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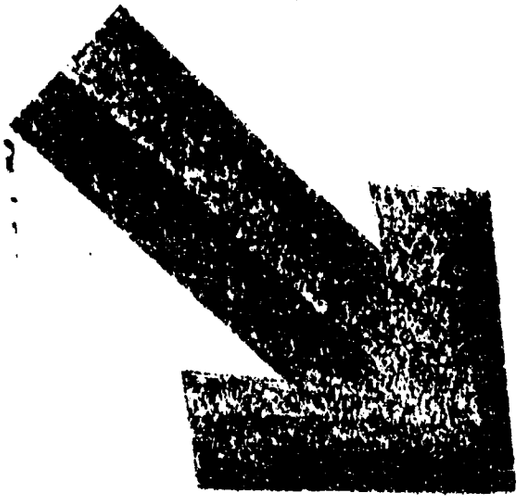

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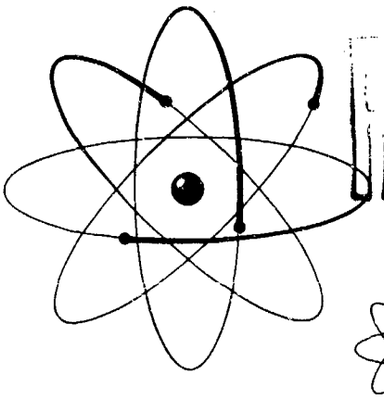

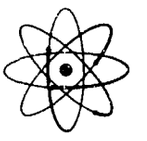

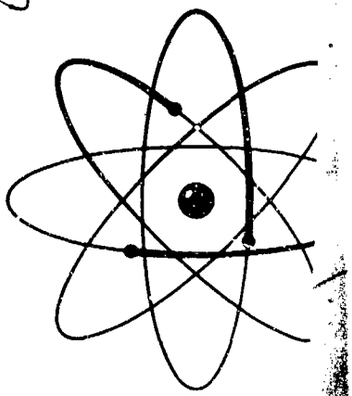

United States Atomic Energy Commission

Division of Technical Information

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BUREAU OF SHIPS GROUP

TECHNICAL INSPECTION REPORT.

(6) Operation Crossroads, U.S.S. Hughes (DD410)

(11) 1946

(12) 115 p.

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[redacted] Date [redacted]

APPROVED:

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

SECRET

USS HUGHES (DD410)

mt (193600)

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VOLUME I

VOLUME II

[redacted]

CONFIDENTIAL

U.S.S. HUGHES (DD 410)

SHIP CHARACTERISTICS

Building Yard: Bath Iron Works Corporation.

Commissioned: 21 September 1939.

HULL

Length Overall: 348 feet 4 inches.
Length on Waterline: 341 feet 0 inches.
Beam (extreme): 36 feet 0 inches.
Depth (molded at side, to main deck, amidships): 19 feet 7 7/8 inches.
Drafts at time of test: Fwd. 12 feet 4 inches.
Aft. 12 feet 6 inches.
Standard displacement: 1,570 tons.
Displacement at time of test: 2,218 tons.

MAIN PROPULSION PLANT

Main Engines: Two sets of Westinghouse turbines, are installed, one set per shaft.
Reduction Gears: Two sets of De Laval double reduction are installed, one per shaft.
Main Condensers: Two are installed in ship.
Boilers: Three Babcock and Wilcox boilers are installed, in ship. 565 psi gauge, 715° F.
Propellers: Two are installed in ship.
Main Shafts: Two are installed in ship.
Ships Service Generators: Four sets are installed in ship. Two 150 K.W. - A.C. and two 40 K.W. - D.C. sets.

[illegible] Changed to [illegible]
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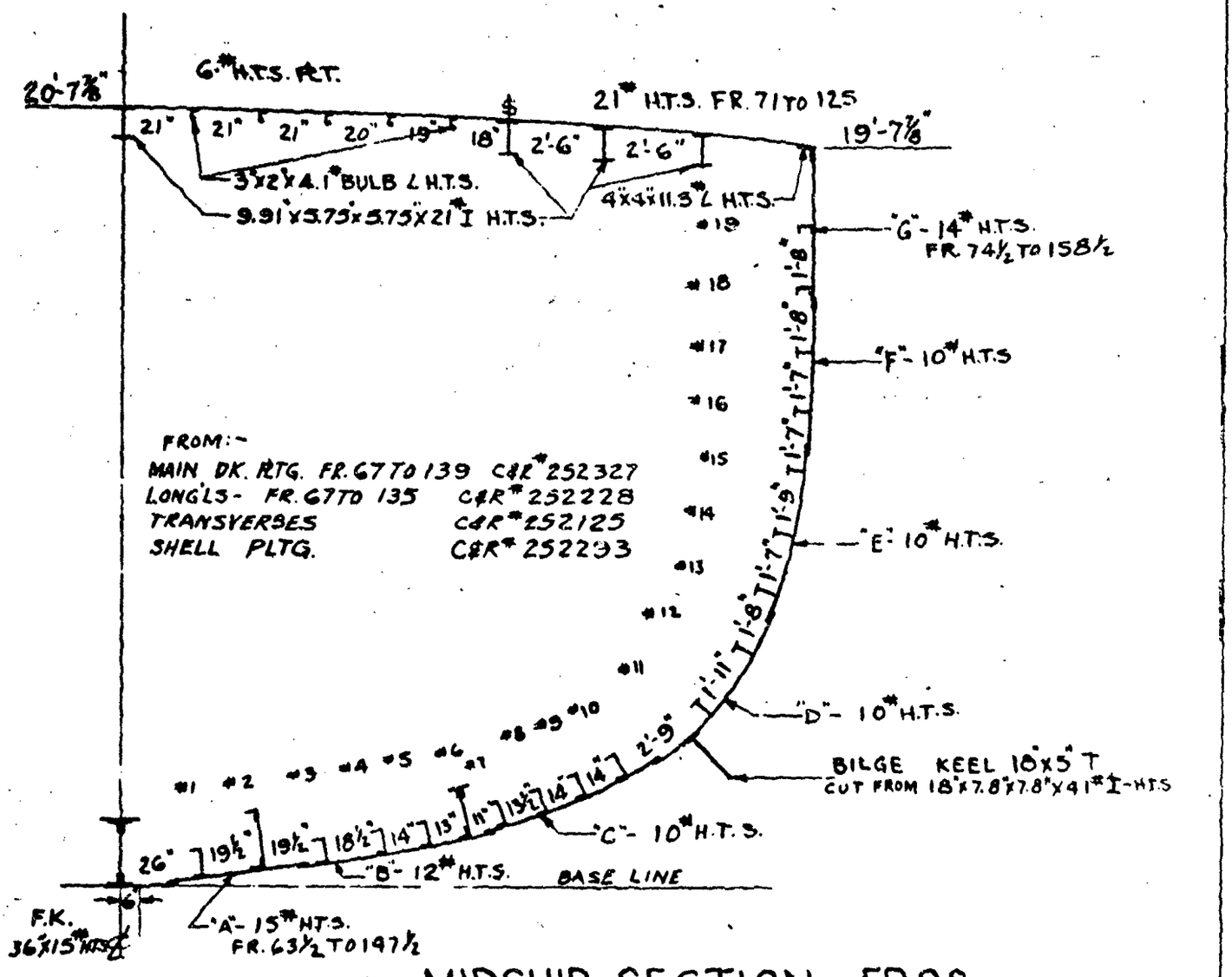
C.V.K. 21"x12" H.T.S. R
" F.P. 12"x12" H.T.S. R
" L's 3"x3"x6.1" H.T.S. DBL T&B.
LONG'L 1-9" x 2½"x2½"x13.4" C H.T.S.
" 2 - 19¼" x 10" R.T. 2½"x3"x4.5" L's H.T.S.
LONG'L 3,4,5 - 8"x2¼"x2¼"x11.5" C's H.T.S.
" 6 - 16¾" x 10" R 3"x2½"x4.5" L's H.T.S.
" 7-8-9-10 - 8"x2¼"x2¼"x11.5" C H.T.S.

LONG'L 11-12-13-14 - 6"x3.06"x5.87" T-H.T.S.
" 15-16-17 - 5"x2.69"x4.48" T-H.T.S.
" 18-19 - 5"x1¾"x1¾"x6.7" L's H.T.S.

T" KEEL BKT. EACH FR. IE
7.65" WEBS SPCD 63"



FROM:-
MAIN DK. RTG. FR. 67 TO 139 C&R" 252327
LONG'LS - FR. 67 TO 135 C&R" 252228
TRANSVERSES C&R" 252125
SHELL PLTG. C&R" 252293

MIDSHIP SECTION FR 98

TEST B

SECRET

U.S.S. HUGHES (DD410)

8277

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

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

	Forward	Aft	List
Before Test B	12' 4"	12' 6"	0°
After Test *B	17' 6"	20' 0"	2° port

*Estimated drafts before vessel was beached.

All four man engineering spaces and compartments A-206; A-404M to A-407M; C-201L, C-204L, C-206A; C-301M, C-302M, C-306M, C-307M, C-309A and C-311A flooded completely, or to the waterline. The sources of flooding were:

1. In the forward engine room through a large crack in awelded joint in the cooling water discharge line from the lubricating oil cooler to the main overboard line, a broken flange in a seachest blow out line, and leaks in the fire and bilge pump overboard discharge valve.

2. In the after fireroom, through several unplugged electrical stuffing tubes which allowed progressive flooding from the forward engine room.

3. In the forward fireroom through progressive flooding from the after fireroom.

4. In the after engine room through five failures in 1/2 inch or 3/4 inch piping connections to the main condenser which was open during the test and through the stern tubes.

5. Spaces aft of engine rooms. - The shell was torn in way of local damage at frame 196 permitting flooding of C-311 and C-206. So far as can be determined, all after spaces flooded progressively from this source by leaks in doors, hatches, and transverse bulkheads. This local damage was not due to the burst.

6. Compartment A-206, the diesel generator room, flooded from the forward fireroom through an open two inch drain line.

7. Compartments A-404M to A-406M flooded through doors progressively from A-407M which was flooded by small leaks in the shell in way of grounding damage.

(b) Structural damage.

HULL

Superstructure - A majority of the top side doors and hatches were damaged during Test A. The stack and uptakes have been damaged. The port bulwark of the navigation bridge is carried away and a few division bulkheads are further distorted. Interior equipment has been damaged by shock and rapid displacement. This is most noticeable in the disarrangement of electronic equipment in the bridge area.

The weather deck is intact, the life lines amidships, port side, are damaged and the starboard section, frames 115 to 120 is carried away. The loading machine is missing. There is additional deflection of the deck aft between frames 175-183 and the deck girders show stress lines in the paint in this area. Apparently, the use of the weather deck has not been reduced by Test B.

Interior compartments - There is significant structural damage to the interior of the crews quarters, between bulkheads 175 and 183. There is a noticeable increase in the damage to the main deck longitudinals and brackets in this area. Bunks are down, ammunition is dislodged, lockers and equipment are thrown about throughout

the ship. Web frames in way of the engine rooms show distortion in way of upper lightening holes. Transverse bulkhead 101 is wrinkled at the port shell. Stanchions supporting platforms are buckled and machinery foundations are crumpled. Many pipe hangars have parted and ventilation duct work is separated at joints.

Underwater hull - There is general panel dishing between frames and longitudinals. This dishing is worst on the light plating near the ends of the ship. It is least noticeable above the turn of the bilge amidships where the shell plating is heavier than it is near the ends of the ship. There is a small amount of leakage through loosened butt seams and weeping rivets in way of panels damaged by grounding. There is a small hole in the shell at about the 12' 6" W.L. at the starboard connection to the transom, which allowed considerable progressive flooding after the ship was beached. This hole is believed to be the result of contact with a submarine grounded just astern of the HUGHES, and is then not attributable to the burst.

MACHINERY

No comment.

ELECTRICAL

The stanchions under the ship's service turbo generator bases were badly distorted. Although there was no visible indication that this had caused damage to the turbo generators, it is quite possible that some misalignment of the units accompanied this distortion.

(c) Damage.

HULL

No comment.

MACHINERY

The machinery plant as a whole is probably damaged beyond repair. The boiler rear casings (inner and outer) were bulged

outward, brickwork (especially floors) were severely damaged. Stack and uptakes were considerably damaged. Main engine throttle manifold hanger plates sheared, allowing manifolds to drop and crush governor control piping. All upper plate flexing bolts of forward supports on both low pressure turbines sheared, allowing turbines and condensers to fall into bilges. Both turbo-generators fell when the supporting stanchions bent. Piping was severely damaged. All machinery was damaged by flooding. There are innumerable cases of lesser damage, and undoubtedly a great deal of major damage that could not be discovered because of the limited nature of the inspection.

ELECTRICAL

All electrical equipment mounted in the machinery spaces and emergency diesel generator room was damaged from flooding. The following electrical equipment received damage from effects other than flooding:

1. Low pressure air compressor motor.

2. Several pump and vent set motor controllers.

3. Electric lights were broken throughout the vessel.

4. Gyro compass and repeaters.

5. Rudder angle indicator and telegraph in pilot house.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

None.

MACHINERY

There was no evidence of heat.

ELECTRICAL

None observed.

(b) Fires and explosions.

HULL

None.

MACHINERY

There was no evidence of fires or explosions.

ELECTRICAL

None observed.

(c) Shock.

HULL

There is evidence of rather high accelerations upward and of rapid displacements forward and to port in the after part of the ship and to starboard in the forward part of the ship. Fittings, furniture equipment, projectiles and powder cans are dislodged from stowages and thrown about, apparently with considerable force. The after torpedo mount is bent slightly aft and the loading machine is missing.

MACHINERY

The HUGHES received an underwater shock of very great severity which caused most of the damage described under I (c) above.

ELECTRICAL

There were numerous indications from electrical damage that this vessel experienced a heavy shock. This was indicated by:

1. Internal damage to various pump motor controllers mounted in the engine room.

2. Extreme distortion to the stanchions under the ship service turbo generators.

3. Breakage of electric light bulbs throughout the vessel.

4. Distortion of wire ways in the engine room.

5. Extreme damage to the gyro compass and some of its repeaters.

6. Dislodgment of storage batteries from their racks.

Most of the shock on this vessel appears to have come from the bottom of the vessel.

(d) Pressure.

HULL

The general panel dishing of the underwater hull, rudder and skeg indicates that the ship was subjected to underwater pressure.

MACHINERY

The stack, uptakes, and boiler casings of the HUGHES had been damaged by blast pressure during Test A. Additional damage was done to them by blast pressure during Test B.

ELECTRICAL

The only pressure effects noted were those that were in the immediate vicinity of hull damage caused by pressure. An example of this is the damage sustained by the port pelorus, when the port windshield on the bridge was carried away.

(e) Effects peculiar to the atomic bomb.

HULL

The only effects noted were the creation of a water wave of tidal proportions at short range and the contamination of all exposed surfaces caused by the presence of radioactive materials.

MACHINERY

An underwater shock of this magnitude, and blast pressure high enough to cause damage at such a distance from an underwater explosion, are apparently peculiar to the Atom Bomb.

ELECTRICAL

None observed.

III. Results of damage.

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

HULL

The ship's main machinery is inoperable, and there is no power available for ship control or electrical power and lighting except that supplied by the emergency generator.

MACHINERY

All power was lost and none could be regained without major repairs requiring extended repair at a shipyard. The machinery

installation as a whole is damaged beyond economical repair. The ship could not be controlled except by such make shifts, not requiring power, as could be devised.

ELECTRICAL

It is considered that the damage sustained by the forward engine room would have resulted in the loss of power and lighting on this vessel. Since the emergency diesel generator room was only subjected to very slow flooding, the essential electrical equipment probably still could have been supplied with power by utilizing the emergency generator. Since the main propulsion auxiliaries on this vessel were all steam driven, the loss of electrical power would not have affected the ship propulsion. Although damage to the gyro compasses, rudder angle indicator and telegraph would have affected the ease of ship control, their functions could be accomplished by means of the standard magnetic compasses and sound powered telephones.

(b) Effect on gunnery and fire control.

HULL

The guns and fire control equipment are apparently intact except for possible water damage to the I. C. and F.C. switchboard. However, the limited amount of electrical power available would allow only a small portion of the ship's guns to be operated.

MACHINERY

No comment.

ELECTRICAL

Outside of possible water damage to the I.C. and F.C. switchboards, the electrical damage to this vessel would not have affected gunnery and fire control equipment. However, due to the limited amount of electrical power that would have been available, only a small portion of the guns on this vessel could have been operated.

(c) Effect on watertight integrity and stability.

HULL

It is believed that the damage sustained by the hull has only slightly reduced its longitudinal strength and that the flooding is a minor significance. Watertight integrity was reduced, however, due to the loosening of dogs on watertight doors and hatches by shock. The stability of the ship was not affected.

MACHINERY

No comment.

ELECTRICAL

From an electrical standpoint, there was only a slight effect on the watertight integrity and stability of the vessel. It appears that the flooding in the after fire room resulted from water from the forward engine room going through some unblanked stuffing tubes. This was due to some carelessness on the part of the repair activity which pulled the cables and did not blank off the open stuffing tubes.

(d) Effect on personnel and habitability.

HULL

Personnel efficiency would have been seriously reduced by radioactivity and by the effect of shock. The habitability of spaces was reduced immediately by the derangement of furniture, fittings and equipment.

MACHINERY

It is estimated that a large percentage of the crew, both above and below decks, would have been killed or severely injured. The ship was made uninhabitable by loss of power, structural damage, generally disarranged condition of interior spaces, and high radioactivity.

ELECTRICAL

It is considered that the loss of electric power would have affected the habitability of the vessel. Undoubtedly cooking, lighting, and ventilation would have to be greatly reduced, since only the diesel generator sets are available to carry the load.

(e) Total effect on fighting efficiency.

HULL

The longitudinal str ength is not impaired. Ship control has not been reduced by damage sustained by the hull and appendages. Buoyancy and watertight integrity are reduced as a result of failures in piping and sea chest connections, however, the crew could have controlled this damage provided they could have remained aboard.

MACHINERY

Fighting efficiency was completely destroyed insofar as machinery is concerned.

ELECTRICAL

The fighting efficiency of the vessel would have been greatly reduced because of the loss of ship service power. Since the emergency diesel generator set would have to supply steering, some pumps, lighting, and ventilation, only a small amount of power would have been available for the gun loads.

IV. General Summary.

HULL

Damage to the hull is confined to structure below the waterline. Light equipment is generally displaced and heavy machinery and equipment are misalignment due to failures in foundations and holding down bolts.

MACHINERY

It is believed that the HUGHES would have been lost if she had been in the open sea at the time of the test. It is not believed that any destroyer afloat could have survived a shock of this magnitude without having her machinery plant immobilized.

ELECTRICAL

The greatest source of electrical damage to this vessel resulted from the flooding in the machinery spaces. In general, most of the electrical damage sustained from the primary effects of the underwater blast was low in the ship. The electrical equipment on the lower level of the engine room suffered much more damage than that on the upper level. However, from the degree of shock damage sustained by the various items of electrical equipment, it is believed that comparable high shock modern Navy equipment probably would have withstood the shock experienced by this vessel. Undoubtedly the modern destroyer split electrical plant, would have withstood the damage better.

V. Preliminary Recommendations.

HULL

Adequate strength in the foundations and improvement in holding down methods of machinery units are essential.

It is believed that the severe damage sustained by electronic gear in the bridge area could have been reduced by supplying adequate means for securing the equipment against the violent displacement and roll of the ship experienced immediately following the shock wave.

Careful attention should be given to the design of supporting hangers for ventilation duct work and piping.

MACHINERY

Specific recommendations based on the experience of the HUGHES are too numerous to list here. A general recommendation is submitted that a study of the foundations and supports of all heavy machinery, particularly turbines, generators, and condensers should be made to determine how they can be made more resistant to shock. Similar studies should be made with respect to piping, particularly pipe hangers.

ELECTRICAL

Considering the flooding experienced in the machinery spaces by this vessel, and the likelihood that damage control personnel would not be immediately available, it is recommended that all electrical equipment which must be installed in the lower levels of the machinery spaces be of the submersible type. Such equipment which is vital to the damage control and fighting efficiency of the vessel should be arranged for operation from the upper levels.

It is recommended that gyro compass element supporting mechanism be made more resistant to shock, and the use of cast aluminum for gyro compass repeaters be discontinued.

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.

Before Test B	Forward 12' 4"	Aft 12' 6"	List 0°
After Test *B	17' 6"	20' 0"	2° port

* estimated drafts before vessel was beached.

All four main engineering spaces and compartments A-206; A-404M to A-407M; C-201L, C-204L, C-206A; C-301M, C-302M, C-306M, C-307M, C-309A and C-311A flooded completely, or to the waterline.

The sources of flooding were:

1. In the forward engine room through a large crack in the discharge line from the lubricating oil cooler, a broken flange in a sea chest blow out line, and leaks in the fire bilge pump overboard discharge valve.

2. In the after fire room through several unplugged electrical stuffing tubes allowing progressive flooding from the forward engine room.

3. In the forward fireroom through progressive flooding from the after fireroom.

4. In the after engine room through five failures in 1/2 inch or 3/4 inch piping and a slight amount through the stern tubes.

5. Spaces aft of engine rooms - The shell was torn in way of local damage at frame 196 permitting flooding of C-311 and C-206. So far as can be determined all after spaces flooded progressively from this source by leaks in doors and hatches and through transverse bulkheads. This local damage was not due to the burst.

