degrees to starboard.

MACHINERY

No comment.

ELECTRICAL

Watertight integrity and stability were not affected by electrical damage.

(d) Effect on personnel and habitability.

HULL

It is believed that casualties to personnel would have been extremely high due to shock, topside blast, blast effects in firerooms, and radioactivity. Habitability of interior compartments was greatly reduced by complete loss of power and by temporary obstruction of living spaces and passages by disarranged equipment.

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MACHINERY

It is estimated that there would have been high personnel casualties from shock and boiler flarebacks. The ship was made uninhabitable by reason of lack of power and high radioactivity.

ELECTRICAL

Habitability was slightly affected by the non-operability of a few vent sets.

(e) Total effect on fighting efficiency.

HULL

The fighting efficiency of this ship was completely lost due to absence of power, shock damage to 8 inch mounts, directors, and fire control electronic equipment and wrecking of the vessels power plant. Personnel casualties would have been high.

MACHINERY

Insofar as machinery is concerned, fighting efficiency was reduced to zero.

ELECTRICAL

The total effect of electrical damage on fighting efficiency was to reduce the accuracy and speed of gunfire due to loss of the gyro.

IV. General Summary of Observers' Impressions and Conclusions.

HULL

It is considered that naval vessels of this type, and ship's personnel, are exceedingly vulnerable to shock, blast pressure, and radioactivity at the range of this ship from an explosion such as that of test B.

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MACHINERY

It is not probable that no cruiser now afloat could withstand a shock of this magnitude without being damaged.

ELECTRICAL

Major electrical damage was sustained by the master gyro and a number of storage batteries. Minor damage was sustained by the ship's service switchboard supports, automatic telephone switches and vacuum tubes of the general announcing system.

Electrical damage did not materially affect the sea worthiness or cruising ability of the vessel but did have a moderate temporary effect on the fighting efficiency.

All electrical damage except to the gyro and telephone switchboard could have been repaired by the ship's force.

V. Any Preliminary or Specific Recommendation of the Inspecting Group.

HULL

No comment.

MACHINERY

A study should be made with a view to increasing the resistance of naval machinery to shock.

A study of stern tube glands should be made to reduce excessive leakage, both under shock and under normal operating conditions.

Studies of floor plates are recommended with a view to making them more secure and also to make them somewhat flexible. The floor plates on the PENSACOLA were almost without exception dislodged and many of them were thrown about with considerable force,

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which would have caused numerous personnel casualties. If some flexibility could be provided, the catapulting effect of the shock on personnel would be reduced.

ELECTRICAL

Specific recommendations have been made under each item of Part C where applicable.

The Commanding Officer's recommendations are as follows:

1. The effectiveness and sufficiency of crew shelters are inadequate. Fire control stations on the topside should be reduced to an absolute minimum. Where possible the equipment and personnel should be below decks. Required topside fire control personnel should be in protected cylindrical or spherical shaped shields.
2. It is doubtful if mounts, directors, foundations, or shelters can be designed that will withstand an attack of this violence and nature. Stronger holding down clips and retaining rings are necessary. Spherical or cylindrical surfaces will provide better protection than flat surfaces.
3. A system of baffling should be installed in the uptakes of boilers to dissipate the air waves going down the stack before reaching the boilers.
4. Methods should be devised for protecting radio and radar antennae, such as protective housings or retractible antennae.
5. Some extra protection for the underwater hull and propelling machinery is necessary. It is possible that new methods of propulsion, such as the "jet" principle, or the use of atomic energy for propulsion will come in use. These, it is believed, may eliminate the vulnerable propeller shaft and simplify the main propulsion plant to an extent which would reduce the shock hazard.

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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.

Drafts before test B; forward 20' -1'' aft 21' -1''.

List 1° port.

Drafts after test B; forward 20' -4'' aft 23' -4''.

List 3 1/2° starboard.

The principal sources of flooding are a 2 inch cooling water line to the ice machinery room which broke in number 1 (starboard) shaft alley and leakage through shaft stern tube glands.

No. 2 (starboard) shaft alley flooded through the stern tube and through opened rivets.

No. 3 (port) shaft alley partially flooded through the stern tube and weeps from adjacent fuel oil tanks.

No. 4 (port) shaft alley partially flooded through the stern tube.

The ice machine room, D-201-E, partially flooded from No. 1 shaft alley through a leaky hatch.

The after engine room flooded with oil and water to a depth of 10 feet at the centerline from leakage through the four after bulkhead shaft glands and from leakage of oil tanks seams.

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U.S.S. PENSACOLA (CA24)

The after fireroom flooded with oil and water to a depth of 10 feet from the after engineroom through bulkhead shaft glands and electrical stuffing tubes.

The forward engineroom flooded with oil and water to a depth of 6 feet from the after fireroom through bulkhead shaft glands.

The forward fireroom had 6 inches of oil and water in the bilges.

The fresh water pump room, A-508-E, partially flooded, presumably from fresh water tanks just forward or from the spare parts storeroom, A-506.

The aircraft small arms stowage, A-416-M, had 2 inches of water on the deck, presumably from the the sprinkling system. A small amount of water accumulated in spaces below gun mounts during the decontamination washing of the ship.

It is believed that had personnel been on board, flooding could have been confined essentially to shaft alleys.

(b) Structural damage.

Damage to the superstructure, except for directors and enclosed mounts is negligible. Some superstructure damage occurred to components already seriously distorted and weakened in test A.

Essentially no damage to hull plating above the waterline was observed. However, overall damage to this ship indicates that some leakage of the bottom shell may exist.

Above the second deck, damage is confined principally to structure previously seriously weakened during test A. In the well deck area, buckling of stanchions and failure of main deck girders was increased as a result of test B. Stanchions above the second deck, severely buckled in test A, were completely fractured

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in test B. Uptake bulkheads, damaged in test A, were further damaged in test B.

Structural and joiner bulkheads between the second deck and first platform are severely buckled in way of number two 8-inch mount due to violent vertical movement of the mount. The only other damage observed on the first platform is buckling of stanchions at frame 113 (between mounts 3 and 4).

In the engineering spaces there is evidence of severe shock and vibration. Structural foundations under condensers are deformed and rivets are sheared, turbine casings are cracked, boiler saddles are slightly damaged, considerable brickwork is knocked down, gratings are displaced and moveable gear is severely disarranged. In both the forward and after firerooms, the 16" x 3/8" centerline column is fractured, having been severely wrinkled by compression and having then failed when placed in tension. Longitudinal and transverse girders supporting the armored deck in way of the engineering spaces are severely buckled in the webs, principally in way of lightening holes.

(c) Other damage.

Machinery.

All boilers would have been rendered inoperable.

Boilers not having their uptakes or armor gratings blanked off after the damage of test A, had their casings again blown out in test B. Brickwork is down in all boilers and foundations and saddles show evidences of severe stresses. The main condenser foundation channel-frame and cross-bracing is distorted and rivets are sheared.

All main turbines were made inoperable by shock. Numbers 1 and 4 astern turbine casings are cracked, and numerous cracks occurred in turbine pedestals and foundations.

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All four fuel oil service pumps in the forward fireroom are damaged by shock, suffering misalignment and breakage of supports.

Numbers 3 and 4 propeller shafts are bent in the after engine room and the after spring bearing on number 4 shaft is damaged.

The bed plate of the anchor windlass is cracked across its entire width, and the port control shaft is frozen.

Electrical.

Many storage batteries are unusable. The starting batteries of both diesel generators are dislodged and wrecked and the after diesel generator room was full of chlorine fumes. The ship's service telephone switchboard and general announcing system are inoperable. Some ventilation sets are inoperable.

Ship control.

The gyro compasses are inoperable.

Fire control.

All directors and rangefinders are inoperable. The forward 5-inch AA director is bent forward and the stable element is broken at the base. The after 5-inch AA director is twisted to starboard. The after main battery director is very difficult to train and elevate by means of handwheels. Most of the controls within the directors and the adjusting knobs on instruments are broken or frozen. The lenses and crosswires in the optics are undamaged, but they cannot be focused. Plotting rooms were slightly damaged by shock.

Gunnery.

- (a) Protected mounts.
General condition, including operability, if known.

All of the 8 inch mounts were damaged
U.S.S. PENSACOLA (CA24)

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severely as a result of test B. The damage was heavier on mounts 1 and 2 than on the other two. The primary failure in each case was the pivot seal casting and its holding down bolts. The pivot seal casting, in addition to housing the weather seal, functions as a holding down clip for the mount and as a retainer for the radial thrust needle bearings. The failure, caused by the underwater shock, allowed the mounts to lift with considerable acceleration from the training race. Ball and roller bearings were displaced, and the mounts dropped to rest in a skewed position. Extensive damage to the rotating structure below the shelf level in mounts 1 and 2 resulted from the primary failure. All of the mounts are completely inoperable as a result of this damage.

No damage to unprotected mounts is observed and all these mounts appear operable.

Electronics.

Electronic equipment in the bridge area suffered severe damage.

II. Forces Evidenced and Effects Noted.

(a) Heat.

There is no evidence of heat.

(b) Fires and explosions.

There are no evidences of fire or explosion, but personnel casualties in engineering spaces would have been high due to boiler flarebacks and shock.

(c) Shock.

The underwater pressure from test B struck this ship at an angle of approximately 357 degrees relative, or essentially from dead ahead. There is evidence of tremendous shock in main battery mounts, in engineering spaces, and to a lesser extent throughout the vessel.

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U.S.S. PENSACOLA (CA24)

Boilers are moved on their foundations, a large amount of brickwork is knocked down, numerous pedestals and other machinery supports are cracked. The casings of numbers 1 and 4 astern turbines are cracked and condenser supports are distorted. Moveable gear is thrown about, powder cans and batteries in magazines are dislodged and projectile stowages in mounts are disarranged.

The centerline stanchions in both the forward and after firerooms are fractured and second deck girders in the engineering spaces are buckled in the webs due to inertia of the armored (second) deck.

(d) Pressure.

Blast pressure in test B caused negligible damage to superstructure. Additional deflection of weather deck areas previously weakened by test A is due primarily to wave action and to upward acceleration of the ship. The ship was affected by underwater explosion pressure, followed by one or more very large sharp waves.

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

Effects noted peculiar to the atom bomb are wave phenomena and a high degree of contamination by radioactivity. It is estimated that personnel casualties above the second deck would have been extremely high due to radiological effects. Radioactivity was carried below decks by blowing out of boiler casings and to some degree by water coming down ventilation ducts from topside intakes.

III. Effects of damage.

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

The machinery plant was completely wrecked as an operating plant. Emergency repairs would have been ineffective even with control of flooding; repairs would require a lengthy shipyard overhaul. Machine ship equipment is wrecked. Ship control was lost

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U.S.S. PENSACOLA (CA24)

through absence of power of any kind. Diesel power (from forward generator only) might have been restored within a short time if undamaged starting batteries had been available.

(b) Effect on gunnery and fire control.

Gunnery and fire control were affected by loss of power and by inoperability of all protected mounts, directors, and rangefinders, and of electronic equipment in the bridge area, due to shock. Damage to powder cans, disarrangement of ammunition stowages, and leakage of powder fumes in magazines would have affected the rate of firing.

(c) Effect on watertight integrity and stability.

Watertight integrity was reduced slightly by loosening of shaft stuffing glands, due to shock. Flooding of the power plant could have been prevented had personnel been aboard. Stability due to flooding was affected slightly. It is estimated that the ship took on 920 tons of water and listed 3 1/2 degrees to starboard.

(d) Effect on personnel and habitability.

It is believed that casualties to personnel would have been extremely high due to shock, topside blast, blast effects in firerooms, and radioactivity. Habitability of interior compartments was greatly reduced by complete loss of power and by temporary obstruction of living spaces and passages by disarranged equipment.

(e) Total effect on fighting efficiency.

The fighting efficiency of this ship was completely lost due to absence of power, shock damage to 8-inch mounts, directors, and fire control electronic equipment and wrecking of the vessels power plant. Personnel casualties would have been high.

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U.S.S. PENSACOLA (CA24)

IV. General Summary of Observers' Impressions and Conclusions.

It is considered that naval vessels of this type, and ship's personnel, are exceedingly vulnerable to shock, blast pressure, and radioactivity at the range of this ship from an explosion such as that of test B.

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

The Commanding Officer's recommendations are as follows:

1. The effectiveness and sufficiency of crew shelters are inadequate. Fire control stations on the topside should be reduced to an absolute minimum. Where possible, the equipment and personnel should be below decks. Required topside fire control personnel should be in protected cylindrical or spherical shaped shields.
2. It is doubtful if mounts, directors, foundations, or shelters can be designed that will withstand an attack of this violence and nature. Stronger holding down clips and retaining rings are necessary. Spherical or cylindrical surfaces will provide better protection than flat surfaces.
3. A system of baffling should be installed in the uptakes of boilers to dissipate the air waves going down the stack before reaching the boiler.
4. Methods should be devised for protecting radio and radar antennae, such as protective housings or retractible antennae.
5. Some extra protection for the underwater hull and propelling machinery is necessary. It is possible that new methods of propulsion, such as the "jet" principle, or the use of atomic energy for propulsion will come in use. There, it is believed, may eliminate the vulnerable propeller shaft and simplify the main propulsion plant to an extent which would reduce the shock hazard.

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VI. Instructions for loading the vessel specified the following:

ITEM	LOADING
Fuel oil	15%
Diesel oil	15%
Ammunition	87%
Potable and reserve feed water	95%
Salt water ballast	1600 tons.

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 "Instruction 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.

Considerable damage to structure and severe shock damage to equipment is evident in PENSACOLA as a result of test B. Structural damage is confined essentially to the interior spaces of the ship except for additional downward deflection of the weather deck and for some aggravation of test A topside damage. Test B damage to stacks, topmast, and directors is made evident by comparing after B photographs 2957-3, page 13, 2959-4, page 37, and 227-283-12, page 10; with after A photographs 1832-2, page 6, 1860-3, page 7, and 1965-3, page 3 of volume 2 of the test A report. The external hull, including sheer strakes and side belt armor appears undamaged. Much of the structural damage to decks and interior spaces occurs in areas where structure had been seriously weakened by the previous test. Bulkheads and stanchions are buckled on the second deck and in certain areas on the first platform. Centerline columns are fractured in both firerooms and structure supporting the armored (second) deck is damaged in way of engineering spaces (forward fireroom photographs 4165-2, page 162, 4165-5, page 164, 4165-6, page 165, 4165-7, page 166, 4165-8, page 163, and 4165-10, page 161; after fireroom photographs 4226-12, page 167 and 575-5, page 168; forward engine room photographs 1691-1, page 181, 1691-3, page 171, 1691-4, page 170, 2982-3, page 176, 2982-5, page 187, 2982-7, page 180, 2982-9, page 178 and 2982-10, page 186).

Machinery, fire control and gunnery installations, ammunition stowage and miscellaneous gear and furniture are severely damaged or deranged by shock throughout the ship. Considerable flooding occurred in machinery spaces and shaft alleys and the ship took a 3 1/2 degree list to starboard. The blast and underwater pressure from test B struck this ship at an angle of approximately 357 degrees relative.

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(b) General Areas of Hull Damage.

Weather deck areas dished during test A, show additional downward deflection as a result of test B. This is particularly evident in the well-deck area (photos 4173-12, page 44 and 2957-8, page 31). Deck deflection scratch gauges installed in this area below the main deck for measuring test A deflection were not re-installed for test B. Additional deck dishing, however, is indicated by increased buckling of supporting bulkheads and stanchions and by the crushing of joiner bulkheads previously buckled by test A. Structural and joiner bulkheads between the second deck and first platform levels are severely buckled in the spaces in way of number two mount, frames 28 to 38 (photos 2080-1, page 160, 2080-2, page 158, 2080-3, page 157, and 2080-4, page 159). The only other damage observed on the first platform occurs at frames 113, where stanchions are buckled.

Numbers one and two main battery mounts are seriously deranged.

In the engineering spaces below the armor deck moveable equipment is displaced and machinery supports are buckled (photos 2982-1, page 169, 1690-1, page 198, 1690-2, page 202, 1690-3, page 201, 1690-4, page 203, 1690-5, page 204, 1690-7, page 174, 1691-5, page 194, 1691-6, page 196, 1691-8, page 200, 1691-10, page 199, and 1691-12, page 195). Turbine casings are cracked (photos 1690-8, page 193 and 1690-11, page 192) and boilers have casings blown out to a greater degree than can be attributed to test A. In both firerooms the centerline column is fractured and the web of the centerline girder is buckled adjacent to the forward and after bulkheads.

(c) Apparent causes of hull damage.

Increased deflection of the main deck and additional buckling of supporting bulkheads and stanchions underneath are considered to have resulted primarily from flexure and from the wave which washed over the ship following the explosion. Inertia forces resulting from the upward acceleration imparted to the ship by underwater pressure and wave action caused further deflection of the main deck

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structure, already seriously weakened as a result of test A. Partial elastic recovery of the main deck from its maximum deflected position is indicated by vertical separation of fractured sections of second deck stanchions and by failure of stanchion end connections, (photos 2080-7, page 116 and 2080-11, page 124). Similarly partial recovery of the second deck is indicated by the fracture separation of centerline columns in the firerooms and pulling of reach rods from their sockets (photos 1690-6, page 173, 1691-3, page 171, 4165-8, page 163, and 4226-12, page 167).

In the spaces underneath number two mount, supporting bulkheads and stanchions are considered to have buckled primarily from shock followed by a violent flexural movement of the ship (photos 2080-1, page 160, 2080-2, page 158, 2080-3, page 157, and 2080-4, page 159). The tendency of the static inertia of the turret to resist this movement appears to have contributed to the failure of the structure underneath.

Derangement of machinery and equipment in the engineering spaces below the armor deck is considered to have resulted primarily from underwater shock. Shock also appears to be responsible for the buckling and distortion of machinery foundations and for the fracture of centerline columns in the forward and after firerooms. Deflection and permanent set of the centerline girders in these spaces is due principally to the inertia effect of the armor deck during the violent upward acceleration of the ship by wave action and underwater pressure. Vertical scratch gauges installed between the inner bottom and second deck in the forward fireroom indicate relative movement (see tabulation of scratch gauge data). Damage to gauge tubes and pointers precludes exact measurement of deflection but the gauge records show two oscillations of large amplitude and numerous lesser oscillations. (Note: Typical scratch gauge installations are shown in photos 1689-1, page 184, 1689-2, page 183, 2081-7, page 133, and 2982-8, page 182).

(d) Principal areas of flooding.

Principal areas of flooding are the after fireroom, the forward engineroom, the after engineroom, all four shaft alleys,

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and the ice machinery room. The principal source of flooding is a broken 2 1/2 inch sea suction line in No. 1. starboard shaft alley supplying cooling water to the ice machinery on the first platform. Progressive flooding occurred through shaft glands, loosened by shock, in bulkheads and stern tubes. The presense of oil in the after engine room is considered to have resulted from leaks in one or more tanks in this space.

(e) Residual strength, buoyancy.

The residual strength of the vessel is somewhat impaired by damage to the weather deck and to girders and columns in the engineering spaces. There is no visual evidence of hog or sag. The Commanding Officer states that the ship seems slightly twisted longitudinally from astern, port quarter up and that the centerline girder in the engineering spaces appears distorted by a clock wise torque, view from aft looking forward. The impression that the ship as a whole is slightly twisted is confirmed by a deck survey made after test A which indicates a total twist of 29 minutes, measured over a 272 foot length, (see test A deck survey data). This condition may have been aggravated by test B, but it is not believed sufficiently serious to have caused machinery or shaft misalignment. No significant damage to shell plating, armor, or keel is noted.

Buoyancy was somewhat reduced by flooding.

As a result of shock and blast damage to boilers and shock damage to machinery and machinery foundations, the ship was without power for propulsion or for the operation of her main battery.

The radiological condition of the ship resulted in rigid restrictions in time available for staff inspections, particularly in compartments below the water line.

B. Superstructure (Exclusive of Gun Mounts).

(a) Description of damage.

Damage to the superstructure, exclusive of gun mounts is superficial except for serious damage to fire control equipment.

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Flat surfaces, horizontal and vertical, in the superstructure suffered minor increase in distortion over that attributable to test A. Sheet metal in the bridge area is dished and bulwarks previously damaged are further damaged as a result of test B (compare after A photo 1759-6, page 27 of volume 2 of the test A report with after B photo 157-11, page 35).

The forward and after stacks, demolished and thrown to port during test A, are further displaced in test B (photos 2957-3, page 13, 2957-8, page 21, and 2957-12, page 15 compared with after A photos 1832-2, page 6 and 1860-3, page 7 of volume 2 of the test A report).

The fore topmast supporting the SG radar antenna, already bent forward in test A is bent sharply down and forward (photo 2957-4, page 6).

The forward 5 inch AA director is bent forward and the stable element is broken at the base (photos 2959-4, page 37, 158-1, page 40, and 158-2, page 41 compared with after A photos 227-520-115, page 22 and 227-520-120, page 9). The after 5 inch AA director is twisted to starboard and rendered inoperable (photo 4073-3, page 20).

Further damage to directors, all of which are rendered inoperable, is described under item C, "Turrets, Guns, and Directors".

(b) Causes of damage.

