AD NUMBER

AD366710

CLASSIFICATION CHANGES

TO: unclassified

FROM: confidential

LIMITATION CHANGES

TO:

Approved for public release, distribution unlimited

FROM:

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AUTHORITY

DSWA ltr., 10 Apr 97; DSWA ltr., 10 Apr 97

BUREAU OF SHIPS GROUP

TECHNICAL INSPECTION REPORT

U.S.S. PENSACOLA (CA24)

TEST ABLE

Defense Atomic Support Agency
Washington, D. C. 20301

VOLUME 1 OF 2

OPERATION CROSSROADS

DIRECTOR OF SHIP MATERIAL

1 JAN 1965

JOINT TASK FORCE ONE

SECRET

REG. NO. [redacted]

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CONFIDENTIAL

BUREAU OF SHIPS GROUP

TECHNICAL INSPECTION REPORT

APPROVED:

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

SECRET

U.S.S. PENSACOLA (CA24)

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CONFIDENTIAL

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U.S.S. PENSACOLA (CA 24)

SHIP CHARACTERISTICS

Building Yard: New York Naval Shipyard.

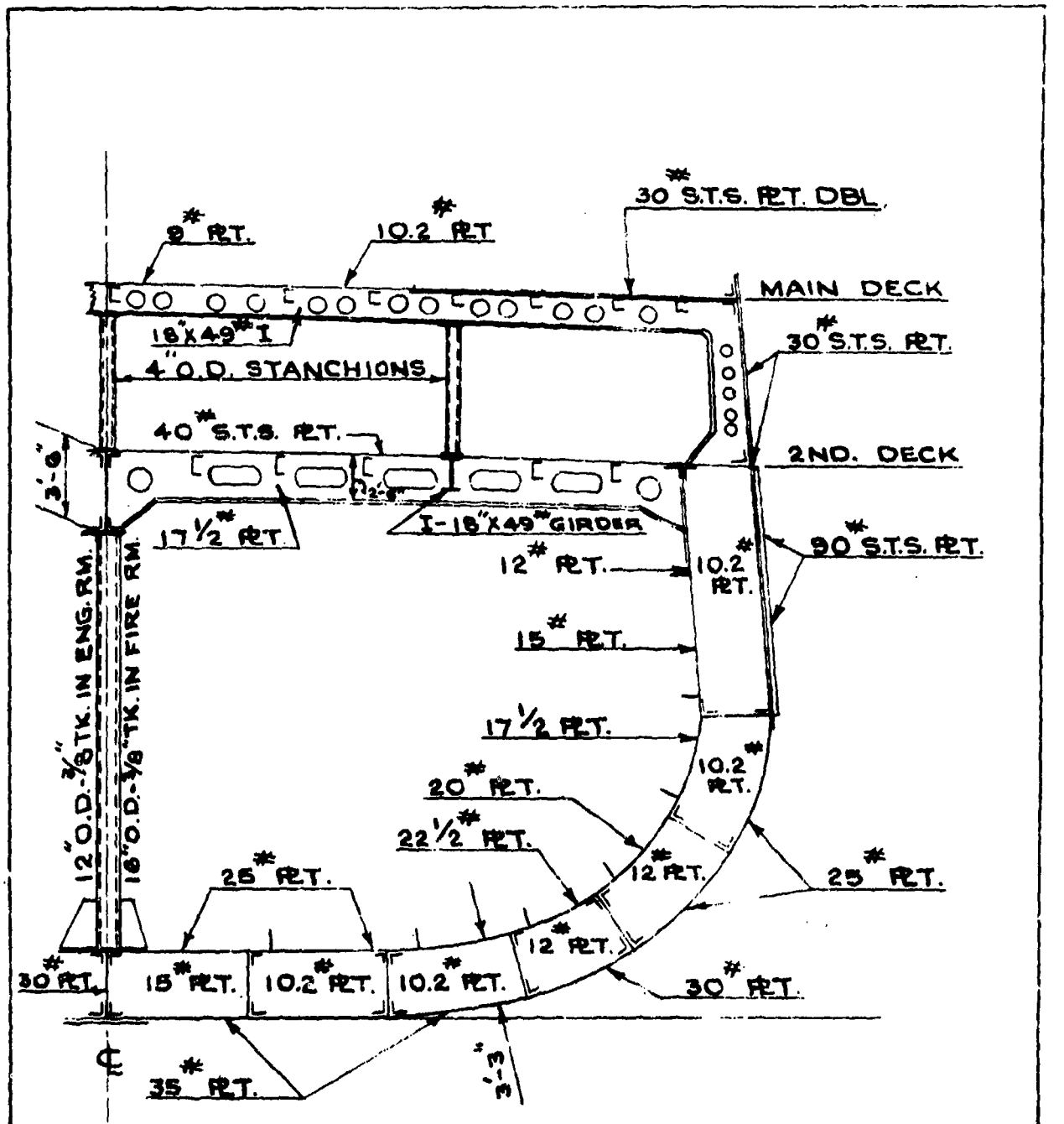
Commissioned: 6 February 1930.

HULL

Length Overall: 585 feet 8 inches.
Length on Waterline: 570 feet 0 inches.
Beam (extreme): 65 feet 3 inches.
Depth (molded at side, to main deck, amidships): 34 feet 1/4 inch.
Drafts at time of test: Fwd. 21 feet 6 inches.
Aft. 21 feet 1 inch.
Standard displacement: 9,100 tons.
Displacement at time of test: 12,840 tons.

MAIN PROPULSION PLANT

Main Engines: Four sets of Turbines installed.
Type: Parsons, Mfg. by New York Navy Yard.
Reduction Gears: Four sets single reduction. Mfg. by De Laval.
Main Condensers: Four installed in ship.
Boilers: Eight installed in ship. Type: White-Foster
Steam press. 300 psi gauge. Temp. 422° F.
Propellers; Four installed in ship.
Main Shaft: Four installed in ship:
Turbo Generators: Four installed in ship. 250 K.W.



TYPICAL MIDSHIP SECTION

TEST A

5634

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

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

HULL

There was no flooding and consequently no change in drafts as a result of the explosion.

(b) Structural Damage.

HULL

There is minor dishing of the weather deck between the bow and frame 60 with some slight buckling of joiner bulkheads below, particularly between frames 10 and 20. Minor cracks appeared in built up riveted frames in the same area. Between frames 60 and 72 the deck failed with a resulting dish about two feet in depth. The failure is manifested by parting of riveted seams, port and starboard, just aft of the uptake deckhouse. Beams and longitudinals below, with their supporting stanchions, failed completely. Slight dishing of the weather deck, with resultant damage to beams and longitudinals below, took place between frames 72-109 and 113-119. Severe dishing (12" - 18") occurred between frame 122 and stern and distorted structure below it. Damage to partition and other bulkheads between main and second decks was apparent in varying degrees between bulkhead 48 and stern. This was most pronounced between frames 60-72 and aft of 119. Closures, doors, and hatches were undamaged except in regions of boiler room uptakes, frames 60-72, and aft of 119. There was some very mild dishing of the shell, port and starboard, between frames 10 and 20, and, between frames 91 and 113, starboard.