6. Compartment A-206 flooded through an open 2 inch line from the forward fireroom.

7. Compartments A-404M to A-406M flooded through doors progressively from A-407M which was flooded by small leaks in the shell in way of grounding damage.

(b) Structural damage.

Superstructure - A majority of the top side doors and hatches were damaged during Test A. The stack and uptakes have received additional damage, the port bulwark of the navigation bridge is carried away and a few division bulkheads are further distorted. Interior equipment has been damaged by shock and rapid displacement. This is most noticeable in the disarrangement of electronic equipment in the bridge area.

The weather deck is intact, the life lines amidships, port side, are damaged and the starboard section, frames 115 to 120 is carried away. The loading machine is missing. There is additional deflection of the deck aft between frames 175-183 and the deck girders show stress lines in the paint in this area. Apparently, the use of the weather deck has not been reduced by Test B.

Interior compartments - There is significant structural damage to the interior of the crews quarters, between bulkheads 175 and 183. There is a noticeable increase in the damage to the main deck longitudinals and brackets in this area. Bunks are down, ammunition is dislodged, lockers and equipment are thrown about throughout the ship. Web frames in way of the engine rooms show distortion in way of upper lightening holes. Transverse bulkhead 101 is wrinkled at the port shell. Stanchions supporting platforms are

buckled and machinery foundations are crumpled. Many pipe hangers have parted and ventilation duct work is separated at joints.

Underwater hull - There is general panel dishing between frames and longitudinals. This dishing is worst on the light plating near the ends of the ship. It is least noticeable above the turn of the bilge amidships where the shell plating is heavier than it is near the ends of the ship. There is a small amount of leakage through loosened butt seams and weeping rivets in way of panels damaged by grounding. There is a small hole in the shell at about the 12' 6" W.L. at the starboard connection to the transom, which allowed considerable progressive flooding after the ship was beached. This hole is believed to be the result of contact with a submarine grounded just astern of the HUGHES.

II. Forces Evidenced and Effects Noted.

(a) Heat.

None.

(b) Fires and explosions.

None.

(c) Shock.

There is evidence of rather high accelerations upward and of rapid displacements forward and to port in the after part of the ship and to starboard in the forward part of the ship. Fittings, furniture equipment, projectiles and powder cans are dislodged from stowages and thrown about, apparently with considerable force. The after torpedo mount is bent slightly aft and the loading machine is missing.

(d) Pressure.

The general panel dishing of the underwater hull rudder and skeg indicates that the ship was subjected to a mild underwater pressure wave.

(e) Effects apparently peculiar to the atom bomb.

The only effects noted were the creation of a water wave of tidal proportions at short range and the contamination of all exposed surfaces caused by the presence of radioactive materials.

III. Effects of Damage.

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

The ships main machinery is inoperable, and there is no power available for ship control or electrical power and lighting, except that supplied by the emergency generator.

(b) Effect on gunnery and fire control.

The guns and fire control equipment are apparently intact except for possible water damage to the I.C. and F.C. switchboard. However, the limited amount of electrical power available would allow only a small portion of the ship's guns to be operated.

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

It is believed that the damage sustained by the hull has only slightly reduced its longitudinal strength and that the flooding is a minor significance. Watertight integrity was reduced a small amount, however, due to the loosening of dogs on watertight doors and hatches by shock. The stability of the ship has not affected.

(d) Effect on personnel and habitability.

Personnel efficiency would have been seriously reduced by radioactivity and by the affect of shock. The habitability of spaces was reduced immediately by the disarrangement of furniture, fittings and equipment, but this appears to be of only a temporary nature.

(e) Effect on fighting efficiency.

The longitudinal strength is not impaired. Ship control has not been reduced by damage sustained by the hull and appendages. Buoyancy and watertight integrity are reduced as a result of failures in piping and sea chest connections, however, the crew could have reduced this considerably, provided they could have remained aboard.

IV. General Summary.

Damage to the hull is confined to structure below the waterline. Light equipment is generally displaced and heavy machinery and equipment are misalignment due to failures in foundations and holding down bolts.

V. Preliminary Recommendations.

Adequate strength in the foundations and improvement in holding down methods of machinery units are essential.

It is believed that the seve re damage sustained by electronic gear in the bridge area could have been reduced by supplying adequate means for securing the equipment against the violent displacement and roll of the ship experienced immediately following the shock wave.

Careful attention should be given to the design of supporting hangers for ventilation duct work and piping.

VI. Instructions for loading the vessel specified the following:

ITEM	LOADING
Fuel Oil	15%
Diesel Oil	15%
Ammunition	66 2/3%
Potable and reserve feed water	95%
Salt water ballast	320

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

DETAILED DESCRIPTION OF HULL DAMAGE

A. General Description of Hull Damage.

(a) The hull effectively withstood the test but is now in poor condition. Grounding of the ship to prevent loss by progressive flooding has caused a portion of the hull damage and has made distinction between actual test and grounding damage difficult in several areas below the waterline. That the ship received a relatively large blow from below the waterline is evident by the overall nature of damage to main and auxiliary machinery and equipment. The amount of flooding permitted by hull damage is insignificant. Photos 2062-1 2061-8, 2061-7, 2996-10, 2061-6, 4211-8, 2996-8, 2974-5, 2062-6 4211-9, 2996-7, 2974-3, 2974-6, 2996-3, 2996-6, 2996-4, 2996-5 and 2061-10, pages 2 to 34 show general exterior views.

(b) The hull has slight distortions of structural bulkheads and a small deflection of the main deck in way of the after machinery space. Damage sustained during Test A is increased in that portion of the main deck between frames 172 to 180, with further buckling of the stanchions at frame 175 and of web frames 175 and 179. The underwater shell is generally washboarded between frames throughout the length of the ship. The damage is most pronounced in the light plating near the bow and stern. In addition, there are long sections dished between longitudinals both forward and aft. The rudder is reported to have been rotated about 10° to port and is uniformly dished in each panel. The skeg also has panels dished.

(c) Apparently, the damage to the shell was caused by the underwater pressure wave. The further deflection of the main deck could have been caused by a water wave, a blast wave, or falling water.

(d) The principal areas of flooding are:

(a) The forward engine rooms and firerooms through piping failures and progressive flooding.

(b) The forward berthing spaces falling water through damaged doors.

(c) The first platform and underwater compartments forward and aft of engineering spaces through shell damage and non tight doors and hatches after the ship was beached. (See Item L for flooding details).

(d) Although the underwater shell is in poor condition and some frames show signs of working, the damage sustained during the test has only slightly reduced the strength in compression of the hull in way of panel dishing. The flooding caused by hull failures is of a minor nature and so slow as to have a negligible effect on buoyancy. The condition of the hull and appendages would have caused only a slight reduction in operability.

B. Superstructure.

(a) Damage.

The port bulwark of the navigation bridge is carried away between frames 60 to 71 where the riveted connection at the bottom failed. It hangs over the side, held by the forward edge (photos 2996-11, 2061-9, 2062-5; pages 35, 36, and 37). Pre-test inspections indicate that the bulwark was crumpled along the after edge and at least one stiffener was cracked before Test A.

The superstructure bulkheads have slight waves but these could easily be from Test A (photo 2076-12, page 38). The stack has additional damage and leans to port (photos 2077-2, 1849-10, 2077-5, 9, 2974-4; pages 39, 40, 41, 42 and 43). The uptakes are damaged to a further extent than after Test A (photos 2077-1, 3, 4, 6, 10; pages 44, 45, 46, 47 and 48). The midship deckhouse has a few divisional bulkheads badly distorted, but this damage is primarily the result of Test A. The two after diagonal braces and the forward supporting bulkhead of the after torpedo mount show some signs of movement. The after deck house damage was apparently caused by Test A.

Throughout the entire superstructure, gear, especially electronics equipment, has been displaced by shock and motion of the ship. (photos 4204-3, 1951-8, 12; pages 49, 50 and 51). Where doors were not closed considerable water has entered from washing down by salvage ships.

(b) Cause of damage apparently was air blast, falling water, and the wave which washed over the ship.

(c) There is no evidence of fire in the superstructure.

(d) It is believed that the damage to the superstructure is too light to permit relative comparison of the resistance afforded by various materials or shapes.

(e) Criticism.

No comment.

C. Turrets, Guns and Directors.

(a) Protected mounts.

Gun shields were dished in Test A. There is evidence of shock in the interior of the mounts. There is no power available to operate equipment (photo 4204-1, page 52).

(b) Unprotected mounts.

There is no further apparent damage to the guns (photo 2062-3, page 53). The loading machine is missing. The trunnion bolts failed.

(c) Directors and Rangefinders.

Directors and rangefinders are damaged to a minor extent, apparently from shock. The Mk. 37 gun director is frozen in

train. The port Mk. 51 director trunnion bolts are sheared. The starboard Mk. 51 director sight ray filters are frozen and the Mk. 14 sight mounting is broken.

D. Torpedo Mounts, Depth Charge Gear.

(a) The mounts operate satisfactorily. All doors mechanisms are operable. The after mount foundation shows signs of movement aft and a slight amount of buckling.

The three torpedoes in the forward mount, which was trained to port, were launched. The two torpedoes in the after mount, which was trained to starboard, made hot runs and are pushed forward almost out of the tubes. The warhead of the after torpedo is resting on the starboard bulwark (photo 2061-10, page 34).

E. Weather Deck.

(a) The deck is usable. Stanchions and pad eyes on the port side forward are bent in or sheared off, in some cases tearing the rounded gunwale. Apparently this damage was caused by a tug.

The lifeline stanchions, frames 115-120, starboard in way of the missing loading machine are gone (photo 2996-6, page 31). There is considerable damage to the port main deck bulwark that appears to have been caused by tugs coming along side (photos 2996-9, 4211-1, 4204-5, pages 54, 55 and 56). The deflection scratch gages indicate movement of the weather deck only in way of previous damage near frame 175 and in way of the after engineering spaces. A tabulation of the locations and recordings of deck deflection scratch gages is included as an Appendix. The deck girders in the after area have stress signs in cracked paint and slight additional buckling (photos 4208-10, 11, 12, pages 57, 58 and 59).

(b) The usability of the weather deck has not been reduced by Test B.

(c) Mooring and towing fittings are in good condition. No boats are aboard. Boat handling equipment is disarranged, but appears to be operable.

F. Exterior Hull.

(a) The exterior hull has many local dishes that appear to have been caused by boats lying alongside. A few tears in the hull around frame 10 port, just below the forecastle deck where pad eyes are torn loose, appear to have been caused by tugs.

(b) Exterior hull fittings appear to be undamaged as a result of the test.

(c) There is no damage to the sheer strake attributable to Test B (photos 4211-11 and 4223-8, pages 60 and 61).

G. Interior Compartments (above waterline).

(a) There is significant damage above the first platform to the crews quarters between bulkheads 173 and 183. In this space there is additional damage over that attributable to Test A. The 3-1/2 inch stanchions at frame 175 are bent (photo 4208-4, page 62). The web frames 175 and 179, are damaged in way of the curved brackets below the main deck and in way of lightening holes between the upper and middle longitudinals (photos 4208-9, 7, 8, 5, pages 63, 64, 65 and 66). The main deck longitudinals are further deflected at frame 179, (photos 4208-10, 11, pages 57 and 58), and are distorted at their connections to bulkheads 175 and 183 (photo 4208-12, page 59).

Deck deflection scratch gages located at frame 175, centerline, indicates a 1-1/4 inch permanent depression of the main deck over that attributable to Test A. Those at frame 159 indicate a 1/4 inch amplitude vibration. No dishing of the first platform is apparent. Berths were disarranged generally and water covered the starboard side of the after first platform deck to a depth of 4 to 6 inches. This water apparently leaked from the Carpenter Shop, C-206-A, through door 2-183-1.

The condition of the after first platform compartments which were inspected after the ship was in drydock is as follows:

Berthing spaces from frame 139 to 183 have from 2 to 6 inches of water on the starboard side. Bunks, bunk stanchions, and other gear are disarranged and generally thrown forward and to starboard. The drinking fountain in C-201-L is dislodged (photo 4058-12, page 67). The passage and peacoat lockers, C-206-A, the smoke generator room, C-208AE, and the steering gear room, C-205-E, have 5 to 6 inches of water on deck. The rudder post packing gland is not leaking. The carpenter shop, C-206A, was completely flooded through a rupture in the shell plating apparently caused by contact with a submarine while beached. The equipment is disarranged. A cabinet is thrown to port. The canvas and awning stowage, C-206-A, is dry and in good condition.

(b) Damage to joiner bulkheads and causes.

There is no apparent damage.

(c) Access closures and fittings.

A considerable number of dogs on doors and hatches were loosened by shock sufficiently to allow progressive flooding throughout the ship.

Condition of equipment.

Bunks are down. Some lockers are overturned. Projectiles and powder cans are loose and scattered on deck. Loose equipment generally displaced to port (photos 4211-4, 4204-7, pages 68 and 69).

(e) There is no evidence of fire.

(f) Piping, cables, ventilation ducts.

Cables are stretched and torn loose adjacent to equipment that has been bodily moved. It is reported that stuffing boxes appear to be loosened. Pipe hangers are broken loose, generally at their overhead connections.

Ventilation ducts are separated at joints throughout the ship. The efficiency of the forward systems below the weather deck has been reduced to a greater extent than that of the after systems. Ventilation duct work in the superstructure is parted in many places. The blowers and fans have not been tested due to lack of power.

(g) Reduction in watertight subdivision, habitability.

Watertight subdivision was reduced by the jarring loose of dogged doors 2-45-1, 2; 2-56-1, 2; 2-147-1; 2-159-1; 2-183-1, 2 and 4 which allowed seepage from one compartment to another during the two week period between the time of the test and the initial boarding. The habitability of living spaces is reduced only to the extent that bunks are down and lockers are thrown about. The utility of several topside ship control spaces is reduced due to equipment being disarranged and damaged (photo 4204-3, 9; pages 49 and 70).

H. Armor Decks and Miscellaneous Armor.

Not Applicable.

I. Interior Compartments (below waterline).

(a) & (b) Damage to structure and causes.

Joiner bulkheads are damaged forward of frame 67 as a result of shock followed by a considerable roll of the ship. Floors in the forward peak tanks, forward of bulkhead 14, are buckled. The shell plating between frames is bulged. T[illegible] distortion of floors framing and plating in this area is more severe near the keel than at the second platform level (photos 4062-10, 6, 9, 8, 4061-1, 2, 3, pages 71 to 77).

In the ammunition stowage A-404-M, on the tank top, frames 25-28, the shell is bulged between frames. Such damage is a typical reaction to underwater shock. Ammunition in the handling room has been thrown to the deck in such a manner as would have been caused by a shock and/or violent rolling. The after bulkhead of the refrigerator space, second platform starboard, is buckled. Apparently this is due to

load transferred upward from the keel through transverse framing. This is in way of the area on the starboard side where grounding damage is the greatest.

The damage to structure in the machinery spaces is light. The hull plating is practically intact. There is some damage on the port side reported to have been caused by tugs. The main transverse bulkheads are generally dimpled slightly between stiffeners. In the firerooms there is a light buckling of webs of transverse frames, extending for a short distance both to port and starboard of the keel (photo 4061-7, page 78). Web frames 106, 110, and 113, on the starboard side of the forward engine room, are buckled around reinforced lightening holes (photos 4058-9, 8, pages 79 and 80). Structural bulkhead 101 in the forward engine room is crumpled in way of the port shell connection due to the inward movement of the shell. The foundation for the starboard cruising turbine is buckled. One half inch foundation hold-down bolts under the turbogenerator are sheared. The flexing plates supporting the low pressure turbines at frames 118 and frame 103 are bent and the bolts sheared.

In the after engine room, port and starboard auxiliary stanchions, frames 128 and 129 respectively, are buckled (photos 4058-2, 4058-4, pages 81 and 82). A longitudinal, (photo 4058-5, page 83), and floor plate supports are distorted. The upper level gratings are slightly dished downward. The static inertia effect of the machinery relative to the rapid upward acceleration of the hull is considered to be the cause for failure of supporting structure in engineering spaces. Where buckling of transverse framing is found underwater pressure loading due to grounding are considered to be causes of damage. Conditions in the after compartments on the second platform are as follows: C-310-A is unopened but is believed to be dry. C-309-M has 6 inches of water on deck. This compartment is empty and has no apparent damage. C-307-A on the 40mm stowages C-307-M and C-308-M are dry and have no damage. C-306-M was being pumped and has about 4 inches of water remaining on deck. The ammunition is disarranged. The depth charge stowages C-305-IM, P&S, are dry but the depth charges

Ventilation ducts are separated at joints throughout the ship. The efficiency of the forward systems below the weather deck has been reduced to a greater extent than that of the after systems. Ventilation duct work in the superstructure is parted in many places. The blowers and fans have not been tested due to lack of power.

(g) Reduction in watertight subdivision, habitability.

Watertight subdivision was reduced by the jarring loose of dogged doors 2-45-1, 2; 2-56-1, 2; 2-147-1; 2-159-1; 2-183-1, 2 and 4 which allowed seepage from one compartment to another during the two week period between the time of the test and the initial boarding. The habitability of living spaces is reduced only to the extent that bunks are down and lockers are thrown about. The utility of several topside ship control spaces is reduced due to equipment being disarranged and damaged (photo 4204-3, 9; pages 49 and 70).

H. Armor Decks and Miscellaneous Armor.

Not Applicable.

I. Interior Compartments (below waterline).

(a) & (b) Damage to structure and causes.

Joiner bulkheads are damaged forward of frame 67 as a result of shock followed by a considerable roll of the ship. Floors in the forward peak tanks, forward of bulkhead 14, are buckled. The shell plating between frames is bulged. The distortion of floors framing and plating in this area is more severe near the keel than at the second platform level (photos 4062-10, 6, 9, 8, 4061-1, 2, 3, pages 71 to 77).

In the ammunition stowage A-404-M, on the tank top, frames 25-28, the shell is bulged between frames. Such damage is a typical reaction to underwater shock. Ammunition in the handling room has been thrown to the deck in such a manner as would have been caused by a shock and/or violent rolling. The after bulkhead of the refrigerator space, second platform starboard, is buckled. Apparently this is due to

load transferred upward from the keel through transverse framing. This is in way of the area on the starboard side where grounding damage is the greatest.

The damage to structure in the machinery spaces is light. The hull plating is practically intact. There is some damage on the port side reported to have been caused by tugs. The main transverse bulkheads are generally dimpled slightly between stiffeners. In the firerooms there is a light buckling of webs of transverse frames, extending for a short distance both to port and starboard of the keel (photo 4061-7, page 78). Web frames 106, 110, and 113, on the starboard side of the forward engine room, are buckled around reinforced lightening holes (photos 4058-9, 8, pages 79 and 80). Structural bulkhead 101 in the forward engine room is crumpled in way of the port shell connection due to the inward movement of the shell. The foundation for the starboard cruising turbine is buckled. One half inch foundation hold-down bolts under the turbogenerator are sheared. The flexing plates supporting the low pressure turbines at frames 118 and frame 103 are bent and the bolts sheared.

In the after engine room, port and starboard auxiliary stanchions, frames 128 and 129 respectively, are buckled (photos 4058-2, 4058-4, pages 81 and 82). A longitudinal, (photo 4058-5, page 83), and floor plate supports are distorted. The upper level gratings are slightly dished downward. The static inertia effect of the machinery relative to the rapid upward acceleration of the hull is considered to be the cause for failure of supporting structure in engineering spaces. Where buckling of transverse framing is found underwater pressure loading due to grounding are considered to be causes of damage. Conditions in the after compartments on the second platform are as follows: C-310-A is unopened but is believed to be dry. C-309-M has 6 inches of water on deck. This compartment is empty and has no apparent damage. C-307-A on the 40mm stowages C-307-M and C-308-M are dry and have no damage. C-306-M was being pumped and has about 4 inches of water remaining on deck. The ammunition is disarranged. The depth charge stowages C-305-IM, P&S, are dry but the depth charges

and spare parts are disarranged. C-303-M and C-304-M are dry but have had ammunition stowage battens dislodged and projectiles thrown about. The 5" powder room, C-302-M has some water on deck and powder cans scattered (photo 4058-10, page 84). The 5" handling room, C-301-M, has 6 inches of water on deck and projectiles thrown about (photo 4058-11, page 85).

(c) Damage to access closures and causes.

The doors and hatches are intact, however, the loosening of dogs under shock permitted progressive flooding.

(d) Condition of equipment within compartments.

In the engineering spaces there is considerable damage to machinery as a result of shock. The flexure plate connection bolts supporting the forward end of both low pressure turbines have failed, dropping the turbines and condensers into the bilges. The boiler foundations are only slightly damaged (photo 4061-8, page 86). Several supports and foundations for auxiliary machinery and electrical equipment have failed from shock (photo 4064-8, page 87). Unsupported or poorly supported pipe lines have carried away. The main and auxiliary steam lines are down about six inches in the forward engine room. Fittings, furniture, and equipment in compartments are broken and in general disorder as a result of the shock and roll of the ship.

(e) Flooding.

See Item L, for flooding details.

(f) Damage to piping, cables, ventilation ducts, shafts.

There is some localized distortion in bulkhead 103, apparently due to the movement of main steam lines. Several open cable stuffing tubes were found, which contributed to progressive flooding. A 3/4 inch drain pipe broke open in way of the diesel generator room, A-206-4E, and permitted flooding of this space. The propeller and shafts appeared to be operable. Below the wate line

there is only a small amount of ventilation duct work, the majority of which appears intact. It is believed that the efficiency of the system has not been reduced to a great extent in the engineering spaces or forward below the waterline.