Test B damage to stacks, fore topmast, and directors is characterized by a displacement forward and downward and is considered due primarily to shock induced by a strong vertical acceleration acting on relatively large masses. The degree of damage caused by blast or by falling water appears slight; in general, flat surfaces not previously weakened by test A, remain essentially undamaged in test B.

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C. Turrets, Guns and Directors.

(a) Protected mounts.

General condition, including operability, if known.

All of the 8 inch mounts were damaged severely as a result of test B. The damage was heavier on mounts 1 and 2 than on the other two. The primary failure in each case was the pivot seal casting and its holding down bolts. The pivot seal casting, in addition to housing the weather seal, functions as a holding down clip for the mount and as a retainer for the radial thrust needle bearings. The failure, caused by the underwater shock, allowed the mounts to lift with considerable acceleration from the training race. Ball and roller bearings were displaced, and the mounts dropped to rest in a skewed position. Extensive damage to the rotating structure below the shelf level in mounts 1 and 2 resulted from the primary failure. All of the mounts are completely inoperable as a result of this damage.

Mount 1.

The pivot seal casting was allowed to lift under the force of the underwater shock by the failure of the connection between the casting and the base ring. The failure is the result of the tearing of the casting around the bolt holes and the failures in tension of many bolts (photos 158-8, page 48, 1676-6, page 46, 1676-7, page 45, 1676-8, page 8). The training race ball bearings and retainers were displaced, forcing the mount to come at rest in a skewed position. The following measurements between the upper and lower ball bearing races, give an indication of the magnitude of the misalignment.

Distance between upper and lower races at front
2 inches.

Distance between upper and lower races at left side
1 11/16 inches.

Distance between upper and lower races at rear
2 11/16 inches.

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Distance between upper and lower races at right side 2 3/4 inches (photographs 1676-9, page 49, 1676-10, page 51, and 1676-11, page 50).

The underwater shock also caused failure of the bolts connecting the cap square to the trunnion support of the elevating nut housing trunnion. This caused misalignment of the shaft connecting the "B" end hydraulic unit to the elevating nut, resulting in the parting of the shaft coupling (photos 1686-2, page 72 and 1686-3, page 73).

Rivets are sheared and the plates sprung in the left powder hoist trunk at the upper level in the gun chamber (photo 1686-5, page 74).

Bolts securing the training pinion lower bearing housing failed in tension when the housing struck the underside of the training rack as the mount lifted (photo 1686-8, page 75).

The transverse bulkhead on the second platform at frame 27, port, and the door in this bulkhead providing access between A-412M and A-411M are severely buckled. The door was opened with difficulty.

Projectiles were torn loose from their stowage on the fixed platform of the projectile flat and considerably disarranged. Powder cans and battens are displaced in all of the magazines. Because of the pivot seal casting failure, with the resulting movement to the rotating structure, the powder circle flat is slightly damaged. The gas seal around the periphery of the flat is demolished.

Mount 2.

The pivot seal casting was allowed to lift under the force of the underwater shock by the failure of the connection between the casting and the base ring. The failure is the result of tearing of the casting around the bolt holes and the failures in tension of many bolts. The radial thrust needle bearing assembly lifted and remained exposed to view from the outside. This jammed the pivot seal casting preventing it from dropping back to a normal position (photos 158-4, page 53, 1684-2, page 54, 1684-3, page 55, 1684-4, page 56, 1684-5, page 57, 1684-6, page 58, 1684-7, page 59, 1684-8, page 60, 1684-9,

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page 61, 1684-10, page 62, and 1684-11, page 63).

The training race ball bearings and retainers were displaced, forcing the mount to come at rest in a skewed position. About twenty-five percent of the ball bearings are missing from the retainers and laying on the powder circle tray and deck (photos 1676-12, page 64, 1677-1, page 69, 1677-2, page 65, 1677-3, page 71, 1677-4, page 70, and 1677-8, page 68). Exact measurements between the upper and lower ball bearings races could not be obtained because of interference from the displaced retainers. The rotating projectile flat was moved six inches to the rear, raised about 4 1/8 inches at the rear edge and lowered about one inch at the front edge, (photos 1677-12, page 98, 1678-1, page 99, and 1678-5, page 78). In the front portion of the training race the ball bearings became lodged between the upper rotating structure and the top of the training rack. This forced down the rack which sheared off a portion of the edge of the supporting flange (photos 1685-7, page 76 and 1685-6, page 77).

The training pinion lower bearing housing struck the underside of the training rack causing the attachment bolts to fail in tension. This permitted the housing to drop down, fall through an open hatch in the powder flat, and land on the projectile flat (photos 1677-2, page 65 1678-2, page 66 and 1685-1, page 67).

Transverse bulkhead 33 on the first platform below the circular foundation of the mount is severely damaged.

Projectiles were torn loose from their stowages on the fixed platform of the projectile flat and considerably disarranged. Powder cans and battens are displaced in all of the magazines (photos 1677-12, page 98 and 1678-1, page 99).

Because of the pivot seal casting failure, with the resulting violent movement of the mount, the rotating structure below the training race is extensively damaged. The powder circle flat is buckled and rivets attaching the deck to the tray support are sheared (photos 1677-5, page 83, 1677-6, page 82, 1677-7, page 81, and 1685-2, page 84). The seal around the periphery of this deck is demolished

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(photos 1678-3, page 89, 1678-7, page 88, 1678-8, page 87, and 1678-9, page 86). The powder circle tray and support is badly distorted. On the left side it was forced against the powder hoist damaging both the tray and hoist (photos 1677-9, page 80, 1677-11, page 79, and 1685-10, page 85).

Mount 3.

The pivot seal casting was allowed to lift under the force of the underwater shock by the failure of the connection between the casting around the bolt holes and the failure in tension of many bolts (photos 1687-1, page 90, 1687-2, page 91, and 1687-3, page 92).

This mount is supported and trained on tapered rollers instead of ball bearings. During the time the mount lifted the rollers shifted about 3/4 inch to the right side but the mount finally settled in an approximately horizontal position. One of the bolts securing the training pinion lower bearing housing failed in tension when the housing struck the underside of the training rack as the mount lifted. The housing remained in place (photos 1687-4, page 93 and 1687-6, page 94). A section of the training rack in way of the housing was forced slightly upward by the impact (photos 1687-5, page 95).

Projectiles were torn loose from their stowages on the fixed platform of the projectile flat and considerably disarranged. Powder cans and battens are displaced in all of the magazines.

Mount 4.

Two sections of the pivot seal casting on the right side were allowed to lift under the force of the underwater shock by the failure of the connection between the casting and the base ring. The failure is the result of the tearing of the casting around the bolt holes and the tension failure of many bolts.

The training race ball bearings and retainers on the rear and right side were displaced but the mount finally settled in a fairly horizontal position (photo 1687-9, page 96).

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The training pinion lower bearing housing struck the underside of the training rack causing the threads to strip on two of the attachment bolts. The housing did not fall free but is precariously held by the remaining bolts (photo 1687-8, page 97).

Projectiles were torn loose from their stowages on the fixed platform of the projectile flat and considerably disarranged. Powder cans and battens are displaced in all of the magazines.

2. Effectiveness of installed turrets or shields.

The 8'' mounts on this class of cruiser are very vulnerable to underwater shock and consequently are badly damaged from the test.

(b) Unprotected mounts.

1. General condition, including operability, if known.

No damage.

2. Effectiveness and sufficiency of crew shelters.

Gun shields as provided on this vessel are insufficient protection for the crew under the conditions of this test.

(c) Directors and range-finders in 8'' mounts.

No damage.

(d) Constructive criticism of design or construction of mounts.

Directors, foundations and shelters.

The design of the pivot seal casting is poor. The casting is complicated and there is little chance for adjustment. All parts must be perfectly machined, and when assembled there is no way to check clearances with a feeler gage. An upward force applied to the casting on the inside, by the rotating structure, would exert more

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than double that amount to the connecting bolts due to the lever action. Parts constructed from forgings or medium steel weldments would withstand shock much better than castings. More adequate means of securing the casting should be developed. See typical section through training race and pivot seal, page 37.

The secondary battery, while receiving little material damage, does not have sufficient protection for the crew. Personnel should be housed in steel shields for protection against blast and radioactive water.

D. Torpedo Mounts, Depth Charge Gear.

Not applicable.

E. Weather Deck.

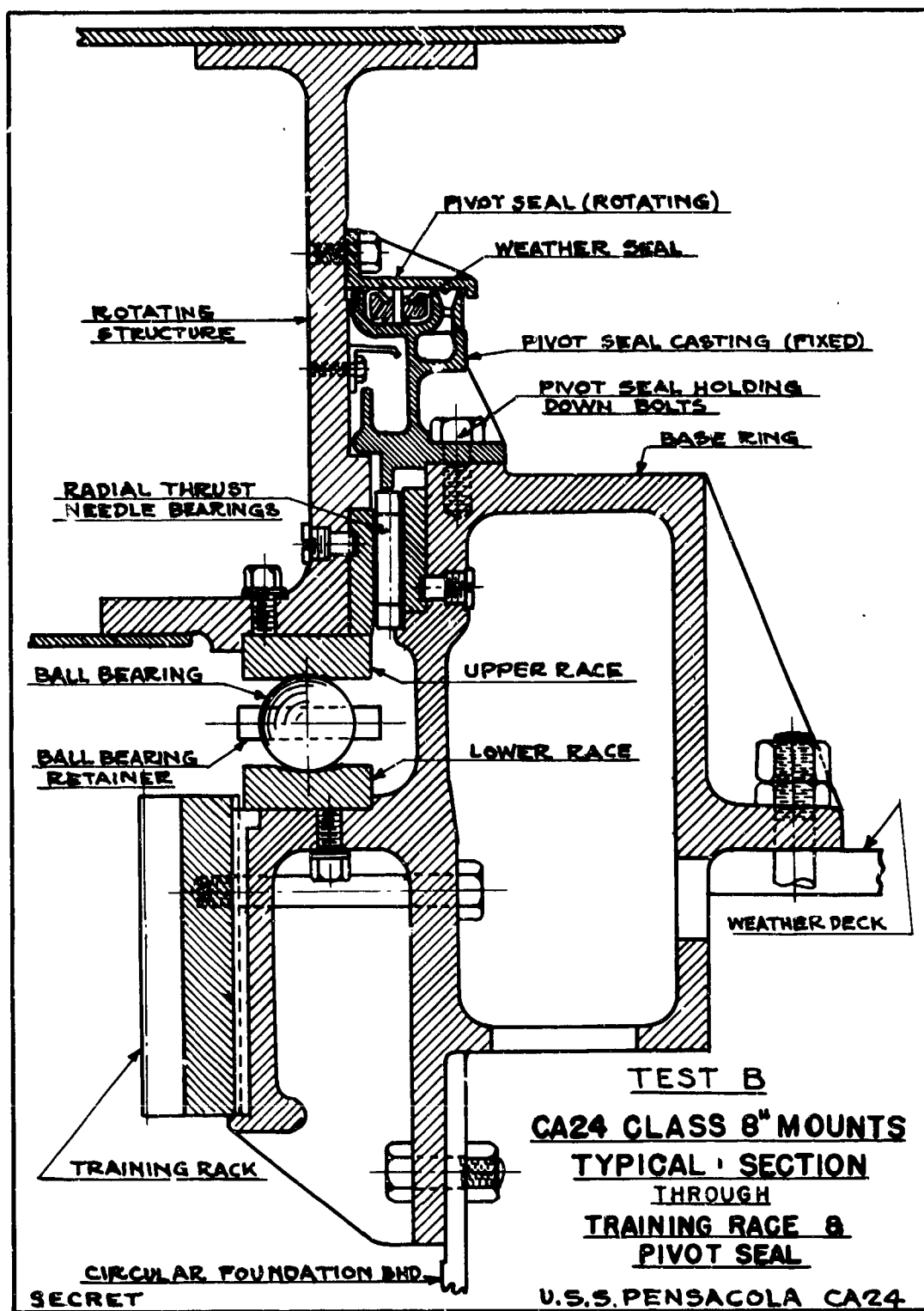
(a) General condition of deck and causes of damage.

Weather deck areas previously weakened by air blast during test A show additional deflection. The areas showing major damage are in way of the main deck well and aft of mount 4. Deck deflection scratch gauges installed for test A between the main deck and second deck in the well deck area were omitted for test B, but additional main deck dishing in this area is indicated by increased buckling of supporting bulkheads and stanchions and tears in deck plating. Some elastic recovery of the main deck after deflection is evidenced by vertical separation of fractured sections of second deck stanchions (photos 2080-11, page 124 and 2081-7, page 133). These stanchions were buckled during test A and fractured in test B. Similar additional damage and partial elastic recovery occurs to lesser degree in the dished areas aft of mount 4.

Increased dishing of weather deck areas is considered to have resulted primarily from the effects of shock, flexure, and from the wave which washed over the ship. Overall examination indicates that test B damage to weather decks probably would have been slight had they not been previously weakened by test A.

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(b) Usability of deck in damaged condition.

The deck is usable except in the center section of the well deck and aft of frame 114 where major dishing occurs.

(c) Condition of equipment and fittings.

Mooring and towing fittings are unimpaired. Boat davits and airplane handling gear appear operable. Life lines and life line stanchions are undamaged by the test. The anchor windlass bed plate is cracked across its entire width and the port control shaft is frozen.

F. Exterior Hull (Above Waterline).

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

The shell plating above the waterline remains essentially undamaged by test B except for a four inch hole found in the plating at the intersection with the main deck about two feet aft of frame 19 on the starboard side. This hole appears to have been caused by a flying fragment.

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

Undamaged.

(c) Details of any impairment of sheer strakes.

There is no appreciable impairment of sheer strakes.

(d) Condition of side belt armor.

The side belt armor appears to be undamaged.

G. Interior Compartments (Above Waterline).

(a) Damage to structure and causes.

There is considerable damage to the structure and equipment of interior compartments above the waterline. Much of this

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damage, however, is the result of test A, with increase of damage as a result of test B.

The starboard shell between the main and second decks is bulged inward approximately one inch between frames 5 and 20. The main deck brackets, port and starboard are damaged in this area. This is believed to be test A damage with some additional distortion from test B. The main deck forward of frame 10 is slightly deflected downward. A scratch gauge at frame 18 records a 1/4 inch movement of the weather deck in both directions with no permanent set.

The second deck area around number 1 barbette shows minor structural damage, and cracked paint indicates stress in the overhead around the barbette. Web frame 26 is damaged due to a slight lifting of the main deck.

A 4 inch hole, apparently caused by a fragment, penetrates the starboard shell plating at the intersection with the main deck about two feet aft of frame 19. The shell also has several dents in this region.

Bulkheads under barbette number two are severely buckled. Structural and joiner bulkheads between the second deck and first platform levels are severely damaged, frames 28 to 38. This damage is attributable to violent movement of mount number 2. Crew's berthing and other equipment are scattered in A-203-3L and frame 46 is buckled at the starboard shell. Bulkhead 48 has slight buckles on either side of the centerline.

In the uptake area over the forward fireroom, the majority of the damage to light structure is the result of test A. However, this damage was apparently increased by test B.

In the second deck crew's space, C-201-L, under the main deck well, the deck deflection and stanchion buckling was increased by test B. A number of stanchions, buckled during test A, broke at the most severely buckled sections or came adrift at their end connections (photos 2080-11, page 124, 2081-7, page 133, and 2082-5, page 147). Partial elastic recovery of the main deck caused considerable separation of the upper and lower portions of stanchion fractures.

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In second deck crew's space, C-202-L, frame 97 is deflected and its supporting stanchions are buckled and torn loose at the upper connection. A scratch gauge located adjacent to the port stanchion at frame 97 indicated a two inch relative vertical movement with about one inch permanent set at the port quarter span. (Damage in second deck living spaces, much of which is test A damage is shown in photos 2080-5, page 114, 2080-6, page 113, 2080-10, page 121, 2080-12, page 122, 2081-8, page 125, 2081-9, page 128, 2082-1, page 137, 2082-7, page 142, 2082-8, page 150, 2082-9, page 153, 2178-2, page 143, 2178-4, page 146, and 2158-3, page 123).

No significant damage occurred on the second deck between frames 97 and 113. At frame 113 on the first platform, port and starboard quarter span stanchions are buckled.

In way of barbette number 4 the main deck is deflected slightly on the forward side and severely on the after side. Bulkhead 119, directly under number 4 barbette, is only slightly affected. The majority of the damage in D-203-L and D-2031L is the result of test A. It is believed to have been increased somewhat by test B.

In the CPO quarters and mess room on the second deck aft of frames 128, there is some evidence of increased damage due to test B (photos 2082-3, page 148, 2082-4, page 144, 2082-6, page 145, 2082-8, page 150, 2082-9, page 153, 2082-11, page 155, 2082-12, page 154, 2179-4, page 151, 2179-7, page 152, and 1755-3, page 149).

(b) Damage to joiner bulkheads and causes.

Second deck joiner bulkheads previously damaged by test A sustained further damage during test B.

Secondary damage of this nature extends from frame 38 aft and is particularly evident in the well deck area and aft of number four turret. Forward of frame 38, damage to joiner bulkheads is primarily a result of test B. In this area buckling of bulkheads is associated with damage to the supporting structure under mount 2 and is due to shock. Forward of mount 1 and in the well deck area the principal cause of damage is considered to downward movement of the

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weather deck as a result of air blast and wave action. Similarly, movement of the main deck is the cause of distortion and tearing of joiner bulkheads in A-203-2L in way of mount 2. Typical damage to joiner bulkheads is shown in photos 2080-9, page 118, 2081-3, page 119, 2081-8, page 125, 2081-9, page 128, 2082-2, page 139, and 2082-3, page 148).

(c) Damage to access closures.

Practically all access closures on the second deck level were either severely or slightly damaged by test A. As a result of test B this damage appears to have been slightly increased.

(d) Condition of equipment within compartments.

Moveable furniture and bunks in all living compartments are badly displaced. Fire extinguishers and ship's gear stowed in lockers and drawers or secured to bulkheads are strewn about the deck. Dishes in pantries are broken. In the general workshop on the second deck, starboard, lathe s are knocked off their foundations after fracture of cast iron footing near the deck. This damage is considered to have resulted from shock (photos 2078-7, page 101, 2078-8, page 102, 2079-10, page 103, 2080-4, page 159, 2982-1, page 169, 4225-10, page 236, and 4225-11, page 237).

(e) Evidence of fire.

There is no evidence of fire.

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

A 2 1/2 inch cooling water line in number one shaft alley leading to the ice machinery is broken. Ventilation ducts above the second deck, not previously damaged by air blast, are disjointed or loosened by the shock and air blast of test B (photos 1691-2, page 172, 1755-3, page 149, 2079-2, page 104, and 2080-10, page 121). Moderate damage to piping insulation in machinery spaces occurs as a result of shock in test B.

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

Watertight subdivision above the second deck was seriously reduced by test A and further reduced by test B, through increased rupture of bulkheads and damage to access closures. Watertight subdivision between the second deck and the engineering spaces is reduced somewhat by damage to uptake bulkheads on the second deck level. Habitability and utility of second deck compartments is temporarily impaired by derangement of bunks and lockers in living spaces, disrupting of miscellaneous small stowages, breakage and derangement of workshop equipment, and by damage to ventilation ducts.

H. Armor Decks.

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

The armor (second) deck shows evidence of elastic deflection in way of the engineering spaces, frames 48 to 97. In addition, a permanent downward set is evident from failures of the supporting girder system. Deck deflection scratch gauges of the vertical stanchion type installed between the inner bottom and second deck in the forward fireroom indicate relative vertical movement. Gauge records show two large oscillations and numerous lesser ones. Bending of gauge pointers and gauge stanchions preclude the use of quantitative data.

The 42 inch centerline longitudinal girder failed adjacent to the forward and after bulkheads of both firerooms (photos 4165-2, page 162 and 4165-10, page 161). A number of the 8 inch second deck longitudinals, port and starboard, also failed adjacent to these bulkheads. In the forward engine room, the 30 inch transverse girders at frames 64 and 68 show web failure, particularly in way of lightening holes and cut-outs for longitudinals (See sketch in ship measurement data appendix and photos 1389-3, page 185, 2982-3, page 176, 2982-5, page 187, 2982-6, page 177, 2982-7, page 180, 2982-9, page 178, and 2982-10, page 186). The transverses are supported at the centerline by heavy pipe columns.

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These columns (16" x 3/8") in both firerooms failed in compression and subsequently fractured due to vertical oscillation of the structure (photos 4165-8, page 163 and 4226-12, page 167). Damage to the structure which supports the armor deck is observed only in way of the large spans in the engineering spaces.

(b) Protection offered spaces below.

Protection offered by the armor deck to spaces below is not materially affected. It is apparent from blowing out of boiler casings that armor gratings are not effective in rejecting air blast.

(c) Condition around openings.

Watertight subdivision between the second deck and the engineering spaces is reduced by test B through damage to uptake bulkheads on the second deck level. Hatches and grating show evidence of slight distortion from vertical movement of the structure. No damage is observed to armor connections.

I. Interior Compartments (Below Waterline).

(a) Damage to structure and causes.

General: Because of the radiological condition of the ship, only limited time was available for staff inspections. Hence, the only below waterline compartments staff inspected were the forward and after firerooms and the forward engine room. These spaces showed considerable structural damage and evidence of severe shock and violent flexure of the ship from underwater pressure and wave action. Transverse bulkheads in the engineering spaces appear adequate as to scantlings and stiffness. No loss of airtightness of airlocks is apparent.