Major superstructure damage appears on the starboard and after faces. Pole masts were bent in smooth curves in the direction of the port bow. Yardarms bowed forward. The joints showed no signs of failure. The tripod mast construction showed no failures in the legs or the deck connections. The loading on the foreleg, which foots on the first platform above bulkhead 43 caused local buckling in that bulkhead. Both the bulkhead plating and stiffeners in regions of the centerline were affected.

Struts between the pole mainmast and superstructure deck pulled the deck doubling plates out of the deck. Load on the after structure caused compression failure in centerline stanchions in the machinery spaces, i.e. after fireroom and engine room.

Both smoke pipes were laid over to port and forward until stopped by other structure. Light uptakes failed in the plating and at the joints.

The 1/4" plating of the aluminum deckhouse on the after portion of the Navigation Bridge failed completely as did aluminum structural shapes. Aluminum rivets behaved poorly.

In general, plating less than 15# weight was unsatisfactory. Doors and hatches dished almost without exception, the hatches to the lesser degree. Deckhouse panels containing doors were more severely affected than solid panels.

MACHINERY

Both smokestacks were knocked over to port and severely crushed. Uptakes were distorted. Boiler casings were damaged structurally. Considerable damage was done to piping, and to the boat and airplane crane by deflection of supporting structures (bulkheads and decks).

ELECTRICAL

Structural damage involving electrical equipment occurred mainly in the following areas:

1. Second deck in quarters aft at frame 127.

2. Main deck forward in battery charging station, frame 48.

3. Main deck starboard center at frames 85 to 100.

4. Superstructure at base of both masts.

5. On main mast and foremast.

6. On forward superstructure and lookout stations.

7. After steering station.

8. All searchlight platforms.

(c) Other damage.

HULL

No comment.

MACHINERY

The casings of all boilers were badly blown out. Smoke indicators, air doors, air door operating gear and brickwork of boilers were moderately damaged. Both stacks were blown over. Uptakes were distorted at their upper ends. Suction flaps in forced draft blower intakes were bent. The after deck winch was thrown out of alignment and its electric controller crushed by deflection of the main deck. The boat and airplane crane was damaged structurally. There was considerable damage to piping (mostly to fire main risers near the main deck, and to small water piping on the second deck).

ELECTRICAL

No major damage to electrical equipment occurred during the test. No damage to electrical equipment occurred which would have prevented the ship from performing combat duty. Inoperable equipment is essentially as follows:

1. Circuits and equipment on masts and yard arms.

2. Searchlights, one-12'', all 24'', all 36''.

3. A few ships service telephones on superstructure.

4. A few lights in superstructure.

5. A few ventilator sets in quarters aft.

6. After warping winch.

7. Emergency radio TBK transmitter, M.G. controller.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

Radiant heat came from 165° relative and at an elevation of about 15° elevation. Paint was blistered and scorched on all exposed surfaces. Horizontal surfaces were not affected as much as vertical surfaces. Decks exposed to radiation were scorched as were all lines and cordage.

MACHINERY

There was no evidence of heat in machinery spaces. There was some scorched paint on the starboard sides of deck machinery.

ELECTRICAL

Cables on after side of main mast were scorched slightly by the radiant energy of the blast.

(b) Fires and Explosions.

HULL

There were no explosions.

A fairly large fire occurred when Army Quartermaster's gear, located on the main deck, between frames 112 and 128, was ignited by radiant heat. The vessel's teak deck was destroyed in way of the burned equipment, as were all life rafts that hung from turret 4 and those stowed on deck at about frame 125.

Burning particles from the fire started another on some fire hose, the burning of which destroyed adjacent wood decking and paint and started fire among lines in Boatswain's stores, A-102-1.

MACHINERY

There was no evidence of fires or explosions in machinery spaces or on exposed machinery.

ELECTRICAL

No electrical equipment was damaged by fires or explosions, except local lighting cables on second deck at frame 127 due to fire on main deck.

(c) Shock.

HULL

There was no evidence of shock damage.

MACHINERY

Some small piping (already badly corroded) broke apparently from shock. There was no other direct evidence of shock on machinery.

ELECTRICAL

No electrical effect was noted which could be attributed to shock.

A contact finger in the controller of the port deck winch broke.

(d) Pressure.

HULL

The pressure wave came from a bearing of about 170° relative. The pressure wave, which did extensive damage, exhibited a strong downward vertical component. This vertical pressure was evidenced by the deflection of the main deck aft and in the way of the well amidships.

The blast funneled through the fore and aft passageways in the after superstructure on both sides of the ship. The light bulkheads and doors in the passageways are distorted.

There are numerous cases of blast damage in areas sheltered from the direct blast and there are also evidences of funneling or focusing of the blast; as for instance, in the athwartship passageway, just aft of the wardroom.

It was noted that while the maindeck was badly dished, other horizontal surfaces stood up much better than vertical surfaces which were more nearly normal to the blast.

MACHINERY

Blast pressure caused damage to boilers and stacks, forced draft blower flaps, and caused structural damage affecting the crane, after warping winch, and piping.

ELECTRICAL

A positive pressure of extremely high value and a negative pressure were noted. No damage to electrical equipment occurred except as follows:

1. A light metal cable covering on after side of main mast carried away.

2. Vertical cable at frame 47 main deck was broken by door carrying away.

3. Some ventilating systems were made inoperable due to collapsing impeller housing.

4. The after warping winch was made inoperable by the collapsing of the main deck at fr ame 128.

5. Two batteries in battery lock were knocked out of battery rack and demolished due to bulkhead bending.

6. The Emergency Radio motor generator controller for the TBK transmitter was cracked and made inoperable by bending of bulkhead.

(e) Any Effects Apparently Peculiar to the Atom Bomb.

The intensity of heat and the high blast pressure at this range are peculiar to the Atom Bomb.

III. Effects of Damage.

(a) Effect on Propulsion and Ship Control.

HULL

No comment.

MACHINERY

All boilers were made inoperable, hence the ship was without steam power. It is estimated that approximately 96 hours would be required for temporary repairs by the ship's force to enable the ship to steam at very slow speed. Major repairs at a Naval Shipyard would be required before normal operation could be resumed. The forced draft blowers could not be operated until the bent flappers were straightened but this could be done by the ship's force within a few hours. The after warping winch would probably require a major

overhaul. Temporary repairs to permit operation of the crane could be made by the ship's force within two days. Damage to piping is only of local effect except that to the firemain riser at frame 128. This supplies water to the sprinkling system of the after 40 MM magazines, and water to this system was cut off by this damage.

Insofar as machinery is concerned, the effect of the test on ship control was to reduce available power to that furnished by the emergency diesel generators.

ELECTRICAL

Electrical damage had a negligible effect on propulsion and ship control.

(b) Effect on Gunnery and Fire control.

The forward 40MM ammunition hoist is inoperable electrically due to the vertical control cable breaking on main deck frame 47 when door collapsed.

(c) Effect on Watertight Integrity and stability.