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

The watertight subdivision has been approximately 90% lost due to the loosening of dogs on watertight doors and hatches. Except for the general displacement of gear and equipment, the habitability of the spaces below the waterline is not affected. The utility of engineering spaces is reduced somewhat by the failure of hold down bolts and of foundation and platform supports. The main machinery is completely inoperable.

J. Underwater Hull.

(a) An exterior examination of the hull was made in drydock. The ship was beached 26 July 1946, and was pumped out and refloated about 20 days later. The ship was then drydocked in order to make a detailed inspection of the underwater hull.

The explosion caused general panel dishing between frames and longitudinals. The degree of dishing is dependent upon the plate weight. The dishing is most prominent forward of frame 43 where the plating is 9# to 10# mild steel. (photos 4050-8, 4223-12, 4044-12, 4062-5, 4048-2, 4032-4, 4058-1, 4224-2, 4050-7, 4224-1 4050-6, 4050-4, and 4050-5, pages 88 to 100 inclusive).

On the starboard side, frames 35-55, extending from the keel up through C strake, severe grounding damage is superimposed upon the bomb damage (photos 4057-11, 4050-2, 4223-10, 4224-3, pages 101, 103, 104 and 105). The plating amidship, frames 52-143, is graduated in weight from 15 to 10 lbs. high tensile steel, strakes A to C, respectively. In this region the dishing, though uniform, is somewhat lighter and is mostly confined to long sections of concavity between longitudinals below the turn of the bilge. (photos 4050-10, 4048-3, 4, 5, 6, 4062-3, 4048-7, 8, 9, 11, 12, 4057-10, 4050-1 4049-12, 11, 9, 7, 6, and 4224-5, pages 106 to 124 inclusive). Aft of

frame 143 the plating is about the same weight as amidships, but is mild steel. The panel dishing aft of frame 143 is about the same below the turn of the bilge as that amidship (photos 4057-3, 4049-1, 4057-4, 6, 4049-5, 3, and 4057-5, pages 125 to 131 inclusive). However, in way of the C strake and above, which is 9 lb. mild steel, the dishing is as prominent as that forward of frame 43, port and starboard (photo 4049-5, page 129).

The sound ranging dome projecting through the keel is roughly dished upward beyond the level of the keel, frame 22 (photo 4048-1, page 132). The plastic coating of the dome is worn away in spots and coral is imbedded in the coating that is left. Any damage due to the pressure wave has been obliterated by grounding damage.

The holes in the starboard counter just below the waterline (photo 4224-10, page 133) are apparently a result of contact with a submarine which was towed to shallow water and grounded just astern of the HUGHES (photos ABCR 227-290-32, ABCR 227-290-33, pages 10 and 12).

The damage caused by contact with coral and sand during the 20 day period that the ship was beached is superimposed upon test damage. Grounding damage is most apparent forward on the starboard side between frames 35 and 55 in way of B and C strakes; and to a lesser extent aft along the starboard side, frames 80-100, in way of A and B strakes. The grounding damage is evidenced by large patches of coral sand imbedded in the plastic coating adhering to the hull plating, by areas in which the plastic has been scraped off (now rusted), and by sharp longitudinal buckling caused by contact with coral ledges. (photos 4057-11, 4050-3, 4050-2, 4049-10, 4049-8, pages 101, 102, 103, 134 and 135).

Sources of flooding through the shell plating are as follows:

A tear in the starboard shell plating at its junctures with the transom in way of buckling at the 12' 6" W.L. (photo 4224-10, page 133). This damage plus a small hole in the transom 3 feet inboard

of the shell at the 14' 6" W.L. and a vertical crack in the starboard shell at frame 189 (photo 4062-2, page 136) flooded the Carpenter Shop, C-206A, and Stores space, C-311A. The tear at the transom juncture is 6 inches long with a 3/4 inch separation and occurs just below a welded seam lap.

A small crack exists in the port shell at frame 132 approximately 7-1/2 feet below the main deck in way of the after machinery space.

At frame 47, starboard, in way of B and C strakes, the shell plating has four small cracks abreast the ballast tanks. There is also evidence of grounding in this area (photos 4057-11, 4223-10, pages 101 and 104).

At frame 36, starboard, there is a crack 4 inches long at the outboard edge of the garboard strake in way of the 5 inch powder magazine A-406-M. There is evidence of severe grounding damage in this area (photo 4053-3, page 102).

There is a leaking riveted plate butt at frame 51, port side, approximately 7 feet above the base line in way of ballast tanks (photo 4048-3, page 107).

There is a leaking riveted plate butt at frame 141-1/2, starboard, at lower edge of vertical seam in B strake (photo 4049-4, page 137).

Visual sighting forward from the stern does not reveal any twist in the hull.

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

It is believed that the damage resulting from the test would not have materially reduced these factors of ship's performance, in as much as all plating and hull appendages, though not fair, were intact and all sources of flooding caused by the explosion could have been easily controlled.

(c) Damage to:

1. Shafts and Propellers.

Apparently intact, the connecting bolts of rope guard of the starboard shaft are sheared. (photo 4060-5, page 208).

2. Struts.

The forward short shaft struts have paint cracks and stress marks adjacent to the hull. Condition of the struts is undetermined due to the marine growth and the thick plastic coating preventing visual inspection.

3. Rudders.

The rudder panels are dished between frames, 2 inches maximum on the starboard side and 1-1/2 inches on the port side. The panel size is 20" x 24". One inch diaphragm spacer rods at the center of each panel are pushed through the plating on the starboard side only. (photos 4060-10, 11, 12, 4224-1, 2, 9, 4062-1, pages 134, 139, 140, 97, 95, 141 and 142).

4. External Keels.

The skeg plating is dished between frames, port and starboard, a maximum of five inches, beginning at frame 161 and continuing to the after end. (4049-2, 4060-8, 9, pages 143, 144 and 145). The bilge keels are intact and apparently in good condition (photos 4050-11, 12, 4057-1, 2, 8, 9, pages 146, to 151 inclusive).

K. Tanks.

(a) Condition of tanks in damaged areas.

Tanks B-5-W, B-7-W, B-6-W, C-6, C-7, C-8, C-9, C-10, C-11, and C-12, are 100% full. Although the tank tops are below the flooded waterline, they show no signs of pressure, indicating that the boundaries are intact. Diesel oil tank C-401-F is still dry.

A-6F has 10 feet of oil. A-5-F has 14 feet of oil. A-2-F has 11 feet of oil. A-4-F is full of water. A-7-F could not be sounded at the present time. These tanks do not appear to be flooding.

(b) Contamination of liquids.

1. Ballast tank C-7, frames 139 to 147, starboard, has a negligible pin hole leak in the shell at frame 141-1/2. This tank was 100% full at time of the test. Ballast tank, A-3-F, is now dry but was apparently flooded after grounding through pin hole leaks and weeping rivets caused by contact with the coral bottom.

2. The contamination and flooding of these ballast tanks is insignificant.

L. Flooding.

The principal causes of flooding are failure of piping to sea connections due to shock and water falling on deck and entering previously damaged doorways. Progressive flooding is permitted by broken pipe lines, by unplugged wiring stuffing tubes, and by many doors and hatches jarred loose by the shock. The hull remained remarkably intact despite widespread dishing of shell plate and working of structual members. (See diagram, page).

Before Test B Drafts Fwd. 12'-4" Aft. 12'-6" List 0°

Estimated After Test B
before beaching. Fwd. 17'-6" Aft 20'-0' List 2° Port.

The vessel took on approximately 1800 tons of water. The ship was beached on Enyu Island to prevent her loss by progressive flooding until such time as she could be boarded and inspected.

Test B Flooding.

The After Engine Room flooded with approximately 390 tons of water. No shell leaks were found. Flooding is caused by leakage through the stern tubes and through five leaks in 1/2 inch or 3/4 inch

piping. The piping failures are (a) a ruptured steaming out connection to the evaporator circulating pump sea chest, (b) a broken fresh water glass on the after condenser which also indicates leakage from the salt water side, (c) a broken vent line on the main condenser, (d) a broken relief valve on the discharge side of the Fire and Bilge Pump, and (e) a broken drain on the salt water side of the lub oil cooler. There is a small crack in the port shell at frame 132, 7-1/2 feet below the main deck. Leakage through this crack is insignificant.

The Forward Engine Room flooded with approximately 350 tons at an approximate rate of 4 feet per hour. There are no shell leaks. Leakage occurred through (a) a large crack in the lub oil cooler discharge line outboard of the discharge valve and inboard of the junction with the main condenser overboard discharge, (b) a broken flange in the blow out connection to a sea chest at frame 104, port, (c) a leak in the forward Fire and Bilge Pump overboard discharge valve, and (d) a steaming out connection to the dynamo condenser injection sea chest.

The After Fireroom flooded with approximately 340 tons of water. There is no apparent leakage through the shell. The after bulkhead has several unplugged electrical stuffing tubes permitting flooding from the Forward Engine Room. Bulkhead 103 between the Forward Engine Room and the After Fireroom has evidence of considerable hydrostatic pressure.

The Forward Fireroom flooded with approximately 480 tons of water. There is no leakage through the shell. Flooding came from the After Fire room and an undiscovered leak from the Forward Engine Room.

The shaft alleys leaked slowly through the stern tubes.

Compartments A-106-L and A-107-L were partially flooded by the down pour of water entering previously damaged main deck doors 1-45-1, 1-56-1 and 1-56-2. Compartment A-104-L had some

water enter through No. 1 gun mount. Compartments in the superstructure which had previously damaged doors have water up to the level of the door coamings.

The Emergency Diesel Generator Room, A-206-4E, has 4 feet of water, approximately 95 tons. This water came from the Forward Fireroom through (a) an open 2 inch pipe connection, (b) a broken 3-4 inch day tank drain line, and (c) electrical stuffing tubes. The IC Room and Sick bays, A-206-2CA and A-206-1AL, flooded from the Forward Fireroom through electrical stuffing tubes.

A-205-L has 6 inches of water on deck which came from A-204-L and A-206 through doors that had been jarred loose. A-204-L has 2 feet of water which probably came through hatch 1-37 from compartment A-106-L.

C-206-A, Sail locker and Smoke Generator Rooms, has a slight amount of water which came through main deck openings. C-205-E, Steering Gear Room, has an unknown amount of water which entered through a leaky deck hatch, 1-183.

Flooding After Beaching.

C-311-A has several holes from 1 to 3 inches in diameter and a 6 inch crack opened 3/4 inch. All are in the same area around the junction of the counter and the starboard shell at frame 189 and between the 12'-6" and 14'-6" waterlines. In this same area the first platform deck is slightly buckled and torn. This damage may have been caused by shrapnel but more probably it was caused by contact with a submarine hull during beaching operations. C-311-A flooded and leaked into other adjacent spaces. C-206-A flooded to 90 percent capacity from C-311-A through the ruptured first platform deck at frame 189 starboard. C-204-L flooded from C-206-A through a leaking door, 2-183-1. Door 2-171-1 also leaks and allowed C-203-LM to flood to a depth of 6 inches. C-202-L flooded from C-203-L to a depth of 6 inches through loosened doors in bulkhead 159. C-205-E flooded to a depth of 3 feet from C-204-L when door 2-183-2 was opened and some water through the overhead hatch, 1-183. The Sail Locker, C-206, flooded to about 3 feet from C-204-L when door 2-183-4 was opened. C-307-A and

C-309-A flooded from C-204-L through loosened hatches 2-171-1 and 2-179. C-306-M flooded from C-204-L through two 3/4 inch pipes that had been broken off at the 1st platform level through leaky hatch 2-177.

After the ship listed upon beaching, water came over the starboard main deck edge and partially flooded B-105. Water then leaked through hatch 1-144, flooding C-201-L and subsequently C-202-L and C-203-L through leaking doors. From C-201-L, through hatch 2-146, and then through door 3-147, C-301-M and C-302-M were flooded.

A-103-L was flooded through hatch 01-15 to a depth of 2 feet while washing down the ship. A-407-M and A-3-F flooded through pin hole leaks in the shell plating resulting from grounding.

From A-407-M, through loosened doors 4-40, 4-33, and 4-29, compartments A-406-M, A-405-M and A-404-M were flooded. Also from A-407-M through hatch 3-42, compartment A-305 was flooded to a depth of several inches.

Other Shell Leaks.

The following spaces have cracks or leaking seams that permit negligible seepage. A-3-F has four small cracks at frame 47 in way of longitudinals 7 and 8. A-4-F has a leaking plate butt at frame 51, port, at the 7 foot waterline. A-406-M has a 4 inch crack at the outboard edge of the garboard strake at frame 36, starboard. C-7-F has a leaking, riveted plate butt at the lower edge of the "B" strake at frame 141-1/2 starboard.

Flooding is widespread. However, had personnel on watch in the engineering spaces been able to plug leaks or close necessary valves, flooding could have been limited to the Forward Engine room. This flooding could have been controlled by using damage control pumps. The ship was air tested in March 1946. Except for untested engine rooms and firerooms, all compartments flooded except A-304-A, A-202-L, A-203-L, and A-206-4E, had satisfactory tightness at the time they were tested.

M. Ventilation (Exclusive of blowers).

(a) Damage to ventilation systems and causes.

Duct connections throughout the ship failed apparently from shock. There are no collapsed or bulged sections indicating that the blast effect was negligible. Some closures are loosened, apparently due to shock. Although none of the ventilation systems could be tested, it is believed that they would not have functioned satisfactorily.

(b) There is no evidence that the ventilation systems conducted heat, blast, fire, or smoke below decks.

(c) It is possible that flooding between magazines and in engineering spaces may have occurred through the ventilation systems. However, there is no evidence to that effect even though some ducts have water in them where duct covers were blown off. This water could have come from the washing down of the ship during radiological decontamination or from the test.

(d) Constructive criticism.

The damage to the systems is primarily due to the failure of hanger straps and to the separation of ducts at joints. These features are apparently inadequate under shock loading.

N. Ship Control.

(a) Damage to ship control stations and causes.

Damage in the bridge area is slight. The port bulwark is carried away but the bridge house bulkheads are intact. Damage to equipment on the bridge level is slight. There is considerable damage in the C.I.C. where equipment is displaced by shock. (Photos 1951-8, 12, pages 50 and 51). The surface search radar equipment is torn loose and lying in the center of the room. In the I.C. Room the gyrocompass is carried from its gimbal mounting by shock and completely demolished. (Photo 1934-1, page 237).

The steering gear is reported to have lost oil from the expansion tank but operates normally in manual control. The gyro compass repeater at this station is broken off and lying on the starboard motor. The after exposed steering station has damaged bulwark. (Photo 4204-8, page 152). Interior communications have not been tested. Since all power sources are inoperable, it is probable that all interior communications would have been lost except for the sound power telephones.

(b) Constructive criticism.

No comment.

O. Fire Control.

(a) Damage to fire control stations and causes.

Damage to fire control stations is negligible. The equipment appears to have been subjected to a mild shock. The MK 14 sight on the starboard director is carried away due to a failure in the mounting. Ray filters on all MK 14 sights were frozen. The elevation locking pin of the starboard director is jammed. The trunnion bolts on the port director are sheared. Plot rooms and protected spaces are intact although equipment therein suffered from shock. The gyro gimbal rotation gearing is destroyed and all top cover windows are shattered on the computer. Damage to the gyro with the resultant loss of the gyro input to various fire control instruments would reduce the effectiveness of the ship.

(b) List of stations having insufficient protection, etc..

No comment.

(c) Constructive criticism.

No comment.

P. Ammunition Behavior.

(a) Ready service ammunition.

No comment.

(b) Magazines.

Ammunition apparently was not subjected to heat or blast and suffered only from shock. Projectiles and Powder cans are not adequately secured in the provided stowages. Projectiles and powder cans are generally displaced in magazines and handling rooms. (Photos 4211-2, page 153, 4061-6, page 154, 4058-10, page 84 and 4058-11, page 85). Depth charge stowage is apparently unaffected. (Photo 4223-11, page 155).

(c) There were no explosions.

(d) There was no gasoline stowage.

Q. Ammunition Handling.

(a) Condition and operability of handling devices.

It is reported that only one out of the four hoists is operable. The shafting and linkage are damaged by shock.

(b) There is no evidence of transmission of heat, fire or blast. It is believed that part of the flooding in way of the 5" powder room A-406M and handling room A-407M is attributable to the powder scuttles in doors 4-40 and 4-33.

(c) Constructive criticism.

No comment.

R. Strength.

(a) Permanent hog or sag.

No evidence.

(b) Shear strains in hull plating.

No shear strains are noticeable in the hull plating. The shell buckles and dishing between frames and longitudinals is due to the underwater pressure and grounding.

(c) Evidence of transverse or racking strains.

No evidence.

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

The after torpedo mount is moved aft slightly, bending the upper end of the two after diagonal supporting braces about 1/4 inch and tearing loose from the forward longitudinal bulkhead about 1/16 inch. Transverse webs frames buckled in way of the forward fireroom at frames 110 and 113, in the forward engine room at frame 106, and on the first platform aft in way of crews space C-204-L. Slight buckling of some floors occurred near the keel at midships and at the bow.

(e) Evidence of panel deflection under blast.

Blast damage on panels is limited to light bulwarks, uptakes and watertight doors topside. The majority of this damage was done by test A.

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.

All machinery spaces, including the diesel generator room, were flooded. Water came from numerous sources including:

1. Broken connection between sea chest and two gage lines, forward engine room.

2. Leak in welded joint of cooling water discharge line to forward main overboard line (outboard of main condenser discharge valve), forward engine room.

3. Broken connections to #2 main condenser (which was open during the test), after engine room.

4. Broken drain line between forward fireroom and diesel generator room.

5. Sources of flooding of No. 1 and 2 firerooms have not been accurately determined. The probably source is the flooded engine rooms through the following interconnecting pipe systems:

1. Low pressure drain main.

2. Main drain.

3. Make up feed system.

4. Emergency feed cold suction lines.

(b) Structural damage.

No comment.

(c) Other damage.

The machinery plant as a whole is probably damaged beyond repair. The boilers rear casings (inner and outer) were bulged outward, brickwork (especially floors) was severely damaged, stack and uptakes were considerably damaged. Main engine throttle manifolds hanger plates sheared, allowing manifolds to drop and crush governor control piping. All upper plate flexing bolts of forward supports on both low pressure turbines sheared, allowing turbines and condensers to fall into bilges. Both turbo-generators fell when the supporting stanchions bent. Piping was severely damaged. All machinery was damaged by flooding. There are innumerable cases of lesser damage, and undoubtedly a great deal of major damage that could not be discovered because of the limited nature of the inspection.

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.

The HUGHES received an underwater shock of very great severity which caused most of the damage described under I (c) above.

(d) Pressure.

The stack, uptakes, and boiler casings of the HUGHES had been damaged by blast pressure during Test A. Additional damage was done to them by blast pressure during Test B.

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

An underwater shock of this magnitude, and blast pressure high enough to cause damage at such a distance from an underwater explosion, are apparently peculiar to the atom bomb.

III. Effects of Damage.

(a) Effect on machinery and ship control.

All power was lost and none could be regained without major repairs requiring many months at a shipyard. The machinery installation as a whole is damaged beyond economical repair. The ship could not be controlled except by such makeshifts, not requiring power, as could be devised.

(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 a large percentage of the crew, both above and below decks, would have been killed or severely injured. The ship was made uninhabitable by loss of power, structural damage, generally disarranged condition of interior spaces, and high radioactivity.

(e) Total effect on fighting efficiency..

Fighting efficiency was completely destroyed insofar as machinery is concerned.

IV. General Summary.

It is believed that the HUGHES would have been lost if she had been in the open sea at the time of the test. It is not believed that any destroyer afloat could have survived a shock of this magnitude without having her machinery plant immoblized.

V. Preliminary Recommendations.

Specific recommendations based on the experience of the HUGHES are too numerous to list here. A general recommendation is submitted that a study of the foundations and supports of all heavy machinery, particularly turbines, generators, and condensers should be made to determine how they can be made more resistant to shock. Similar studies should be made with respect to piping, particularly pipe hangars.

DETAILED DESCRIPTION OF MACHINERY DAMAGE

A. General Description of Machinery Damage.

(a) Overall condition.

The machinery plant is completely inoperable. Extensive damage was done to boilers, turbines, piping, condensers, and various auxiliaries by shock and blast pressure. All machinery spaces (including diesel generator room) were flooded. As there would have been very heavy personnel casualties, it is doubtful whether this flooding could have been controlled if the crew had been aboard.

(b) Areas of major damage.

Both firerooms and engine rooms.

(c) Primary causes of damage.

Blast pressure caused extensive damage to the boilers and stack. Most of the other damage was caused by shock and flooding.

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

The machinery plant was completely disabled by the test. It could not be made operable without a major overhaul. No emergency power was available as the diesel generator room was flooded.

Note: This report is written entirely from external inspection of equipment. It was not practicable to attempt operation of units or to open them for more detailed inspection, except in a very few cases noted in the report. Such additional inspection would undoubtedly disclose damage not found on visual inspection.

B. Boilers.

Test Baker caused severe damage to boiler casings and brickwork on the HUGHES. All boilers were made inoperable and would require extensive repairs before they could be operated. Secondary damage from Test B resulted from flooding of the boiler rooms to the outside water level.

(a) Air casings.

The damage to air casings during Test A was greatly increased by Test B. The rear walls and inner rear casings of all boilers were bulged out by pressure and the outer rear casings were similarly bulged. Repaired panels of #1 boiler were blown out again. The failures of the casings were similar to those during Test A. The casing panel flanges sheared at the bolts of the drum connections and where large panels failed. The flanges held with the sheet tearing next to the flange. (See photos 2078-4, 5, and 6; pages 156, 157, and 158).