An overall study of relative vertical motion of structure in engineering spaces indicates an elastic deflection of the order of one inch in way of fractured columns and an undetermined maximum deflection in way of long spans in firerooms.

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Scratch gauges (see table of gauge readings) located in the forward fireroom, 8 feet from the forward and after bulkheads, show two vertical major elastic movements of the second deck relative to the inner bottom at frame 50 and at frame 59, with negligible permanent set. Since the welds of the lower pipes to the tank top fractured the large deflection readings obtained are not of significance.

It seems likely that the sequence of events causing damage in PENSACOLA is as follows (biast effect omitted).

1. The pressure wave impinged on the underwater hull, causing violent upward acceleration and vibration, shock damage to gunnery and fire control installations and machinery foundations, and distortion of girders under the second deck due to inertia of the armor deck.

2. Subsequently, the ship was struck bow-on by one or more huge waves, causing uplift of the bow of sufficient suddenness to induce two flexural vibrations of large amplitude. Such an uplift could account for the general increase in damage to deep frames and deck supports above the second deck. Flexure of the ship as a whole could account for:

- (a) A pulling-together of the second deck and tank top.

- (b) Bending of propeller shafts and loosening of bulkhead stuffing glands.

- (c) Leakage of oil tank rivets and seams.

- (d) Evidence that transverse deep frame 64 was subjected to bending upward as well as downward.

It is not believed that flexure of the ship, if it occurred to any great degree, was caused by arrival of the underwater pressure wave, inasmuch as war damage experiency and model tests indicate that ship flexure occurs when the peak of the pressure wave impinges on a part only, of the underwater area.

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Firerooms.

In both the forward and after firerooms the centerline column is completely fractured (photos 4165-8, page 163 and 4226-12, page 167), at frames 54 1/2 and 78 1/2, and the centerline girder is buckled in the web adjacent to the forward and after bulkheads (photos 4165-2, page 162 and 4165-10, page 161). In both fire-rooms the fractured column is belled at the break. Belling of the pipe column was caused by compression loading, the break occurring later due to tension during vertical oscillation of the structure. Scratch gauges indicated that the armor deck overhead underwent two major and numerous minor elastic deflections with respect to the tank top. Permanent deflection of the second deck is indicated by distortion of the longitudinal centerline girder and deck longitudinals near their connections. Permanent sag in the overhead appeared to be approximately the same in both spaces.

It will be noted from the photographs that web failure of girders occurs principally in way of lightening holes. It appears that installation of face bars around the periphery of these holes would have augmented greatly the resistance of the girders to shear (photos 1689-3, page 185, 2982-5, page 187, 2982-9, page 178, 2982-10, page 186, and 4165-2, page 162). Boiler casings and brickwork are damaged to a greater degree and can be attributed to test A (photos 4164-7, page 205, 4166-1, page 209, and 4166-2, page 210).

Shock damage to small auxiliaries in the forward fireroom is severe. All four fuel oil service pumps suffered misalignment and breakage of supports.

Forward engine room.

This space shows signs of shock and resulting deflection and vibration of hull structure, (photos 1690-1, page 193, 1690-2, page 202, 1690-3, page 201, 1690-4, page 203, 1690-5, page 204, 1690-6, page 173, 1690-7, page 174, 1690-8, page 193, 1690-9, page 190, 1690-10, page 188, 1690-11, page 192, 1690-12, page 189, 1691-1, page 181, 1691-2, page 172, 1691-3, page 171, 1691-4, page 170, 1691-5, page 194, 1691-6, page 196, 1691-7, page 197, 1691-8, page 200, 1691-10, page 199, 1691-11, page 191, 1689-1, page 184, 1689-2, page 183,

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2982-1, page 169, 2982-3, page 176, 2982-5, page 187, 2982-6, page 177, 2982-7, page 180, 2982-8, page 182, 2982-9, page 178, 2982-10, page 186, 2982-11, page 175, and 2982-12, page 179). At time of inspection the bilges were still covered with water and a thin film of oil.

Transverse boundary bulkheads 61 and 72 do not show evidence of permanent deformation. Longitudinal connections under the second deck and at the inner bottom where observable show no signs of damage. The port and starboard longitudinal boundary bulkheads have waves about 3/8 inch to 1/2 inch in depth. This distortion was present after test A, but appears to be slightly greater as a result of test B.

Longitudinals under the second deck show no signs of tripping or working except between frames 61 and 64, where longitudinals numbers 2, 3 and 4 show about 1 1/2 inch permanent set downward (photo 1691-4, page 170). Where the longitudinals pass through deep frames 64 and 68 the deep frames are cut out. Buckling of the frame webs occurs in way of the cut-outs and lightening holes (See sketch).

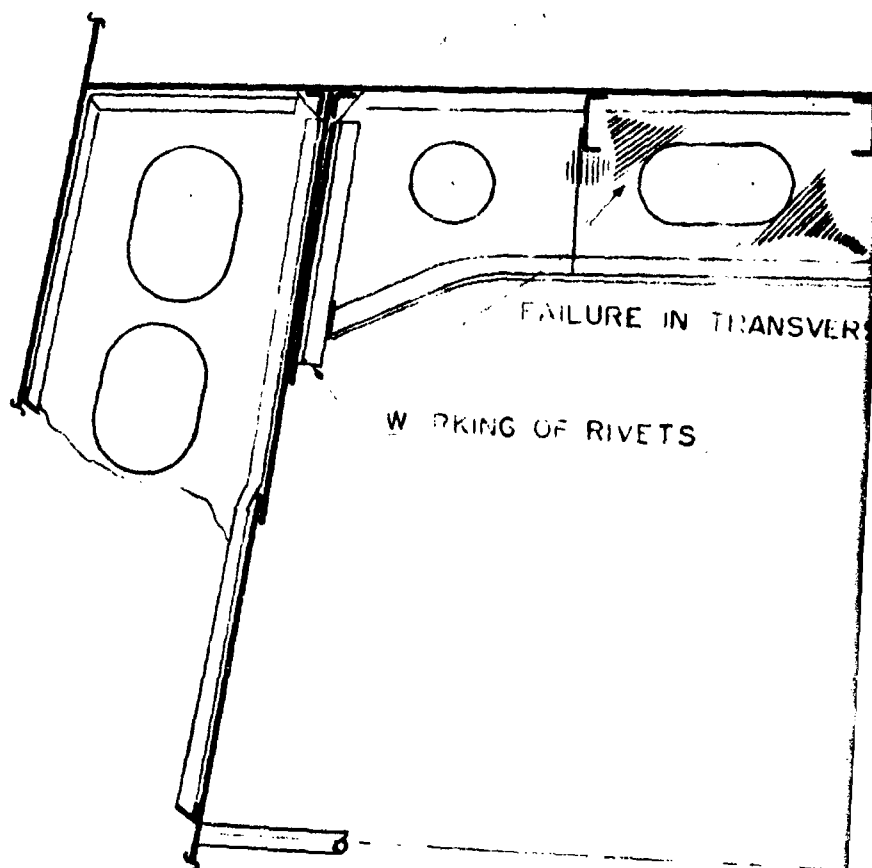
Examination of the column and beam at frame 64 affords evidence of vertical movement, the column suffering alternate tensile and compressive stress during severe vibration of the structure. The presence of compression buckles in the lower portion of the web of frame 64, in addition to buckles near the second deck, indicates that this frame was subjected to severe bending stresses upward as well as downward. The large lightening holes in this transverse contributed materially to web failure. A scratch gauge indicates that the overhead moved downward 1/2 inch relative to the tank top and returned to its original position. Upward movement of structure is indicated by a 1/4 inch permanent deflection downward of the girder flange directly over the column and by a slight separation of the column upper connection.

No damage to the centerline girder is evident in the forward engineroom except in way of the column at frame 64 although a scratch gauge located at frame 68 indicates a relative downward movement of 3/4 inch.

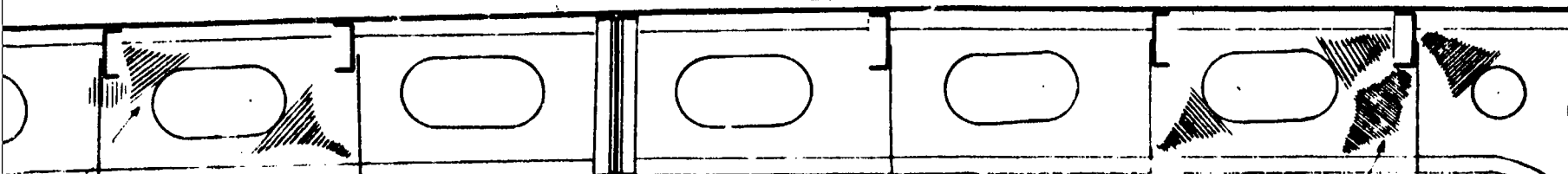
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PORT
SIDE



2ND DECK



FAILURE IN TRANSVERSE BEAM

FAILURE IN TRANSVERSE BEAM

CRACKING OF RIVETS

NO PERMANENT SET
1/2" MOVEMENT IN
BOTH DIRECTIONS

1/2"

GAGE LOCATED
AT FRAME 63 1/2

1 1/2" MOVEMENT IN
IN BOTH DIRECTIONS
NO PERMANENT SET

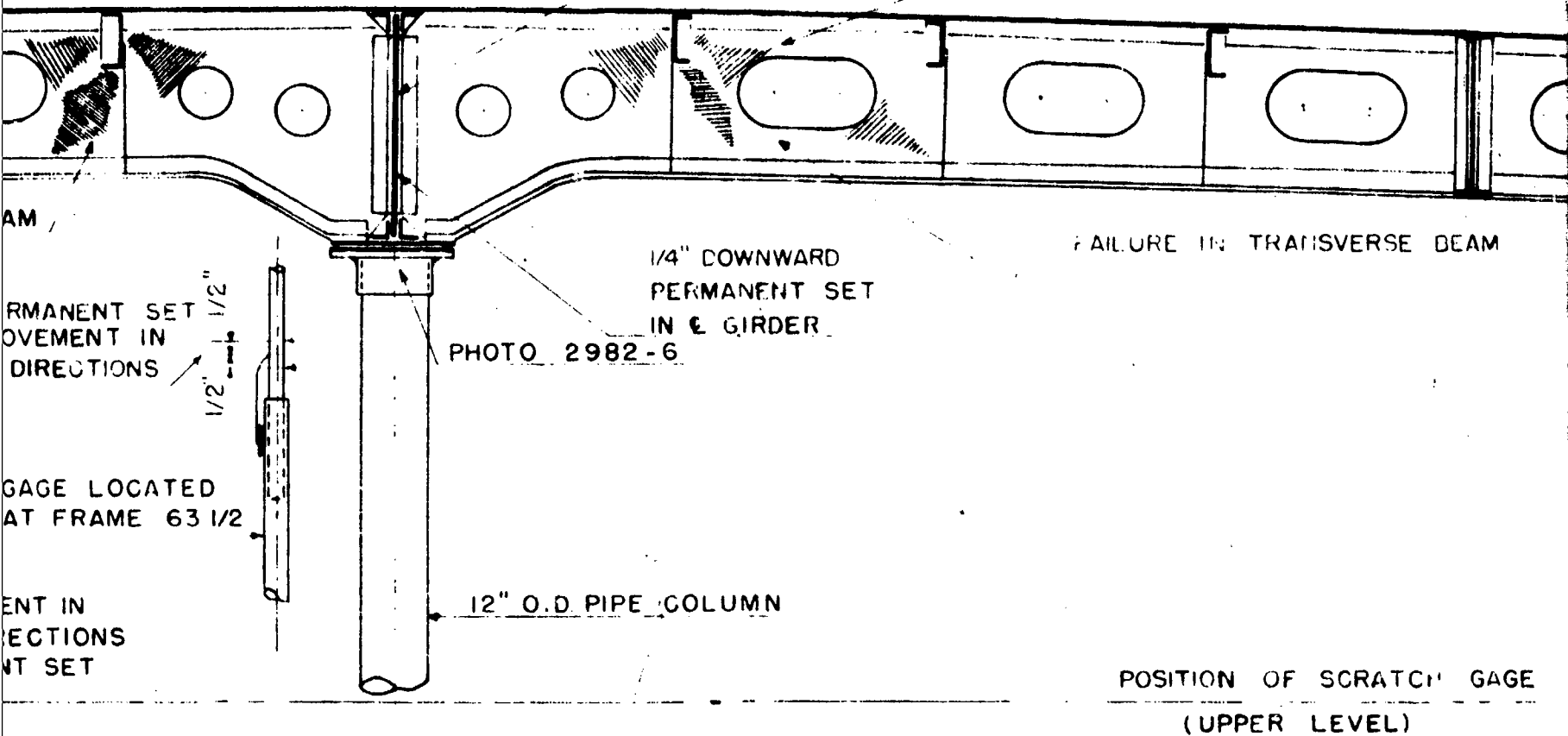
1 1/2"

FR. 64, LOOK

2

DEEP & GIRDER

PHOTO 2982-9



FR. 64, LOOKING FWD., FWD. ENGINE RM.

PORT

MOVEMENT

2ND DECK

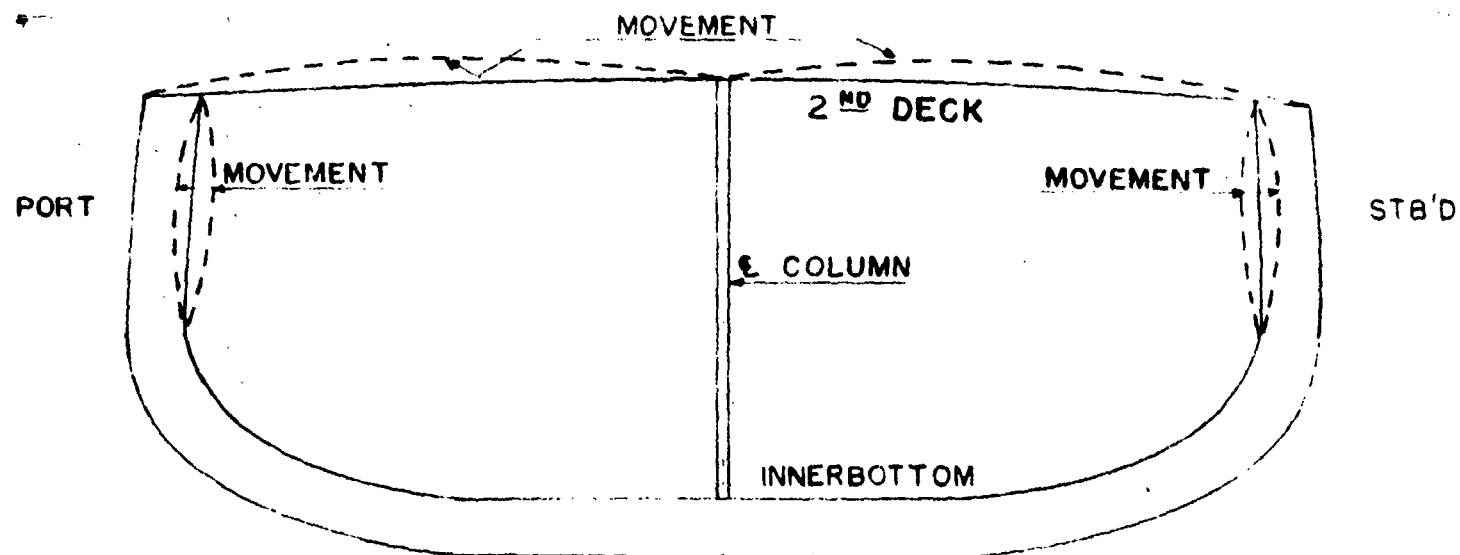
PHOTO 2982-3

RE IN TRANSVERSE BEAM

WORKING OF RIVETS

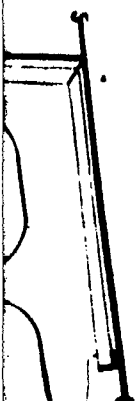
STB'D
SHELL

POSITION OF SCRATCH GAGE
(UPPER LEVEL)



DIAGRAMMATIC
FR. 64 LOOKING FWD.

K



STB'D
SHELL



STB'D

BU. OF SHIPS

NAVY DEPT.

6
DAMAGE AT FR. 64
FWD. ENGINE RM.
TEST B

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At frame 64, port, lower level, a reach rod secured at the upper level and to a machinery foundation, is bowed and pulled out of its socket. A downward movement of about 2 inches was required to bend the rod and at least 1 1/4 inch to pull the rod out of its socket (photo 1691-3, page 171). Near this point the upper level is deflected downward about 1 1/2 inch. At frame 62, starboard, a similar reach rod is out of its socket but not bowed. The upper level is not deflected at this location (photo 1690-6, page 173).

The horizontal athwartships scratch gauge on the upper grating level at frame 64 shows a lateral relative movement of longitudinal bulkheads of 1 1/2 inch, both inward and outward. The horizontal athwartship gauge, upper level, frame 69, was broken, loose by shock and the gauge pipe telescoped with no definite readings of movement.

The foundation structure of the main condenser is composed of an 8 inch horizontal channel frame supported by vertical legs, cross-braced. The forward and after bracing is bowed about 1/8 inch and athwartship members are tripped. Rivets are sheared at connections of the legs to the frames. The legs do not appear bowed.

Turbine foundations show signs of working as indicated by cracking of paint in joints between the turbine casting and the fabricated supporting structure. The number one and number four astern turbine casings are cracked. Damage to turbine and condenser foundations and to turbine casings is shown in photos 1690-1, page 198, 1690-2, page 202, 1690-3, page 201, 1690-4, page 203, 1690-5, page 204, 1690-8, page 193, 1690-11, page 192, 1691-5, page 194, 1691-6, page 196, 1691-7, page 197, 1691-8, page 200, 1691-10, page 199, 1691-12, page 195, 4225-12, page 215, 4226-1, page 214, 4226-2, page 216, 4226-3, page 217, 4226-5, page 221, and 4226-6, page 220. Structural foundations of built up plates, except for sheared rivets, appear to have suffered little damage.

The upper and lower level of grating supports are damaged. The upper level, frames 61 to 64, port is deflected downward about 1 1/4 inch, (photos 1690-9, page 190, 4203-1, page 227, and 4225-6, page 226). The lower level is intact generally except

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at the butt, frame 67, where the weld is fractured (photo 1690-7, page 174). At frame 70, upward movement occurred at the centerline where a part of the framing cut through the lagging of a pipe (photo 1690-10, page 188).

After engineroom.

Because of radiological conditions and the presence of oil in the after engineroom a complete staff inspection was not made in this space. The Commanding Officer reports that this compartment suffered shock damage as follows:

1. No. 3 high pressure and low pressure turbines are shifted inboard. The foundations and pedestals are cracked and broken.
2. No. 3 condenser saddles are bent and the rivets sheared.
3. No. 4 propeller shaft which passes through this space is bent and the after spring bearing is damaged. Number 3 shaft appears bent in the after section.
4. The framework supporting No. 3 and No. 4 generators is bent.

Dewatering of the after engineroom resulted in a decrease in soundings in port wing service tanks D-924-F and D-930-F, indicating rupture of these tanks.

Bottom fuel tanks C-920-F, C-921-F, C-922-F, C-927-F, in way of the after engineroom showed a slight increase in volume suggesting possible cracks in the tank tops or damage to manhole covers, resulting in volume gain from the flooding in the engineroom. Subsequent dewatering during salvage operations and checking of the engineroom revealed no source of leakage. Consequently, some leakage into the tanks by reason of damage to the bottom shell plating is suspected.

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(b) Damage to joiner bulkheads and causes.

Not applicable.

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

The Commanding Officer estimates that about 20% of all watertight hatches and doors below the waterline were distorted to such an extent that they were made non-watertight against a small pressure head.

(d) Condition of equipment within compartments.

Floor plates, lockers, and moveable gear were thrown in complete disorder throughout all engineering spaces.

(e) Flooding.

Flooding occurred in both enginerooms, in the after fireroom, all four shaft alleys, and the ice machinery room. Machinery and structure in the after engineering spaces was coated with oil from leaking fuel tanks, constituting a fire hazard when these spaces were pumped down.

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

Lube oil piping is pulled out and distorted on number one independent lube oil pump. A 2 1/2 inch cooling water line to the ice machinery room is fractured in the starboard shaft alley. Piping as a whole seems to have withstood test B except for isolated cases of distortion and hanger damage. Reach rods are damaged in machinery spaces and a bevel gear shaft in the windlass room is dislodged.

Propeller shafts numbers 3 and 4 in the after engine-room appear bent and all four shaft glands leak. Shafts gland leakage was the principal source of flooding in the engineering spaces.

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

Due to the effects of underwater shock, watertight subdivision in way of shaft alleys and engineering spaces is reduced, principally through loosening of propeller shaft stern tube and bulkhead glands. In other areas below the waterline, watertight integrity appears to be only slightly affected. Due to flooding, loss of power, loss of light and ventilation, and general disarrangement of equipment and portable gear, habitability and utility of compartments below the waterline was temporarily but appreciably reduced.

J. Underwater Hull.

- (a) Interior inspection of underwater hull.