HULL

Since there was no flooding and no appreciable displacement of heavy material, there was no effect on stability. All watertight boundaries and closures below the second deck remained intact, so that watertight integrity was not impaired below that level. Aft of amidships, above the second deck, watertight integrity was somewhat impaired by failure in the main deck and by the distortion of bulkheads and door frames.

MACHINERY

No comment.

ELECTRICAL

No comment.

(d) Effect on Personnel and Habitability.

HULL

The habitability of the ship was only slightly impaired as a result of the explosion. The loss of power would have reduced the services available in living spaces. Repairs in the galley would be necessary before meals could be prepared.

MACHINERY

It is believed that all personnel in the firerooms would have been casualties if boilers had been steaming at the time of the Test. It is not believed that any other personnel casualties would have occurred below decks. Habitability would have been greatly reduced by loss of steam power, and to some extent by damaged piping.

ELECTRICAL

No effect occurred other than the loss of a few ventilating units.

(e) Effect on Fighting Efficiency.

HULL

Failure of the polemasts, smoke pipes and certain fire control instrument foundations would have caused severe reduction in efficiency, through the effect on electronics, mobility and fire control. The longitudinal structural strength has been slightly impaired by the dishing of the main deck between frames 60 and 72, and 122 and stern; however, the stringer plates remained intact with very little distortion. The seaworthiness has been slightly impaired by the holding of the main deck between frames 60 and 72, and by the failure of weather doors and hatches topside.

MACHINERY

As the ship lost all steam power she was no longer an effective fighting unit.

ELECTRICAL

Electrical damage had only a slight effect on fighting efficiency.

IV. General Summary of Observers' Impressions and Conclusions.

HULL

From the hull material standpoint, the ship could have been made sufficiently operable, by ship's force, to return to port for repair, but would not have been an effective fighting unit without shipyard repair.

MACHINERY

It is believed that on a modern cruiser, exposed as the PENSACOLA was, the damage to the boilers would not have been as heavy.

ELECTRICAL

The only electrical equipment damaged by the test was either in the direct path of the blast or in the way of structural failures which caused secondary damage.

Searchlights were the major item in the direct path. They were the cast aluminum design. It may be presumed that had they been of a later design, less damage would have occurred.

Cable and motor controllers suffered most damage due to structural failures. Suitable mounting arrangements such as now required by BuShips specification would have prevented most controller damage.

V. Preliminary Recommendations.

HULL

1. Light structures topside should be eliminated or built into the superstructure. These items include deck lockers, flag bags, light splinter shields, look-out tubs, etc.

2. The athwartship and fore-and-aft passageways should be closed in to prevent accumulation of blast pressure in restrictive locations. The superstructure should be joined wherever possible to avoid blast traps. Overhanding gun positions and platforms should be avoided for the same reason.

3. The design of cruiser stacks should be restudied. Possible developments are a squat conical stack which should be designed to survive high blast pressures and a two-strength stack of conventional dimensions consisting of a heavy lower section extending about six feet above the superstructure level and a very light upper section which is designed to survive only service conditions. In the second case, the blast pressure would be expected to carry the light upper stack over the side, permitting emergency steaming through the heavy stump.

4. Large areas of weather deck exposed to blast loadings (such as the well deck and after weather deck on PENSACOLA) might have a more uniform distribution of plating weights across the deck instead of concentrating the strength in the stringer. The design, location and number of supporting stanchions, bulkheads, etc., should be carefully analyzed to avoid discontinuities and concentrations and to limit deck deflection. Attention should be given to the design of stanchions supporting major structural members such as those in the engineering spares.

MACHINERY

1. Boilers, uptakes, and stacks should be made more resistant to blast pressure.

2. Deck machinery and piping should be supported in such a way that they are not likely to receive secondary damage from deflection of decks or bulkheads.

ELECTRICAL

Specific recommendations have been made under each item of "Detailed Description of Machinery Damage", where applicable.

TECHNICAL INSPECTION REPORT

SECTION I - HULL

GENERAL SUMMARY OF HULL DAMAGE

I. Target Condition After Test.

(a) Comparison of drafts and list before and after test; general areas of flooding, sources.

There was no flooding and consequently no change in drafts as a result of the explosion.

(b) Structural damage.

There is minor dishing of the weather deck between the bow and frame 60 with some slight buckling of joiner bulkheads below, particularly between frame 10 and 20. Minor cracks appeared in built up riveted frames in the same area. Between frames 60 and 72 the deck failed with a resulting dish about two feet in depth. The failure is manifested by parting of riveted seams, port and starboard, just aft of the uptake deckhouse. Beams and longitudinals below, with their supporting stanchions, failed completely. Slight dishing of the weather deck with resultant damage to beams and longitudinals below, took place between frames 72-109 and 113-119. Severe dishing (12''-18'') occurred between frame 122 and stern which distorted structure below it. Damage to partition and other bulkheads between main and second decks was apparent in varying degrees between bulkhead 48 and stern, being most pronounced between frames 60-72 and aft of 119. Closures, doors, and hatches were undamaged except in regions of boiler room uptakes, frames 60-72, and aft of 119. There was some very mild dishing of the shell, port and starboard, between 10 and 20, and, between frames 91 and 113, starboard.

Major superstructure damage appears on the starboard and after faces. Pole masts were bent in smooth curves in the direction of the port bow. Yardarms bowed forward. The joints showed no signs of failure. The tripod construction showed no failures

in the legs or the deck connections. The loading on the foreleg, which foots on the first platform above bulkhead 43 caused local buckling in that bulkhead. Both the bulkhead plating and stiffeners in regions of the centerline were affected.

Struts between the pole mainmast and superstructure deck pulled the deck doubling plates out of the deck. Load on the after structure caused compression failure in centerline stanchions in the machinery spaces, i.e. after fireroom and engine room.

Both smoke pipes were laid over to port and forward until stopped by other structure. Light uptakes failed in the plating and at the joints.

The 1/4" plating of the aluminum deckhouse on the after portion of the NavBridge failed completely as did aluminum structural shapes. Aluminum rivets behaved poorly.

Plating, in general, less than 15# weight was unsatisfactory. Doors and hatches dished almost without exception, although the hatches were the better. Deckhouse panels containing doors were more severely affected than solid panels.

(c) Other damage.

No comment.

II. Forces Evidenced and Effects Noted.

(a) Heat.

Radiant heat came from 165° relative and at an elevation of about 15° elevation. Paint was blistered and scorched on all exposed surfaces, even on horizontal surfaces. However, horizontal surfaces were not affected as much as vertical surfaces. Decks exposed to radiation were scorched as were all lines and cordage.

(b) Fires and explosions.

There were no explosions.

A fairly large fire occurred when Army Quartermaster's gear, located on the main deck, between frames 112 and 128, was ignited by radiant heat. The vessel's teak deck was destroyed in way of the burned equipment, as were all life rafts that hung from turret 4 and those stowed on deck at about frame 125.

Burning particles from the fire started another on some fire hose, the burning of which destroyed adjacent wood decking and paint and started fire among lines in Boatswain's Stores, A-102-1.

(c) Shock.

There was no evidence of shock damage.

(d) Pressure.