Additional damage to the lower casings of these boilers was caused by displacement of the ship's structure being transmitted to the boiler casings. The lower side casings and the brick pans were buckled a slight amount. (Photographs 2078-9 and 10; pages 159 and 160).

(b) External fittings.

No apparent damage to external fittings resulted from Test Baker as far as could be found by visual inspection. Boilers and pressure fittings attached were tested hydrostatically to 150 lbs. sq. in. after Test B, and showed no leakage.

(c) Fuel oil burner assemblies.

No apparent damage to fuel oil burners due to Test B was found by visual inspection.

(d) Brickwork and furnaces.

Direct damage to brickwork during Test B resulted from the displacement of the rear walls due to air pressure and to shock transmitted to the boiler from the ship's structure. (Photos 2076-1, 2075-7 and 8; pages 161, 162 and 163.)

The rear walls were moved during Test B from 3 to 6 inches from their position after Test A. The total displacement of the rear walls from their original position before Test A tapered from nothing at the floor to 12 to 14 inches at the steam drums.

All deck bricks were displaced and thrown up to port. This displacement was so violent that the brick pans were bared on the starboard sides of the furnaces (Photos 2952-1, 2076-3 and 4; pages 164, 165, and 166) and the bricks were piled up about 2 1/2 feet high on the port side. (Photos 2075-11, 2076-2 and 2951-12; pages 167, 168, 169, and 170). The plastic on the top of the side walls and the upper courses of brick were dislodged. (Photos 2076-1, 2076-5, 2075-9 and 10, 2951-11 and 2952-2; pages 161, 169, 171, 172, 173, and 174.) The brick bolts were all intact but some had fallen out with the bricks. An examination of these brick bolts showed no stripping of threads or distortion of the bolts, and it is believed that the nuts had not been in place during Test B.

(e) Steam, water drums and headers.

No apparent damage was found by visual inspection after Test B. A hydrostatic test of 150 lbs.sq.in. was placed on all boilers and all pressure parts held satisfactorily at this pressure.

(f) Tubes.

No apparent damage resulted from Test B. See comment under paragraph (e) above.

(g) Foundations.

The foundations of boilers #1 and #2 were visually inspected and found to be undamaged from Test B. Holding down bolts were intact, welds were undamaged, and no evidence of distortion of the saddles was observed. The ship's structure in the vicinity of the boiler foundations was distorted (wrinkled frames and longitudinals).

(h) Stacks and uptakes.

The stack and uptakes of the HUGHES had been damaged and thus weakened by Test A. The damage after Test B therefore, was additive to that of Test A but it is considered that the effect of Test B would have been severe even if the vessel had not been damaged by Test A. The damage from Test B is believed to have been caused by falling water and air blast.

The stack was severely distorted and was pushed from starboard to port so that it was about one foot out of line at the top. (Photo 2077-2; page 39). The port side of the stack just above the transition piece was buckled. (See photos 2077-5, 9, 10, 11 and 12; pages 41, 42, 48, 175 and 176.) The outer stack casing was ruptured on the centerline in front and on the lower port side. The port side of the after face of the transition piece between the stack and the uptake was ruptured along the joint between the sheet and the frame. (Photo 2077-12.)

The starboard sides of the uptakes were severely dished and ruptured; (Photos 2077-3, 2077-1, 4 and 6, 4204-6; pages 45, 44, 46, 47 and 177), the port sides were also dished and ruptured but to a lesser extent. (Photos 2078-1 and 2; pages 178 and 179). The top of both port and starboard legs of #3 boiler uptakes were dished in very severely and the gas passage from this boiler would have been restricted about 50%. (See photos 2077-1, 7 and 8; pages 44, 180 and 181.) The frame of the starboard leg of #3 boiler breeching failed at a rivet hole from the effect of this dishing. (Photo 2077-7; page 180.) The tops of breeching legs to #1 boiler were dished very slightly, which would not have restricted the gas passage.

C. Blowers.

1. All of the forced draft blowers turned freely by hand and apparently sustained no damage, except #2 blower which was pushed aft very slightly by shock. This resulted in buckling one of the reinforcing ribs on the blower casings. (See photos 2075-6, 2952-4; pages 182 and 183).

2. This blower turned freely by hand and showed no evidence of misalignment. It is not believed that operation of this blower would have been impaired.

D. Fuel Oil Equipment.

The fuel oil equipment was apparently undamaged except as noted below:

(a) Heaters.

No. 1 fuel oil heater had been pushed down about 1 1/2 inches at the after end. The supporting bracket was buckled. It is believed that the function of the heater would not have been impaired.

E. Boiler Feedwater Equipment.

The boiler feedwater equipment appears to be undamaged. This equipment was not tested.

F. Main Engines.

This vessel's main engines sustained damage as a result of Test B that rendered them completely inoperable. Extensive secondary damage resulted as machinery and piping hangars failed, releasing their loads to crush adjacent machinery. Photos 2950-9, 11, 4059-6,7 ; pages 184, 185, 186, and 187. The misalignment caused to the engines by failure of their forward structural supports completely inactivated them. Had they been operating at the time of the blast, the high rotative speed of the

turbines coupled with instantaneous misalignment of a large amount would probablyhave sheared all engine connections including main condenser injection and overboard connections and could well result in the loss of the vessel.

The main engine casualties of this vessel are outstanding examples of the inadequacies of this type engine support in its present form to withstand shock of this magnitude. This type of engine suspension is in common use on many modern warships of the navy and is considered an extremely vulnerable point at which the entire ships mobility can beincapacitated. Careful examination of the L.P. turbine support failures indicate that under the tremendous acceleration of the hull caused by the blast, the forward L.P. turbine supports (flexing plates and transverse girders) failed while transmitting this acceleration to the mass of L.P. turbines and condensers. Sheared bolts and their holes show the shearing action to be in the upward direction, the engine support girder being literally blown away from the turbine and its flexing plate. (See drawings; pages 54 and 55). The fact that the turbine support girder is badly bent down substantiates this. (See photos 151-12, 153-1, 5, 9 and 10, 2951-2, 4 and 9 and 4059-1; pages 188, 189, 190, 191, 192, 193, 194, 195 and 196).

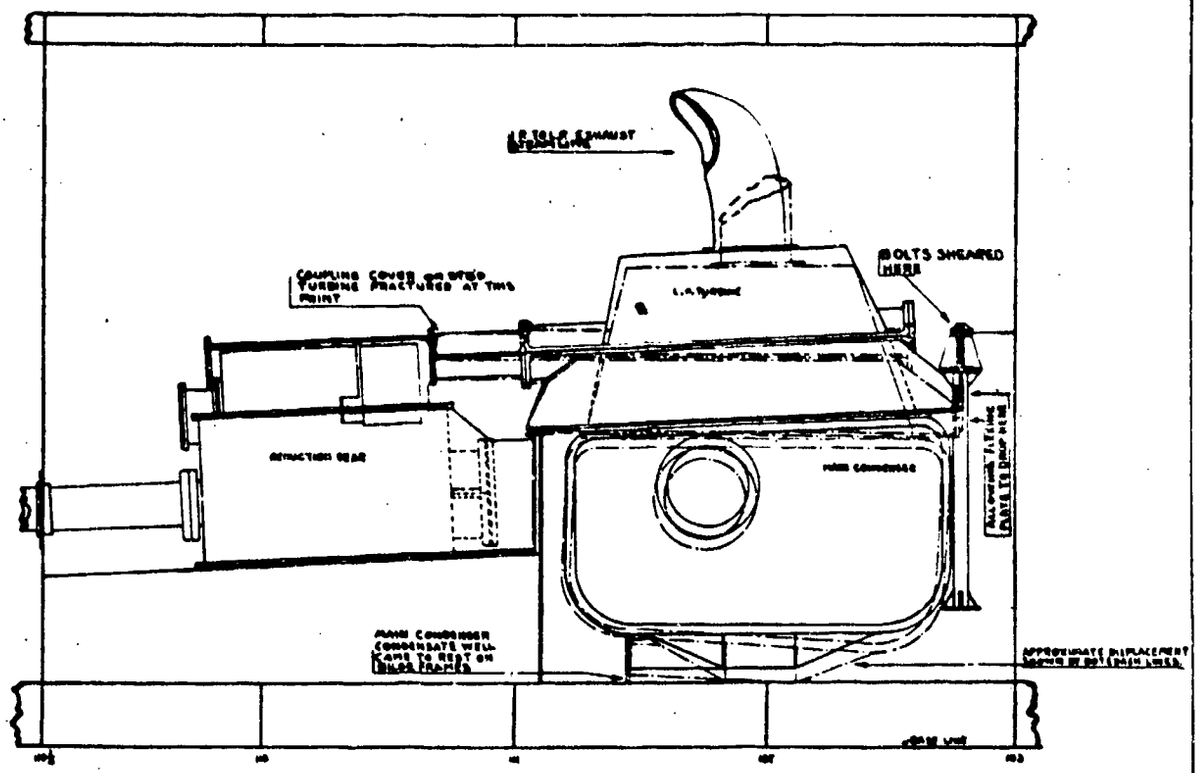
(a) Casings.

The main engine casings were intact. There was no evidence of perforation by missiles nor were there any cracks or fabrication failures noted. Severe shock may have started the longitudinal casing joints leaking.

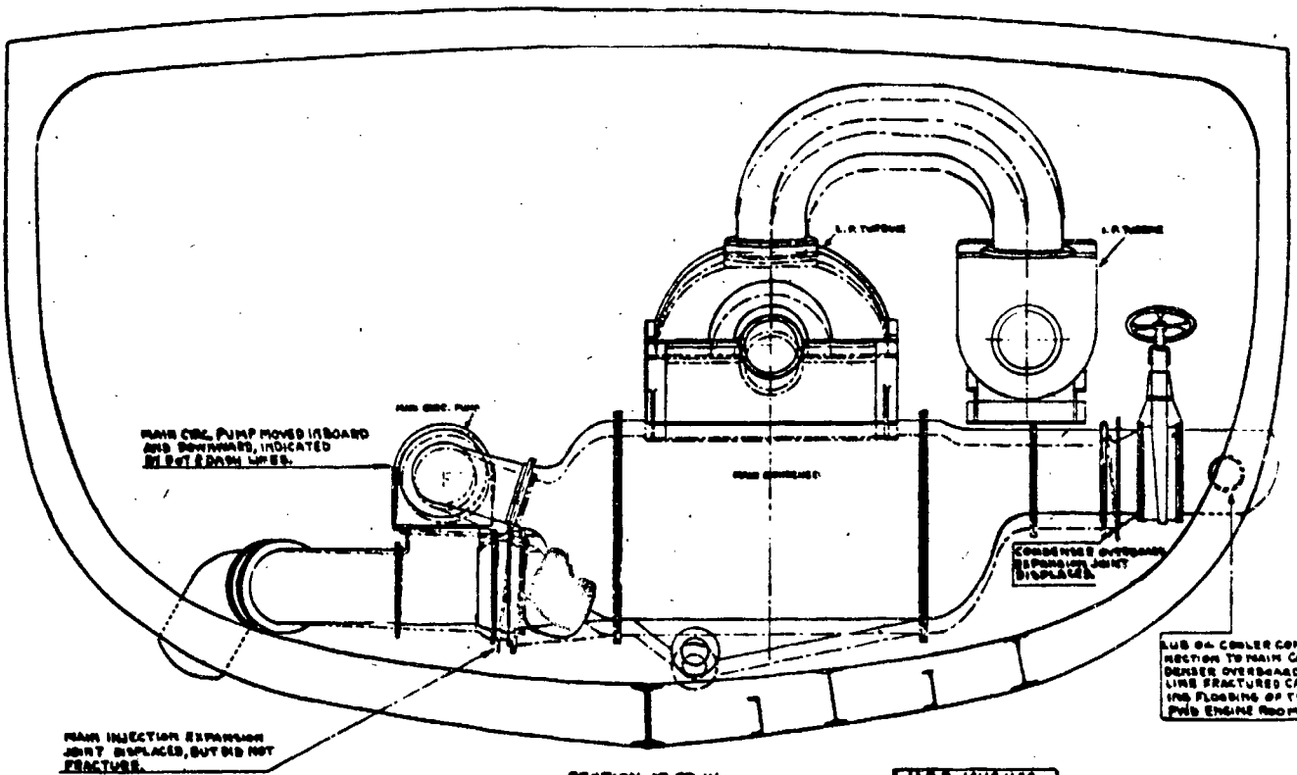
(b) Bearings.

The turbine bearings were not opened for examination. There were no broken bearing caps, covers, or bolts, and from an external examination, they appeared to be intact.

(c) Rotors.



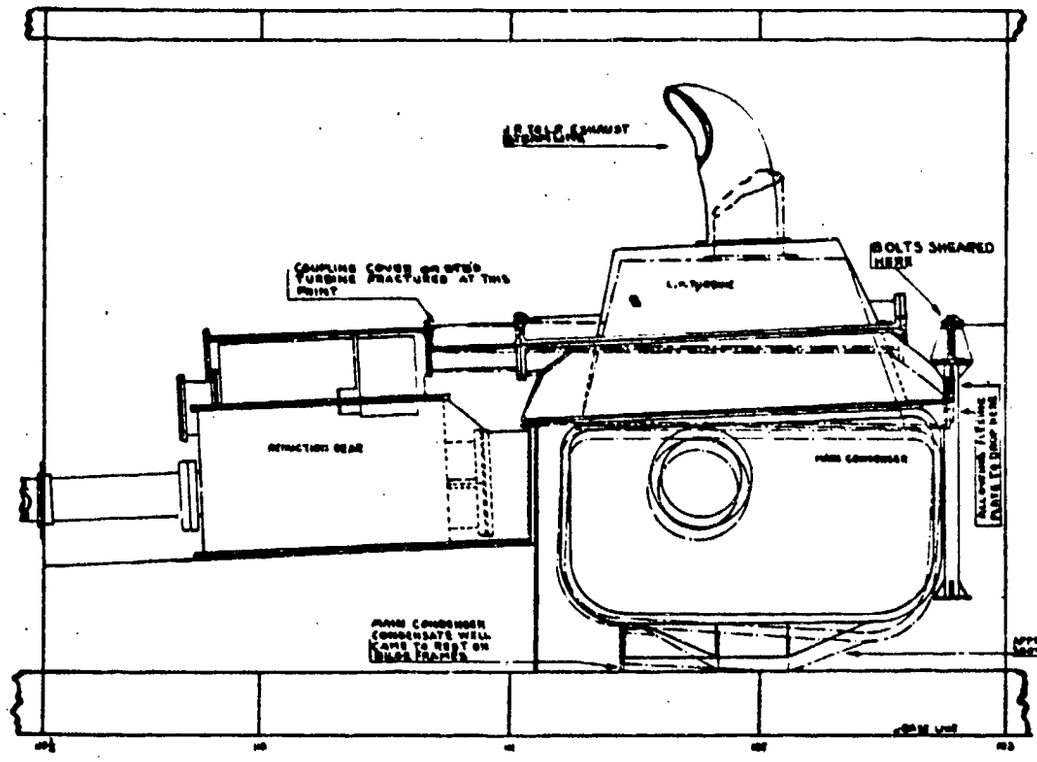
STARBOARD LOW PRESSURE TURBINE, LOOKING TO PORT.
SCALE ½" = 1 FOOT.



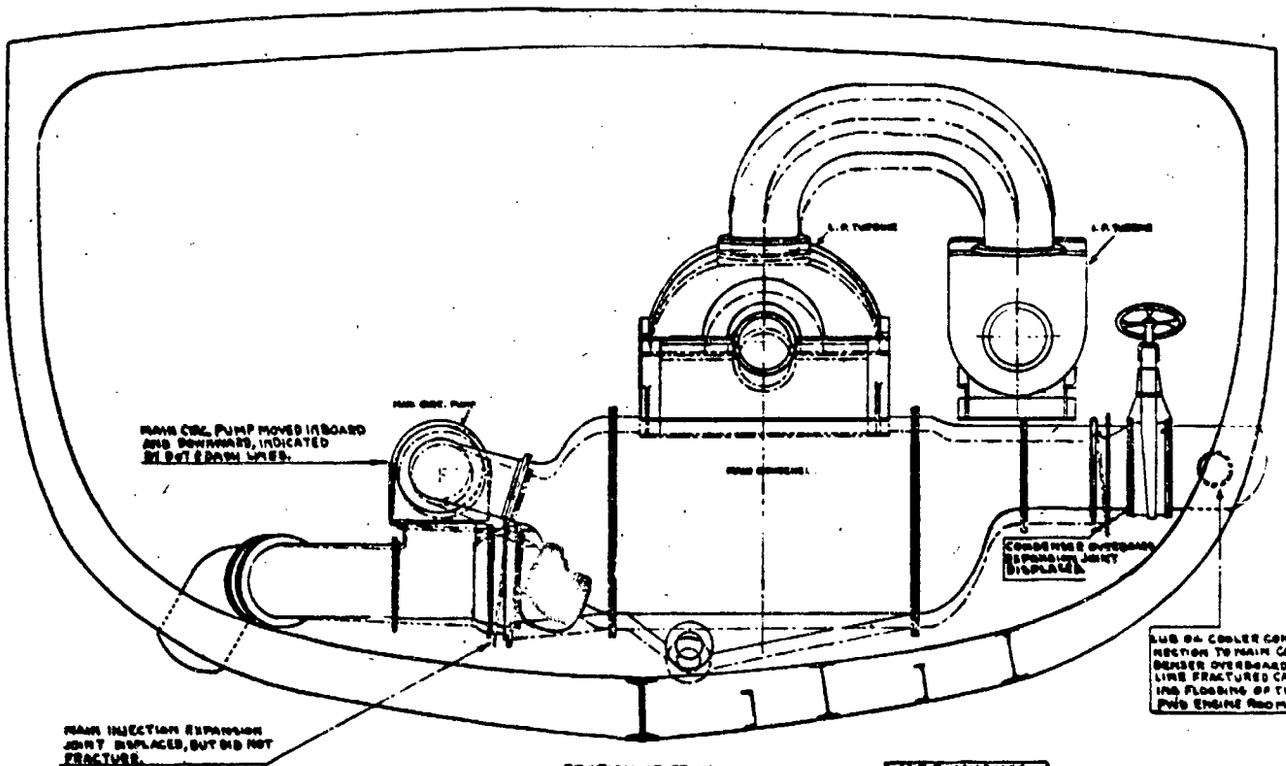
SECTION AT FR. III
LOOKING FOR'D.
SCALE ½" = 1 FOOT.

U.S.S. HUGHES
TEST BAKER
ORIGINAL POSITION SHOWN IN SOLID LINES. DISPLACEMENT SHOWN IN DOT & DASH LINES.
MACHINERY GROUP COORDINATE
90-403-61-S.

8277



STARBOARD LOW PRESSURE TURBINE, LOOKING TO PORT.
SCALE ½" = 1 FOOT.



SECTION AT FR. III
LOOKING FOR'D.
SCALE ½" = 1 FOOT.

USS HUGHES
TEST BAKER
ORIGINAL POSITION SHOWN IN SOLID LINES. DISPLACEMENT SHOWN IN DOT & DASH LINES.
MACHINERY GROUP
CASUALTIES
NS 469-61-S.

8277

The L.P. turbine rotors were examined through the L.P. turbine upper casing inspection covers. This permitted inspection of the last wheel at each end of the rotor which appeared to be undamaged.

No damage was observed to any of the L.P. turbine interiors, cylinders, astern chest, nozzle blocks, or supports. It is believed that both L.P. turbine coupling flanges will be found on close inspection bent due to the stresses imposed on them when the forward end of the turbines dropped. The H.P. and I.P. rotors were not examined.

(d) Blading and shrouding.

Except for inspections noted under "Rotors", no observations were possible for blading and shrouding. It was not possible to jack the turbines due to great misalignment.

(e) Packing and glands.

The packing and packing glands were not disassembled for inspection. Externally, they appear to be intact.

Severe shock has undoubtedly broken the carbon rings.

(f) Valves.

The valves mounted on the turbines are undamaged.

Both throttle manifolds suffered severe casualties due to their hangar plates shearing, permitting them to fall. The starboard throttle manifold dropped approximately 6 inches, crushing its governor control piping into the auxiliary air ejector. The port throttle manifold dropped approximately 2 inches outboard. The inboard hangar held although it was bent badly where it secures to the manifold. Resultant main steam line displacement occurred in both instances incident to the throttle casualties.

(See photos 153-2, 4059-6 and 9, 153-3 and 2950-6,7 and 8; pages 197, 186, 198, 199, 200, 201, and 202.)

(g) Foundations.

Complete failure of both low pressure turbine forward supports resulted from Test B. All the upper flexing plate hangar bolts sheared, while transmitting hull acceleration to the L.P. turbines and condensers, permitting the low pressure turbines and main condensers to drop onto the main hull frames in the bilges. This casualty was identical in both engine rooms. The degree of engine and condenser displacement was limited (4 to 6 inches) only by the proximity of the hull frames to the lower part of the main condensers. (Photos 2951-2, 4, 9, and 153-6; pages 193, 194, 195 and 203).

It is believed that this casualty is a result of the low pressure turbine and condenser mass failing to respond to the rapid acceleration of the hull proper under the impetus of the severe underwater shock. The low pressure turbine flexing plates are secured on top by bolting to a fabricated structural girder, which in turn, is supported from the main hull frames by three stanchions. The top flexing plate bolts sheared and the structural girder is badly bent indicating that the shearing action was upwards, the transverse engine support girder pulling away from the flexing plate. (Photos 153-1, 5, 9, 10 and 151-12, 2951-2, 9, 4059-1; pages 189, 190, 191, 192, 188, 193, 195 and 196.)