There is no visible evidence of damage to the underwater hull. However, the study of interior structure indicates that some bottom damage probably exists. Gain in volume of bottom tanks under the flooded after engineroom indicates possible damage to the bottom shell plating inasmuch as no damage to tank top plating has been discovered. A cursory examination of the underwater body by divers revealed no apparent damage.

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

Any existing damage to the underwater hull appears to have negligible effect on buoyancy, operability, and maneuverability. Stability was somewhat affected by free surface in flooded engineering spaces.

- (c) Damage to propeller shafts.

The Commanding Officer reports that number 3 and 4 shafts in the after engineroom are apparently bent and that the after number 4 spring bearing is damaged. Shaft stuffing glands and gland connections to bulkheads leaked as a result of movement of the shafts relative to the ship structure.

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(d) Details of impairment of keel structure.

No damage observed.

K. Tanks.

Examination of tanks was limited by the presence of liquids in the tanks and radiological conditions.

In the forward and after firerooms, oil weeps around rivets in the wing tank longitudinal bulkhead, port and starboard, were observed.

The following information was reported by the Commanding Officer:

1. Fuel oil tanks in way of shaft alleys.

The port bulkhead bulged and 12 rivets failed in D-5-F. The starboard bulkhead is bulged in way of D-1-F, D-2F, D-4-F, D-6-F, and D-10-F.

2. Fuel oil tanks in way of after engineroom.

Dewatering of the after engineroom resulted in reduced soundings in port wing service tanks C-924-F and C-930-F, indicating rupture of these tanks. Bottom fuel tanks C-920-F, C-922-F, and C-927-F showed a slight increase in soundings after the test. This gain indicates possible filling of these tanks through cracks in the tank tops or damage to manhole covers incident to the flooding in the engine room. Damage to bottom shell plating is also a possible cause of gain in the bottom tanks.

Results of tank soundings in way of the after engineroom are as follows:

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Tank	Before Test	After Test	Loss (gals.)
C-925-F	0'-6"	0'-7"	----
C-924-F	15'-3"	12'-11"	1346
C-930-F	19'-7"	4'-1"	8885
C-919-F	0'-3"	0'-3"	----
C-920-F	0'-4"	0'-7"	----
C-926-F	0'-5"	0'-5"	----
C-927-F	0'-1"	0'-4"	----
C-928-F	0'-1"	0'-1"	----
C-921-F	0'-1"	0'-10"	----
C-922-F	0'-"	0'-7"	----

(b) Contamination of liquids.

Contamination of fuel oil probably exists in port wing service tanks C-924-F and C-930-F and in bottom fuel oil tanks C-920-F, C-922-F and C-927-F in way of the after engine room.

(c) Damage to torpedo defense system.

Not applicable.

L. Flooding.

The major sources of initial flooding were a broken 2 inch salt water service line in No. 1 shaft alley, D-505-E, and the stern tubes. Progressive flooding was permitted by main propulsion bulkhead shaft glands, by a leaky hatch, by bulkhead wiring stuffing tubes, and by sheared rivets and distorted bulkheads.

Before test B drafts	Fwd. 20'-1"	Aft 21'-1"	List 1° port
After test B drafts	Fwd. 20'-4"	Aft 23'-4"	List 3 1/2° stbd.

The vessel took on approximately 920 tons of water and changed her list 4 1/2 degrees to starboard.

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No. 1 shaft alley, D-505-E, flooded completely with 28 tons of water through a broken 2 inch salt water service cooling line for the ice machinery in D-301-E and the stern tube. The broken line failed at a threaded connection inboard of an open sea valve permitting free flow of water into the shaft alley. The shaft alley flooded into the access trunk and overflowed into the ice machinery room D-301-E, through a leaky hatch at frame 97. The shaft alley had been air tested in April 1946 and had a 4.5 ounce drop compared with an allowable drop of 6.0 ounces in 10 minutes, indicating satisfactory tightness. No. 2 shaft alley, D-503-E, flooded completely with 83 tons of oil and water through the stern tube and from D-5-F through opened rivets. One rivet, having had the head completely sheared off, allowed a stream of water and oil to flow into the shaft alley. This space had been air tested in March 1946, and had a drop of 22 ounces compared with an allowable drop of 4.5 ounces in 10 minutes, indicating unsatisfactory tightness.

No. 3 shaft alley, D-502-E, partially flooded to a depth of 4 feet with 40 tons of oil and water through the stern tube and weeps from outboard fuel oil tanks. Air testing in March 1946, showed a drop of 28 ounces, an allowable drop of 5.0 to 0.5 ounces in 10 minutes indicating unsatisfactory tightness.

No. 4 shaft alley, D-506-E, partially flooded to a depth of 5 1/2 feet with 20 tons of water through the stern tube. Air testing in September 1943, indicated satisfactory tightness with a drop of 1.5 ounces compared with an allowable drop of 5.0 ounces in ten minutes.

The ice machine room, D-301-E, partially flooded to a depth of 4 feet with 53 tons of water from No. 1 shaft alley through a leaky hatch. This space when air tested in October 1943, had a 3 ounce drop compared to an allowable 4.5 ounce drop in 10 minutes.

The after engineroom had 10 feet of water and oil on the centerline and approximately 15 feet on the starboard side, approximately 300 tons. The oil and water came from the shaft alleys through the shaft bulkhead glands and from slightly opened

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seams in oil tanks C-924-F and C-930-F. Oil tanks C-920-F, C-922-F, and C-927-F also had boundaries into the engineroom opened permitting slight flooding from the engineroom into the three tanks. Upon pumping down the engineroom approximately 1000 gallons was removed from each of C-924-F and C-930-F. Flooding in the engineroom was of such a rate that one Chrysler pump could control the flooding.

The after fireroom had 10 feet of flooding water and oil, approximately 300 tons, which came from the after engineroom through shaft bulkhead glands and electrical bulkhead stuffing tubes.

There were slight oil weeps around rivets in the port and starboard longitudinal bulkheads.

The forward engineroom had 6 feet of oil and water, approximately 100 tons. This flooding water came from the after fire-room through shaft bulkhead glands.

The forward fireroom had 6 inches of oil and water in the bilges. This was about normal seepage. There were slight oil weeps in the port and starboard longitudinal bulkheads.

The fresh water pump room, A-508-E, was partially flooded from an unknown source which was presumed to be from either the fresh water tanks just forward or the spare parts store room, A-506.

The aircraft small arms stowage, A-416-M, had 2 inches of water on deck from an unknown source but which may have come from the sprinkling system.

The underwater body was examined by divers. The divers were required to stay approximately 6 feet from the hull during the inspection. This inspection found no apparent damage to the underwater hull or the stern tubes.

The steering gear room, D-313-E, had no flooding. This space when air tested in March 1942, had a drop of 2.6 ounces compared to an allowable satisfactory drop of 10.0 ounces in 10 minutes.

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The flooding in this vessel was aggravated by the fact that no damage control personnel were on board to institute action to stop the flow of entering water in the shaft alleys. It is believed that had personnel been on board flooding could have been limited to the shaft alleys and could have been kept to a minor amount.

M. Damage to Ventilation System and Causes.

(a) Damage to ventilation system and causes.

There is some additional damage above the second deck to light ventilation ducts previously damaged by test A. This damage is considered to have resulted partly from underwater shock transmitted through the ship structure and partly from downward movement of the weather deck as the result of flexure and wave action (photo 2079-2, page 104, 2080-10, page 121, 2080-12, page 122, and 2178-9, page 138). In compartment A-203-2L, all vent ducts show joint failure. Many compartments below the main deck had from one to five inches of water on deck, the water having apparently come through ventilation openings from the topside.

In the forward engine room, ventilation ducts and piping secured by hangers from the overhead are in general unbroken but are bent forward (photo 2982-11, page 175). At frames 68 on the port side, a ventilation duct support strap is broken (photo 1690-12, page 189). At frame 62 on the port side, upper level, the bottom of the main supply ventilation duct is bowed downward about 2 inches and the lagging is hanging down. This may have resulted from air blast or by the force of water from the explosion coming down the intake (photo 1691-2, page 172).

Habitability of spaces below decks is somewhat affected by failure of the ventilation system because of the loss of power and shock damage to blowers.

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

Air blast apparently was not conducted with greater force than that required to cause light damage to ducts. Conduction of

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a slight amount of radioactive water is probable, through topside ventilation intakes. There is no evidence of conduction of heat, fire, or smoke below decks.

- (c) Evidences that the ventilation system allowed progressive flooding.

None.

- (d) Constructive criticism of design and construction of the ventilation system.

Because of the severe shock and vibration undergone by this ship, it is doubtful whether additional resistance built into the ventilating system would have materially reduced overall damage to the system.

N. Ship Control.

The steering gear room was not inspected. In general, visible damage to electronic and other equipment in the bridge area appeared greater than in test A. The ship's service telephone exchange is severely damaged.

O. Fire Control.

- (a) Damage to fire control stations and causes.

- 1. Directors and elevated control positions.

Elevated control stations were seriously affected by blast and shock. The shock wave apparently caused considerable whipping of the four enclosed directors due to their location high in the superstructure. The forward director is bent forward and downward at the base. The after A.A. director was twisted in train to starboard. Roller path assemblies in both A.A. directors are seriously damaged (photos 157-10, page 39, 158-1, page 40, 158-2, page 41). The main battery director shows evidence of severe shock. Train and elevation can be accomplished only by hand operation. Adjusting devices and controls in the four directors were nearly all frozen. The lenses

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and crosswires in most optics are in good condition but the instruments cannot be focused or moved in train or elevation.

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.

Directors not enclosed are inadequately protected from the effects of the bomb. Personnel would probably be casualties. Following the burst the station become untenable because of radioactivity, except for comparatively short periods of time. Directors that are housed in shields provide better protection for the instruments and personnel.

Radioactivity is still a problem with enclosed directors but to a lesser degree. The fighting efficiency of the ship would be reduced as the result of casualties to the director from the blast.

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

Directors should be located lower in the superstructure. Shockmounting of the instruments therein should be given consideration. Shields or other protection should be provided for instruments and personnel for directors which are now in the open. Diameters of the roller paths should be made as large as practical to distribute the support over a larger area. Main battery directors, with larger diameter roller paths, survived the shock wave better than did the A.A. directors.

P. Ammunition Behavior.

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

Satisfactory, except for some evidence of shock.

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

Ammunition in the magazines did not explode or burn. The stowages all show evidence of shock. The battens and other parts of stowage racks in the powder magazines are bent and torn loose. The powder containers were displaced and scattered about. Many of the containers were cut open just below the rims by the rims of adjacent containers. Strong fumes of ether alcohol are present in the forward magazines where the containers are open. In magazines where powder containers were stacked nearly to the overhead, the upper layer of containers show dents and creases where they were thrown up against the overhead. Practically all powder sample bottles are broken and the powder scattered. No powder is decomposed. When inspected there was no change in methyl-violet paper. The undamaged maximum-minimum thermometers indicate that the highest temperature in the magazines during or since the test was 89° F. 8" projectiles, stowed on the projectile flat, fixed portion of the mounts, were torn loose and disarranged (photographs 1677-12, page 98 and 1678-1, page 99).

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

All ammunition stowages are insufficiently protected from shock. Although this had no effect on the ships survival it would be hazardous to the crew.

(d) Behavior of gasoline stowage facilities.

No information available.

Q. Ammunition Handling.

(a) Condition and operability of ammunition handling devices.

Power was not available to test ammunition hoists. The only hoist tried out by manual operation was the lower powder hoist for mount 2. It jammed after a few inches movement in either direction. The right powder hoist trunk in mount 2 is the only one

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visibly distorted. It was damaged at the powder circle level where the powder circle tray was also severely distorted (see Item C). Powder scuttles in undistorted decks or bulkheads are operable. Some of the powder scuttles in distorted decks or bulkheads are operable. The powder scuttles in mount 2 are operable despite the extensive damage to this mount.

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

There is no evidence that any ammunition handling device contributed to passing to heat, fire, blast or flooding water.

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

It appears that ammunition handling devices withstood the effects of the test comparatively well.

R. Strength.

- (a) Permanent hog or sag.

There is no visual evidence of any hog or sag. No deck survey was made after test B.

- (b) Shear strains in hull plating.

No diagonal buckling or other signs of shear strain are observed in hull plating.

- (c) Evidences of transverse or racking strains.

Visual evidence exists of a possible slight twist of the ship. It is believed that any twist is a carry over from test A, with a possible slight increase in rotation as a result of test B (see test A deck survey data).

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

Principal structural failures affecting longitudinal strength of the ship, are:

1. Web buckling of the deep centerline girder adjacent to the forward and after bulkhead of both firerooms.
2. Damage to port and starboard second deck longitudinals in the engineering spaces, similar to the centerline girder damage.
3. Moderate permanent downward deflection of the armored (second) deck in way of the engineering spaces.

Important structural failures indirectly affecting longitudinal strength through reducing effectiveness of the ships girder as a whole, are:

1. Damage to transverse girders overhead in the engineering spaces.
2. Fracture of the centerline column in both fire-rooms (frames 54 1/2 and 78 1/2).
3. Damage to transverse bulkhead 33 on the first platform under mount 2.

Items of secondary importance to overall structural strength, are:

1. Distortion of webs and flanges of deep frames under the main deck and along the side shell, port and starboard (principally test A damage).
2. Damage to supporting structure of machinery in the engineering spaces.

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3. Increased damage, in test B, of miscellaneous structure throughout the ship due to shock and vertical movement of decks and mounts.

(e) Evidence of panel deflection under blast.

Panel deflection under blast is confined to a very slight increase of damage to flat surfaces in the superstructure and to boiler casings and ventilation ducts.

(f) Turret, machinery, and gun foundations.

Under mount 2, transverse bulkhead 33 on the first platform is severely damaged.

Under mount 1, transverse joiner bulkhead 27 on the second platform, port, is severely buckled.

No damage to unprotected mounts is observed. Damage to machinery supporting structure is described in item I.

The Commanding Officers impressions relating to impairment of longitudinal strength of PENSACOLA are as follows:

1. There is no visual evidence of any permanent sag. The residual strength of the ship is very greatly impaired due to distortion and failure of many strength members.

2. The general condition of the hull was in such a state that the vessel could not be operated or even considered seaworthy.

3. It is believed that this ship is slightly twisted longitudinally from the stern, port quarter up. The centerline longitudinal which goes through the firerooms appears to have been distorted by a clockwise torque viewed from aft looking forward. In lower deck spaces one can hear the ship work in the sea.

S. Miscellaneous.

No remarks.

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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.

The #1 shaft alley was completely flooded by water entering through a ruptured 2 inch cooling line to the ice machine, and water backed up into the ice machine room. The other shaft alleys were partially flooded through the stern tube glands. The forward engine room was flooded to an average height of about 2 feet above the lower level floor plates, and the after engine room and after fire room to just below the upper gratings. This water apparently entered through the stern tube glands, and shaft bulkhead stuffing boxes, flooding progressively forward.

(b) Structural damage.

No data taken by Machinery Group.

(c) Other damage.

All boilers were severely damaged, including damage to casings, brickwork and stacks. The foundations appear to have moved upward. Holding down bolts were bent and stretched. One soot blower on #8 boiler was knocked off. The main engines were damaged beyond repair with numerous cracks in bearing and foundation pedestals and supports, and one crack in #1 astern turbine casing. No. 2 reduction gear sagged about 1/4 inch at its after end when the foundation casting broke. Damage to spring bearings of #4 main shaft indicates misalignment of the shaft. The main condenser foundations twisted slightly, #1 and #4 condensers dropped slightly. The condensers probably leak. Nearly all pumps had some damage to their foundations, this being especially heavy in the forward fireroom. The anchor windlass bedplate was cracked all the way across.

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There was considerable damage to piping throughout the ship. Both machine shop lathes were knocked over. There were many items of comparatively minor damage.

Damage to boilers would have been more severe if they had not already been damaged by test A, because blast pressure could vent out the ruptured casings of #1 - 4 boilers, and because the uptakes of boilers #6 and 8 were blanked off after test A, preventing blast pressure from entering them.

II. Forces Evidenced and Effects Noted.

(a) Heat.

There was no evidence of heat.

(b) Fires and explosions.

There was no evidence of fires or explosions.

(c) Shock.

Most of the damage was done by an underwater shock of very high magnitude. Effects of this shock were apparent throughout the ship, particularly in the machinery spaces. This accounts for practically all of the damage to machinery except that mentioned under (d) below.

(d) Pressure.

A blast pressure of considerable magnitude is evidenced by the fact that damage to uptakes and boiler casings remaining from test A was increased. Temporary repair work to the casings of boilers #5 and #7 was blown out. It is believed that undamaged boilers would have suffered more from blast pressure than these did (see I (c) above).

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

An underwater shock of this magnitude is believed to be peculiar to the atom bomb.

III. Effects of Damage.

- (a) Effect on machinery and ship control.

The machinery plant as a whole is inoperable. Many units are damaged beyond repair. Diesel generators could not be operated as the starting batteries were knocked out of their racks and damaged, and the diesel engines themselves may be damaged. Propulsion and ship control were destroyed, and could not be restored by the ship's force.

- (b) Effect on gunnery and fire control.

No comment.

- (c) Effect on watertight integrity and stability.

No comment.

- (d) Effect on personnel and habitability.

It is estimated that there would have been high personnel casualties from shock and boiler flarebacks. The ship was made uninhabitable by lack of power and high radioactivity.

- (e) Effect on fighting efficiency.

Insofar as machinery is concerned, fighting efficiency was reduced to zero.

IV. General Summary of Observers' Impressions and Conclusions.

It is not believed that any cruiser now afloat could withstand a shock of this magnitude without being heavily damaged.

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V. Any Preliminary General or Specific Recommendations.

A study should be made with a view to increasing the resistance of naval machinery to shock.

A study of stern tube glands should be made to reduce excessive leakage, both under shock and under normal operating conditions.

Studies of floor plates are recommended with a view to making them more secure and also to make them somewhat flexible. The floor plates on the Pensacola were almost without exception dislodged and many of them were thrown about with considerable force, which would have caused numerous personnel casualties. If some flexibility could be provided, the catapulting effect of the shock on personnel would be reduced.

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DETAILED DESCRIPTION OF MACHINERY DAMAGE

A. General Description of Machinery Damage.

(a) Overall condition.

Extensive damage to the boilers, main turbines, and numerous auxiliaries made these units inoperable. Many of them were damaged beyond repair. Both engine rooms, the after fireroom, the ice machine room, and #3 shaft alley were flooded. The diesel generators were made at least temporarily inoperable because of the starting batteries being knocked over. A more detailed inspection, which was not possible because of lack of time and facilities for opening machinery and testing it, and because of the high radioactivity in the ship, would no doubt disclose additional damage. The heavy coating of fuel oil on the lower level of both engine rooms also militated against a more complete inspection. Some auxiliaries were not inspected as the time available for inspection was limited by radiological hazard.

(b) Areas of major damage.

Major damage existed in both enginerooms and fire-rooms, in the machine shop, and possibly in other areas that could not be inspected because of the time limitations imposed by radiological hazard.

(c) Primary causes of damage.

The primary cause of damage was shock, and to a lesser extent blast pressure. Flooding also caused a great deal of damage. The flooding came from several sources, the chief one being a broken cooling water line in #3 shaft alley. All stern tube glands leaked. A large amount of fuel oil entered the after engine-room from a ruptured fuel tank.

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

The test made the entire machinery plant inoperable. A major overhaul would be required to make it operable. A great

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deal of the machinery is damaged beyond repair. Had the machinery been operating, the damage would have been even more severe.

B. Boilers (S-51).

The boilers of the PENSACOLA suffered severe damage from shock and pressure of the blast during test B. It is considered that stacks, uptakes and boiler casings may have been damaged sufficiently to make the boilers inoperable, and that temporary repairs would have required at least 24 hours. Dislodged brick would have precluded heavy steaming, but light steaming for a limited time might have been possible. In some cases, it is difficult to differentiate between damage caused by test A and that caused by test B, or to estimate what damage would have occurred if the boilers had not been damaged before test B.

(a) Air casings.

Air casings of boilers, except boiler #5 and #7, were not repaired after test A, when they were heavily damaged. No evidence of blast was observed on these unrepaired boilers but the shock from test B knocked down some casing panels which were already loosened by test A. Photograph 4164-7, page 205 shows damage to #3 boiler casing. The air casings of boilers #5 and #7, which had been temporarily repaired after test A, were blown out again by the blast of test B. The blast pressure could vent out the ruptured casings of the unrepaired boilers, thus preventing damage that would have occurred if they had been in good condition. The uptakes of boilers #6 and #8 had been blanked off after test A, which prevented additional damage to these boilers.

(b) External fittings.

No hydrostatic tests on the pressure parts of these boilers could be made, hence the fittings were only visually inspected. All fittings were apparently undamaged except for #4 soot blower on #8 boiler. The threads between the swivel tube and the element were stripped and the set screws had sheared the tube permitting the soot blower head to fall away from the boiler front, rotating around the steam supply pipe connections. Photos 4226-10, page 206 and 4226-11, page 207.

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(c) Fuel Oil Burner Assemblies.

The fuel oil burner pressure parts were apparently undamaged from test B, insofar as could be determined by visual inspection. The air shutters were stiff to operate and some had been displaced.

(d) Brickwork.