The pressure wave came from a bearing of about 170° relative. The pressure wave, which did extensive damage, exhibited a strong downward component. This vertical pressure was evidenced by the deflection of the main deck aft and in the way of the well amidships.

The blast funneled through the fore and aft passageways in the after superstructure on both sides of the ship. The light bulkheads and doors in the passageway are distorted.

There are numerous causes of blast damage in areas sheltered from the direct blast and there are also evidences of funneling or focusing of the blast. As for instance, in the athwartship passageway, just aft of the Wardroom.

It was noted that while the maindeck was badly dished, other horizontal surfaces stood up much better than vertical surfaces which were more nearly normal to the blast.

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

If radioactivity is disregarded, the intensity of heat was the only peculiarity observed.

III. Results of Test on Target.

(a) Effect on propulsion and ship control.

No comment.

(b) Effect on gunnery and fire control.

No comment.

(c) Effect on watertight integrity and stability.

Since there was no flooding and no appreciable displacement of heavy material, there was no effect on stability. All watertight boundaries and closures below the second deck remained intact, so that watertight integrity was not impaired below that level. Aft of amidships above the second deck watertight integrity was somewhat impaired by failure in the main deck and by the distortion of bulkheads and door frames.

(d) Effect on personnel and habitability.

The habitability of the ship was only slightly impaired as a result of the explosion. The loss of power would have reduced the services available in living spaces. Repairs in the galley would be necessary before meals could be prepared.

(e) Total effect on fighting efficiency.

Failure of the polemasts, smoke pipes and certain fire control instrument foundations would have caused severe reduction in efficiency, through the effect on electronics, mobility and fire control. The longitudinal structural strength has been slightly impaired by the dishing of the main deck between frames 60 and 72,

and 122 and stern; however, the stringer plates remained intact with very little distortion. The seaworthiness has been slightly impaired by the holing of the main deck between frames 60 and 72, and by the failure of certain weather doors and hatches topside.

IV. Ceneral Summary of Observers' Impressions and Conclusions.

From the hull material standpoint, the ship could have been made sufficiently operable, by ship's force, to return to port for repair, but would not have been an effective fighting unit without shipyard repair.

V. Preliminary Recommendations.

1. Light structures topside should be eliminated or built into the superstructure. These items include deck lockers, flag bags, light splinter shields, look-out tubs, etc.

2. The athwartship and fore and aft passageways should be closed in to prevent accumulation of blast pressure in restricted locations. The superstructure should be faired wherever possible to avoid blast traps. Overhanging gun positions and platforms should be avoided.

3. Cruiser stacks should be radically redesigned. Two possible developments are a squat conical stack which should be designed to survive high blast pressures and a two-strength stack of conventional dimensions consisting of a heavy lower section extending about six feet above the superstructure level and a very light upper section which is designed to survive only service conditions. In the second case, the blast pressure would be expected to carry the light upper stack over the side, permitting emergency steaming through the heavy stump.

4. Large areas of weather deck exposed to blast loadings (such as the well deck and after weather deck on PENSACOLA) should have a more uniform distribution of plating weights across the deck instead of concentrating the strength in the stringer. The design, location and number of supporting stanchions, bulkheads, etc., should

be carefully analyzed to avoid discontinuities and limit deck deflection. Large expanses of armor plating over machinery spaces were insufficiently supported on this vessel.

VI. Instructions for loading the vessel specified the following:

ITEM	LOADING
Fuel oil	15%
Diesel oil	15%
Ammunition	67%
Potable and reserve feed water	95%
Salt water ballast	1600 tons.

Details of the actual quantities of the various items aboard are included in Report 7, Stability Inspection Report, submitted by the ship's force in accordance with "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 superstructure has moderate damage to light plating on the after sides where the blast impinged directly. Both smokestacks have been blown down to port and forward. The main deck has several large areas of dishing, principally in the well deck and aft of mount 4. The second deck has a small amount of depression in the middle body over the engineering spaces. Large centerline stanchions in the engineering spaces are damaged. The underwater body is not damaged enough to give any noticeable change in tank capacities or panel failures in observable areas.

(b) General areas of damage are where flat surfaces were directly exposed to the blast and directly underneath on supporting structure.

(c) Apparent cause of damage is the high loading imposed by the blast.

(d) No flooding from sea. Compartment A-3-F changed rate of seepage, materially, into compartment A-413-M.

(e) The residual strength of the main deck is slightly impaired, especially in the well deck area where torn plating in the light center section might extend into the stringer plates with the ship working in a seaway. Buoyancy is unimpaired. The hull is still operable although damage to the smokestacks would impair the boiler operation seriously.

B. Superstructure.

(a) Description of damage.

1. Forward superstructure.

The SG radar pole mast is bent forward in a smooth

curve such that a tangent at the mast head would be approximately 60 degrees with the vertical (Photo Nos. 1759-8, page 12, and 1761-12, page 14). The mast is canted about 5 to 10 degrees to port of the centerline position. The radar platform appears to be undamaged but the SK radar array has been carried over the side. Yardarms, port and starboard, are angled slightly forward of the intact position. All rigging on the mast is carried away. The pole mast supporting the radar platform is bent forward in a smooth curve beginning above the junction of the four inch tubing supports to the eight inch gun director stool, about 12 feet above the fire control platform level (Photo 1860-3, page 7, and 1968-6, page 11). The failure is one of bending under load with no evidence of local weakness. There are no joint failures. There is no evidence of damage to the cylindrical gun director stool (10# STS).

The fire control station (06 level) contains considerable debris. Fighting lights on the starboard side are broken. The port side fighting lights are intact. The platform (15# plate) is washboarded somewhat but is perfectly usable. The 10# vertical shield is undamaged except in the after panel which is dished forward between stiffeners (Photo No. 1966-9, page 54). The upper edge of this panel is about five inches out of line. Flat sheet metal surfaces of equipment on this level lookout are dished on the starboard side. The circular tubs on the port and starboard tripod legs are undamaged. Cast aluminum treads on the ladder leading down to the sea cabin and radar control room house top have failed near their connections, leaving only the ladder rails, which are badly twisted (Photo No. 1968-5, page 21).

The forward searchlight platforms are generally intact. Broken aluminum castings on the searchlights render them inoperable (Photo Nos. 1968-3, page 19, and 1968-4, page 20). The 1/4 inch aluminum portion of the sea cabin and radar control room housetop (aft of frame 47 1/2) has suffered considerable distortion, especially at the deck edges where the movement of deck house sides has caused buckling of the deck edge (Photo Nos. 1760-10, page 25, and 1760-9, page 26). In addition, the transverse riveted seam at frame

47 1/2, connecting the aluminum portion of the housetop to the steel portion has failed near the starboard deck edge. The rivets are pulled through the plate (Photo No. 1760-10, page 25). Life railings on the housetop level and the ladders to the searchlight platforms are distorted where unprotected. Two sheet metal gear lockers have been demolished and blown away. Several others are blown off their foundation to positions about 10 to 15 feet forward.