The forward high pressure turbine foundation, a cantilever structure, showed plated deformation and the engine is undoubtably out of alignment.

(h) Fittings.

No damage to any of the turbine fittings was observed.

(i) Miscellaneous.

Both low pressure turbine coupling connector covers were damaged. No. 1 connector cover was broken at the reduction gear end. This failure occurred when the forward end of the turbine dropped exerting a bendi , stress on the cast aluminum cover. No. 2 connector cover is pulled out of its packing gland unevenly, also indicating a bending stress though not as severe as #1. It is unbroken. (Photos 4058-7, 153-8, and 2950-10; pages 204, 205, and 206.)

The after end L.P. turbine support feetl, while showing no damage externally, will no doubt reveal elongated holes and bent bolts on disassembly, and possible bending of the support shelf plate which is a structural appendage of the main reduction gear base.

BEARING LEAD DATA

STARBOARD L. P. TURBINE - FORWARD BEARING

Forward lead	Before Test B	After Test B	Difference
Top	.014	.0035	.0105
Center lead			
Top	.0115	.003	.0085
After lead			
Top	.011	.0035	.0075

STARBOARD L. P. TURBINE - AFTER BEARING

Forward lead			
Top	.010	.0035	.0065
Center lead			
Top	.014	.003	.011
After lead			
Top	.0105	.0025	.008

G. Reduction Gears.

From a visual inspection, the main reduction gears appear to be undamaged except for the probable bending of the low pressure first reduction pinion gear flanges incident to the low pressure turbine casualty. Since it was impossible to jack the gears due to the engine misalignment it cannot be definitely said that there is no other gear deformation.

(a) Foundations and casings.

It is believed that there was sufficient underwater shock to cause distortion of the main reduction gear base plate.

The casings were not punctured or broken.

(b) Gears and shafting.

The gears were not examined internally.

(c) Bearings.

The bearings were not opened for inspection. There was no external evidence of damage.

(d) Couplings.

Both low pressure turbine couplings are damaged due to the displacement of the low pressure turbines.

(e) Fittings.

All observable reduction gear fittings appear to be intact.

(f) Turning gears.

The turning gears are apparently undamaged,

however, no attempt was made to operate them due to the low pressure turbine casualties and the electric driving motor being grounded out from salt water flooding.

Note: Both gears have been completely immersed in salt water due to the flooding of the engine rooms.

H. Shafting and Bearings.

(a) Shafting.

The port and starboard shafts were examined and appear to be intact.

(b) Bearing and bearing foundations.

There is much evidence of shaft whipping under the blast. Spring bearing holding down bolts are loose and bearing shocks are displaced, turning around their bolts. There are no evidences of displacement of the bearings in the transverse plane. The bearing foundations appear to be intact. (Photo 157-2; page 207.)

(c) Alignment.

peller shafting. There is no apparent misalignment of the pro-

(d) Stern tubes, bulkhead glands, etc.

There is a slight leak at the joint of the port forward stern tube bearing at the stern tube face weldment. This may have been caused by the shaft whip jarring the joint. All other glands appear to be intact and show no evidence of twisting.

The starboard intermediate strut after fairwater is broken loose at its circumferential joint. (Photo 4060-5; page 208.)

The starboard rope guard is crushed into the space between the after end of the main strut and the forward hub of the wheel. (Photo 4060-6; page 209.)

Plastic paint cracks around the strut palms indicate severe flexure of these members.

I. Lubricating System.

The lubricating oil system was inspected and appears to be undamaged except as noted below:

(a) The governor control piping of the main turbines was damaged due to dropping of the main steam manifold. The piping did not appear to be ruptured. (Photo 2950-9; page 184.)

(b) The 6 inch main lubricating oil discharge line to the turbines and gear in the forward engine room was crushed by a falling object so that its area was reduced about 50%. This damage would limit operation of the turbines and gear in this space.

(c) The L.P. turbine lubricating and governor control piping is bent due to engine displacement. No fractures of piping were observed.

J. Condensers and Air Ejectors.

The starboard main condenser dropped about 6 inches and the port main condenser dropped about 4 inches, resting on the main hull frames in the bilges. This was caused by the shearing of bolts in the flexing plates supporting the forward end of the low pressure turbine. The main condenser is bolted to the lower half of the turbine casing.

The eight sway braces under each main condenser were bent down in the bilges from the weight of the main condensers and low pressure turbines. The dynamo condenser was apparently undamaged except for the foundation bolts. Three were found to be loose.

(a) Water boxes.

The motors of all pumps on the lower level in all machinery spaces were flooded and the turbine driven units had their lube oil contaminated by flooding.

The pedestals that supported the forward end of the flapper valve castings, which in turn supported the main circulating pumps in both engine rooms, were broken due to shock. (Photos 4059-2, 153-11 and 12; pages 211, 212, and 213.)

L. Auxiliary Generators.

The two ship's service generators had been under water due to flooding. The damage sustained by their foundations would preclude the possibility of operating the generators without completely realigning them after rebuilding their foundations.

(a) Foundations.

Both generators had moved on their foundations. The foundation stanchions were bent and the generators moved downward about 1 inch. The box frames that support the generator reduction gear and turbine sheared the bolts in the after end of #1 generator box frame, all other foundation bolts were loose. (Photo 2951; page 242.)

(b) Turbines.

Apparently undamaged. They have not been jacked over by have not been jacked over by hand.

(c) Gears.

Apparently undamaged. They were not inspected internally.

(d) Coolers.

Apparently undamaged.

(e) Governors.

Apparently undamaged. Overspeed trips were worked by hand.

(f) Valves and fittings.

Apparently undamaged.

M. Propellers.

The propellers were inspected while the ship was docked and are apparently undamaged.

N. Distilling Plant.

The distilling plant was apparently undamaged externally. The foundation bolts were loose. The foundation had dropped approximately 1 inch due to buckling of stanchion under the upper level at this point. The combined dynamo circulating and condensate pump had been removed prior to the test. The remaining pumps had been flooded.

It is considered probable that a hydrostatic test of the distilling plant would disclose leaks in the tubes due to shock.

O. Refrigerating Plant.

The refrigeration plant was apparently undamaged.

P. Winches, Windlasses, and Capstans.

There was no apparent damage to the winches or windlasses as far as could be determined from visual inspection.

Q. Steering Engine.

There was no apparent damage except from flooding and the rudder was operated manually from 15° left to amidship. Both trick wheels and pilot house wheel turned freely by hand. There was evidence of shock in the steering gear room where the gyro repeater pedestal was sheared, on the after deck house where the rudder angle indicator pedestal was sheared, and in the pilot house where both the rudder angle indicator and the gyro repeater pedestal sheared. The material of construction of all these pedestals was cast aluminum. Shock did not affect the steering gear itself.

R. Elevators, Ammunition Hoists, Etc.

Elevators - not applicable.

The 5 inch ammunition hoists show no apparent damage.

S. Ventilation (Machinery).

There was no apparent damage to any of the ventilation fans. All that were accessible turned freely by hand.

T. Air Compressors.

The high pressure air compressor was apparently undamaged except the cooling water inlet line had broken at the threaded connection where it entered the compressor. This could have been readily repaired by the ship's force. (Photo 1681-6; page 214.)

The low pressure air compressor crank case mounting feet on the outboard side was cracked. The material is cast iron. The compressor was apparently undamaged otherwise.

U. Diesel Generators and Boats.

The diesel generator was apparently intact, from visual inspection. The upper tier of starting batteries in

the battery rack was dislodged. The generator room was completely flooded from the forward fire room through a 1 inch drain line, thus the generator was out of commission from secondary damage. No boats were aboard during Test B.

V. Piping.

(a) Main steam.

The main steam lines were inspected and appear to be undamaged except as noted below: The main lines were subjected to a hydrostatic test of about 100 lbs.sq.in. on the date of inspection and found to be intact.

The failure of two spring hangers caused the starboard 7 inch main steam line in the forward fireroom to sag 6 inches. Dropping of the line with its boiler stop valve resulted in the bending of the drain lines attached to the valve. (Photo 2951-6; page 215.)

The failure of a spring hangar caused the port side 7 inch main steam line in the forward fireroom to sag about 4 inches. The drain pipe attached to the boiler stop valve was badly bent and the expansion fitting at bulkhead 89 was distorted. The joint appears to be tight. (Photos 2951-10; page 216.)

The failure of the after two spring hangars on the port side 5 inch main steam line from #3 boiler, combined with the failure of the manifold support bolts in the forward engine room permitted the steam line to sag 6 inches. This resulted in the distortion of the bulkhead closure expansion fitting. The joint appears to be tight. (Photos 153-2 and 3, 2950-6 and 8, 2952-3, 4059-6, 8, 9, and 10; pages 197, 199, 200, 202, 217, 186, 218, 198 and 219.)

Failure of the main steam manifold support bolts and spring hangars in the steam lines connected to the turbines in the forward engine room, conbined with failure of steam line hangers in the after fireroom, caused the turbine lines to

drop 6 inches. They are now supported only at the lower portion of the bulkhead expansion joint, on the top of the main gage board and at their connections to the turbines.

Failure of the anchor rod and spring hangars of the 5 inch and 7 inch starboard main steam lines in the after fireroom and the anchor rod and hangars of the starboard 8 inch line in the forward engine room plus the failure of the manifold support bolts in the after engine room caused the entire starboard main to drop 6 inches. The line now is supported only on the lower portion of the bulkhead expansion joints and on an auxiliary steam line in the forward engine room. The expansion joints have been distorted at bulkheads 103 and 118 and a welded seam in the joint at bulkhead 118 has been torn so that the joint is no longer watertight. (Photos 2076-6, 2951-7 and 2950-12; pages 220, 221, and 222.)

One spring hanger failed in the steam line to the high pressure turbine and two spring hangers failed in the line to the low pressure turbine in the after engine room.

The above spring hangers failed either by shearing through the strap bolt holes, shearing of the 1/2 inch strap bolts, or by stripping of the spring tension bolt threads. Shearing through the strap bolt holes caused the majority of the failures. Failure of the hangars was caused by shock. (Photo 2076-7; page 223.)

(b) Auxiliary steam.

The auxiliary steam lines were inspected and appear to be undamaged except as noted below: The main lines of this system were subjected to a hydrostatic test of about 100 lbs.sq. inch and found to be intact.

The 1/2 inch bolts of two strap hangers in the shore steam line in the forward fireroom failed in single shear.

The steaming out connection for the auxiliary circulating water pump suction sea chest in the forward engine room was bent and ruptured by a falling object. Failure of this

connection contributed to the flooding of the engine room. (Photo 4059-4; page 224.)

Failure of two strap hangars of the port side 2 1/2 inch auxiliary steam line in the after engine room caused the line to drop 2 inches and resulted in distortion of the bulkhead closure expansion fitting. The joint appears to be tight. (Photo 2076-8; page 225.)

The steaming out line of the distiller circulating water pump suction sea chest in the after engine room was ruptured at its connection to the sea chest. Corrosion of the joint appears to have been the main reason for failure. Leakage through the break contributed to the flooding of the engine room.

Failure of the pipe hangars was due to shock.

(c) Auxiliary exhaust.

The auxiliary exhaust piping appears to be undamaged except as noted below. The system was not tested.

A hangar strap bolt failed in shear in the starboard 8 inch exhaust line in the after fireroom.

(d) Condensate and feedwater.

The condensate and feedwater lines were inspected and appear to be undamaged except as noted below. The main feed discharge lines were subjected to a hydrostatic test of about 100 lbs.sq.inch and the lines were found intact.

A 1/2 inch hangar rod bolt failed in double shear in the starboard 6 inch main feed discharge line at about frame 93.

Three 1/2 inch bolts of the 6 inch main feed discharge lines supporting bracket failed in single shear at about frame 94. Failure of the bolts allowed the line to sag about 4 inches and resulted in distortion of the expansion joint at bulkhead 89. Distortion of the joint caused failure of a welded seam so that the joint is no longer watertight.

The port and starboard main feed discharge lines dropped about 4 inches at bulkhead 103 due to failure of hangars on both sides of the bulkhead. The expansion joints at the bulkhead were distorted as a result of this damage, however, they appear to be intact.

(e) Fuel oil.

The piping of this system appears to be undamaged. None of the lines were tested.

(f) Lubricating oil.

The lubricating oil lines appear to be undamaged except as noted below. The lines were not tested.

Two pipe hangars on the discharge line of the starboard lubricating oil pumps tore loose at the weld to the supporting structure. The 6 inch line between the pump and the cooler in the forward engine room was smashed by a falling object reducing its cross-sectional area about 50.

Note: About 10% of the steam gages on the main turbo-generator and distilling plant gage boards are damaged. Their pointers have either jumped the stop pins or are beyond zero. This damage was caused by shock.

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

This piping was inspected and appears to be undamaged except as noted below. None of the lines were tested.

The screwed joint of a 1/2 inch salt water cooling line broke off at its connection to the high pressure air compressor in the forward fireroom. (Photo 1681-6; page 214.)

(h) Condenser circulating water.

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

The screwed suction and discharge gage lines of the auxiliary circulating water pump in the forward engine room broke off at their respective connections to the pump suction and discharge lines. Leakage through the sea chest valves and the ruptured lines contributed to the flooding of the engine room.

A leak occurred in the welded joint of the cooling water discharge line of #1 main lubricating oil cooler to the overboard discharge line of #1 main condenser. Leakage through this ruptured joint contributed largely to the flooding of the forward engine room. It should be noted that the oil cooler cooling water connection is outboard of the main condenser overboard sea valve and that the sea valve of the cooling water line was inadvertently left open during Test B. (Photos 2951-5 and 1681-6; pages 226 and 214.)

The gage glasses and air ejector drain connections to the fresh water sides of #2 main condenser broke off. Due to the leaky condition of the condenser tubes and open sea valves, salt water leaked into the fresh water side of the condenser and out of these into the bilges through the ruptured connection. These leaks, together with the leak through the steaming out connection on the distiller circulating pump suction sea chest caused flooding of the engine room.

Note: All piping connected to both main condensers is deranged due to the displacement of the condensers.

(i) Drain.

The drain piping appears to be undamaged. None of the piping was tested for leakage.

(j) Compressed air.

The air piping appears to be undamaged. The lines were not tested.

(k) Hydraulic.

The hydraulic piping appears to be undamaged. None of the piping was tested.

(l) Gasoline.

Not applicable.

W. Miscellaneous.

Machine shop equipment was apparently undamaged by the bomb. The equipment, when inspected, had been completely flooded, but this is believed to have taken place during decontamination of the ship as it is located on the main deck. The door to the space was torn off by Test A and the water sprayed over the ship freely entered the space.

(a) Gasoline stowage and equipment.

Not applicable.

(b) Messing machinery.

No apparent damage.

(c) Messing equipment.

No apparent damage.

(d) Laundry equipment.

No apparent damage.

SECTION III - ELECTRICAL

GENERAL SUMMARY OF ELECTRICAL DAMAGE

I. Target Condition After Test.

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

Not observed.

(b) Structural damage.

The stanchions under the ship's service turbo generator bases were extremely distorted. Although there was no visible indication that this had caused damage to the turbo generators, it is quite likely that some misalignment of the units accompanied this distortion.

(c) Damage.

All electrical equipment mounted in the machinery spaces and emergency diesel generator room was damaged from flooding. The following electrical equipment received damage from effects other than flooding:

1. Low pressure air compressor motor.
2. Several pump and vent set motor controllers.
3. Electric lights were broken throughout the vessel.
4. Gyro compass and repeaters.
5. Rudder angle indicator and telegraph in pilot house.

II. Forces Evidenced and Effects Noted.

(a) Heat.

None observed.

(b) Fires and explosions.

None observed.

(c) Shock.

There were numerous indications from electrical damage that this vessel experienced a large amount of shock. This was indicated by:

1. Internal damage to various pump motor controllers mounted in the engine room.

2. Extreme distortion to the stanchions under the ship service turbo generators.

3. Breaking of electric light bulbs throughout the vessel.

4. Distortion of wire ways in the engine room.

5. Extreme damage to the gyro compass and some of its repeaters.

6. Dislodgment of storage batteries from their racks.

Most of the shock on this vessel appears to have come from the bottom of the vessel.

(d) Pressure.

The only pressure effects noted were those that were in the immediate vicinity of hull damage caused by pressure. An example of this is the damage sustained by the port pelorus, when the port windshield on the bridge was carried away.

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

None observed.

III. Results of Test on Target.

(a) Effect on propulsion and ship control.

It is considered that the damage sustained by the forward engine room would have resulted in the loss of power and lighting on this vessel. Since the emergency diesel generator room was only subjected to very slow flooding, the essential electrical equipment probably still could have been supplied with power by utilizing the emergency generator. Since the main propulsion auxiliaries on this vessel were all steam driven, the loss of electrical power would not have affected the ship propulsion. Although damage to the gyro compasses, rudder angle indicator and telegraph would have affected the ease of ship control, their functions could be accomplished by means of the standard magnetic compasses and sound powered telephones.

(b) Effect on gunnery and fire control.

Outside of possible water damage to the I.C. and F.C. switchboards, the electrical damage to this vessel would not have affected gunnery and fire control equipment. However, due to the limited amount of electrical power that would have been available, only a small portion of the guns on this vessel could have been operated.

(c) Effect on watertight integrity and stability.

From an electrical standpoint, there was only a slight effect on the watertight integrity and stability of the vessel. It appears that the flooding in the after fire room resulted from water from the forward engine room going through some unblanked stuffing tubes. This was due to some carelessness on the part of the repair activity which pulled the cables and did not blank off the open stuffing tubes.

(d) Effect on personnel and habitability.

It is considered that the loss of electric power would have affected the habitability of the vessel. Undoubtedly cooking, lighting, and ventilation would have to be greatly reduced, with only the diesel generator sets available to carry the load.

(e) Effect on fighting efficiency.

The fighting efficiency of the vessel would have been greatly reduced because of the loss of ship service power. Since the emergency diesel generator set would have to supply steering, some pumps, lighting, and ventilation, only a small amount of power would have been available for the gun loads.

IV. General Summary of Observers' Impressions and Conclusions.

The greatest source of electrical damage to this vessel resulted from the flooding in the machinery spaces. In general, most of the electrical damage sustained from the primary effects of the underwater blast was low in the ship. The electrical equipment on the lower level of the engine room suffered much more damage than that on the upper level. However, from the degree of shock damage sustained by the various items of electrical equipment, it is believed that comparable high shock modern Navy equipment probably would have withstood the shock experienced by this vessel. Undoubtedly the modern destroyer split electrical plant, would have withstood the damage better.

V. Any preliminary general or specific recommendations of the Inspecting Group.

Considering the flooding experienced in the machinery spaces by this vessel, and the likelihood that damage control personnel would not be immediately available, it is recommended that all electrical equipment which must be installed in the lower levels of the machinery spaces be of the submersible type. Such equipment which is vital to the damage control and fighting efficiency of the vessel should be arranged for operation from the upper levels.

It is recommended that gyro compass element supporting mechanism be made more resistant to shock, and the use of cast aluminum for gyro compass repeaters be discontinued.

DETAILED DESCRIPTION OF ELECTRICAL DAMAGE

A. General Description of Electrical Damage.

(a) Overall condition.

The electric plant of this vessel was completely inoperative primarily due to flooding, while various electrical units were made inoperative from shock, and from the loss of steam.

(b) Areas of major damage.

The engine rooms, the I.C. room, and electric workshop received the most electrical damage.

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

The greatest amount of electrical damage was caused by the flooding of the vessel, while secondary damage was caused by the extreme underwater shock that this vessel experienced.

(d) Operability.

Considering the loss of steam on the vessel, and the possible misalignment of the ship service turbo generator sets, it is extremely doubtful that power would have been available from the ship service turbo generators. In addition, all electric pumps on the lower level of the engine room would have been lost due to flooding of this space. However, considering the fact that the emergency diesel generator room was only subjected to very slow flooding, the emergency generator probably would have been available for vital services.

(e) Types of equipment most affected.

The motor controllers and gyro compasses suffered the greatest damage on this vessel.

B. Electrical Propulsion Rotating Equipment.

Not applicable.

C. Electric Propulsion Control Equipment.

Not applicable.

D. Generators - Ship's Service.

There was no visible damage sustained by the ship's service generators. However, it should be noted that the stanchions under the turbo generator bases were extremely distorted. It is quite likely that some misalignment of the units accompanied this distortion. Since the sets were not jacked over, the alignment of the units could not be checked. Photograph No. 2951-1, page 242 shows the stanchion distortion.

E. Generators - Emergency.

The only damage sustained by the emergency generators was of a secondary nature from the flooding of the diesel generator space.

F. Switchboards, Distribution and Transfer Panels.

Although there was an extensive damage from flooding, little shock damage was sustained by switchboards and distribution panels. The engine room auxiliaries power panel (Type TU switches) mounted in the forward starboard corner of the low level of the after engine room, was distorted. This was caused by the steam line above the panel moving down under shock, and hitting the top of the power panel. Due to the lack of time, the power panel was not opened in order to ascertain whether the switches were damaged.