All brickwork showed evidence of shock and an upward thrust. Floor bricks were dislodged and appeared to have been knocked upward and then fallen back into place. Plastic corbels at tubes and along side walls were broken and knocked down onto the floor. These had been cracked during test A but were additionally damaged by the shock during test B. Front and rear walls did not appear to have been changed appreciably from their condition after test A. Photos 4165-12, page 208, 4166-1, page 209, and 4166-2, page 210.

(e) Headers, Steam and Water Drums.

No hydrostatic test was made after test B. Visual inspection shows no damage although the condition of the foundations indicates that these boilers were subjected to a severe shock. Inspection of the outsides of drums at A and B tube rows showed no damage. The drums were not opened for internal inspection.

(f) Tubes.

No apparent damage from test B was observed from visual inspection. See comment under (e) above.

(g) Foundations.

All boiler saddles showed evidence of severe stresses and indicated an upward motion of all boiler pressure parts. All of the boiler foundation holding down bolts were stretched and bent. These saddles are fabricated from steel plates bent into an angle and placed back to back to form the saddle. All bolts bent away from the vertical portion of the saddle and indicate that the motion of the boiler was almost vertical. The foundations themselves

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showed no evidence of stressing or failure. Photos 4164-8, page 211, 4085-5, page 212, and 4085-6, page 213.

(h) Stacks and uptakes.

Stacks and uptakes were severely damaged during test A. The stacks were crushed slightly more after test B. Because of their severely crushed condition after A, the amount of damage that would have been done to them by B if they had been undamaged is conjectural.

C. Blowers, Forced Draft (S-53).

1. Blowers in the after fireroom were turned by hand and all turned freely except blower #7, which was turned with difficulty. The cause of binding of #7 blower could not be determined by visual inspection.

2. Blowers in the forward fireroom were not turned.

3. All blowers, except #7, appeared from visual inspection to be operable.

D. Fuel Oil Equipment (S-55).

1. No damage to fuel oil equipment except as noted below was found by visual inspection.

(a) Heaters.

Two pneumatic tubular gage glasses were broken in the after engine room. These gages were located on the starboard side of the vessel on the upper level.

E. Boiler Feedwater Equipment (S-56).

1. The boiler feedwater equipment appears to be undamaged except as noted below:

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(a) Heaters.

Undamaged.

(b) Deaerating tanks.

Not applicable.

(c) Feedwater tanks, hot well etc.

The tubular gage glasses were broken and the bottom of the tank dished down slightly on the feed tank in the forward engineroom.

The feed tank in the after engineroom dropped about 2 inches. The connected piping at the bottom of the tank was slightly wrinkled but not damaged.

F. Main Engines (S-41).

1. No. 1 Main engine (forward starboard).

The cast iron bracket supporting the after end of the low pressure turbine was cracked. The bottom of this bracket is bolted to a pad on the main reduction gear foundation. The crack extends diagonally from the top of the bracket, near the point where the turbine casing is attached, downward through the lightening holes to the gear pad. (Photos 4226-1, page 214 and 4225-12, page 215). It is about 1/8" wide at its widest point. (Photo 4226-2, page 216). This crack allowed the turbine casing to drop about 1/4" until the upper part of the casing rested on the shaft. The casing of this turbine had a circumferential crack of maximum width about .025 inch at the after end of the cylinder. (Photo 4226-3, page 217). A reinforcing rib at this end of the turbine was cracked through. The holding down bolts of the forward bearing standard were loose and cracked paint indicated severe shock. No fractures were noted at the forward end.

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2. No. 4 Main engine (forward port).

(a) There is a cast iron spacer bracket between the after end of the cruising turbine and the forward end of the high pressure turbine. This bracket is bolted to both turbine casings, and supports the cruising turbine clutch and reduction gear casings. This bracket was cracked completely through from top to bottom. (Photo 4225-8, page 218). The forward cruising turbine bearing standard broke off on the starboard side, allowing the turbine to drop. (Photo 4226-7, page 219). The sliding foot of the cruising turbines forward bearing standard was cracked on the port side. (Photo 4226-7, page 189).

(b) There was no visible damage to the high pressure turbine.

(c) The forward bearing standard of the low pressure and astern turbine was cracked all the way through, and was broken in several places at the fillets. (Photo 4226-6, page 220). The after support bracket of this turbine had a crack similar to that described above for #1 low pressure turbine. (Photo 4226-5, page 221).

3. No. 2 Main engine (after starboard).

(a) The after support bracket of the low pressure and astern turbine had a crack similar to that described above for #1.

(b) There was no other visible damage to this main engine.

4. No. 3 Main engine (after port).

(a) The low pressure and astern turbine supports, forward and aft, failed in a manner very similar to failures described above for #4. (Photos 4225-5, page 222, 4225-7, page 223, 4225-4, page 224, and 4225-3, page 225).

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5. The forward engineroom had been flooded to an average depth of about 9 inches above the lower level floor plates. The after engineroom had been flooded to a depth just below the upper gratings. Although the space had been dewatered, all machinery in this engine-room was covered with a heavy coating of fuel oil at the time of the inspection. (Photos 4225-6, page 226 and 4203-1, page 227). It is possible that some small cracks exist that were not found during the inspection because of the presence of this fuel oil.

6. All floor plates and gratings in both enginerooms were dislodged. On the after starboard corner of the after engineroom, the floor plates were thrown over and outboard of the overboard discharge of the main condenser. (Photos 4225-6, page 226 and 4203-1, page 227).

7. A large number of foundation bolts and flanged connection bolts were found to be stretched beyond their elastic limits and loose. This condition is general in the main turbines.

8. All main turbines are inoperable. All turbines are undoubtedly out of alignment. Most of the installation is beyond repair. The high pressure turbines may be salvageable.

9. If the turbines had been in operation at the time of test B, the damage to them would have been much greater.

10. Details of damage to turbines.

(a) Casings.

The only casing found damaged was that of #1 low pressure and astern turbine. (See paragraph 1A above - photo 4226-3, page 217).

(b) Bearings.

There were failures of bearing supports in all low pressure and astern turbines and in #3 and #4 cruising turbines (See above). The bearings were not opened for inspection, and showed no damage externally.

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(c) Rotors.

The rotors not observed.

Note: The after end of each of the low pressure and astern casings dropped sufficiently to jam the blades.

(d) Flading and shrouding.

Not observed, see paragraph 10 (c) above.

(e) Packing and glands.

Not opened for inspection. No damage was visible externally. On the damaged turbines, the labyrinth packing is doubtless crushed.

(f) Valves.

No apparent damage.

(g) Foundations.

See detailed discussion of each main engine above. The engine foundations attached to ship's structure appears to be undamaged.

(h) Fittings, (oilsights, thermometers, clearance indicators, etc.).

All spinner (telltale) vanes on the oilsights were jarred out of place and are missing.

12. A great deal of additional damage would undoubtedly be found if the turbines were opened for interior inspection.

G. Reduction gears (S-42).

1. There was no apparent damage to the reduction gears. They were not inspected internally.

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H. Shafting and Bearings (S-43).

1. There was no indication of damage to the main shafting except on the spring bearing for #4 shaft as noted below. Shafting and bearings in #2 fireroom and the shaft alleys were not inspected.

(a) Shafting.

No comment.

(b) Bearing and bearing foundations.

The oil retainer rings on the forward spring bearing of #4 shaft, after engine room, were completely knocked off of the spring bearing casing, the bolts having been broken.

(c) Alignment.

There was no misalignment apparent from visual inspection, however, the shafts are probably out of alignment.

(d) Stern tubes, bulkhead packing glands, etc.

There was no apparent damage to the bulkhead glands. There was leakage past all of the stern tube and bulkhead glands which was an important factor in the flooding of the machinery spaces.

I. Lubrication System (S-45).

1. There was no damage evident in the lubrication system.

J. Condensers and Air Ejectors (S-46).

1. There was no evidence of damage to the condensers in the after engine room. In the forward engine room, the main condensers dropped slightly due to shearing of rivets in the foundation. The foundations of #1, #3 and #4 main condensers had twisted slightly.

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The condenser saddle rivets connecting to the foundations were bent and in some cases sheared. It is probable that there are numerous leaks in the condensers, which could not be determined by visual inspection.

2. There was no apparent damage to the auxiliary condensers as far as could be determined by visual inspection.

K. Pumps (S-47).

1. All connected pumps driven by the cruising turbines, viz., main lube oil, clutch oil, and main air pumps were made inoperable due to the casualties to the turbines. There was no visible damage to these pumps in themselves.

(a) Feed pumps.

1. The main feed pumps were turned by hand and showed no apparent damage. The holding down bolts were stretched and loose in the holes, but it is considered that this would not have impaired operability.

2. The upper foundation bracket casting of #1 emergency feed pump was cracked through the bolt hole. The lower foundation bracket appeared to be undamaged. The pump had moved a slight amount away from the top foundation. The #2 emergency feed pump was similarly damaged. These pumps are mounted on bulkheads and appear to have cast iron brackets. It is believed that these emergency feed pumps would have been inoperable until repairs of foundations could be accomplished. Damage to these pumps may have been more extensive had these pumps been operating. (Photo 4164-10, page 228).

(b) Circulating pumps.

The main condenser circulating pumps and the auxiliary condenser circulating pumps were apparently undamaged.

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(c) Condensate pumps.

The condensate and air pumps were apparently undamaged.

(d) Fire pumps.

Reciprocating fire pumps in enginerooms were apparently undamaged except that holding down bolts were loose. The fire and bilge pumps were undamaged.

(e) Lube oil pumps.

Attached lube oil pumps driven from the cruising turbines are apparently undamaged but inoperable due to turbine casualties. No. 1 turbine driven lube oil pump had been pushed slightly to starboard as evidenced by a slight twist in the discharge lines. (Photo 4226-4, page 229). All other lube oil pumps were undamaged.

(f) Fuel oil pumps.

1. Extensive repairs by a tender or a repair yard to fuel oil pumps would be required before they could have been operated. If these pumps had been operating when the blast occurred much more extensive damage would probably have resulted.

2. All four fuel oil service pumps in the forward fireroom were damaged. On #1 fuel oil service pumps, the upper bracket cracked at the bolt holes. (See photo 4166-3, page 230). The stud bolts on the lower bracket sheared and the pump dropped about three inches. The casting around one of the stud connections of the lower bracket was broken.

3. No. 2 fuel oil service pump had dropped similarly to #1. The upper bracket casting was broken at the angle between the foot and the arm of the bracket. (Photo 4165-1, page 231). The stud bolts of the lower bracket sheared. The stud bolts of the lower bracket of #3 sheared. (Photo 4164-11, page 232). The upper bracket and bolts appeared to be loosened but had not failed. Some movement downward appeared to have taken place.

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4. No. 4 fuel oil service pump appeared to have been pushed from port to starboard. The port side of the upper bracket casting was broken at the bolt holes and the bracket moved about 1/2 inch out of position on this side. (Photo 4164-12, page 233). The starboard side of this casting was not appreciably damaged and the lower bracket and bolts were in place. The bolts of the lower bracket could not be examined for distortion without removal.

5. No. 2 fuel oil booster and transfer pump had been damaged by the cracking of the upper bracket casting inboard of the holding bolts. (Photo 4165-1, page 231). The lower bracket appeared to be undamaged. No. 1 fuel oil booster and transfer pump appeared to be undamaged. Both of these pumps are mounted on a longitudinal bulkhead on the port side in #1 fireroom.

(g) Other pumps.

Not inspected due to limitation on the time available for inspection.

Note: As pumps were not opened for visual inspection, or operated, the only damage visible was that to foundations.

It is considered that in most cases of pumps whose foundations were damaged, the failure of the upper brackets and subsequent movement of the upper part of the pumps would have caused binding of the pistons and possibly some distortion of the piston rods. (Photo 4164-11, page 232, 4164-12, page 233, 4165-1, page 231, 4166-3, page 230, and 4166-4, page 234.

L. Auxiliary Generators (Turbine and Gears (S-61).

There was no apparent damage to the ship's service generator turbines and gears.

M. Propellers (S-44).

The propellers were not inspected.

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N. Distilling Plant (S-58).

The distilling plant was not inspected.

O. Refrigerating Plant (S-59).

The refrigerating plant was not inspected. The ice machine room was flooded by water coming up from the shaft alley below through a broken salt water cooling line.

P. Winches, Windlasses and Capstans (S-20 - S-26).

Winches - no apparent damage was caused by test B.

Windlasses - the cast bed plate supporting the hydraulic pump electric motor, and electric brake was cracked across its entire width between the motor and brake. A 1/4" hydraulic vent line on the main hydraulic on the starboard unit was broken off near the threads. The port control shaft was frozen in the pedestal on the forecastle, however, the port wildcat was operated by power and the operating gear was turned with a wrench after it was disconnected from the pedestal. It appeared that the starboard windlass was also operable, since both the port and starboard units are driven by the same motor and there appeared to be no damage other than the cracked bed plate on the main drive. However, neither of these units can be considered reliable for normal operation.

Q. Steering Engine (S-22).

No apparent damage.

R. Elevators, Cranes, Ammunition Hoists, Etc. (S-78-S-83).

No apparent damage.

S. Ventilation (Machinery) (S-38).

The ventilation machinery was not inspected.

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T. Air Compressors (S-49).

There was no apparent damage to the compressors.

U. Diesels (Generators and Boats) (S-50).

There was no apparent damage to the forward emergency diesel generator from visual inspection. Batteries were dislodged from the battery rack and strewn about the room. The after emergency diesel generator could not be checked closely due to battery fumes. Batteries were dislodged from the battery rack and other loose accessories were thrown around the room. The port side of the diesel generator was apparently undamaged. The emergency diesel driven fire pump was apparently intact. The batteries were knocked out of the battery rack and strewn about the room.

V. Piping (S-48).

(a) Main steam.

1. The piping in this system appears to be undamaged except as noted below. The lines were not tested.

2. Practically all of the main steam line strap hangers in the forward engineroom and after fireroom were slightly bent as a result of shock.

3. Pipe hangers failed in the following locations, due to shearing of strap bolts:

(a) Two hangers in the steam line to port side high pressure turbine in the forward engineroom.

(b) One hanger in the 9" starboard steam main in the forward fireroom. (Photo 4226-9, page 235).

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(b) Auxiliary steam.

1. The auxiliary steam piping appears undamaged except as noted below. The lines were not tested.
2. The sliding joint of the forward engineroom high level steam smothering valve pulled out of the valve stem as a result of shock.

(c) Auxiliary exhaust.

1. The auxiliary exhaust piping was inspected and appears undamaged, except as noted below. The lines were not tested.
2. The hanger securing bolts of one of the hangers for the 9" auxiliary exhaust main in the forward engineroom pulled out of the tapped holes in the deck.

(d) Condensate and feedwater.

The condensate and feedwater piping appears to be undamaged. None of the piping was tested.

(e) Fuel oil.

1. The fuel oil piping was inspected and appears to be undamaged except as noted below. The piping was not tested.
2. The glasses and tubes of four fuel oil pneumercators in the forward engineroom were found to be shattered by shock.

(f) Lubricating oil.

1. The lubricating oil piping appears to be undamaged except as noted below. The piping was not tested.

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2. Oil was found to be leaking out of a loose riveted joint of the main lubricating oil storage tank in the forward engine-room.

3. The discharge line of #1 lubricating oil pump was slightly kinked as a result of shock. The area of the line is only slightly affected.

4. One of the screwed connections of #1 wet air and condensate pump broke off at the pump and the slip joint of the valve controlling the lubricating oil supply to this pump jumped out of the valve stem.

(g) Fire main, sprinkling and salt water cooling.

1. The above piping was inspected and appears to be undamaged except as noted below. The piping was not tested.

2. A screwed cooling water line broke off at its connection to #2 main circulator pump.

3. A 2" cooling line to the ice machine broke in #3 shaft alley, inboard of the sea valve. The valve had been left open. This was one of the major sources of the flooding.

(h) Condenser circulating water.

A visual inspection indicates that the piping is apparently undamaged. The piping was not tested.

(i) Drain.

A visual inspection indicates that the piping is apparently undamaged. None of the piping was tested.

(j) Compressed air.

This piping is apparently undamaged. It has not been tested.

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(k) Hydraulic.

The hydraulic piping appears to be undamaged. None of it has been tested.

(l) Gasoline.

The gasoline piping does not appear to have been damaged as a result of test B. It has not been tested.

Note: A number of steam and feedwater gages were found to be damaged. Damage was reflected in the pointers being on the opposite side of the stop pin or at some point beyond the zero mark.

W. Miscellaneous.

(a) Machine shop equipment.

Both lathes of the machine shop were badly damaged. The forward unit was broken in three pieces and the after unit was broken off directly above the foundation bolts. The forward unit was laying on its side, the after unit against the bulkhead. (Photo 4225-10, page 236 and 4225-11, page 237).

(b) No other miscellaneous equipment was inspected.

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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.

Draft was not observed. General areas of flooding in way of electrical equipment was in forward engine room, after fire-room and after gyro room. Sources of flooding were not observed.

(b) Structural damage.

Damage appreciably affecting the electric plant was essentially as follows:

1. The foundation securing bolts at the lower starboard corner of the ship's service switchboard in the forward engine room sheared off allowing one end of the switchboard to drop about 2 1/2 inches. Apparatus on the board was not damaged.
2. Supporting framework for ship's service generators in after engine room was bent.

(c) Other damage.

Significant damage to electrical equipment was as follows:

1. Gyro compass suspension springs and supporting gimbals distorted. Compass was rendered inoperable.
2. Vacuum tubes for general announcing system control equipment damaged. Control is inoperable.

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3. Ship's service telephone switchboard selector switches broken. Switchboard inoperable.
4. Several vent sets inoperable due to damaged casings.
5. A number of storage batteries damaged beyond repair.

II. Forces Evidenced and Effects Noted.

(a) Heat.

There was no evidence of damage due to heat.

(b) Fires and explosions.

There was no evidence of damage due to fires or explosions.

(c) Shock.

Damage was evidenced by sheared switchboard support bolts, damaged gyro compass, dislocated storage batteries and bent generator supports.

(d) Pressure.

There was no evidence of damage due to pressure.

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

There were no effects noted which were considered peculiar to the atom bomb.

III. Effects of Damage.

(a) Effect on propulsion and ship control.

Ships propulsion was not affected by electrical damage. Ship control was slightly affected by the loss of the gyro and the general announcing system.

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(b) Effect on gunnery and fire control.

Gunnery and fire control were somewhat affected by the loss of the gyro.

(c) Effect on watertight integrity and stability.

Watertight integrity and stability were not affected by electrical damage.

(d) Effect on personnel and habitability.

Habitability was slightly affected by the non-operability of a few vent sets.

(e) The total effect on fighting efficiency.

The total effect of electrical damage on fighting efficiency was to reduce the accuracy and speed of gunnery due to loss of the gyro.

IV. General Summary of Observers' Impressions and Conclusions.

Major electrical damage was sustained by the master gyro and a number of storage batteries. Minor damage was sustained by the ship's service switchboard supports, automatic telephone switches and vacuum tubes of the general announcing system.

Electrical damage did not materially affect the seaworthiness or cruising ability of the vessel but did have a moderate temporary effect on the fighting efficiency.

All electrical damage except to the gyro and telephone switchboard could have been repaired by the ship's force.

V. Preliminary Recommendations.

Specific recommendations have been made under each item of Section III where applicable.

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DETAILED DESCRIPTION OF ELECTRICAL DAMAGE

A. General Description of Electrical Damage.

(a) Overall condition.

The overall condition of the electric plant is essentially the same as before Test B, except for the following:

1. Forward ships' service switchboard foundation bolts sheared.
2. After fireroom starboard wireway flooded.
3. Ship's service telephone switchboard inoperable due to connection block and selector switch failures.
4. General announcing switchboard and control inoperable due to vacuum tube failures.
5. Gyro compasses inoperable.
6. A few vent sets inoperable.
7. A large percentage of portable storage batteries were damaged beyond repair due to jarring out of stowage racks.

(b) Areas of major damage.

Forward engine room, gyro room, and after fireroom.

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

Underwater shock in forward engine room and gyro rooms. Flooding in after fireroom.

(d) Effect of target test on overall operation of electric plant may be summarized as follows:

1. Turbo-generator sets were inoperable due to lack of steam. Foundations for generator sets No. 3 and 4 were bent. Generator sets No. 1 and 2 were probably fully operable on return of steam. These two generator sets could carry the ship's electrical

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load. Diesel generators were apparently operable. The one in use continued to run until its fuel supply was exhausted.

2. Electric engine and boiler auxiliaries were operable electrically except the auxiliary circulating pump in the after engine room which was flooded.

3. Electric propulsion not applicable.

4. (a) Sound powered telephones were practically 100% operable.

(b) Ship's service dial telephones were inoperable.

5. Fire control circuits were operable except two 40MM gun circuits which were inoperable due to ruptured control cable.

6. Ventilator sets were practically all operable electrically.

7. Lighting was operable except for a few fixtures in way of hull structural failures.

(e) Types of electrical equipment most affected.

Storage batteries and gyro compasses.

B. Electric Propulsion Rotating Equipment.

Not applicable.

C. Electric Propulsion Control Equipment.

Not applicable.

D. Ship's Service Generators.

There was no visible damage. They were apparently operable. Supporting framework for No. 3 and No. 4 generators is bent. It is possible that these generators may be out of line but this is not apparent from a visible inspection.