The forward bulwark (10#M.S.) of the Navigating Bridge level (04 level) is buckled slightly but is still effective (Photo No. 1967-12, page 29). The instruments on the bridge have suffered moderate damage, most of which probably could be repaired for temporary use by the ship's force. Flat sheet metal surfaces are dished, torn and badly distorted where exposed. The 20# bridge wings, port and starboard, are undamaged and the 20# curved deck shields for the 40mm mounts, port and starboard, are also undamaged, except at the after inboard ends of the shields which are pushed forward at the upper flange relative to the base. The 15# plate, stiffened with 15# stiffeners, which forms the outboard fore and aft portion of the 40mm gun tubs is dished slightly between stiffeners where exposed. The deck is buckled slightly but is still usable.

The aluminum portion of the deck house (aft of frame 47 1/2 approximately) is badly distorted and torn. The starboard bulkhead is pushed sharply inboard with the maximum deflection nearly two feet at the after end. The bulkhead is lifted about 3 inches from the deck for about three feet at the after end. The door set diagonally in the after starboard corner is crushed and the door frame badly distorted and torn (Photo Nos. 1761-1, page 31; 1759-11, page 28; 1967-10, page 32). The after bulkhead is dished severely on the starboard side. On the port side, the after bulkhead has been ruptured by the blast in way of the emergency sea cabin (Photo No. 1968-1, page 36). The bulkhead plating has failed along a horizontal joint about a foot above the deck level and is blown bodily into the sea cabin, hinging about the overhead. Damage extends into the door which is in the diagonal portion of the house bulkhead. Horizontal joints in the aluminum plating generally failed due to shear or pulling through of rivets. Vertical joints failed both due to rivet failure and tearing of the plate at the line of rivets.

The aluminum doors, port and starboard, are caved in, with a deep vertical crease running the full height of the door at center. The port bulkhead of the sea cabin was partially shielded from the blast. The bulkhead is racked and dished. A vertical seam in the aluminum plating has failed as shown in Photo No. 1760-7, page 39.

The flagbags, port and starboard, are blown forward and demolished. They are fabricated of 1/8 inch steel and bronze. Photo Nos. 1759-6, page 27, 1759-11, page 28, 1968-2, page 35, 1759-1, page 37, and 1760-11, page 38, show the general condition of the flag bags. All exposed pipe railings are bent and distorted. Many joints are parted at the welds.

Structure on the emergency level (03 level) is generally intact forward of frame 47. Equipment in the pilot house and chart house is intact. The after starboard corner of the deck house (frame 48) is dished lightly for a distance of about four feet on both the starboard and after faces. The starboard bulkhead of the radar transmitter room is dished moderately between stiffeners. The after bulkhead is dished slightly over the whole surface. The principal damage on the emergency level has occurred in the athwartships passage between the forward house and the radar transmitter room (frame 48 to 49). The blast wave funneled through this passage, dishing the two bulkheads forming the passage. Photo No. 1761-2, page 40, shows the character of the damage.

The communication platform (02 level) is undamaged on the port side except at the extreme rear of the platform where the forward smokestack has been blown hard against the foremast structure. The platform is also intact on the starboard side as far aft as frame 46. Between frame 46 and the after end of the platform on the starboard side, the deck is lightly buckled in transverse waves except at the extreme rear portion which was protected from the blast by the 40mm gun shield. The ladder at frame 48, starboard, leading to the emergency platform, is blown forward at the lower end, causing the aluminum treads to fail at their connections to the rails as a result of the racking action (Photo No. 1967-8, page 42).

The after face of the 40mm gun shield (20#) on the starboard side is pushed forward along the upper edge. The maximum deflection is about three feet at the outboard edge of the high portion of the after face. The weld connecting the shield to the deck is broken for a distance of about four feet inboard of the deck edge. Photo No. 1966-9, page 54, shows a general view with the starboard shield visible in the lower right corner.

The portion of the communication platform aft of the deck house and between the port and starboard gun shields is moderately buckled with transverse waves about four inches deep. This condition is apparently the result of the impact of the forward smokestack against the deck edge. Photo No. 1758-12, page 41, illustrates the condition of the after portion of the communication platform. The forward smokestack has brought up hard against the port after portion of the platform resulting in distortion of the port gun shield and a pipe stanchion, frame 53, which supports the radar transmitter house above.

The deck house on the communication platform is intact except on the port side at frame 46. The door leading into the companionway shows distortion and joiner work in the companionway is dished although the area was sheltered from the blast. The after bulkhead of Radio I, A-0203-C, is dished lightly between stiffeners. It appears probable that the damage in this area is the result of blast coming up the companionway from below.

Extensive blast damage has occurred on the superstructure deck (01 level) aft of frame 38. The compartments forward of this point are generally intact. The blast wave apparently entered on the 01 level by way of the companionway at frame 46, centerline, coming up from the athwartships main deck passageway below through the badly damaged access trunk. The deck at frame 47 is bulged up for the full width of the house. The deck beam rivets have pulled through the deck (Photo No. 1754-4, page 46). The entire superstructure deck from frame 52 forward to frame 38 shows evidence of upward movement. Metal joiner bulkheads on the starboard side are warped from frame 38 to frame 52 on both sides of the fore and aft passage. The general location of major buckles is over door

frames near the under side of the communication platform. Identical conditions exist in the port passageway from frame 43 aft. Damage to the jointer door to the Captain's cabin, A-0108L, port side, frame 43, is shown in Photo No. 1761-6, page 43. The door panels are blown in and the door and door frames deformed as the result of the Captain's pantry and stateroom F, frame 45, port, are also blown in. The door frames are twisted and butt welds broken. Transverse bulkheads 46 and 48, adjacent to the centerline companionway, are severely dished and all doors in the vicinity are dished. Rounded corners of joiner bulkheads are crumpled about one foot above the deck level. The overhead of staterooms in the vicinity of frame 52 shows the transverse buckles inflicted in the communication platform. A ventilation duct at frame 50 on the port bulkhead of the centerline passage is crushed as a result of the blast pressure, (Photo No. 1761-8, page44).

On the exterior, the deckhouse sides, port and starboard, and the forward bulkhead are intact except aft of frame 45 on the port side. The panels between frames 45-46, 46-47, and 47-48 are visibly dished between the superstructure deck level and the communication platform level. The traces of the superstructure deck and bulkhead 46, indicated by cracked paint, are very clear. The cause of this damage is not apparent.

The deckhouse bulkheads between the main and superstructure decks are undamaged except for bulkhead 46, the after bulkhead of the wardroom. All interior spaces on the main deck level in the forward superstructure are intact. The main deck athwartships passageway between frames 46 and 49 is a principal area of blast damage to the superstructure. This passageway is formed by the foremast structure on the forward side and the fidley house enclosing the uptakes to the forward smokestack on the after side. The superstructure deck (01 level) forms the overhead. Bulkhead 46 is dished entirely across the deckhouse, with maximum deflection occurring in way of the doors opening into the wardroom. Photo Nos. 1761-5, page 48, and 1754-2, page 49, show the condition of these doors and the adjacent bulkhead. Bulkhead 49 is dished aft somewhat and the doors and door frames in the bulkhead are badly dished and distorted. Photo Nos. 2161-10, page 50, 1755-1, page 51, and 1754-3, page 52, show the condition of this bulkhead.