The battery charging switchboard, Bureau of Ships Drawing No. BDE1-S6201-800, mounted in the battery charging and electrical work shop on the main deck was slightly damaged. The longitudinal joiner bulkhead in the space was extremely distorted,

and its movement against the switchboard, dislodged the board from its rear bottom mounting, and left it tilted at an angle of about 30 degrees. The distortion of the board resulted in the binding of the rheostat hand wheels; however, other than this, there was no visible signs of damage to the board proper. Photograph 1932-11, page 235 shows the switchboard dislodged from its foundation. The failure of the holding down bolts probably prevented damage to the switchboard.

G. Wiring, Wiring Equipment and Wire Ways.

Other than minor isolated damage, the wiring and wiring equipment on this vessel stood up quite well under the underwater shock. The bottom supporting channels of an athwartship Method "D" wire way on the upper level of the after engine room was distorted from the shock. These were about 1/8 inch channels, and were bulged down about 1 inch. This damage is shown on Photograph 2950-4, page 241. The longitudinal wireway run in the electric shop showed signs of shock damage. In one instance, the wireway support failed when the 1/4 inch strap bolt sheared, and in the other instance, when the strap welded to the overhead failed. Photograph 1932-9, page 234, shows the weld failure, and photograph 1932-10, page 233 shows the wire way damage sustained when the strap bolt sheared.

Various cable stuffing tubes were found to be leaking on this vessel. However, no details as to the material used in these tubes, or their condition before test, was available.

Wire ways in the machinery spaces were flooded.

H. Transformers.

No damage was sustained by this equipment other than flooding.

I. Submarine Propelling Batteries.

Not applicable.

J. Portable Batteries.

The portable 175 ampere hour batteries in the battery charging and electric shop were dislodged from the battery rack. There was no means of securing the battery in this rack. Although one of the batteries had fallen 2 feet, there were no signs that the case had been cracked. It could not be ascertained as to whether or not the battery suffered any internal damage. Photograph 1932-12, page 236, shows this damage.

Recommendations.

(a) It is recommended that some means be provided to secure batteries in their racks, so they will not be dislodged under shock conditions.

(b) The securing device should be an integral part of the battery rack to insure the batteries will be secured at all times.

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

Although there was a large amount of shock experienced by this vessel, all motor units seem to have withstood the shock in good shape.

The low pressure air compressor motor mounted on the port side of the after fire room had its bed plate cracked at two of the holding down bolts, and the threads partly stripped at another bolt. The cast iron foot on the compressor body was also cracked. Photographs 1681-2, page 227 and 1681-4, page 229 shows the damage to this equipment.

Vent set controller 1-99 in the upper level of the fire room had its trip coil and low voltage release coil armature assembly dislodged from the phenolic mounting base. This damage resulted when the mounting screws pulled loose from the phenolic base. This controller was manufactured by the Westinghouse Electric Manufacturing Company and was a type 11-200-SN, 3 phase, 60 cycle, 440 volts.

The No. 2 fire and flushing pump motor controller mounted on the starboard side of the lower level of the after engine room had its lock-in device distorted. Photograph 2950-1, page 238 shows this damage. This controller was manufactured by the Cutler-Hammer Company and was of the across the line magnetic type, 3 phase, 60 cycle, 440 volts.

The distiller condensate circulating pump controller mounted in the after engine room, had one of the contactors dislodged from the phenolic mounting base. This failure occurred when the mounting screws stripped out of the phenolic base. Photograph 2950-2, page 239, shows this damage. This unit was manufactured by the Westinghouse Electric and Manufacturing Company, and was of the magnetic across the line type, 3 phase, 60 cycle, 440 volts.

The diesel fuel oil supply mounted in the after engine room, had one of its contactors broken away from the phenolic base. This damage occurred when the mounting screws stripped out of the phenolic base. Photograph 2950-3, page 240 shows this damage. This unit was manufactured by the Westinghouse Electric Manufacturing Company and was of the magnetic across the line type, 3 phase, 60 cycle, 440 volts.

The automatic bus transfer for the 5 inch gun director mounted in the forward engine room had its arc shoots broken and dislodged. This unit was manufactured by the Cutler-Hammer Company, Serial No. B-631970A1.

The controller for the 5 inch loading machine, mounted in the electric shop, had the dashpot for the overload relay dislodged from its mounting. The spring support that held the dashpot in place was dislodged under shock. Photograph No. 1932-8, page 232 shows this damage. This unit was manufactured by the Ward Leonard Company, Serial E98989A25.

The open phase indicator relay on the steering control panel for the port steering motor was broken. Photograph No. 4210-3, page 244 shows this damage.

Most of the motors and motor controllers in the engine rooms were damaged due to the flooding of these spaces.

Discussion and Recommendations.

It is considered that the modern Navy type motors and motor controllers would have withstood the underwater shock received by this vessel in far better shape than the obsolete Navy designs installed.

Careful consideration must be given to the flooding problem on thin-skinned vessels, like a destroyer. In the case of this particular vessel, most of the electric pumps and machinery auxiliaries installed on the lower levels of the machinery spaces were flooded out. The loss of these pumps would have greatly hampered damage control work under actual battle conditions. Accordingly the following is recommended:

(a) Vital motors and motor controllers, i.e. those units essential to the damage control and fighting efficiency of the vessel which must be mounted in the lower levels of the machinery spaces, should be of the submersible type.

(b) That all such submersible type units be arranged for operation from the upper level of the machinery spaces.

L. Lighting Equipment.

There were numerous cases of lamps being broken throughout this vessel. In general, these were the rough service type. Pendant types, high impact types, and some lamps that were mounted on the obsolete spring shock mounts stood up quite well in comparison to the plain rough service lamps without shock mounts. An example of this was in the crew's washroom at frame 145. In one case, a type 9-S-4535L lighting socket was spring mounted, and the lamps did not break. In the same space, another fixture with the same socket was rigidly mounted, and the lamp did break. There was a general indication that where the high impact types or the pendant type lamps could not be used, some sort of a shock mount was required.

M. Searchlights.

Although there was some indication that additional damage had been sustained by the searchlights on this vessel from the underwater blast, the damage that was received from test B could not be accurately evaluated.

N. Degaussing Equipment.

No damage, other than water damage from flooding.

O. Gyro Compass Equipment.

The Mark XI Mod. 4 Sperry gyro compass mounted in the I.C. room experienced severe shock damage, and was completely inoperative. The gimbal suspension springs either elongated or were broken, and the whole gyro element dropped to the bottom of the binnacle. Photograph 1934-1, page 237 shows the damage to the gyro.

The gyro repeater mounted in the steering engine room was dislodged when its mounting column broke. Photograph 4210-2, page 243 shows this damage.

The Mark XVII Mod. 3 Sperry gyro repeater in the pilot house had its cast aluminum mounting column broken.

The port pelorus mounted on the wing of the bridge was bent inboard and slightly forward. This was primarily due to the local hull failure.

Recommendations.

(a) It is recommended that the gyro element supporting mechanism be made more resistant to shock.

(b) The use of cast aluminum for gyro repeaters should be discontinued.

P. Sound Powered Telephones.

Sound powered telephone outlet 9-S-4807L mounted on the forward starboard rail of the main direction platform had its case ripped. This was due to improper mounting. A solid kick pipe was installed from the deck to the outlet. Relative movement of the outlet and the deck caused the pipe to break the case. This damage would have been avoided had a cable connection, as is Navy standard practice, instead of a pipe connection, been made to the deck below.

Q. Ship's Service Telephones.

Not applicable.

R. Announcing System.

Reproducers, Type CNX-49155, Serial 6680, mounted on the port side of the pilot house, and at frame 108 main deck port, had the unit knocked out of the shell from the shock. This was probably due to improper lining up on the mounting screws.

S. Telegraph.

The rudder angle indicator and telegraph mounted in pilot house, Henschel Drawing 10-875 Alt. 1 had its aluminum column broken by the shock.

Recommendation.

The use of cast aluminum for this type of equipment should be discontinued.

T. Indicating System.

No damage observed.

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

No damage was sustained by this equipment other than water damage.

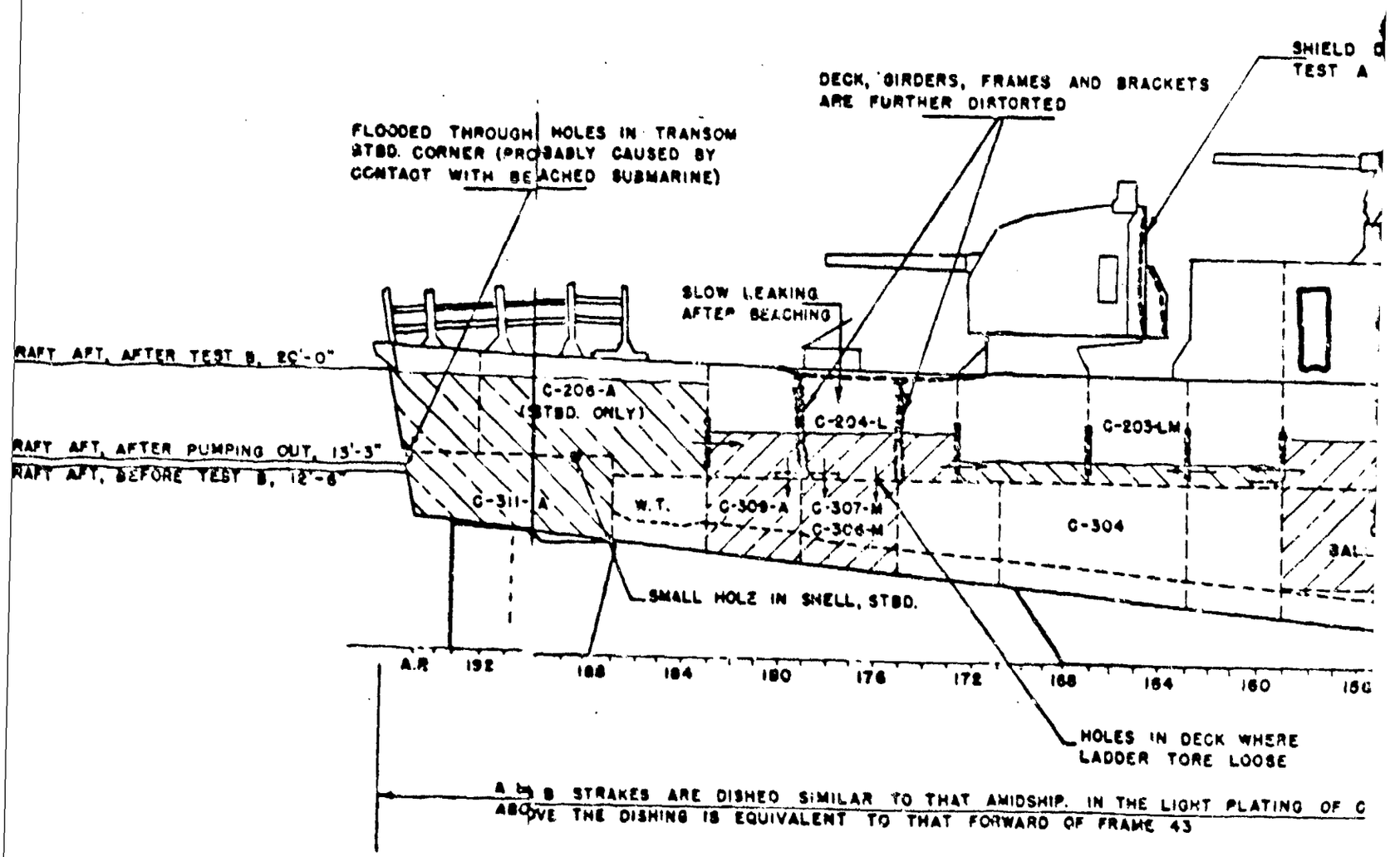
V. F.C. Switchboard.

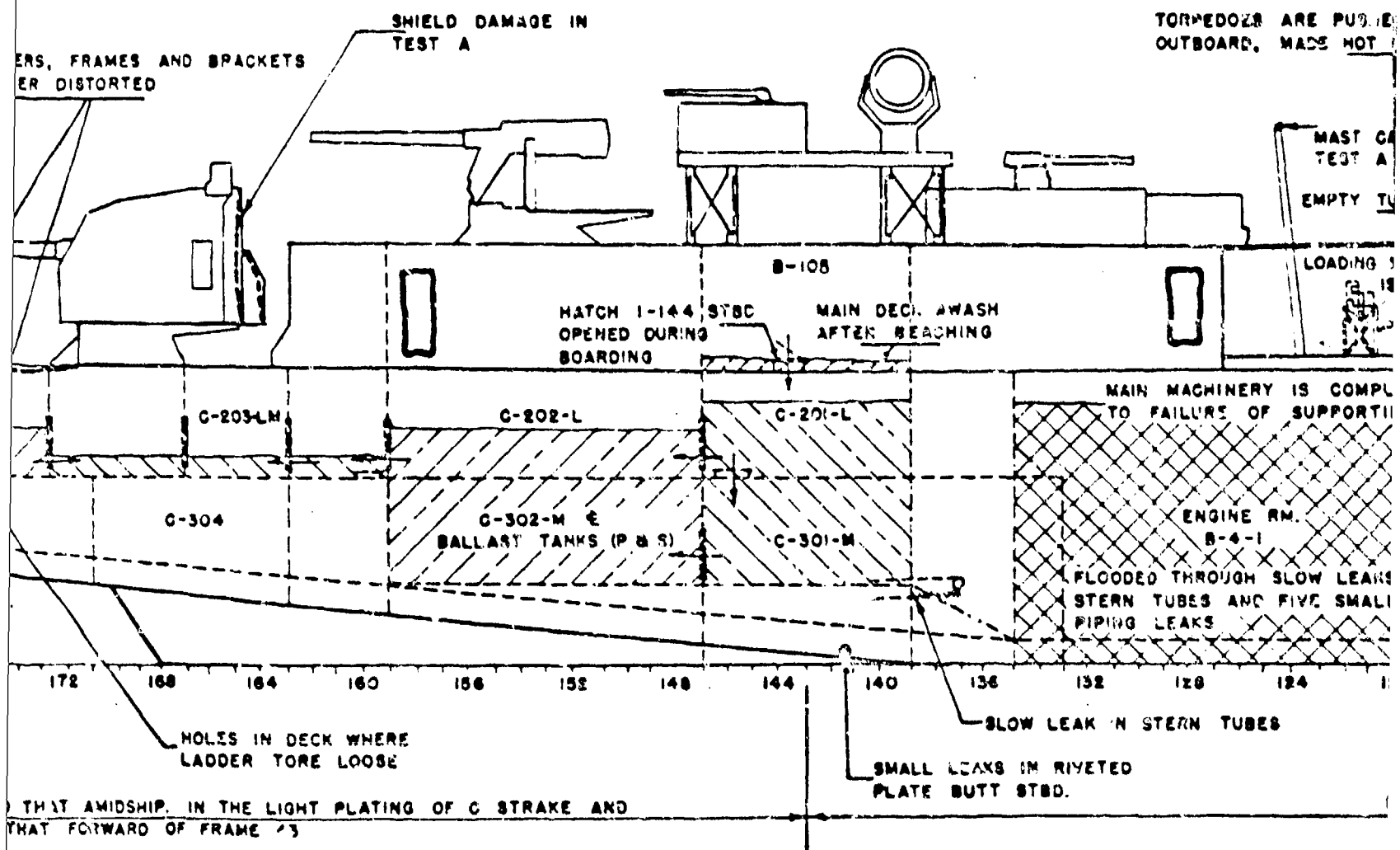
No damage sustained by this equipment other than water damage.

APPENDIX

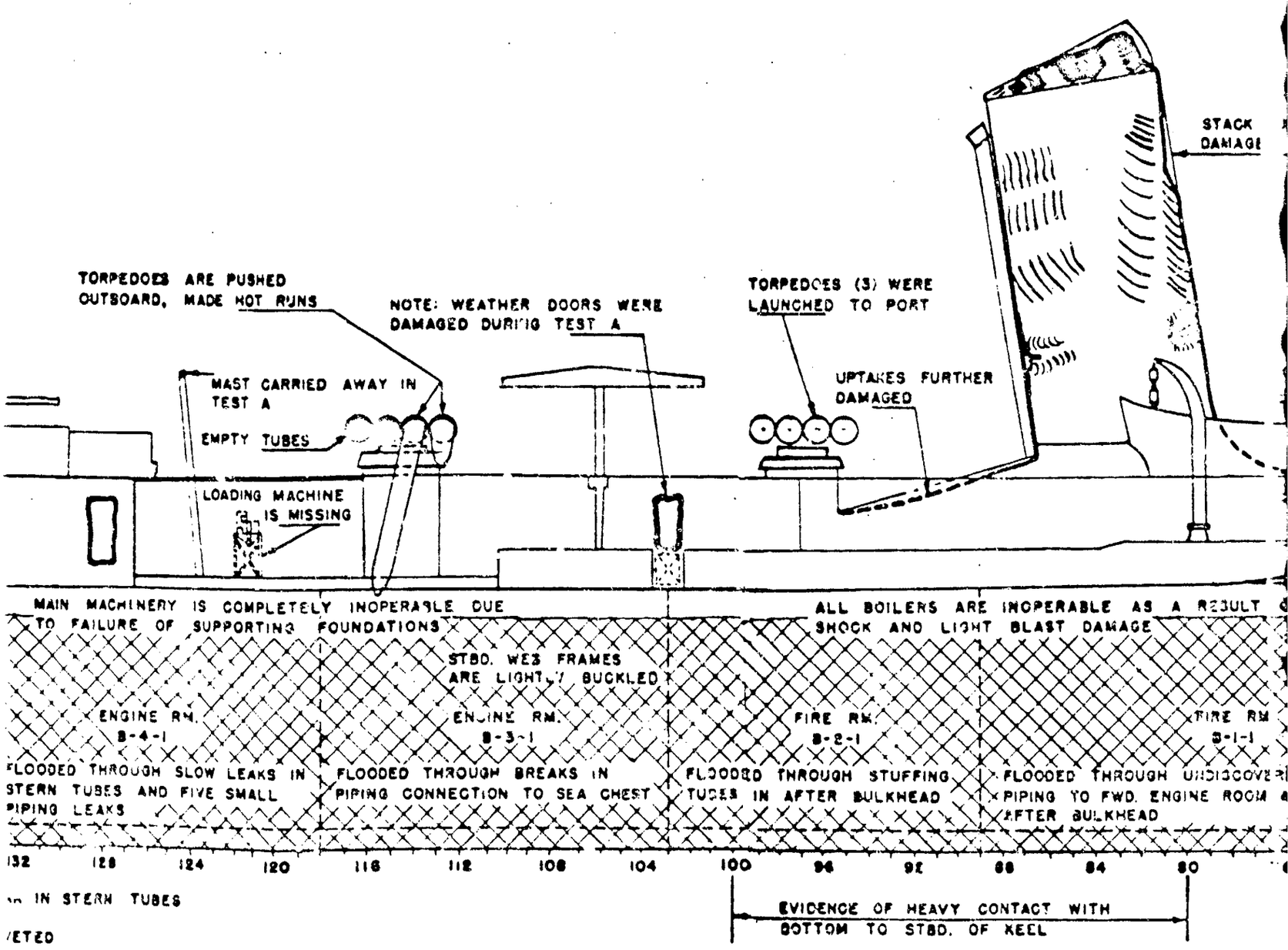
SHIP DAMAGE DIAGRAM

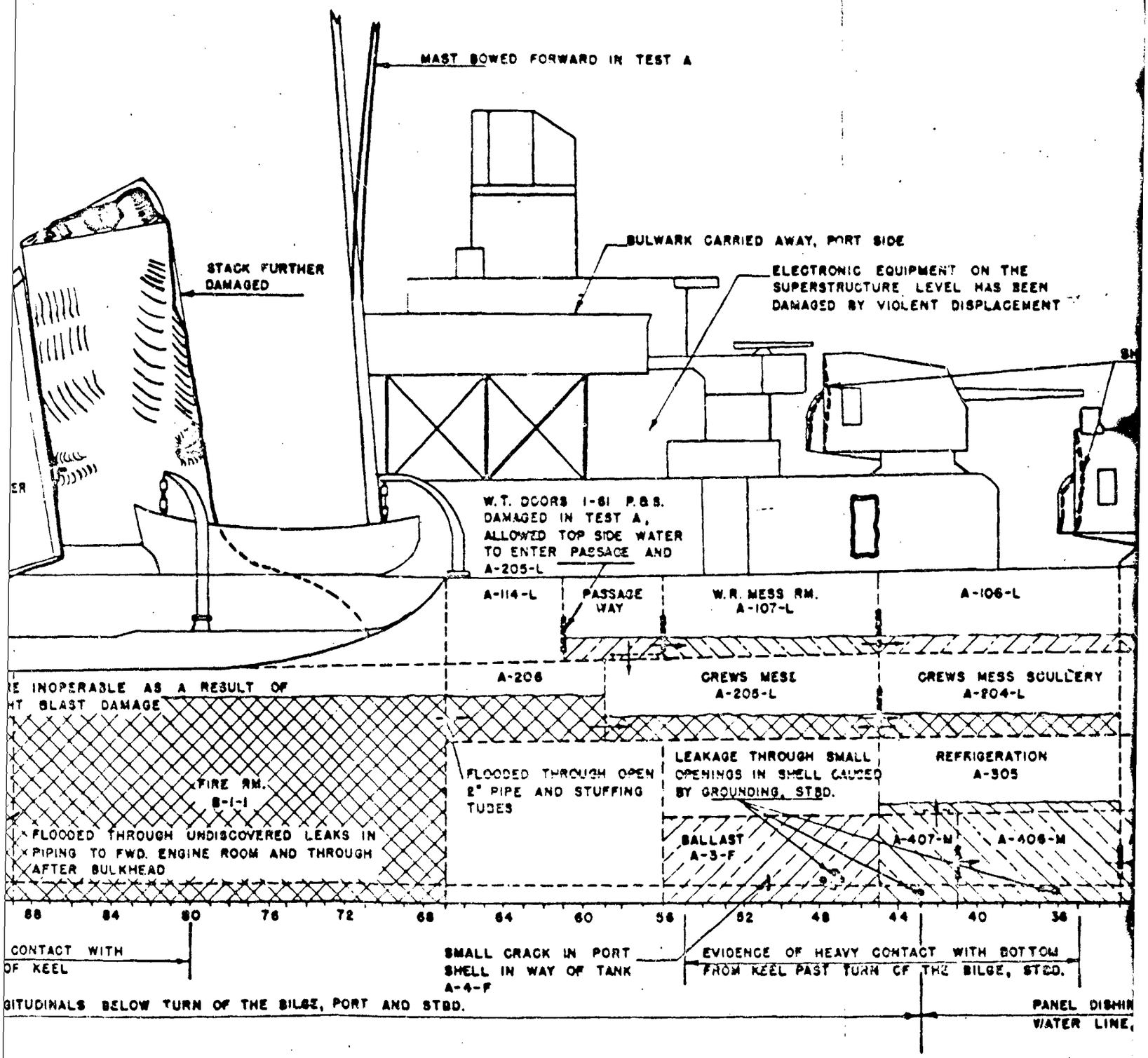
TEST BAKER


DECK, GIRDERS, FRAMES AND BRACKETS ARE FURTHER DISTORTED
FLOODED THROUGH HOLES IN TRANSOM STBD. CORNER (PROBABLY CAUSED BY CONTACT WITH BEACHED SUBMARINE)
SLOW LEAKING AFTER BEACHING
RAFT AFT, AFTER TEST B, 20'-0"
RAFT AFT, AFTER PUMPING OUT, 13'-3"
RAFT AFT, BEFORE TEST B, 12'-6"
C-206-A (STBD. ONLY)
C-204-L
C-203-LM
C-311-A
W.T.
C-309-A
C-307-M
C-306-M
C-304
SMALL HOLE IN SHELL, STBD.
A.R
192
188
184
180
176
172
168
164
160
HOLES IN DECK WHERE LADDER TORE LOOSE
A by B STRAKES ARE DISHED SIMILAR TO THAT AMIDSHIP. IN THE LIGHT PLATING OF C
ABOVE THE DISHING IS EQUIVALENT TO THAT FORWARD OF FRAME 43