E. Generators - Emergency.

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Starting batteries on both forward and after sets were jarred out of racks. Batteries in forward room were damaged beyond use. After batteries were apparently usable. There was no evidence of damage to either forward or after diesel generator sets. Both were apparently operable.

For recommendations, see comments under Item J.

F. Switchboards and Distribution Panels.

The forward and after switchboards were both operable after Test B. The forward ship's service switchboard moved up and down due to underwater shock. Bolts securing starboard lower end of switchboard foundation to its supporting bracket were sheared off allowing switchboard to settle about 2 1/2 inches lower than normal. The supporting foundation was bent at each holding down bolt at the bottom of the board. Ebony asbestos blocks installed to prevent vibration of busses were broken. Bevel gears for hand operation of generator field rheostats were jammed due to bent supporting brackets. All switches, circuit breakers, and meters were apparently undamaged and operable. See photographs 1679-10, Page 238; 1679-12, Page 239; 4061-9, Page 240; 4061-10, Page 241; 4061-11, Page 242.

Recommendations.

a. Switchboards should be of box frame construction to distribute the weight over a considerable area. foundations should be constructed so that warping of supporting decks or bulkheads will not break or distort the apparatus on the board. The construction details should be in accordance with Navy Department General Specifications. S62-1 wherever practicable.

G. Wiring, Wiring Equipment and Wireways.

The starboard wireway in the forward fireroom was flooded. There was slight movement of cables in racks in machinery spaces. There was no damage to wireways, racks, or wiring equipment evident other than above.

H. Transformers.

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No damage.

I. Submarine Propelling Batteries.

Not applicable.

J. Portable Batteries.

The forward emergency diesel batteries were dislodged from racks and badly damaged. Covers, jars and terminals were broken. The batteries in the battery locker were knocked about and badly damaged. The batteries for the after emergency diesel were jarred out of racks but were not damaged. The reason for most battery damage was the lack of locktype battens and holding down clamps. See photograph 1679-5, Page 252.

Recommendations.

a. Battery stowage racks and securing means should be so designed that the batteries are held securely in place and so that the securing means do not lend themselves to careless use or inadvertent non-use.

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

On the control panel for the 50 KVA motor generator set No. 3 the frequency meter glass was broken due apparently to being hit by some flying object. The door was unlatched, probably from the same cause.

The magnetic starter, G. E. Cat. 693290Z, for the brine overboard pump in the forward fireroom, lower level, had its interior jarred out of enclosure. The molded phenolic panel broke at a bolt hole.

In the crew's quarters, second deck, frame 122, the vent controller overload relay contact assembly was displaced. See photograph 1692-5, Page 243.

The lathe controller arc chutes tipped up. Apparently these chutes were not locked. See photograph 1692-5, Page 243.

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The machine shop vent controller panel was torn out at corner bolt holes. The controller case pulled loose from the mounting bolts. See photograph 1692-2, Page 245 and Photograph 1692-3, Page 244.

The anchor windlass hydraulic pump and motor cast iron bed is cracked between the magnetic brake and motor. The windlass is still operable.

Recommendations.

a. Contactors, motor controllers and similar devices to be used on shipboard should be so constructed that the component parts will withstand a high degree of shock without derangement or breakage. Navy Department Specifications 17C10 and 17C17 describe suitable construction details. Supporting means for equipment of this type should be such that a considerable distortion of supporting bulkheads or decks can take place without damage to the mechanism.

L. Lighting Equipment.

Lighting in general was not affected except as noted below:

1. Two ceiling fixtures in the forward engine room suffered broken glasses.
2. One spring mounted light fixture in central station had a shattered lamp. See photograph 1679-6, Page 246.
3. One spring mounted light fixture in the after fireroom had an unhooked spring.
4. Two light bulbs in ceiling fixtures in the after engine room were broken.

M. Searchlights.

Not observed after Test B.

N. Degaussing Equipment.

Not observed after Test B.

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O. Gyro Compass Equipment.

The forward master gyro compass showed evidence of heavy shock. Only two gimbal ring supporting springs remained in place; all others were dislodged. The compass came to rest in the bottom of binnacle case, probably wrecking the oscillating motor. The spilling of mercury was great enough to allow the sensitive element float to rub on the mercury flotation bowl. The compass was an Arma Mark VIII, Mod. 8A. See photograph 1679-8, Page 247 and photograph 1679-9, Page 248.

The after master compass was not accessible and was not observed.

Recommendations.

a. Master gyro compasses should be redesigned to provide greater resistance to shock. Suitable mounting arrangements to mitigate shock damage to existing master compasses should be provided pending availability of a suitable design.

P. Sound Powered Telephones.

No damage.

Q. Ship's Service Telephones.

This vessel is equipped with an obsolescent 100 line Automatic Electric Company telephone exchange which sustained the following damage from underwater shock:

1. All connectors were jarred out of their switchjacks.
2. Shelf wiring was damaged when torn from cabinet by the falling of the connectors.
3. Connector banks were damaged in some cases from striking, or being hit by other objects.
4. Some connectors in falling and taking all slack out of the shelf wiring, had their base plate broken off or badly bent, and in some cases the cast

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frame base of the strowger switch was broken where secured to the banks. Wipers and shafts were bent.

5. One line switch rack was jarred loose at one end and fell on the rack below. See photograph 1679-1, Page 249 and photograph 4061-12, Page 250.

Numerous Type A desk sets were damaged in being thrown about and by falling.

Numerous Type B bulkhead sets were damaged. In the majority of cases the cover was jarred off and broken. It is noted that all Type B sets observed damaged were of the phenolic type. One Type B had its hand set bracket broken. See photograph 1679-7, Page 251.

Telephone batteries were disarranged and some acid spilled. It is not believed, however, they suffered any material damage other than this. See photograph 1679-5, Page 252.

Ship's company could accomplish repairs allowing partial operation of the exchange, with about 10% trunking, in a relatively short time. It is not believed the damage would have occurred to a new shock resistant system had it been installed properly on this vessel.

Recommendations.

- a. Automatic telephone switchboards should be of a type which will withstand a high degree of shock.

- b. The use of desk sets similar to the present Type A sets should be discontinued or a means should be provided to secure them to the desks.

- c. The use of non-locking type of support for hand-sets should be discontinued.

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R. Announcing Systems.

RCA 1 and 2 MC announcing system located in central station was rendered inoperable from the dislodgement and breakage of tubes in the amplifier and control racks. It was noted that on all but one type, 38166A tubes, the grid terminals broke off. See photographs 1679-2, Page 253 and 1679-3, Page 254.

Replacement of dislodged and broken tubes should allow complete operation of this system. Underwater shock is considered responsible for this damage.

Recommendations.

a. A mounting arrangement to withstand a high degree of shock should be provided for all equipment incorporating vacuum tubes.

S. Telegraphs.

No damage.

T. Indicating Systems.

The constant frequency unit for the shaft revolution system was rendered inoperable from the dislodgement and breaking of vacuum tubes. This is a Type 4 Electric Tachometer Company unit located in the I. C. room. See photograph 1679-4, Page 255.

The salinity indicator mounting in the forward engine room was displaced, broken, and bent. This instrument was mounted to throttle board by 3/8" strap iron. The indicator itself showed no signs of damage.

Recommendations.

a. Equipment incorporating vacuum tubes should have mounting for the tubes so designed as to withstand a high degree of shock.

b. Salinity indicators should be so designed that

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instruments, relays and similar devices are not supported from the enclosing case and especially should not be secured to a hinged front cover. Construction details should conform to the requirements of Navy Department Specifications 17C10 and 17C17 where applicable.

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

No damage.

V. F. C. Switchboard.

No damage.

W. Miscellaneous.

There was no damage to any of the Code 660 special material installed for the test.

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APPENDIX

SHIP MEASUREMENT DATA

TEST BAKER

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SHIP MEASUREMENT DATA

A. (a) Deck Survey.

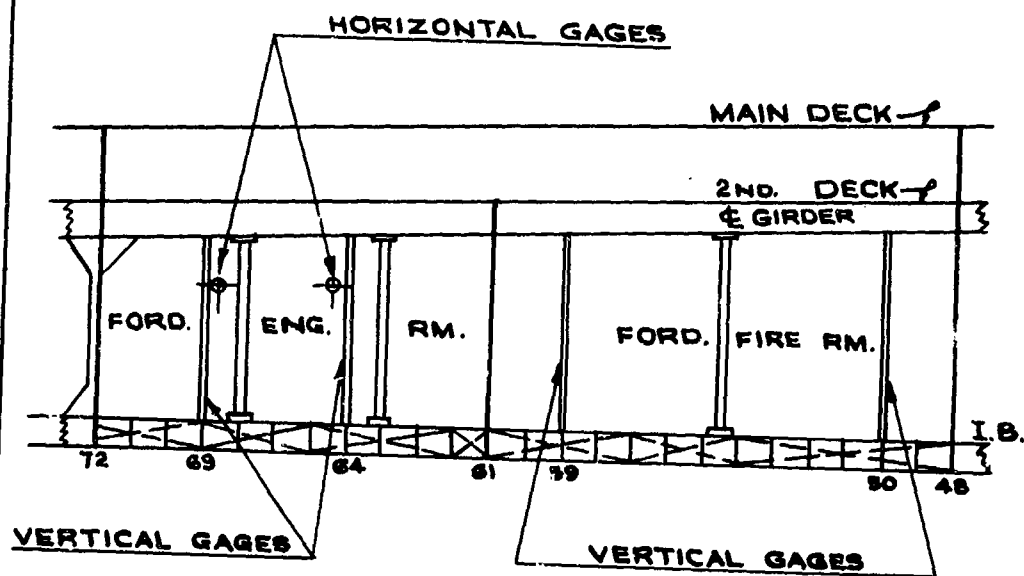
No deck survey could be conducted on this vessel after test B due to the presence of radioactivity.

(b) Scratch Gages.

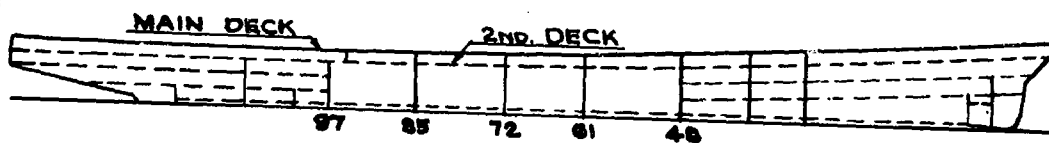
The majority of the scratch gages were removed from this ship after test A. Some additional gages were installed in the forward fireroom and forward engine room. Information regarding these, taken from the inspectors' reports, indicates severe underwater shock with a relative movement between the inner bottom and second deck of approximately one inch. No permanent set was observed. (Pages 98 and 99).

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INBOARD PROFILE FR3.48-72
SHOWING LOCATIONS OF SCRATCH GAGES



DECK DEFLECTION GAGES
TEST BAKER

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DECK DEFLECTION GAGESSHIP CA 24 TEST "BAKER"

FR. NO.	DECK	TYPE	MOVEMENT	REMARKS
64	UPPER LEVEL ENGINE ROOM	HORIZONTAL	1 1/2" INBOARD 1 1/2" OUTBOARD	
69	UPPER LEVEL ENGINE ROOM	HORIZONTAL		PIPE BROKEN LOOSE & TELESOPED
64 &	I.B. TO 2ND. DK. ENGINE ROOM	VERTICAL	1/2" COMPRESSION	NO PERMANENT SET
69 & (10' AFT.)	I.B. TO 2ND. DK. ENGINE ROOM	VERTICAL	3/4" COMPRESSION	NO PERMANENT SET
50 AND 59 &	I.B. TO 2ND. DK. FIRE ROOM	VERTICAL	GAGES INDICATE TWO MAJOR AND SEVERAL MINOR ELASTIC DEFLECTIONS. NO RECORD OF PERMANENT SET AS GAGE CONNECTIONS FAILED.	

NOTES:

1. MAJORITY OF SCRATCH GAGES THROUGH-OUT SHIP WERE REMOVED AFTER TEST "ABLE".
2. ABOVE INFORMATION OBTAINED FROM HULL INSPECTORS' REPORTS.

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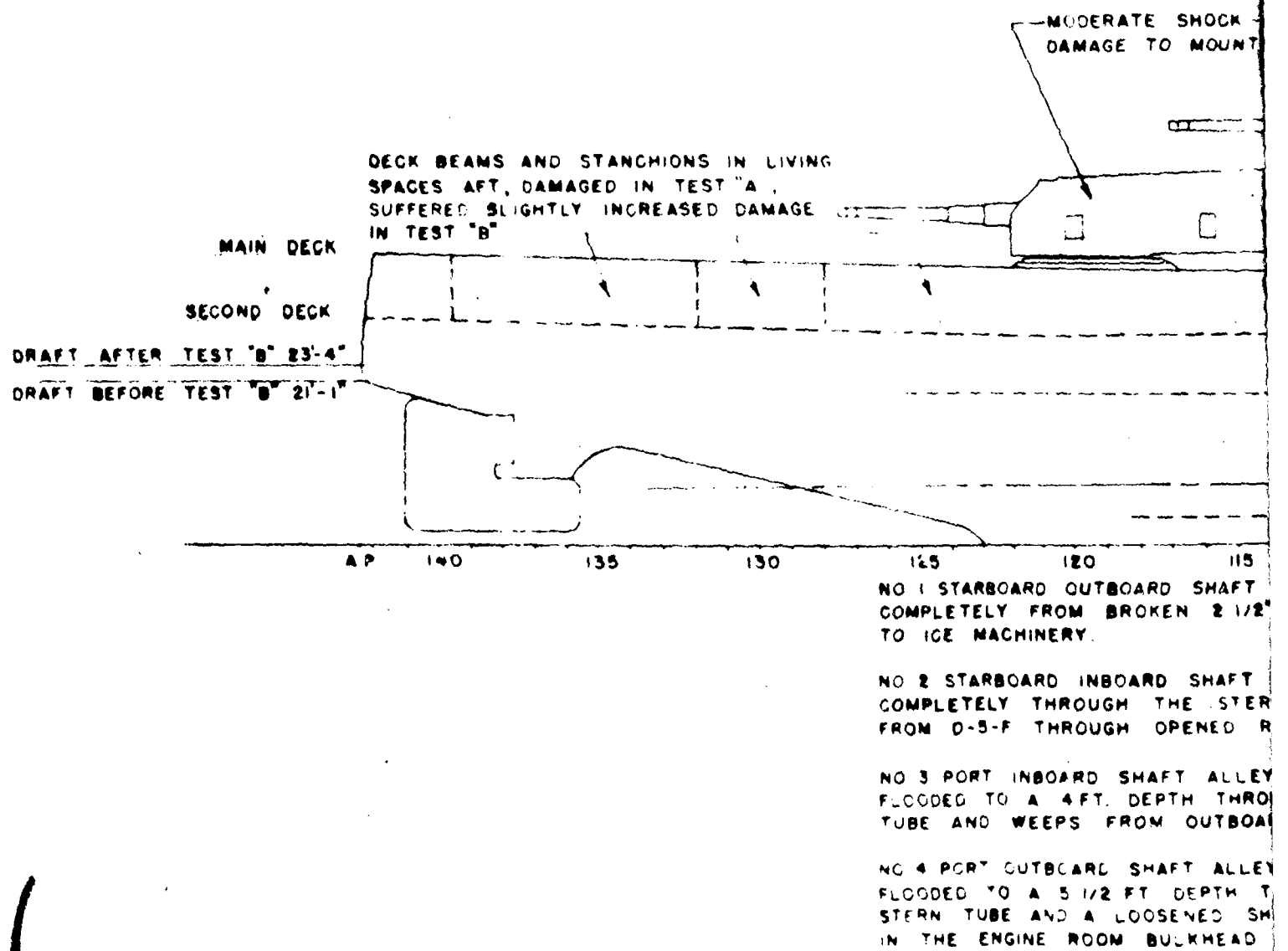
APPENDIX

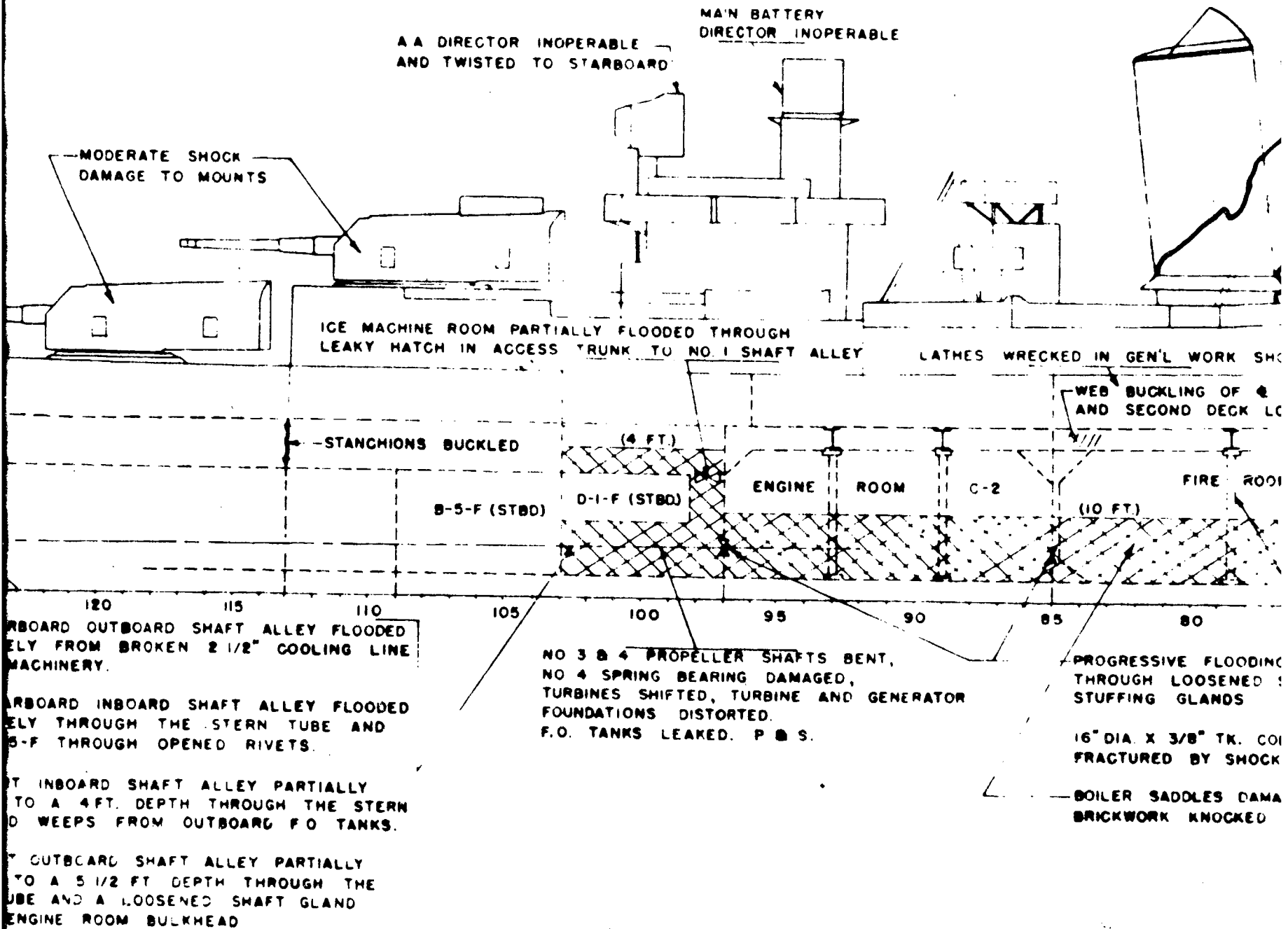
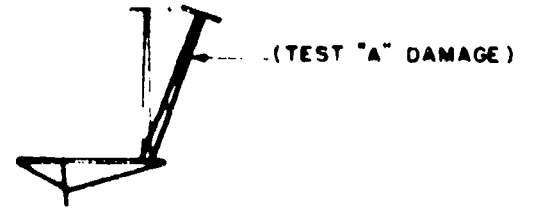
DAMAGE DIAGRAM

TEST BAKER

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2

— (TEST "A" DAMAGE)

STACKS (WRECKED IN TEST "A")
SUFFERED ADDITIONAL DISPLACEMENT

UPTAKE BULKHEADS ON SECOND
DECK (DAMAGED IN TEST "A")
SUFFERED ADDITIONAL DAMAGE.

MAIN DECK GIRDERS AND
SUPPORTING STANCHIONS
SUFFERED INCREASED
DAMAGE UNDER WELL DECK
AREA, FRAMES 61 TO 72

WRECKED IN GEN'L WORK SHOP (STBD)

WEB BUCKLING OF G GIRDER
AND SECOND DECK LONG'S

TRANSVERSE FR 64 BUCKLED
IN WEB AND FLANGE PULLED
DOWN 1/4"

WEB BUCKLING OF G GIRDER
AND SECOND DECK LONG'S

FIRE ROOM B-2

ENGINE ROOM C-1

FIRE ROOM B-1

(10 FT)

(8 FT)

6" OIL AND WATER
IN BILGES

85

80

75

70

65

60

55

50

45

40

PROGRESSIVE FLOODING
THROUGH LOOSENED SHAFT
STUFFING GLANDS

CONDENSER SUPPORTS
DISTORTED AND TURBINE
CASINGS CRACKED

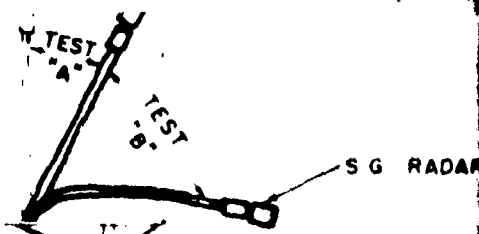
16" DIA. X 3/8" TK COLUMN
FRACTURED BY SHOCK

16" DIA. X 3/8" TK. COLUMN
FRACTURED BY SHOCK.