The superstructure deck which forms the overhead is blown up as described above and shown in Photo No. 1754-4, page 46.

The access trunk at frame 46-47, centerline, is badly distorted and dished as illustrated in Photo Nos. 1754-12, page 47, 1761-4, page 45, and 1754-2, page 49. The doors, port and starboard, are blown in and the trunk has pulled away from the overhead all the way around.

The port and starboard sides of the fidley house surrounding the uptakes to the forward smokestack are buckled slightly with moderate damage to the air intake louvres (Photo No. 1754-11, page 97). The after bulkhead of the fidley house is buckled severely on the port side. The distortion extends forward to the bulkhead at frame 58 1/2 through the longitudinal bulkheads. The engine room exhaust ventilator at the starboard after corner of the house (Photo Nos. 2157-7, page 104 and 2157-10, page 105), is moderately distorted. The deckhouse bulkhead adjacent to the ventilator is torn and blown inboard in way of the door to the airplane spare parts stowage (Crossroads office). The damaged area is shown in Photo Nos. 2157-7, page 104, 1767-8, page 106, and 2157-10, page 105, after the torn plating was cut away. Photo Nos. 2157-9, page 107, 1761-11, page 114, and 1767-7, page 101, show the condition of the port side of the bulkhead and the badly dished door to the fire control shop.

The forward smokestack is leaning about 50 degrees to port and has been driven forward so that it is hard up against the port 40mm gun shield on the communication platform level. The stack is torn and collapsed with the principal distortion occurring four or five feet above the cape (Photo Nos. 1966-8, page 53, and 1966-9, page 54). The upper stack is buckled severely with failures occurring in both vertical and horizontal riveted seams (Photo No. 1968-8, page 55). The outer stack is badly torn in the crumpled sections just above the cape (Photo Nos. 1967-7, page 57, and 1967-9, page 58). The cape is buckled and the fidley is distorted and dished. The overhead of the fidley deckhouse is dished generally in the exposed areas. The smoke deflector has been ripped from the top of the stack and is lying at frame 53, starboard (Photo Nos. 1966-6, page 96, and 1754-11, page 97).

2. After Superstructure.

The after smokestack is bent to port and forward around the port leg of the airplane crane tripod (Photo Nos. 1967-7, page 57, 1967-9, page 58, and 1966-7, page 59). The leg of the tripod is bent slightly. The top of the stack is about 30 feet to port and 25 feet forward of the normal position. The stack is twisted in a clockwise sense and is ruptured on the starboard side. The base of the stack is crushed on the port side. The stack cape is tilted to port and wrinkled. All stack guys on the starboard side have carried away. The radar towers on the port and starboard sides of the stack are thrown down. The tubular steel towers are twisted severely. The incinerator door just aft of the stack is dished inward about twelve inches by the blast and the incinerator exhaust uptake is torn loose from the incinerator stack. The galley smokepipe has broken clear of the stack except at the extreme top of the stack and is hanging over the side (Photo No. 1966-7, page 59).

The superstructure deck forward of and on either side of the stack has several local depressions, but these appear to be the result of normal service rather than test A. An area of severe damage occurs immediately aft of the stack in way of the galley skylight at frame 84-85. The face of the skylight is dished severely with failures at both the forward and after ends of the center jamb. The upper port cover has been torn free and is lying on the deck. The forward coaming is badly distorted. (Photo Nos. 1758-7, page 60, 1758-10, page 61, and 1851-4, page 62). The deck plating in way of the skylight is bent sharply downward around the skylight. Consequently, the skylight is down relative to the rest of the deck. This appears to be the result of several influencing factors. A heavy 36" searchlight mounted on the starboard wing of the searchlight platform at frame 87 fell to the deck, striking the forward center portion of the skylight. Much of the damage to the forward portion of the skylight appears to be due to this source. The rear (high) portion of the skylight is landed on the deck beam at frame 85 under the superstructure deck. This beam supports the tubular frame work foundation for the 20mm clipping room at frames 86-88 and is supported in the galley by three pipe stanchions. Pressure loading on the clipping room has resulted in deflection of beam 85 and

buckling of the stanchions below (Photo No. 1756-4, page 83). Some of the damage to the after portions of the skylight is due to this deformation. In addition, the general appearance of the skylight face, the forward face of the S.P. radar room and the parts box fixed thereon, (Photo Nos. 1758-10, page 61, and 1851-4, page 62) indicates that a strong pressure wave was reflected off the after smokestack and adjacent structures which resulted in a general dishing of flat surfaces in the vicinity of the skylight.

The after portion of the starboard searchlight platform bulwark (03 level, frames 85-88) has been bent forward. The starboard searchlight yoke (cast aluminum) has failed and the searchlight was carried forward and down to the galley skylight on the superstructure deck level. The port searchlight and bulwark are intact. The transverse bulwark joining the port and starboard searchlight tubs on the forward side is bent forward about 45 degrees. The platform deck is dished slightly between stiffeners, possibly due to normal service.

The 20mm clipping room is dished on the port, starboard and after faces about one to two inches. The port door in the after face is dished about 1/2 inch. The port and starboard gun tubs are intact due to shielding by superstructure aft. The clipping room is supported by a tubular steel frame work at all four corners. There is evidence of crushing of the forward supports and the supporting beam and stanchions under the superstructure deck are buckled, indicating that the structure just forward of the mainmast has been deflected forward relative to the deck.

The non-structural SP radar shack on the superstructure deck under the clipping room is dished in on all four sides to a depth of 5-8 inches. The door on the starboard side is badly dished (Photo No. 1758-8, page 63). The bulkhead corners are buckled (Photo No. 1758-10, page 61). This structure appears to be crushed by the displacement downward and forward of the clipping room above.

The mainmast is deflected forward about two feet. Most of the deflection took place above the tripod apex level. The after main battery director platform is undamaged. It is constructed of 20 pound STS plating. The cylindrical director foundation is intact. However, the ladder to the director, secured at top and bottom is bent about 14 inches to port at the center. Radar antennae brackets welded to the port and starboard sides of the cylindrical director foundation are deflected forward about a foot.

The after fire control station, C-0302-C, of 20# STS is intact. The starboard bulwark around the platform is deflected inboard about six inches at frame 100. The after bulwark is deflected forward about three inches at the upper edge. Equipment in the fire control station is undamaged.

On the first level above the superstructure deck, the starboard bulkhead of the auxiliary CIC room is dished approximately one inch. Equipment inside is undamaged. The flag bags at the forward end of the platform are dished aft as a result of blast reflection off the superstructure immediately forward. The starboard Mk. 51 director at frame 93 is demolished. The director platform is blown forward. The ten inch pipe support and director tube is bent forward. The after cantilever frame under the platform has broken at the welded knuckle.