ERS, FRAMES AND BRACKETS
ER DISTORTED
SHIELD DAMAGE IN
TEST A
TORPEDOES ARE PU
OUTBOARD, MADE HOT
MAST C
TEST A
EMPTY T
LOADING
B-108
HATCH 1-144 STBD
OPENED DURING
BOARDING
MAIN DECK AWASH
AFTER BEACHING
MAIN MACHINERY IS COMPL
TO FAILURE OF SUPPORTI
C-203-LM
C-202-L
C-201-L
C-304
C-302-M &
BALLAST TANKS (P & S)
C-301-M
ENGINE RM.
B-4-I
FLOODED THROUGH SLOW LEAK
STERN TUBES AND FIVE SMALL
PIPING LEAKS
172
168
164
160
156
152
148
144
140
136
132
128
124
HOLES IN DECK WHERE
LADDER TORE LOOSE
SLOW LEAK IN STERN TUBES
SMALL LEAKS IN RIVETED
PLATE BUTT STBD.
THAT AMIDSHIP. IN THE LIGHT PLATING OF C STRAKE AND
THAT FORWARD OF FRAME

B


STACK DAMAGE
TORPEDOES ARE PUSHED OUTBOARD, MADE HOT RUNS
NOTE: WEATHER DOORS WERE DAMAGED DURING TEST A
TORPEDOES (3) WERE LAUNCHED TO PORT
MAST CARRIED AWAY IN TEST A
EMPTY TUBES
UPTAKES FURTHER DAMAGED
LOADING MACHINE IS MISSING
MAIN MACHINERY IS COMPLETELY INOPERABLE DUE TO FAILURE OF SUPPORTING FOUNDATIONS
ALL BOILERS ARE INOPERABLE AS A RESULT OF SHOCK AND LIGHT BLAST DAMAGE
STBD. WEB FRAMES ARE LIGHTLY BUCKLED
ENGINE RM. B-4-1
ENGINE RM. B-3-1
FIRE RM. B-2-1
FIRE RM B-1-1
FLOODED THROUGH SLOW LEAKS IN STERN TUBES AND FIVE SMALL PIPING LEAKS
FLOODED THROUGH BREAKS IN PIPING CONNECTION TO SEA CHEST
FLOODED THROUGH STUFFING TUBES IN AFTER BULKHEAD
FLOODED THROUGH UNDISCOVERED PIPING TO FWD. ENGINE ROOM AFTER BULKHEAD
132 128 124 120 116 112 108 104 100 96 92 88 84 80
IN STERN TUBES
ETED
EVIDENCE OF HEAVY CONTACT WITH BOTTOM TO STBD. OF KEEL
PLATING IS LIGHTLY DISHED IN LONG CONCAVE SECTIONS BETWEEN LONGITUDINALS BELOW TURN OF THE


MAST BOWED FORWARD IN TEST A
STACK FURTHER DAMAGED
BULWARK CARRIED AWAY, PORT SIDE
ELECTRONIC EQUIPMENT ON THE SUPERSTRUCTURE LEVEL HAS BEEN DAMAGED BY VIOLENT DISPLACEMENT
W.T. DOORS 1-61 P.&S. DAMAGED IN TEST A, ALLOWED TOP SIDE WATER TO ENTER PASSAGE AND A-205-L
A-114-L
PASSAGE WAY
W.R. MESS RM. A-107-L
A-106-L
A-206
CREWS MESS A-205-L
CREWS MESS SCULLERY A-204-L
INOPERABLE AS A RESULT OF BLAST DAMAGE
FIRE RM. B-1-1
FLOODED THROUGH UNDISCOVERED LEAKS IN PIPING TO FWD. ENGINE ROOM AND THROUGH AFTER BULKHEAD
FLOODED THROUGH OPEN 8" PIPE AND STUFFING TUBES
LEAKAGE THROUGH SMALL OPENINGS IN SHELL CAUSED BY GROUNDING, STBD.
REFRIGERATION A-305
BALLAST A-3-F
A-407-M
A-406-M
88 84 80 76 72 68 64 60 56 52 48 44 40 36
CONTACT WITH OF KEEL
SMALL CRACK IN PORT SHELL IN WAY OF TANK A-4-F
EVIDENCE OF HEAVY CONTACT WITH BOTTOM FROM KEEL PAST TURN OF THE BILGE, STBD.
GITUDINALS BELOW TURN OF THE BILGE, PORT AND STBD.
PANEL DISH
WATER LINE,

ARRIED AWAY, PORT SIDE

ELECTRONIC EQUIPMENT ON THE SUPERSTRUCTURE LEVEL HAS BEEN DAMAGED BY VIOLENT DISPLACEMENT

SHIELDS DAMAGED IN TEST A

FLOODED WHILE WASHING DOWN

W. R. MESS RM. A-107-L

A-106-L

A-104-L

A-103-L

MAIN DECK

REWS MESS A-205-L

CREWS MESS SCULLERY A-204-L

1 ST. PLATFORM

KAGE THROUGH SMALL HINGS IN SHELL CAUSED GROUNDING, STBD.

REFRIGERATION A-305

DRAFT

DRAFT

DRAFT

2 ND. PLATFORM

LAST 3-F

A-407-M

A-406-M

A-405-M

A-404-M

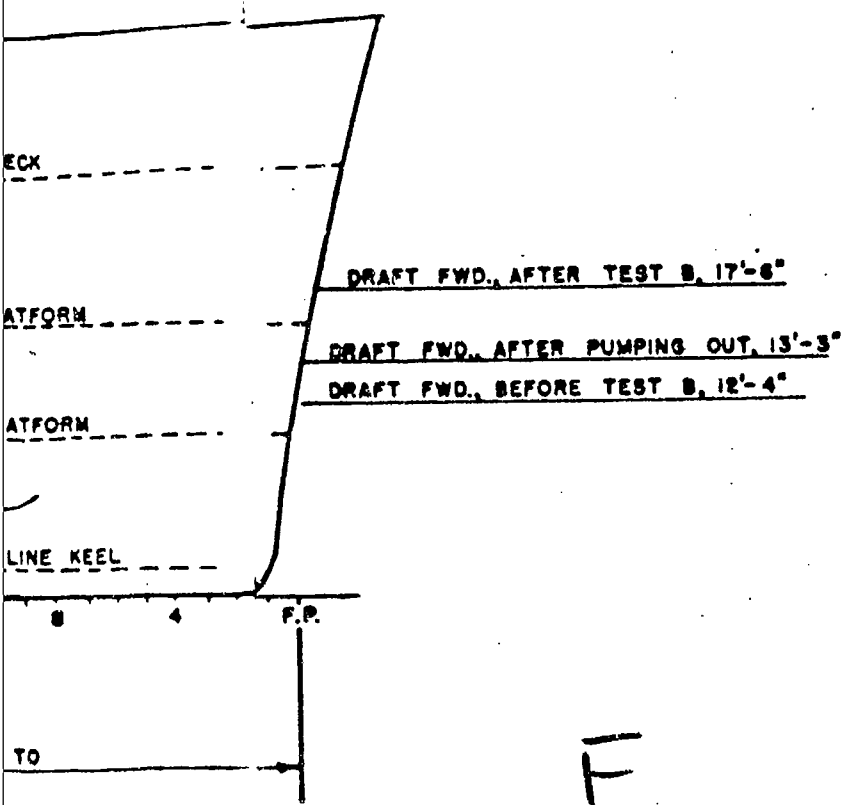
CENTER LINE KEEL

52 48 44 40 36 32 28 24 20 16 12 8 4 F.P.

EVIDENCE OF HEAVY CONTACT WITH BOTTOM FROM KEEL PAST TURN OF THE BILGE, STBD.

PANEL DISHING BETWEEN FRAMES AND LONGITUDNALS FROM KEEL TO WATER LINE, PORT AND STBD.

F



LEGEND

FLOODING INCIDENT TO BEACHING AND WASHING DOWN.

SLOW FLOODING

F

SECRET

NAVY DEPT. BUREAU OF SHIPS

DAMAGE

TEST B

U.S.S. HUGHES DD 410

APPENDIX

SHIP MEASUREMENT DIAGRAM

TEST BAKER

APPENDIX

SHIP MEASUREMENT DATA

Deflection scratch gages.

Vertical deck deflection gages which were installed before test A were again used in test B. A tabulation of gage locations and records is on page 89. In addition, horizontal and vertical long base gages were installed in the after fireroom and after engine room. Locations and readings of these gages are tabulated on page 90.

DECK DEFLECTION GAGES

SHIP DD 410 — TEST B

LOCATION			MAXIMUM	MAXIMUM	PERMANENT SET		REMARKS
FR. NO.	DECK	DIST. OFF ℄	COMP.	EXP.	DISTANCE	EXP. / COMP.	
9 1/2	MAIN	℄	0	0	0	0	
20	MAIN	℄	0	0	0	0	
32 1/2	MAIN	℄	0	0	0	0	
159 1/2	SECOND	℄	1/4"	0	0	0	
172 1/2	SECOND	℄	0	0	0	0	
175 1/2	SECOND	℄	2 3/8"	0	1 5/16"	COMP.	

SECRET

DECK DEFLECTION GAGES

SHIP DD 410 TEST B

LOCATION			MAXIMUM	MAXIMUM	PERMANENT SET		REMARKS
FR. NO.	DECK	DIST. OFF ℄	COMP.	EXP.	DISTANCE	EXP. / COMP.	
96	AFT FIRE RM.	PORT	0	0	0	0	BET. BOTT. SHELL LONG'L & MAIN DECK LONG'L
97	AFT FIRE RM.	STB'D	0	0	0	0	BET. BOTT. SHELL LONG'L & MAIN DECK LONG'L
100	AFT FIRE RM.	HORIZONTAL MIDHEIGHT	0	0	0	0	
120	AFT ENG. RM.	℄	0	0	0	0	BET. BOTT. SHELL LONG'L & MAIN DECK LONG'L
133	AFT ENG. RM.	STB'D	0	0	0	0	BET. BOTT. SHELL LONG'L & MAIN DECK LONG'L
133	AFT ENG. RM.	HORIZONTAL MIDHEIGHT	SHOCK BROKE WELDED CONNECTION ON STARBOARD SIDE.				

8277

APPENDIX

COMMANDING OFFICERS REPORT

TEST BAKER

REPORT #11

COMMANDING OFFICERS REPORT

This report will of necessity overlook many items of importance. It has been impossible in the short time we have had to make the thorough inspection that was made after "A". Where the remark "No comment" occurs does not necessarily mean no damage, rather it means we didn't notice any or didn't have time to thoroughly investigate. Likewise the tremendous amount of flooding and washing down has made the determination of the cause of the damage difficult. Where damage has been due to water it is skipped over lightly, the concentration being placed on what we believe to be bomb damage. Some of the damaged equipment may have suffered much more damage than we have noted, but being unable to operate any machinery by power we have had to base our remarks on quick, visual observations. The ship received a very heavy shock from the starboard quarter. This moved the ship side ways and forward with very rapid acceleration. Heavy equipment, machinery, gun mounts, electronics gear, the loading machine, torpedoes etc. were torn loose, holding down bolts elongated and in other ways subjected to very heavy strain due to the inertia of their bulk. The blow was evenly applied to the ship's bottom and moved the ship's frame whereas these heavy objects tended to remain stationary. Had the blow been concentrated even slightly on any portion of the hull, it is felt that failure of structural members would have been much greater and possibly resulting in total failure. However, this is not the case and the hull though weakened remained relatively intact. Not so the equipment mentioned above. The lighter equipment suffered this inertia shock and later a second inertia shock when the movement of the ship ceased. This caused the lighter equipment which had been thrown from its stowage or torn from its foundation by the first shock wave to pile up against the port bulkheads in the ship. The main steam line, swinging rather loosely after shearing its supports in the first shock also moved to port under the force of the second shock. Boiler bricks are another example. The heavier equipment did not as a rule react to the second shock, example, spring bearings. Where foundation

bolts are stretched the equipment is in some cases slightly displaced and this displacement is to starboard. The loading machine did not remain around for the second shock. It went over the side on the first shock wave, as the ship literally moved out from under it.

SECTION III

SECTION A - HULL

A.

Parts (a), (b), and (c).

Overall condition of the hull is amazing considering the location of the ship, 600 to 650 yards, bearing 085 degrees from the blast. There is no great distortion of the hull. The only ruptures caused by the bomb were shrapnel holes in the fantail. The screws and shafts appear to be undamaged. The rudder was knocked about 10 degrees to port and dished and perhaps slightly ruptured. The "B" strakes on both sides of the keel are slightly dished from frame 10 to 145 starboard. Frames 10 to 51 showed additional dishing caused by grounding, also a half dozen pin hole leaks at frames 45 and 51 caused by grounding, and on the port side from frame 40 to 145. The garboard strake is dished at frame 90 starboard and 105 port. All of this dishing is slight but sufficient to cause crinkling of frames and longitudinals and bulging of bulkheads. The skeg is dished but apparently not ruptured. There is some damage at frame 45 port which appears to have been due to twisting of hull. Bulkheads in ice machine room and magazine below are buckled slightly. This is believed due to twisting of the ship while grounded. At frame 173 there appears to be a slight buckling of inboard bulkhead to C-308-M and in all longitudinals from this point in a line to the port shell plating. The compartments on the other side of this bulkhead are full of depth charges and shelves in the engineers store room C-307-A so we were unable to investigate for signs of distortion, but evidence indicates slight whip of the fantail. Above these compartments the hull damage sustained in test Able and believed due to downward component of force applied on blast tower installed on main deck, was increased and spread. The scratch guage showed a downward movement of the deck of about 3" and a return of 1 1/4". Compartment C-304-M frame 167 centerline division bulkhead shows compression from the top. All frames and longitudinals and beams in C-204 show additional crinkling.

About 75% more other frames, beams, and longitudinals and the bulkhead to the steering gear room show bulging and crinkling that was not apparent after Able. It is our opinion that the fantail whipped around a point at about frame 173. Distortion is noticeable as far forward as frame 147, bulkhead stiffeners at 2nd platform deck level are buckled, and as far aft as frame 183, steering gear room bulkhead. There appears to be a slight distortion to #4 gun mount foundation. This gun trains stiffly, and there is some cracked paint on the gun foundation at the centerline at about frame 172 in the over head of the handling room.

At frame 155 starboard side the web of the frame crinkled just above 1st platform deck. At the centerline in C-302-M just below the 1st platform deck, the beam is distorted slightly and bulkheads are slightly buckled in bulkhead stiffeners at the keel shows very slight temporary distortion. Many of the signs noted above are very slight amounting in some cases to little flaked or cracked paint, in other cases the evidence is much greater, but all tend to show a whipping of the fantail. #4 gun roller patter foundation has been slightly distorted but not enough to prevent operation of the gun. We did not investigate foundation of gun #3 closely, but it is believed to be undamaged, although this gun was hard hit.

The dishing of the B strakes (noted above) caused buckled bulkheads, crinkled frames, and longitudinals, particularly in way of lightening holes every place that an inspection was possible in the hold.

There is a cluster of holes in the starboard side of the fan tail caused by some large portion of the LSM 60 hitting the ship. This caused a general dishing in which distorted the cant frame and bulged and ruptured the deck to the ship fitters shop. The port bulwark was ruptured by one of the torpedoes from the forward mount when they went over the side. However, the majority of the damage to this bulwark was caused by the LCI that boarded the HUGHES while delivering pumps.

The stack and uptakes suffered 100% more damage then that received during test Able. The stack now leans to port; it did lean to starboard. It had been split, ruptured, distorted, and buckled. The port bulwark bridge level was sheared off and is hanging over the side. This is believed caused by the down fall of water. The ship was stern to the blast. It was turned 180 degrees and the down pour of water fell on the forward part of the ship. The door, starboard side of entrance to blower room 0101, which had a webbed frame was buckled, believed due to hosing down, although pressure must have been in the neighborhood of 20 lbs./Sq. in. Starboard forward 20mm gun tub was dished, cause unknown. Stanchions on the starboard side amidships in way of the loading machine are missing, and the catwalk stanchion is broken and bent indicating that the loading machine may have gone over the side to starboard, although it is some slight evidence that cleared the ship to port.

There is an additional shrapnel hole in the forecastle deck and many pieces of what is thought to be the LSM 60 and considerable coral on forecastle deck and superstructure. Stanchions and pad eyes on port side of forecastle are bent in and sheared off in some cases opening up the rounded gunwale. This must have been caused by a tug coming alongside, but this is strongly denied by salvage crews.

The after torpedo mount foundation braces are distorted indication a movement of the foundation aft, probably due to the hot run of the two torpedoes in this mount. The doors to torpedo mounts were open, but they operate normally now and they are believed to have open by an initial boarding team or salvage crew.

(d) Compartments flooded during test Baker and causes.

Crews mess A-205-L, Wardroom country 106-L and 107-L were all flooded by water coming in door at break of forecastle. These doors were blown off in test Able and jury rig doors lashed in place. The amount of water taken aboard in this manner and in these spaces is believed to have been very small to negligable. Compartment A-104-L forward of officers country took on some water through #1 gun mount. All spaces in the superstructure took on some water from wardroom country through missing doors.

Amount taken from the bomb unknown, since more came in when washing down. All of those spaces were filled to level of the coaming. A-204-L took some water from wardroom country through hatch 1-37 which was jammed open. It is felt that the amount of water due to the bomb received and retained in these compartments was small to negligible. Compartment A-206 was flooded from the forward fire room B-11 through cable runs and through a broken line in the diesel room. This was a 3/4" drain line from the dry tank to the fire room bilges. It was broken in the diesel room and unfortunately the valve in this line was left open. However, the IC room and sick bay were flooded through the stuffing boxes and it is assumed the diesel room would have flooded in the same manner even if this drain line had not been broken. The forward fire room was flooded completely. Salvage crews have reported a definite flooding connection between the #1 fire room and #1 engine room. Ships force has not located this trouble but has eliminated the main and auxiliary steam lines, the main drain and the feed water piping. There was considerable lube oil in these spaces. However, the 5 gallon lube oil tank in #1 fire room was knocked off it's foundation and broken and guage glass on tank in #2 fire room was broken. Also there are no lines from engine room to fire room on these systems so that a cross connection is impossible. The high pressure drain system was eliminated leaving only the low pressure drain systems, the fire main, the cooling main, the fire and diesel systems as possible cross connections. Time was not available to test these systems although no broken piping was located in any of these lines. The salvage gang is still positive that #1 fire room flooded from #1 engine room. There were no leaking tanks and the entire outer skin of the ship in the fire rooms were intact except for dishing in the bilges which will be discussed later.

The #2 fire room was reported to be hooked up with the after engine room in the same manner as the #1 spaces. The check of these spaces did not proceed quite as far as in the other two in that the main drain was not checked. Compressed air systems were not checked, but are considered highly unlikely.