VERTICAL REACH RODS PULLED
OUT OF SOCKETS, AT FR 62 & 64

BOILER SADDLES DAMAGED AND
BRICKWORK KNOCKED DOWN

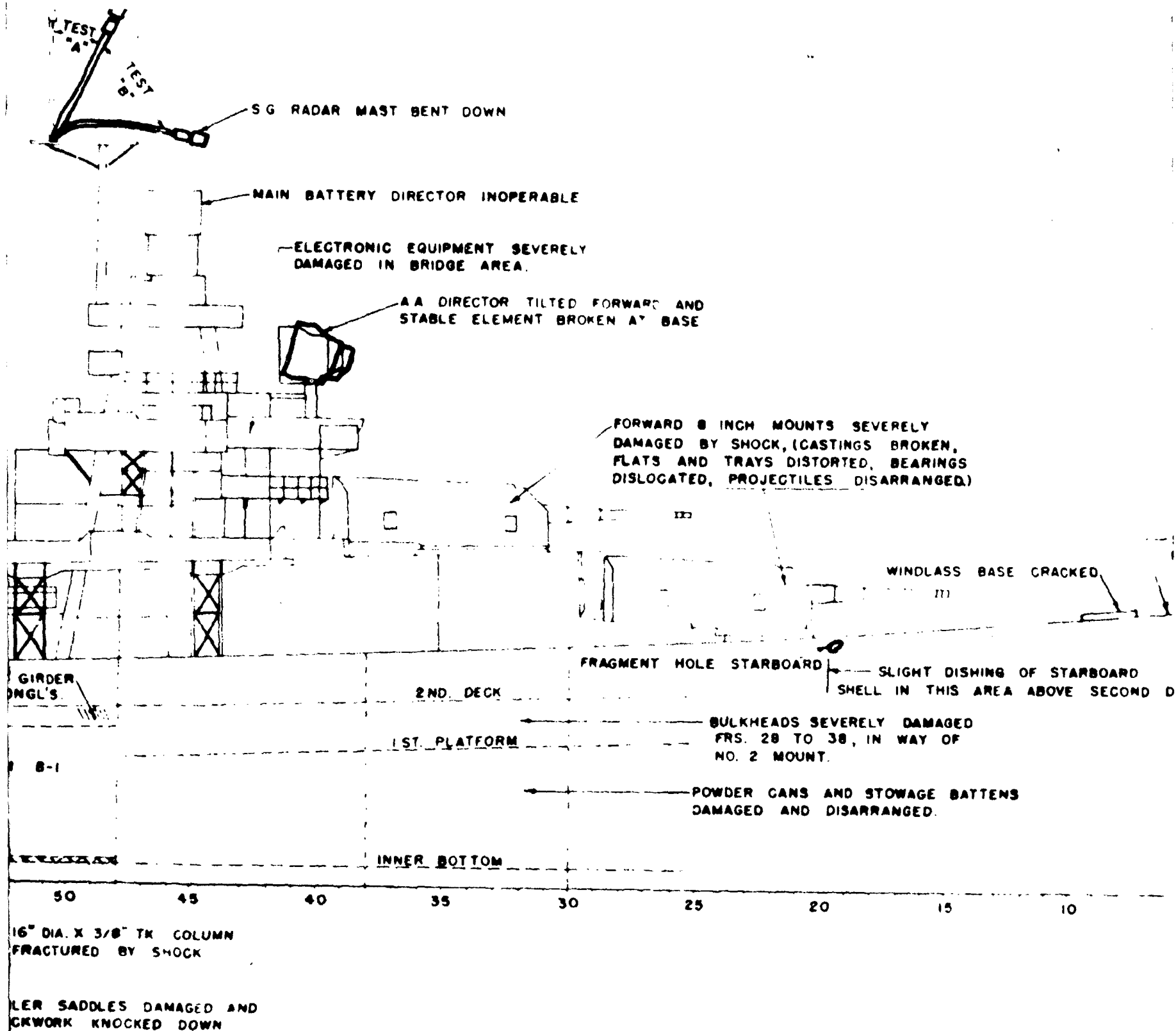
BOILER SADDLES DAMAGED AND
BRICKWORK KNOCKED DOWN



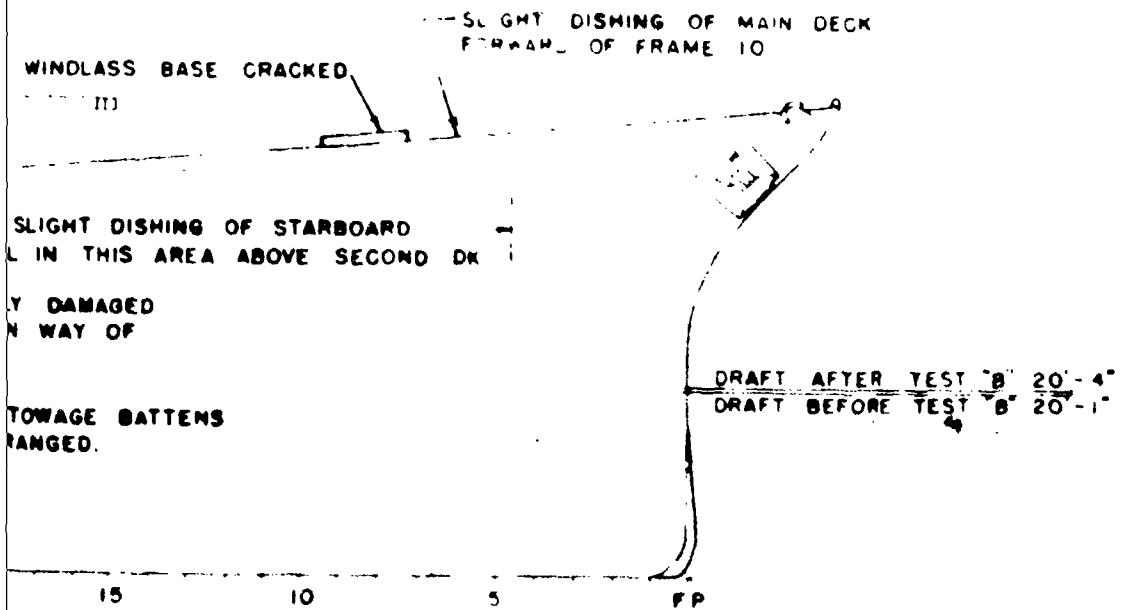
MAIN BAT

ELECT
DAMAG

3



VERELY
BROKEN,
BEARINGS
(ARRANGED)



SLOW FLOODING

NAVY DEPT BUREAU OF SHIPS
DAMAGE
TEST
USS PENSACOLA

APPENDIX

COMMANDING OFFICER'S REPORT

TEST BAKER

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U.S.S. PENSACOLA (CA24)

SECTION I

PART A - GENERAL SUMMARY

I. Target Condition After Test.

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

Drafts before test:	Forward	20' 1"
	Aft	21' 1"
	Mean	20' 7"

Drafts after test:	Forward	20' 4"
(August 1st)	Aft	23' 4"
	Mean	21' 10"

There was a five degree list to starboard on 1 August 1946. The general areas of flooding were as follows:

1. No. 1 shaft alley was flooded by a ruptured salt waterline, and leakage around stern tube. No. 2 shaft alley was partially flooded by leakage from the stern tube; partial failure of starboard bulkhead and leakage around shaft packing gland to engine room. No. 3 and 4 shaft alleys were partially flooded due to stern tube leakage and to leakage through shaft packing glands to engine room.
2. The after engine room (C-2) was partially flooded by leakage through shaft glands and from ruptured oil tanks.
3. The after fireroom (B-2) was partially flooded by leakage through shaft glands from the after engine room and through ruptured fuel oil tanks.
4. The forward engine room (C-1) was partially flooded by leakage through shaft glands from after fireroom and from ruptured oil tanks.

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5. The ice machine room (D-301-E) was partially flooded by water from number one shaft alley.
6. The fresh water pump room (A-508-E) was partially flooded from an unknown source presumed to be from ruptured fresh water tanks forward.

(b) Structural damage; superstructure; hull interior of hull, above and below the armored deck.

There was considerable structural damage to the ship, apparently caused by pressure waves both underwater and above water. The ship appears to have suffered from one or more severe jolts, presumably caused by the ship being struck and tossed around by the wave, or waves created by the detonation of the bomb.

Joiner bulkheads, frames, stanchions, watertight doors and hatches on the main deck and superstructure were ruptured or distorted. The weather decks which had been patched or somewhat strengthened prior to the test again failed in some places or were further distorted.

The hull was bulged inward somewhat, mostly on the port side with one or two failures where plates were riveted together.

Interior of the hull above the armored deck showed that joints of bulkheads, decks, stanchions, watertight doors and hatches were bent and distorted. Bulkheads below the armored deck were bulged in. Stanchions were bent, and the main stanchion in the center of both firerooms were cracked into two parts. Watertight doors and hatches were bent, distorted, and failed. Supporting frameworks for turbines, auxiliary machinery and bearings were cracked, in some cases the machinery shifting positions.

(c) Operability, Machinery, Electrical, Ship Control, Fire Control, Gunnery Electronics.

The operability of machinery following Test A was impaired completely. This was due to distortion of the shafts, misalign-

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ment of all main propulsion machinery, cracked turbine casings and the fact, again, that the pressure wave transmitted through the air blew out casings of all boilers with open flues. Most auxiliary machinery in the engine rooms and firerooms was damaged to some extent. Steam lines, oil lines and waterlines apparently distorted and twisted in some cases.

The overall condition of operability of electrical equipment was not determined but it appears that most of the equipment was damaged by flooding and distortion.

It has been impossible to fully inspect or to test ship control, fire control, gunnery and electronics equipment. In general, it appears that none of this equipment is operable.

(d) Heat; Fire; Estimated Personnel Casualties.

There was no evidence of either extreme heat or fires. Estimated personnel casualties, it is believed, would have been one hundred per cent on the topside due to the pressure and shock waves. This would include ship control personnel, fire control personnel, five-inch gun personnel, and automatic weapon personnel, which is approximately thirty-five per cent of the wartime allowance of personnel. It is believed that another six per cent would have perished in the firerooms from the pressure wave and flareback issuing through the boiler casings. In addition, personnel in lightly enclosed spaces such as radar rooms, ammunition clipping rooms, repair stations and so forth would have suffered severely from this pressure wave. This would bring the estimated casualties to a total of about sixty per cent of wartime allowance, exclusive of the effects of radioactivity.

II. Forces Evidenced and Effects Noted.

(a) Heat.

There was no effect of heat noted.

(b) Fires and explosions.

There was no evidence of fires or explosions.

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(c) Shock.

There was, apparently, a very pronounced shock wave transmitted both through the air and through the water. The direction of these waves is not definitely known but apparently the shock was expended against the port side, though the angle is not known. The principal areas affected from the underwater wave were B and C sections of the ship. The shock wave in these sections shifted and misaligned main propelling machinery, cracked turbine casings, shifted auxiliary machinery, jarred floor plates out of place, loosened lockers and equipment attached to bulkheads and decks.

It was impossible to make a full and complete inspection of the detailed damage and structural failures due to the limited time allowed in most compartments.

The overall effect was to place the main propulsion machinery, auxiliaries, and electrical equipment out of commission.

The shock wave transmitted through the air had much the same effect as the shock wave of Test A. From the inspection of the topside it was seen that the shock wave had caused the masts to be bent even more than from Test A. The forward AA director was bent forward from its base; the after AA director was twisted around in train; the shields of the MB directors were bent and distorted. Glass windows in directors, open bridge, and instruments were broken out and the stacks distorted more than before. Equipment on the superstructure was jarred loose from decks and bulkheads and most enclosed areas were a shambles from the effects of the shock wave.

(d) Pressure.

The pressure wave was similar to the shock wave, acting through the water on the underwater body and through the air on the superstructure and the above water hull. The underwater pressure wave affected mainly the B and C sections of the ship. The direction is not definitely known but the port side of the underwater hull took the brunt of the wave. The pressure wave dished in the hull plating of the after engine room, after fireroom and forward engine room.

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Rivet seams opened and allowed water and oil from ruptured tanks to partially flood these spaces. The main propulsion machinery was dislodged by the shock wave and this combined with the pressure wave caused distortion of the shafts, allowing leakage through shaft glands. The pressure wave caused joiner bulkheads, frames, stanchions and decks to be bulged, distorted and ruptured. Watertight doors were dished and distorted.

The pressure wave transmitted through the air was similar to that to Test A. The superstructure in many cases was distorted or demolished and the main deck was dished and distorted. The main deck had been patched and strengthened since Test A but these patches and even other portions of the main deck ruptured or failed.

(e) Effects apparently peculiar to the atom bomb.

The effects peculiar to the atom bomb were in Test B, nearly the same as those for Test A. That is, the particularly large lethal area both underwater and in the air. Terrific damage was caused by the tremendous power and force of the shock and pressure waves which is many, many times as powerful as that of the ordinary bomb.

The important and most peculiar effect of the atom bomb, intense radioactivity, was more pronounced in Test B than in Test A. This is a real and effective hazard both offensively and defensively. This is evidenced by the fact that, after one month crews have been unable to reboard their ships in safety. Geiger counter readings reach 170 roentgens in some topside locations.

III. Results of The Test on The Target.

(a) Effect on propulsion and ship control.

The major damage to main propulsion was misalignment of the turbines and shafting, cracked turbine casings and ruptured boiler casings. The effect of this damage was to immobilize the ship and to place main propulsion machinery out of commission for a considerable period.

Ship control was not tested nor fully inspected after Test B.

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(b) Effect on gunnery and fire control.

Although none of the gunnery or fire control equipment has been tested, it is apparent that the fire control system is inoperative. The forward AA director has been bent forward at the base from the shock wave and is inoperative. The after AA director has been twisted to starboard, all gearing broken, and roller path bearings scattered. Both MB directors show evidence of severe shock and cannot be operated. All rangekeepers and optical rangefinders are inoperative. From hurried examinations it was noticed that mark 15 and mark 14 gunsights on 40 and 20MM mounts are apparently undamaged. Fire control radar antennas were slightly damaged.

The forward turrets were lifted from their roller paths by the shock as evidenced by the derangement of the bearings, some of which were on the deck below. All four turret pivot seal castings were broken. All safety links installed for the test were broken. All breach plugs left open for test cannot be closed. The forward lower powder hoist of turret No. 2 is jammed. The right powder hoist in turret No. 2 is buckled at the powder circle, other ammunition trunks appear to be undamaged.

The 5-inch AA mounts appear to be undamaged from a visual inspection. Most equipment shows some evidence of shock and must be considered to be misaligned but no equipment is twisted or distorted.

The training and elevating systems of turrets and mounts are inoperative. It is considered that the entire gunnery and fire control systems are useless.

(c) Effect on watertight integrity and stability.

Due to the underwater pressure wave striking the underwater hull the watertight integrity was seriously affected. Watertight subdivisions of the ship were distorted and in many cases failed. The majority of watertight closures were distorted or failed. By B plus seven day the draft aft had increased 2' 3" and the draft forward had increased 3". In addition, the ship had acquired a five degree list to starboard which was increasing daily. Hence the effect of the bomb was to seriously reduce watertight integrity, stability and seaworthiness.

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(d) Effect on personnel and habitability.

The most significant effect on personnel and habitability was that due to intense radioactivity which penetrated even to the lowest decks. This radioactivity was high enough to have had serious effect on surviving personnel.

In addition, the shock wave made many compartments not habitable throughout the ship. Furniture and equipment was shaken loose and tossed about. Loss of electric power, too, resulted in loss of cooking facilities, lighting and ventilation below decks. Ventilation ducts were ruptured and all living spaces did not have adequate ventilation.

(e) Total effect on fighting efficiency.

The fighting efficiency of the ship was reduced to nothing by the effect of the underwater detonation of the atom bomb. Four main factors of damage causing this loss of efficiency are as follows:

1. Main propulsion was completely out of commission, causing the ship to stop dead in the water.
2. Gunnery and fire control systems were heavily damaged so that local control and hand power must be resorted to (if it is at all possible to fire the guns.).
3. Damage to the hull and the consequent loss of stability and seaworthiness.
4. Sixty per cent immediate personnel casualties and subsequent assumed loss of all personnel from radioactivity.

With this amount of damage and the reduction in personnel it is doubtful if the ship could be brought into port. Certainly it could not be considered an effective fighting ship.

IV. General Summary.

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✓ The shallow underwater detonation of the atom bomb had three major effects: An underwater pressure and shock wave; an air pressure and shock wave, and radioactive contamination of a large area.

The effect of the underwater waves were extremely great over a large area. The damage done to the underwater hull and the main propulsion machinery was such as to immobilize the ship and to materially reduce its seaworthiness.

The effect of the air waves were not as pronounced as the same waves of Test A. However, the effect on gunnery, ship control and personnel was such as to substantially reduce the efficiency of these elements.

The radiologically contaminated water which covered the entire ship and in some cases penetrated below decks was the most significant factor. Radioactive particles penetrated the paint and porous materials and remained with great tenacity despite measures taken to decontaminate. The high radioactivity has prevented re-boarding for a period of 30 days at the time of this writing.

V. Conclusions and Recommendations.

In general, the same recommendations may be drawn from Test B as from Test A concerning design:

1. Installation of a system of baffling in the uptakes of the boilers to dissipate the air waves going down the stack before reaching the boiler.
2. Eliminate, insofar as practicable, all vertical surfaces and the installation of strong, spherical surfaces.
3. Use soft patches to vent topside compartments exposed directly to the force of the pressure waves.
4. Vital ship control, fire control and exposed radar stations should be armored.
5. Provide methods of protecting radio and radar antennae, such as protective housings or retractable antennae.

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In addition, the underwater damage sustained shows that some extra protection for the underwater hull and propelling machinery is necessary. It is possible that new methods of propulsion, such as the "jet" principle, or the use of atomic energy for propulsion will come into use. These, it is believed, may eliminate the vulnerable propeller shaft and simplify the main propulsion plant to an extent which would reduce the shock hazard.

The contamination of the ship by radioactive water has presented a real and dangerous problem. The complete facts of radioactivity are not at hand and a method of decontaminating cannot be suggested, but methods of protecting personnel must be devised.

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SECTION I

PART C - INSPECTION REPORT

SECTION A - HULL

A. General Description of Hull Damage.

(a) Overall condition of vessel.

In general the ship underwent a severe underwater shock and a lesser pressure wave to those portions above the waterline. Throughout the ship below the main deck, bulkheads and decks are distorted, many joiner bulkheads have failed, as well as stanchions, watertight doors and hatches. Considerable flooding took place in the main machinery spaces. The topside was further damaged as evidenced by the further demolishing of both stacks and the distortion of the main mast and gunnery equipment.

(b) General areas of hull damage.

The most severely damaged areas were the B and C sections of the ship and the shaft alleys in the D section of the ship.

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

The apparent cause of hull damage in each area was the underwater pressure wave.

(d) Principle areas of flooding with sources.

No. 1 Shaft Alley - D-505-E.

2" salt waterline for ice machine cooling water failed and slight leakage around stern tube.

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No. 2 Shaft Alley - D-503-E.

Stern tube bearing cooling waterline; slight leakage around stern tube; sheared rivets in starboard bulkhead; and packing gland to engine room.

No. 3 Shaft Alley - D-502-E.

Slight leakage around stern tube and packing gland to engine room.

No. 4 Shaft Alley - D-506-E.

Slight leakage around stern tubes and packing gland to engine room.

After engine room C-2.

From leakage around packing glands to shaft alleys and from ruptured oil tanks.

After fireroom - B-2.

From C-2 around shaft packing glands and from ruptured oil tanks.

Ice Machine Room.- D-301-E.

Through hatch to No. 1 shaft alley.

Fresh water pump room - A-508-E.

Source unknown.

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

The residual strength of the ship was very greatly impaired due to distortion and failure of many strength members. The buoyancy was considerably reduced by flooding and the general condition of the hull was in such a state that the vessel could not be operated or even considered seaworthy.

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B. Superstructure (Exclusive of Gun Mounts).

(a) Description of damage.

Bridge area not greatly changed. Midship deck house and stacks - both stacks were pushed down further and more failures of plates and stiffeners noted. After deck house and tower - not greatly changed.

(b) Causes of damage in each area.

The air pressure wave and descending fountain of water.

(c) Evidences of fire in superstructure.

None.

(d) No remarks.

(e) Constructive criticism of superstructure design or construction.

Vertical and flat surfaces should be eliminated as much as possible and spherical surfaces substituted wherever possible.

C. Turrets, Guns and Directors.

(a) Protected mounts.

Turret No. 2 was more extensively damaged than any other turret. It was tilted forward sufficient to lower the forward side at the roller path 5 1/2" and raise the after side a similar amount. The holding down bolts were sheared. Practically all the ball bearings were lying in the powder circle. The vertical thrust bearings were visible from the outside of the turret. The position of the mount in train changed 25 minutes toward the port.