On the superstructure deck level, aft of the SP radar shack, the after portion of the splinter shield around the starboard 40mm quad. mount at frame 96 has failed at the end bracket and is deflected forward about two feet at the upper edge (Photo No. 1966-12, page 64). The after portion of the port 40mm gun shield has suffered damage (Photo No. 1758-9, page 65). The ready service box on the starboard side at frame 102 has been torn from the deck and overturned. The sheet metal sun shields on the ready service boxes located on the superstructure are damaged by blast, either pressed down against the box or torn up and mangled. Ventilator screens are blown out. Photo No. 1758-8, page 63 shows damage to the after engine room ventilator at frame 87, starboard. The starboard. 20mm gun bulwark at frame 110 is deflected inboard about

four inches at the upper edge. The bulwark has pulled away from the deckhouse at the after end as a result of improperly fitted connections. A similar failure has occurred on the port side. Two fire hoses under the overhang of mount 3 are in disorder.

The mainmast after tripod legs have pulled upward from the superstructure deck approximately 3 1/2 inches starboard and 1 1/2 inches port, as a result of the forward movement of the upper part of the mast (Photo Nos. 2161-5, page 70 and 2161-6, page 72). The supporting deck structure is obviously under-designed for the type of loading applied by the blast. The deck is buckled upward in way of the port leg (frame 92) and the deck is pulled away from the supporting beams. A light stiffener under the tripod base is distorted (Photo No. 1757-6, page 71). The deck under the starboard tripod leg appears to be torn (Photo No. 1757-7, page 73).

On the main deck, the forward bulkhead of the after superstructure, bulkhead 71 1/2, is dished to a depth of from three to ten inches over the entire span (Photo Nos. 1758-11, page 79 and 1755-12, page 80). The portions at the wings on frame 74 are also dished. The doors and door frames are dished about five inches. The port and starboard passageways under the superstructure which are open to the weather at both ends have suffered heavy damage from the funneling effect of the air shock wave through the passages. The bulkheads on each side of the passage are dished severely and doors are distorted and dished (Photo Nos. 1755-11, page 81, 1756-3, page 87, and 1756-5, page 86 show starboard passageway; 1757-9, page 82, 1757-8, page 84, and 1757-5, page 85 show port passageway). The louvres of the fire room air intakes on the port and starboard sides of the fidley, frames 75 to 83, are undamaged. This may be due to an equalization of pressures between the uptakes and the passageways. The outboard deck house plating, port and starboard, in way of the carpenters and shipfitters shops, is dished slightly. Gas cylinders stowed in each passageway are deranged but are otherwise undamaged. The port and starboard bulkheads, including doors, of thegalley (frames 83-88) are dished inboard about two inches. The overhead of the galley is deflected downward about six inches. The transverse channel beam in way of the galley skylight is tripped and deflected downward about 1 1/2 inches (Photo No. 1756-4, page 83).

The stanchions under beam 85 are buckled severely as the result of excessive loading transmitted through the tubular supports for the 20mm clipping room structure and through the after coaming of the galley skylight. The engine room exhaust ventilator in the starboard passageway, frame 86, is dished about one inch.

Bulkhead doors and door frames in way of the athwartships passageway and access C-107L, port and starboard, are dished inward about 3/4 inch. The centerline stanchion at frame 92 is slightly crushed, indicating a slight downward movement of the superstructure above. Forward displacement of the mainmast (approximately 3/4 inch at the deckhouse level) is evidenced by deflection of the mast bracket at the overhead. Deck house ventilator screens are generally blown inward and demolished.

Bulkheads and doors in the superstructure in way of the boat stowage on the main deck level are generally dished lightly (1" to 2") between spans (Photo No. 1757-4, page 116). Bulkhead 104 is dished slightly on the starboard side (Photo No. 1756-6, page 118). The deckhouse sides and doors on the starboard side around mount 3 (frames 110 to 112) are dished about two inches. The after deckhouse bulkhead at frame 113 is dished inward from 1 1/2 inches on the port side to nearly five inches near the starboard corner. The bulkhead also appears to be crushed slightly due to a downward load on the deck above.

Light sheet metal plating in the vicinity is generally badly distorted. Photo No. 1757-3, page 117, shows a collapsed ventilation duct at frame 102, port.

(b) Causes of damage in each area.

The primary cause of damage to the superstructure was the air shock or blast wave. In most cases, the wave acted in the manner of a very high wind (energy in the form of velocity) rather than a shock wave (energy in the form of pressure). The blast is highly directional and rather easily deflected by heavy structure. The blast wave thus tends to reflect and intensify its action against weak points or weaker structure. Restricted areas such as passageways, overhangs or narrow openings between heavy structures

appear to result in a concentration of velocities in these locations with resulting increased damage to the boundary structure.

The heat flash or radiation from test A caused only minor damage which included light scorching of exposed paint surfaces and a minor and localized fire. Thermometers in exposed containers such as ready service boxes, etc., showed no rise in temperature, indicating that the duration of high intensity heat was extremely short.

There is no evidence of underwater shock. In general, shock damage is lacking, an indication that the time of application of the air shock wave was relatively long, an impact of low order.

(c) Evidences of fire in superstructure.

Exposed painted surfaces were lightly scorched by the heat flash. Plating was unaffected. A fire in four lengths of 2 1/2 inch fire hose at frame 28 on the main deck caused some rubber wash deck hose in the blower room, A-101-E, to ignite by conduction. The fire smothered as the result of lack of oxygen. No other fires occurred in the superstructure.

(d) Estimate of relative effectiveness of:

1. Various plating thicknesses.

Plating less than 10# suffered general distortion even when partially shielded from the blast. Plating above 10# and under 20# was dished lightly to moderately on exposed flat surfaces. Shaped surfaces, cylindrical, etc., showed greater resistance.

2. Various shaped surfaces.

Surfaces which had smooth unobstructed contours were highly resistant to blast damage, if properly supported. However, cylindrical gun tubs up to 20# STS fastened only at the deck showed considerable deflection at the free upper edge. Connection of the terminal ends of gun tubs to superstructure bulkheads were of little assistance. Shape was not of great value where restrictive conditions occurred, such as in passageways and under overhangs.

3. STS compared to MS.

There was little real difference in the critical weights of STS compared to MS plating. STS plating showed significant increase in resistance over comparable MS plating but joint failure largely nullified the advantage. Failures in STS structures were generally joint failures of various types.

4. Aluminum structures.

Aluminum bulkheads and decks appear to be unsatisfactory. The major superstructure damage occurred in aluminum plating. Riveted seams in aluminum plating were chief sources of weakness. Aluminum ladder treads failed when ladders were racked by blast. Cast aluminum searchlight yokes cracked. Heat had no apparent adverse effect on aluminum plating.

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

1. Outstanding equipment and projections on superstructure must be eliminated. Necessary equipment should be built into a smooth unencumbered surface. Such structural projections as bulwarks, boxes, lockers, booths, flag bags, narrow walkways, etc., must be eliminated. Equipment such as searchlights directors, masts, rigging, radar arrays, antennae, etc., must be extensively re-designed, eliminated and consolidated.

2. The superstructure should be decreased in size, especially in height. Only action stations should be placed above decks, if possible. Wardrooms, staterooms, galleys, workshops, etc., should be placed in the hull proper. Spherical or elliptical smooth surfaces should be employed in forming the units of the superstructure.