The forward engine room B-3-1 had the worst leaks of any place in the ship. The main one which was leaking about 200 gal.

a minute was in the lube oil cooler discharge outboard of the discharge valve and inboard of the junction of this line with the main condenser overboard. The line apparently failed from force of the shock on it and had been weakened by electrolysis, errosion, corrosion, etc. This leak has been stopped by driving a plug in the 8" lube oil cooler discharge line at the junction with the main overboard. The suction valve does not hold nor does the main condenser injection valve, but the discharge valve is almost tight allowing only 500 gals. per day to pass through the valve. A sea clamp 2 1/4" wide with a rubber gasket was placed around the pipe at the leak and when taken up stopped the remaining flow of water which had been about 500 gal. per day. There was one other pin hole leak in a steaming out connection to the dynamo injection sea chest. This was stopped with wrapping. The after engine room B-4-1 had several small leaks as noted below.

1. Ruptured steaming out connection to sea chest for evaporator circulating pump. This was plugged and wrapped with rags.

2. A broken fresh water guage glass line indicating that there is a leak from the salt to fresh water side of the after condenser.

3. Leak at the bulkhead flange of the stern tube stuffing box housing. This leak is small but could not be repaired because of inaccessibility.

4. A broken vent line on the condenser which was plugged with a wooden plug.

5. Broken relief valve discharge side of fire and bilge pump. Plugged.

6. Broken draw line salt water side lube oil cooler. Plugged.

All fresh water tanks, coffer-dams and fuel tanks are intact except C-7 which has a pin hole leak in a seam at frame 141 1/2 starboard side. This was caulked. C-311-A flooded due to a crack at about frame 190 (pin hole leak) and several holes in the starboard side of the fantail made by shrapnel. These holes are from 1" to 3"

in diameter, one about 2' above the water line in the stern plating and a cluster of holes about 6" below the water line at the junction of the bottom, the side plating and the stern plating. A plate with rubber gasket was bolted over the cluster of holes and the pin holes leak was caulked, however it is felt this compartment will flood again in time, probably in a week or two. The deck of the ship fitters shop C-206 was flooded from below by ruptured deck which will be discussed later. Door 2-183-1 was jarred loose and permitted flooding of crews quarters C-204-L. The smoke screen generator room, the sail locker and the steering gear room did not flood at this time. The water in C-204-L seeped through the flush deck hatches and flooded bulk stores C-309-A and magazines C-306-M. This water also came through holes in the deck where ladder securing brackets had torn holes in the deck. All other compartments and tanks and voids were to the best of our knowledge not flooded during test Baker. This results in taking on the following approximate number of tons of water.

C-311-A	27			
C-309-A	17			Using 23.5 tons/in. submersion gives increase in draft of 6 1/2' leaving from 6" to 8" of freeboard.
C-306-M	11			
C-204-L	4/5	Flooded of	112 - 90	
B-4-1	.9	"	434 - 390	
B-3-1	.9	"	392 - 353	
B-2-1	.9	"	385 - 336	
B-1-1	.9	"	537 - 483	
A-206	.9	"	106 - 95	
Other Water			20	
Total			1822 Tons.	

The additional flooding occurred due to being beached. At frame 45 there was a badly dished panel with about a half dozen pin hole leaks. The majority of this dished spot and all of the leaks were caused by beaching as the coral sand is firmly ground into the hull in this area. A-407 is flooded and the doors in this area were sprung and dogs loosened due to the blast causing flooding of A-406, A-405 and A-404. These spaces constitute the forward magazines. Some small amount of water also came through the

hatch into the ice machine room A-305. When the ship beached and the above compartments flooded she was sitting firmly on the bottom and at high tide the water came over the deck and into the starboard head B-105. The hatch to crews living quarters C-201-L had been opened, it is believed by the salvage crews, but might possibly have been due to bomb shock. C-201-L and C-202-L flooded solid on the starboard side and to depth of 5' on the port side. The ship was listed to starboard after grounding. C-203-L flooded to depth of 2' starboard, dry to port. This flooding was due to connecting doors 2-147-1 and 2-159-1 being loosened by shock. These spaces constitute the after living space. Hatch 2-146 and door 3-147 did not hold and magazines C-301 and C-302 were flooded. This is all of the flooding caused by beaching. These spaces did not and would not have taken water except for the beaching. Flooding due to washing down: CPO mess room A-103-L is the outstanding example. All superstructure and spaces above the main deck took varying amounts of water from washing down. Most of this water ran out again. Some water came into the handling room from gun mounts. Steering aft took on some water in this manner through hatch 1-183 which was open and more water when the door to the living spaces C-204-L was opened. The same occurred in the sail locker when door 1-183-4 was opened.

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

It is felt that the tremendous amount of crinkling and buckling has greatly reduced the rigididity of the hull, but it is felt that the hull retains about 80% of its strength. Buoyancy was practically unchanged. Operability was slightly reduced due to above mentioned loss of rigidity. The ship is very sensitive to light blows.

B.

(a) This item has been covered in item Able to the best of our observations. The following additional items of minor interest are added:

Garbage can rack missing.
Reel of manila on fantail missing.

MK22 and MK4 radars further mangled.
Searchlight more thoroughly demolished.
Mounting on MK14 sight on starboard MK51 director sheared off.
All but one horizontal aerial broken again.

(b) All our damage caused by shock blast.

(c) There is no evidence of fire anywhere on the ship.

(d) No estimate can be made at this time on this section other than the comments made in report of Test Able. Much more thorough investigation is required.

(e) Same as for test Able with emphasis on keeping away from this bomb.

E.

(a) This is covered in Item Able.

(b) Deck is still fully useable.

(c) The forward boat davit is slightly distorted but operable; all other equipment normal except the wire netting in port after life net stowage which is missing.

F. Covered by Item Able.

G and I, Item H does not apply.

(a) Covered by Item Able.

(b) About the same as from test Able. Suffered some additional damage due to washing down.

(c) Dogs on doors and hatches were in the majority of cases loosened. The effect of this loosening is covered in the description of ship's flooding. Most of the topside fittings were missing from test Able.

(d) Condition of equipment within compartments: Ruined, wrecked, and demolished. All bunks, most lockers, most stowages, all chairs, most tables, most projectiles and powder cans, all loose equipment, boiler floor bricks, gratings in most spaces and some electronics gear etc. were hurled across the compartment and piled up in port forward corner.

(e) There is no evidence of fire.

(f) Damage in way of piping has been discussed under flooding in Item Able. Many cables were stretched, torn, and broken when equipment to which it was attached was hurled off its foundation. Stuffing boxes were believed to be loosened; in any event they leaked. Ventilators systems were parted throughout the ship. Many light bulbs were broken, more forward than aft.

(g) Compartments were absolutely unliveable in their present condition. Water tight integrity has been discussed under Item Able.

J. Covered under Item Able.

K. Covered under Item Able.

L. Covered under Item Able.

M. Ventilation.

The vent ducts were parted in almost every part of the ship due to the shock. Blower motors, fans, closures etc. were not tested in any manner because of radiological hazards. The possibility of some of the flooding that occurred such as between magazines may have been through the vent system, but if so this was not noticed during our inspections. Very little attention was given to vent systems because of the limited time.

N.

Ship control was not inspected very thoroughly because of radiological activity in the superstructure, the damage done by washing down. Additional damage due to the bomb was mainly to

the gyro compass which was thrown out of its gimbals. It was completely demolished. Phone jacks and hand sets were torn down or knocked off in some cases, and it is felt the systems were sufficiently grounded out to be useless. CIC was a mess of spare parts and equipment. The SC radar was knocked loose and thrown into the center of the room; other equipment was in general put out of commission. The steering gear lost oil from the expansion tank but operated normally in manual operation. Due to secondary flooding it could not be tested with power as everything was shorted out. The anchor windlass operated normally when emergency power was supplied. There may be other damage to the ship control system, but the inspection was too limited to reveal more.

O. Fire Control.

This is covered sketchingly in the gunnery portion of this report. Inspection was not as complete or thoroughly as was possible in other sections of this report.

P, Q, R and S are covered as thoroughly as was possible in other sections of this report.

SECTION III

SECTION B - MACHINERY

A. General description of machinery damage.

(a) The overall condition of machinery is not good. Most of the machinery will turn over by hand in fact every piece tested did so, but that is no indication that when brought up to speed the accumulative effects of the bomb would not prove fatal and the machinery turn out to be inoperative. It is recommended that all the machinery on the ship be soaked down with consol oil or tectyl and tested with power at a later date.

(b) Damage to machinery is general and is in direct proportion to its weight.

(c) The cause in all cases appears to be inertia with elongations, or shearing of holding down bolts or failure of supporting members.

(d) The plant was definitely put out of commission and is inoperable.

B. Boilers.

#1 Boiler: This was the boiler that was patched after test Able, on the saturated steam side. The brick work on the side wall was knocked out from the mud drum down to within 2' of the deck. The top of the back wall near the steam drum on both sides lost some bricks. The front plastic wall is cracked and the deck bricks are completely ripped up. The deck pan appears to be undamaged. The tubes and drums are undamaged. A 140 pound hydrostatic pressure test was put on this boiler and the pressure dropped to 110 pounds in 15 minutes due to a leaky hand hole plate. The superheated side of this boiler suffered same damage as saturated side. The side wall was torn down from the mud drum to within 1 1/2' of the deck.

The deck was completely ripped away, front plastic cracked, and a few bricks missing from top of rear wall.

#2 Boiler Saturated side: The deck was completely ripped up, the side wall torn down from the mud drum down to within 2 1/2' of the deck. The plastic front wall was ripped away and more bricks are gone from the rear wall. This latter is additional damage over test ABle. Superheated side: The deck is ripped up, the front plastic and brick fell from the back wall. Drums and tubes appear to be undamaged. A 140 pound hydrostatic test dropped to 120 pounds in 15 minuted due to leaky superheater drains not result of test Baker.

#3 Boiler. Saturated side: The deck is completely ripped up and the brick work pushed downward about 8". The side wall bricks are torn down from the mud drum down to within one foot of the deck. No added damage to front and rear walls. Superheated side: Side wall is torn down from mud drum to within 1 1/2 feet of deck. The deck is completely ripped away. No added damage to front and back walls.

A 130 pound hydrostatic test on #3 boiler dropped to 125 pounds in 20 minutes. There are no visable leaks in this boiler and drums and tubes are apparently undamaged.

The sliding feet and saddles on all boilers appear to be undamaged although frames in the bilges under the boilers are slightly crinkled, apparently from the dishing in the B strakes on both sides of the ship in this area.

There is little additional damage to the air casings below the main deck level. The topside damage to the uptakes was 100% more than after Able. The stack leans as much to port as it did to starboard. There are additional cracks and distortion.

The gratings in the fire rooms on the lower level were knocked about and their supports badly bent, bolts shearing in some cases. There is no damage to fuel oil tanks other than noted in Item Able of hull report.

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C. Blowers.

Number 1, 2, 3 and 4 forced draft blowers were turned over by hand and appear to be undamaged. Numbers 5 and 6 blowers were laid up with tectyl and are now frozen, perhaps due to the flooding, but not believed due to primary bomb damage.

D. Fuel oil equipment and miscellaneous boiler room gear:

#1 Fuel oil service pump apparently undamaged.

#2 Fuel oil service pump frozen apparently due to flooding.

#3 and 4 fuel oil service pumps were laid up with tectyl and appear to be undamaged.

#1 and 2 emergency feed pumps are undamaged although #1 was already out of commission due to lack of spare parts.

#1 and 2 fire and bilge pumps undamaged.

#1 and 2 hand fuel oil pumps undamaged.

Fuel oil booster pumps and fuel oil transfer pumps apparently undamaged.

Piping in the fire rooms will be covered later under Item V.

E. Boiler feed water equipment.

(a) Heaters #1 and #2 feed heaters appeared to be undamaged, but no test was conducted.

(b and c) The surge tanks #1 and #2 were apparently undamaged. They were full of water before and after the test. All feed bottoms were undamaged.

(d) No comment. Pumps are treated elsewhere.

F.

Main turbines were rather heavily damaged. The flexiplate on both L.P. turbines and condensers dropped about 2 1/2 inches and are resting in the bilges. 3 anchor bolts are loose on the after end of the after L.P. turbine. The foundation of the forward H.P. turbine buckled slightly. Time limited any further observation of the main turbines.

G.

Reduction gears in after engine room appeared to be undamaged. In the forward engine room the quill shaft cover on the L. P. turbine was broken at the after end. More extensive examination was not possible. Gears are rusting badly.

H. Shafting and bearings.

Spring bearing. Holding down bolts stretched and loosened, bearings moved upward and possibly slightly to starboard. The leak around the bulkhead flange of the starboard stern tube gland housing has been described under Item Able of the Hull section.

I. Lubricating systems.

The leaks in the cooling system (discharge line forward and drain line aft are covered in Item Able of Hull section.

J. Condensers and air ejectors.

#2 main condenser and the dynamo condenser have leaks from the salt to fresh water side as shown by the pressure on fresh water side guage lines, one of which was broken on #2 main condenser and constituted a leak in the after engine room. Both condensers dropped about 2 1/2 inches and are resting in the bilges. The vent line on salt water side of #2 condenser was also broken causing another leak in this engine room. No damage to the air ejectors was noted.

K. Pumps.

#2 main feed pump has 6 anchor bolts loose on forward end and starboard side. #1 main feed pump has one loose bolt. Both pumps were jacked over with no difficulty and no apparent damage to connecting lines. #1 and #2 main and cruising condensate and booster pumps jacked over by hand and appear to be undamaged. Fire and bilge pumps appear to be undamaged except #4 which has a broken relief valve which contributed to flooding in the after engine room.

Lube oil pumps appear to be undamaged. All other pumps were jacked over and appear to be normal.

L. Generators.

#1 and #2 main generators were dropped about 4" due to failure of foundation. The turbines and gears are undoubtedly out of alignment. They were not jacked over and holding down bolts appear to be normal. These are larger generators (250KW) than the original installations (150KW).

M. Propellors appear to be in perfect condition.

N. Distilling plant anchor bolts on both effects were stretched and loose. No tests of any kind were attempted on this unit.

O. Refrigeration plant suffered no visable damage.

P. Anchor windlass operated normally on emergency power from an LCI, other winch was not tested, appeared to be undamaged.

Q. Steering gear lost oil from the expansion tank and was grounded out by flooding, but operated normally in full manual control. Apparently undamaged by the bomb.

R. Ammunition hoists.

Dredger hoists appear to be normal. Upper hoists are too fragile. Three of the four are inoperable.

S. Vent systems: No comment.

T. Air compressors.

Appear to be undamaged but were not jacked over.

U. Diesel generator was flooded out. It was not jacked over but from visual inspection appeared to be undamaged by the blast.

V. Pipe lines.

(a) Main steam: The main steam line from #1 boiler had all hangers broken in the forward fire room and the line sagged about six inches. The expansion joint between forward and after fire rooms was pulled out about eleven inches. The steam from #2 boiler has two broken hangers and the main steam from #3 boiler has one broken hanger. The main throttles in the forward engine room dropped about six inches. The starboard main steam line in the forward engine room broke its hanger and sagged slightly to port about six pulling out the expansion joint. The hanger bolts on the main throttle in the after engine room were torn out on the starboard side. A 105 pound hydrostatic test was put on the main steam line and no leaks found except on packing glands of main throttles.

(b) Auxiliary steam lines were tested hydrostatically at 130 pounds and no leaks found except around a few packing glands. In the fire rooms the port auxiliary steam line sagged about two inches at the bulkhead leading into the after fire room.

(c) No test was made on auxiliary exhaust lines.

(d) The feed discharge lines were tested to 130 pounds. No damage found in enginerooms. The expansion joint on the starboard feed line pulled out about six inches, sagged about 3 inches and was partially ripped away from the after bulkhead of the forward fire room. All other feed piping was inspected visually and no damage noticed.

(e) No test was made on fuel oil piping.

(f) No test was made on lube oil piping.

(g) No test was made on fire main piping.

(h) Condenser circulating water piping was undamaged except for broken vent line aft and pin hole leak in steaming out connection forward. After main condenser and the dynamo condenser here leaks from salt to fresh water side.

(i) No test was made on drain piping although it was eliminated as a source of leakage between forward engine room and any other spaces.

(j) No test on compressed air systems.

(k) Hydraulic systems undamaged except for loss of oil in expansion tank of steering gear. Depth charge release and gunnery hydraulic systems not checked.

(l) No gasoline.

(m) Other systems: No comment.

W. Bearing leaks.

Before test Baker	Result of Bomb	Post test readings
Forward bearing	Forward bearing	Forward bearing
Fwd. 014	.0035	.017
Mid. .0115	.003	.012
.0115	.003	.012
Aft. .011	.0035	.0125
After bearing	After bearing	After bearing
Fwd. .010	.0035	.011
Mid. .014	.003	.015
.014	.003	.015
Aft. .0105	.0025	.0105

SECTION III

GUNNERY EQUIPMENT

5"/38 Guns. All guns when first test operated in both train and elevation except #1 which would not train. The gearing in #1 is either stripped or disengaged. All guns are very tight, especially #3 and #4 in elevation. All telescopes are badly fogged, probably from the many was[illegible]ings received by the ship. The bulkhead stowage of projectiles in the mounts and handling rooms and the bin stowage of powder and projectiles in the magazines proved very unsatisfactory. Ammunition was thrown all over the stowage spaces. The projectile hoists to the guns proved extremely vulnerable in the shafting and linkages, and only 1 of the four hoists was operable. Trunnion bolts and counter weights are loose, and the safety link in mounts #1 and #4 parted. The breach block of gun #3 binds.

40mm. The guns themselves appear undamaged. On the port mount the elevation positive stop was blown off.

20mm. No comment.

Loading machine. The machine was blown over the side due to structural failure at the trunnion bolts. Only 1 of the 4 holding down bolts were sheared. The carriage itself was cracked in one place.

MK51 Director. The MK14 sight on the starboard director was blown off the director when the mounting failed. Only 2 air hoses held it to the director. On all MK14 sights the ray filters were frozen, but the sights appear in satisfactory condition otherwise. The elevation locking pin of the starboard director was jammed. The trunnion bolts on the port director were sheared.

Torpedo Mounts. The 2 mounts operate satisfactorily in train. All door mechanism are operable. According to reports received, the 3 torpedoes in the forward mount (which was trained to port) were launched. The 2 in the after mount (trained to starboard) were pushed forward in the tube and were hanging down on deck.

Plotting room. Computer: All knobs and hand cranks are either frozen or are excessively tight. Stable element: The top cover windows were shattered. The gyro gimbal rotation gearing was destroyed.

MK37 Gun director. The director is frozen in train, but there is no apparent damage to elevation. The MK4 and MK22 antennae, badly damaged by test Able, were further damaged by test Baker. The antennaes were pushed to port and are completely mangled.

MK27 Torpedo director. The torpedo speed and gyro angle knobs are frozen.

It is regretted that this portion of the report is so sketchy, but there was no time for more careful study and damage from washing down that casual visual examination was not enough.

SECTION III

SECTION C - ELECTRICAL

Flooding was so general that almost all electrical equipment was grounded out and no test was possible. The anchor windlass was the only piece of equipment tested and it was normal. The gyro compass was thrown out of its gimbals and it dropped. The repeater in steering aft was broken loose from its mountings. The diesel generator and all switchboards and the IC room were all grounded out from flooding. The 36 inch searchlight was further demolished.

SECTION III

SECTION D - ELECTRONICS

(a) General electronics damage.

Damage to electronics equipment was heavy. Very little equipment remained operable. In nearly all cases, equipment was soaked by salt water and many units were jarred heavily, straining cables and breaking some tubes. In some cases, gear was torn loose from shock mounts completely. Damage to ship equipment and cables prevented application of power. Nearly all gear could be considered inoperable.

(b) MK4 #1231, Location: CIC gun director.

Both deyer tubes shattered, main frame shocked and jarred badly, one meter cracked. Voltage regulator unit has beentaken for further test. No evaluation of damage to these removed equipments could be made of course, since they were removed prior to the writer's inspection.

(c) MK4 automatic fire control unit. Location: Radar transmitter room.

Torn completely from shock mounts, cables strained, possibly broken internally, badly jarred.

(d) MK22 #518.

Salt water soaked, jarred, and some units removed for further investigation.

(e) SG-1 #655.

Salt water soaked, equipment badly jarred, one meter smashed in transmitter unit, VC remote PPI scope in pilot house completely overturned, torn from mounts, and smashed. Very little damage except from salt water to control-indicator unit.

(f) SC-2 #115.

Transmitter unit water soaked and jarred badly. Indicator unit knocked from mounts and smashed on deck. One unit removed for further investigation.

(g) I, J. Radio transmitters and receivers.

All of the following radios and transmitters were soaked by salt water. Some received damage from shock, as indicated.

RAK/RAL	Emergency radio, jarred from shock mounts.	
RAK/RAL	Radio 1.	
TAJ/6	Emergency radio.	
TDQ/RCK	Radio 1.	
RBA/2	"	
RBB/2	"	Gear jarred badly, cables strained.
RBC/2	"	
TCS/1?	"	
TBL/2	"	
TBS/	"	Cables strained and gear jarred badly.
TBK/5	"	
RBO	"	

(h) Radio transceivers.

MN salt water soaked, jarred from mounts, hanging by cables. MAN torn completely from mounts, smashed on deck. SCR-608 No apparent damage, except from salt water.

(i) QGB #479 Location: Chart house, lower sound room.

No apparent damage other than from salt water. Lower sound room dry; gear apparently undamaged; condition of sound head undetermined.

(j) DAS-3 Loran. Location: Chart house.

Torn from mounts, jarred and smashed in places. Removed for further study.

(k) LR-1 #96. Location: Radio 1. Frequency meter.

Water soaked and jarred.

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

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.**

Ardith Jarrett

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