The bearing path in turret No. 1 was damaged. One section of the bearing retainer is out of position. The bottom of

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the training pinion casting was broken and bolts sheared. The guns were elevated 2 degrees by the blast.

The roller bearings in turret No. 3 and ball bearings in turret No. 4 were undamaged.

The pivot seal covers on all turrets were buckled and cracked. All guns showed evidence of recoil. All safety links which were in during the test were broken. All breech plugs left open for test cannot be closed now. There appeared to be no damage to ammunition hoists except the right powder hoist in turret No. 2 was buckled in the powder circle. The only buckled bulkheads noted in the turrets were those of the ready boxes in turret No. 1. The shell decks were intact except that nearly all projectiles in all turrets were torn loose from the securing chains and scattered.

The turret armor was adequate.

(b) Unprotected mounts.

No damage to these mounts was observed. The starboard 40MM mount was moved in train from 090° to 180°. The forward 20MM mounts were elevated to the vertical position. All gun barrels appear to be in good condition. The blast, weather and decontamination have removed some paint and most of the grease. The operability of these mounts is unknown.

The effectiveness and sufficiency of crew shelters are inadequate.

(c) Directors and rangefinders.

All directors and rangefinders are inoperable. The after main battery director, MK 35, is very difficult to train and elevate by the hand wheels. Neither AA director, MK 33, can be trained or elevated. The forward AA director, MK 33, is bent forward and down on its tube. The after AA director, MK 33, was twisted to starboard by the blast. The roller path is damaged and the bearings are scattered. Most of the controls within the directors and the adjusting knobs on the instruments are broken or frozen. Some

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stable element amplifier tubes are broken. The lenses and crosswires in the optics appear undamaged but they cannot be focused. The stable element in the forward AA director is broken at the base.

It is doubtful if mounts, directors, foundations or shelters can be designed that will withstand an explosion such as these were exposed to. Stronger holding down clips and retaining rings are necessary. Spherical or cylindrical surfaces will provide better protection than flat surfaces.

D. Torpedo Mounts, Depth Charge Gear.

Not applicable.

E. Weather Decks.

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

The well deck between frames 62 and 71 had been patched and strengthened after Test A. However, it failed in many places on Test B. Remaining weather decks were further distorted. All weather decks could be used after Test B from a strength point of view. Mooring and towing fittings which were not demolished by Test A were in most cases slightly distorted but not beyond use.

F. Exterior Hull Above Waterline.

The exterior hull plating was slightly dished around frames in many places; however, no ruptures were noted. There was apparently no damage to the side armor belt.

G. Interior Compartments Above Waterline.

In general the interior of all compartments inspected were very severely damaged. Joiner bulkheads in most places had failed. Nearly all vent ducts were ruptured or had failed. Piping and cables were in most cases distorted or had failed. At least 70 % of all doors and hatches were distorted or had failed. There was no evidence of fire. An estimate of the reduction in watertight subdivision is about 80%, habitability 100%; and utility 70%.

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H. Armor Decks.

No damage observed. Protection below appears ample. Only damage below appears to be from shock. Condition around certain hatches, gratings and bulkheads shows evidence of warping and buckling from shock. No damage observed in connections to vertical armor.

I. Interior Compartments Below Waterline.

Same as Item G except that it is estimated that about 20% of all watertight hatches and doors were distorted to such an extent that they were made non-watertight against a small pressure head. For flooding see Item A. The estimated reduction in watertight subdivision is about 40%; habitability 100%; and utility 95%.

J. Underwater Hull.

No remarks.

K. Tanks.

(a) Condition of tanks in areas of damage.

D-1-F. Viewed from No. 1 shaft alley.

Starboard bulkhead bulged.

D-5-F. Viewed from No. 2 shaft alley.

Port bulkhead bulged and twelve rivets failed.

D-10-F; D-6-F; D-2-F. Viewed from No. 3 shaft alley.

Starboard bulkhead slightly bulged.

D-4-F. Viewed from No. 4 shaft alley.

Starboard bulkhead bulged.

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No remarks.

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D-10-F; D-6-F; D-2-F. Viewed from No. 3 shaft alley.

Starboard bulkhead slightly bulged.

D-4-F. Viewed from No. 4 shaft alley.

Starboard bulkhead bulged.

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The following tanks in the area of C-2 were sounded and results were as follows:

Tank	Before Test	After Test	Loss Gals.
C-925-F	0' 6"	0' 7"	---
C-924-F	15' 3"	12' 11"	1346
C-930-F	19' 7"	4' 1"	8885
C-919-F	0' 3"	0' 3"	---
C-920-F	0' 4"	0' 7"	---
C-926-F	0' 5"	0' 5"	---
C-927-F	0' 1"	0' 4"	---
C-928-F	0' 1"	0' 1"	---
C-921-F	0' 1"	0' 10"	---
C-922-F	0' 1"	0' 7"	---

It is apparent from the above soundings that tanks C-924-F and C-930-F were ruptured by the test and the loss in volume was due to the dewatering process of C-2 after the test. These tanks were service tanks and loss represents oil. C-920-F, C-921-F, C-922-F, C-927-F, show a slight increase. They are bottom tanks and were evidently slightly ruptured during the test and filled from the engine room while it was flooded.

L. Flooding.

(a) Description of major flooding areas and sources.

See Item A section (d)

It is believed that all areas flooded was through a slow progressive process and that it could have been controlled through damage control measures.

M. Ventilation.

At least 80% of the ship's ventilation ducts failed and it is estimated that at least 60% of the closures failed also. Many compartments below the main deck had from one to five inches of water on their decks which apparently came through ventilation openings from the topside.

N. Ship Control.

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Ship control equipment and instruments have not been tested or inspected.

O. Fire Control.

All four enclosed directors were damaged from shock and blast. Only the main battery directors Mk 35, can be trained and elevated by hand wheels and the after one of these binds in both train and elevation. The roller path assemblies of both AA directors, Mk 33, were severely damaged. The forward AA director was pushed forward and downward on its tube. The after AA director was twisted in train to starboard. The adjusting devices and controls in all directors were nearly all frozen. The lenses and crosswires in most optics are in good condition but cannot be focused or moved in train or elevation.

The elevated control stations suffered the effects of blast and shock.

Plotting rooms and protected spaces were slightly damaged from shock.

All topside stations had insufficient protection. The fighting efficiency of the ship as a result of this explosion was completely lost. Fire control stations on the topside should be reduced to an absolute minimum. Where possible the equipment and personnel should be below decks. Required topside fire control stations should be in protected cylindrical or spherical shaped shields.

P. Ammunition Behavior.

No ammunition exploded or burned. All ammunition stowages show evidence of shock. The battens and other parts of stowage racks are bent and torn loose. The ammunition containers are scattered about. Many of the 8" powder tanks were cut open just below the rims by the rims of the tanks just above them. Strong fumes of ether alcohol are present in the forward 8" magazines where the powder containers are open. In magazines where ammunition containers were stacked nearly to the overhead, the upper layer of containers show dents and creases where they were thrown up against the overhead.

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Practically all powder sample bottles were broken and the powder scattered. No powder is decomposed. So far there has been no change in methyl violet paper. The undamaged maximum-minimum thermometers indicate that the highest temperature in the magazines during or since the test was 89° F.

Ammunition stowages were all insufficiently protected from shock. Ammunition containers that can be locked to each other would have stood up under the shock better than those used.

Gasoline stowage facilities were not inspected.

Q. Ammunition Handling.

No power has been available to test ammunition hoists. No ammunition hoist trunk was visibly distorted except the right powder hoist in turret No. 2 at the powder circle level. The only ammunition hoist tried out by manual operation was the lower forward powder hoist for turret No. 2. It jammed after a few inches movement in either direction. Powder scuttles in undistorted decks or bulkheads are operable. A few of the powder scuttles in distorted decks or bulkheads are operable and some are not. The powder scuttles in turret No. 2 are operable despite the extensive damage to this turret.

There was no evidence that any ammunition handling device contributed to passing of heat, fire, blast or flooding water.

Insufficient information is available to make any constructive criticism of design or construction of ammunition handling devices. It appears that these devices withstood the effects of the explosion better than most other parts of the ship.

R. Strength.

There is no visual evidence of any permanent hog or sag. It is believed, however, that the ship is slightly twisted longitudinally from the stern, port quarter up. Nearly all vertical stanchions are distorted and a great many failed. It may be noted that the 12" vertical structural stanchion at frame 54 in the forward fireroom failed near the bottom and a similar stanchion in the after fireroom at frame 78 likewise failed near the top. Scratch gages in these spaces were

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torn loose and demolished. The centerline longitudinal which goes through these spaces appears to have been distorted by a clockwise torque view from aft looking forward. In lower deck spaces one can hear the ship work in the sea. From the above remarks and evidence of lesser damage to strength members of the ship it is not considered seaworthy. It is also considered unsafe for personnel to reboard under any condition.

S. Miscellaneous.

No remarks.

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SECTION I

PART C - INSPECTION REPORT

SECTION B - MACHINERY

A. General Description of Machinery Damage.

(a) Overall condition.

The overall condition of machinery is poor. All machinery and equipment that could be inspected shows evidence of severe shock. Shafts, main turbines and condensers are misaligned and some turbine casings are cracked. Many items of equipment and machinery have been flooded. Boilers have had casings blown out and steam lines are twisted, distorted and out of line.

(b) Areas of major damage.

The areas of major damage are the after engine room, after fireroom and forward engine room.

(c) Causes of damage in each area.

Damage in the engineering spaces was caused by the shock and pressure waves. The shock wave caused turbine casings to crack, and to jar machinery and equipment from their bases. The pressure wave caused seams to open. The after engine room partially flooded through the shaft glands and from ruptured oil tank C-930-F. The pressure blast down the stacks and through the uptakes caused the boiler casings again to burst.

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

The effect of the test on the operation of the machinery plant was to completely immobilize the ship for a considerable period of time.

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B. Boilers.

Boilers in B-1 have casings blown outward still farther than after Test A. No. 7 boiler in B-2 has casings on starboard side after section blown out (No. 7 and No. 5 boilers were repaired after Test A). No. 5 boiler casings seem undamaged but this may be attributed to the fact that the uptake at the battle bars is blanked off with 5 pound plate.

Number 4 soot blower element on boiler No. 8 was blown out completely. It was damaged before on Test A.

The fuel oil burner assemblies seem to be undamaged.

In all eight boilers there is considerable brickwork on the deck. Deck in No. 5 boiler appears to have been pushed upward.

Evidence in B-1 that all boilers have "squatted" to a certain degree. No. 3 boiler has a leak in starboard front of mud drum which indicates tube leakage. No. 2 boiler has one securing bolt sheared on inboard saddle, No. 3 has two bolts sheared (inboard saddle) and No. 4 has one (inboard saddle).

Unable to comment on the condition of the tubes except for the leak noted on No. 3 boiler at front of starboard mud drum.

C. Blowers.

No remarks. Blowers in B-2 were turned over by hand and No. 7 blower was found to be out of line. No comment for blowers in B-1. Foundations appear to be intact, but a thorough examination was not possible. External fittings appear to be undamaged. No comment. Ladders in air lockers were moved inboard but no loss of airtightness is apparent.

D. Fuel Oil Equipment.

Not examined. Outwardly appears undamaged.

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E. Boiler Feedwater Equipment.

Not examined. Hot well after engine room, now 2 inches closer to the deck.

F. Main Turbines.

(a) Casings.

All low pressure turbine casings cracked. No. 1 low pressure lower after end is cracked for about 5 feet from foundation up toward casing half-flanges. No. 2 low pressure cracked at forward bearing foundation and sliding feet. No. 3 low pressure forward bearing foundation and sliding feet broken. No. 4 low pressure lower casing after end is cracked for about 3 feet from foundation up to casing half-flanges. No. 1 high pressure forward bearing foundation cracked and spread. No. 2 high pressure forward bearing foundation cracked and spread. No. 4 high pressure cracked between forward bearing and cruising engine.

(b - f) No remarks.

(g) The foundations under high pressure and low pressure engines are cracked and spread.

(h) No remarks.

G. Reduction Gears.

No remarks.

H. Shafting and Bearings.

(a) Number 3 shaft appears to be bent in after section. No. 4 shaft appears to be bent in section along after side of No. 3 engine.

(b) All after steadying bearings cracked and broken.

(c) No remarks.

(d) Leaking slightly.

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I. Lubrication System.

(a - d) No remarks.

(e) Return oil lines from No. 1 cruising engine are twisted and moved up. Lube oil suction line on No. 1 independent lube oil pump pulled out and distorted.

J. Condensers and Air Ejectors.

(a - e) No remarks.

(f) Foundations and Saddles.

Nos. 1, 2, 3, 4. Saddles spread, twisted and bent. Several rivets sheared off at corners of each.

K. Pumps.

No. 2 auxiliary feed pump foundation is fractured behind steam chest. This pump may still be operable.

Nos. 1, 2, 3, 4, 5 and 6 fuel oil service pump foundations (supports for steam chests) are fractured. Pumps seem to have dropped 2 to 3 inches. No. 2 fuel oil booster pump steam chest support fractured. No. 3 and No. 4 fuel oil boosters moved slightly but still appear operable. No. 3 auxiliary feed pump steam chest support fractured.

No. 1 independent lube oil pump moved up and out-board. (May still operate).

L. Auxiliary Generators.

No remarks.

M. Propeller.

No remarks.

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N. Distilling Plant.

(a) Evaporators.

No. 1 unit appears as before Test B. No. 2 unit; bases of evaporators sets are distorted.

(b) Distilling condensers.

No remarks.

(c) Feed heaters.

Unobserved.

(d) Miscellaneous.

Combination pumps are misaligned, other damage not apparent because of fuel oil coverage of appurtenances during flooding of compartment.

O. Refrigerating Plant.

There is evidence of severe shock to this compartment, but no remarks with regard to machinery damage.

P. Winches, Windlasses and Capstans.

(a) Foundation broken between motor and brake.

(b - f) No remarks.

(g) Equalizing line from starboard main oil return broken.

Q. Steering Engines.

Not observed.

R. Elevator, Ammunition Hoists, Etc.

Not observed.

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S. Ventilation (Machinery) .

Not observed.

T. Air Compressors.

Appear undamaged.

U. Diesels (Generators and Boats).

Motor whaleboats were not aboard during Test B.

Diesel generator sets are as before Test B with the exception of starting batteries which were destroyed.

V. Piping.

The piping as a whole seems to have withstood the shock. In many cases however, hangers were either distorted or broken. Lagging does not preclude the possibility that lines were ruptured. The salt water cooling line passing through No. 1 shaft alley ruptured, causing flooding of that and adjacent compartments.

W. Miscellaneous.

No remarks.

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SECTION I

PART C - INSPECTION REPORT

SECTION C - ELECTRICAL

A. General Description of Electrical Damage.

(a) Overall condition.

Electrical machinery auxiliaries are out of commission from flooding. Equipment using battery starting apparatus is 75% inoperative.

(b) Areas of major damage.

No complete inspection of effects of shock, therefore the major damage was in flooded machinery spaces.

(c) Causes of damage in each area.

No comment.

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

Not determined.

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

Not determined.

B. Electric Propulsion Rotating Equipment.

Not applicable.

C. Electric Propulsion Control Equipment.

Not applicable.

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D. Ship's Service Generators.

No damage noted from visual inspection to electrical parts, not accessible to further tests.

E. Emergency Generators.

No visible damage, unable to make other tests.

F. Switchboards and Distribution Panels.

No visible damage, unable to make other tests.

G. Wiring, Wiring Equipment and Wireways.

No visible damage, unable to make other tests.

H. Transformers.

Not inspected.

I. Submarine Propelling Batteries.

Not applicable.

J. Portable Batteries.

No mounting damage noted. 10% of the jars were cracked in the battery locker and starting batteries for forward diesel. Cable connections are broken in forward diesel from shock. Acid spilled in battery locker and forward diesel from overturned acid broken jars.

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

Not determined other than flooding as above mentioned.

L. Lighting Equipment.

Not determined.

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M. Searchlights.

Not applicable.

N. Degaussing Equipment.

Not determined.

O. Gyro Compass Equipment.

Not determined.

P. Sound Powered Telephone.

Not determined.

Q. Ships Service Telephones.

Exchange is damaged beyond repair by ship's force.
Strowger switches are jarred out of racks and the wiring is completely askew. Not determined.

R. Announcing System.

Not determined.

S. Telegraphs.

Not determined.

T. Indicating Systems.

Not determined.

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

Not determined.

V. F. C. Switchboards.

Not determined.

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SECTION I

PART C - INSPECTION REPORT

SECTION D - ELECTRONICS

A. General Description of Electronics Damage.

(a) Overall condition.

In main radio room, all receivers were intact and there was no visible evidence of smashed parts, broken knobs, etc. The LR-1 frequency meter, which was damaged in Test A, was forced out of its case. Two operating tables were pulled out from the bulkhead. Articles not well secured, such as chairs, patch cords and head telephones were found astray.

In radio transmitter room, the upper section of the TDE-2 transmitter fell out on its hinges and landed on the deck; one large vacuum tube was found broken. The operating table was pushed out from the bulkhead. A cabinet was overturned and articles were found scattered about the deck.

In emergency transmitter room, some of the dust panels on the TBK-5 and TAJ-19 transmitters were knocked off. A phone panel and power panel on the forward bulkhead were bulged out. Doors on the tube cabinet and DC power panel were forced open. Miscellaneous articles were found adrift.

In CIC forward, the top of the DRT and plotting table was caved in. The top of the VG radar repeater was smashed. One section of the SP indicator stack was pulled out of its case. Loose gear was found adrift.

In CIC aft, the plotting table was smashed. The top of the VG radar repeater was caved in. Shock mounts on the frame of the Mark 28 radar were pulled loose. The cathode ray tube in the VC indicator was broken and the front panel of the indicator was pulled out. Spare gear was found adrift and drawers were pulled out of their cabinets.

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In chart house and flag plot electronic equipment suffered no additional damage, although the DAS-1 loran equipment looked smashed to a greater degree than before.

Antennae remaining on the mainmast after Test A seemed to be about the same, but the TBS-2 transceiver antenna appeared more severely damaged than before. The SP parabola was in about the same condition and in the same relative position as before.

The SG stub mast on the foremast was bent over to a greater degree, but the antenna was still attached. Most of the yard-arm antennae were badly smashed and some are missing.

Fire control radar antennae forward were damaged to a greater extent than before. A new antenna installation on the main battery director was found crushed.

In general, visible damage to electronic equipment appeared greater than before. Topside damage to remaining equipment was as great as before. Several equipments were moved out of position or pulled loose from their mountings. A more thorough inspection would probably reveal extensive damage to vacuum tubes and component parts inside equipments.

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Defense Special Weapons Agency
6801 Telegraph Road
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 declassified the following reports:

/✓AD-366588 ~~4~~	XRD-203-Section 12✓
AD-366589 ~~✓~~	XRD-200-Section 9
AD-366590 ~~✓~~	XRD-204-Section 13
AD-366591 ~~✓~~	XRD-183
/✓AD-366586 ~~X~~	XRD-201-Section 10✓
/✓AD-367487 ~~X~~	XRD-131-Volume 2-
✓✓AD-367516 ~~4~~	XRD- ~~1~~ 143✓
✓✓AD-367493 ~~4~~	XRD-142✓
AD-801410L✓	XRD-138✓
AD-376831L✓	XRD-83✓
AD-366759 ~~✓~~	XRD-80
✓✓AD-376830L ~~X~~	XRD-79✓
/✓AD-376828L ~~4~~	XRD-76✓
/✓AD-367464 ~~X~~	XRD-106✓
AD-801404L✓	XRD-105-Volume 1✓
/✓AD-367459 ~~X~~	XRD-100✓

TRC

18 April 1997

Subject: Declassification of Report

AD-376836L ✓	XRD-98 ✓
AD-376835L ✓	XRD-97 ✓
AD-376834L ✓	XRD-96 ✓
AD-376833L ✓	XRD-95 ✓
X AD-376832L ✓	XRD-94 ✓ <i>re-ingest</i>
✓✓ AD-367458 ✓	XRD-93 ✓
~~AD-367457~~ ✓	XRD-92-Volume 2 ✓
~~AD-367456~~ ✓	XRD-91-Volume 1 ✓
~~AD-367455~~ ✓	XRD-90 ✓
~~AD-367454~~ ✓	XRD-89 ✓
AD-367453 ✓	XRD-88 ✓
~~AD-367452~~ ✓	XRD-87 ✓
AD-366764 ✓	XRD-86
AD-376837L ✓	XRD-99
AD-366758 ✓	XRD-78
AD-366734 ✓	XRD-44
AD-366763 ✓	XRD-85 ✓
AD-376829L ✓	XRD-77 ✓
✓✓ AD-367462 ✕	XRD-103 ✓
✓✓ AD-367463 ✕	XRD-104 ✓
✓✓ AD-367461 ✕	XRD-102 ✓
AD-367460 ✓	XRD-101 ✓

TRC

18 April 1997

Subject: Declassification of Reports

AD-801406L ✓ XRD-114✓

In addition, all of the cited reports are now **approved for public release; distribution statement "A" now applies.**

Arduith Jarrett
ARDITH JARRETT
Chief, Technical Resource Center