3. Various units of the superstructure should be located so as to avoid interference effects which intensify the blast effect in restricted areas. All passageways, either athwartships or fore and aft which open to the weather must be eliminated. Overhanging

sponsons, gun tubs and other platforms must be held to a minimum. Bridge wings should be of the small, folding type and should be rigged out only when maneuvering or docking.

4. Indispensable superstructure must be compact and streamlined. It is estimated that structure of not less than 20# plate, properly stiffened would have been required to withstand the forces experienced by this ship. The camber of decks should be increased and heavy longitudinal bulkheads employed to carry topside weights down to main girder supports. Properly designed tripod masts should be employed in lieu of pole masts and should not be required to support the superstructure weights.

5. Doors and door frames, as now constructed, are very weak points in any exposed bulkhead. A strong effort should be made to eliminate as many weather doors as possible. Small quick acting scuttles in the overhead should be substituted for emergency access. Doors should not be used to aid ventilation of compartments. Weather doors which are indispensable should be constructed as hatches, with stiffening coamings located at the knife edges. The stiffeners should be extended from deck to overhead and should be bracketed into transverse beams. Weather doors should be avoided under overhangs as well as in restricted passages.

C. Turrets, Guns and Directors.

(a) Protected mounts.

1. General condition, including operability, if known.

The 8 inch mounts are only slightly damaged as a result of test A. Adequate protection from blast and heat of the bomb is provided by the shields. Mounts 2 and 4, which were in condition "Yoke" during the test, received some slight material damage within the gun house from the bomb blast. Powder and projectiles were laying exposed in the gun chambers of these mounts but remained unaffected by the heat and were only slightly displaced. Paint on the outside

surface of the gun shields is slightly blistered from the heat of the bomb. The alignment of the main battery is fair being slightly outside of allowable limits. Nine out of ten guns are fully operable.

Mount 1.

A ventilation pipe in the gun chamber is broken off near the shelf plate level from shock. There was indications that this pipe was weakened previously by corrosion.

Mount 2.

The transverse bulkhead between the gun chamber and the range finder booth was buckled by blast. Dishing is sufficient to misalign the shell port sliding cover frames so that the covers jammed.

A fire was started in equipment on the main deck under the overhang of mount 1. This heated the deckhouse bulkhead at frame 113 which started a fire in the gear locker, compartment D-106L. The inflammable material in the locker burned until it was entirely consumed. This gear locker is directly below and opens into the powder transfer room of mount 2. Although powder was stowed in the powder hoist and gun chamber of the mount no damage resulted except a smoking up of the bulkheads, training rack, pinion, ball bearings and races.

Mount 3.

The left gun is inoperable due to a broken diaphragm in the counter recoil system. These diaphragms frequently fail during normal conditions and the casualty may not have been caused by the test. In any event, the gun would have been disabled only temporarily as the diaphragm could be replaced by the crew in a few hours.

Mount 4.

Paint on the outside of the gun shield is blistered from sustained heat of a fire aft and to either side of the mount.

Although the mount was in condition "Yoke" and ammunition was exposed in the gun chamber, no damage from fire occurred inside except a slight discoloration of the paint around the doors (Photographs 1764-6, page 123, 1965-9, page 128, and 2158-5, page 139). The left front door is missing, apparently blown off and carried overboard. Covers on the range finder windows were jammed closed from the blast. A ventilation duct just inside the left rear door of the gun house was badly dished by the blast.

2. Effectiveness of installed turrets or shields.

Mounts in condition "Zed" are effective against the atomic bomb under the conditions of the test. Light structure, inside of mounts that are in condition "Yoke" is susceptible to blast pressures. It appears that powder in mounts that are in condition "Yoke", but shielded from the direct rays of the bomb, remains stable.

(b) Unprotected mounts.

1. General condition, including operability, if known.

All 5 inch/25 mounts are operable. Alignment with the director is poor especially on the port side where the deck is damaged.

The 40mm mounts are inoperable due to ordnance failures but can be repaired by the ship's force in a matter of several hours.

40mm and 20mm shields are slightly distorted from the blast.

2. Effectiveness and sufficiency of crew shelters.

5 inch, 40mm and 20mm splinter shields of the types aboard PENSACOLA afford inadequate protection for the crew from the blast and radiated heat of the atomic bomb.

(c) Directors and range finders.

1. General condition, including operability, if known.

The shutter on the left range finder ear of mount 3 is blasted inward. Canvas bloomers around the scopes are torn. The instrument is otherwise undamaged but is inoperable due to the shutter damage.

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

The 40mm and 20mm batteries, while receiving only moderate damage, do not provide sufficient protection for operating personnel. Personnel should be housed in steel shields for protection against the pressure wave and radiated heat.

D. Torpedo Mounts, Depth Charge Gear.

Not applicable.

E. Weather Deck.

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

There are three principal areas of damage to the main deck, which is the weather deck throughout. These are the well-deck area (frames 60 to 72), abreast gun mount 4 (frames 115 to 120) and aft of gun mount 4 (frames 125 to stern). In the other areas, the condition of the deck is as follows:

Bow to frame 14	intact
Frame 14 to frame 18	depressed about 3/16".
Frame 18 to frame 26	undamaged.

Frame 26 to frame 29	depressed slightly.
At about frame 35	raised slightly.
Frame 48 to frame 60	depressed slightly.
Frame 60 to frame 72	serious failure of well deck area.
Frame 72 to frame 109	generally depressed, with maximum at frame 97 of about 1 3/8 inches.
Frame 113 to frame 120	Depressed about one inch and buckled.
Frame 120 to stern	dished and buckled.

The pattern of failures in the weather deck outside of the three major areas of damage appears to be made up of both panel failures under direct loading of the air blast and compression buckling as the result of a sagging action in the ship's girder. The general condition of the weather deck outside the areas of major damage are shown in Photo Nos. 1755-7, page 88, 1968-9, page 89, 1755-8, page 90, 1967-3, page 91, 1967-5, page 92, 1967-2, page 93, 1967-4, page 94, 1966-6, page 96, 1754-11, page 97, 1756-6, page 118, 1965-7, page 119, and 1756-7, page 120. Note light overall scorching of the wooden deck where exposed to the heat radiation. Strong "shadows" are cast by gun mounts, bitts, ventilators and similar objects, leaving unscorched deck behind them. A small fire has occurred at frame 28, centerline. Four lengths of fire hose, mounted on bulkhead 29, have ignited and burned completely. The deck is charred in way of the fire (Photo No. 1755-6, page 95).

A major panel failure has occurred in the well deck area between frames 60 and 72. The principal deflection is confined to the light medium steel plating (9#-10.2#) which forms the center three strakes. The stringer plates (two courses of 30# STS) are intact and only slightly deflected. Thus the longitudinal

strength of the hull girder is not appreciably affected. General views of the well deck panel failure are contained in Photo Nos. 2157-7, page 104, 2157-8, page 106, 2157-9, page 107, 2157-10, page 105, and 1767-2, page 108. As indicated by the water on the deck (Photo No. 1767-2, page 108), the area of maximum depression is in way of the center strake of plating between frames 63 and 66. The fore and aft location appears to have been influenced primarily by the direction of the blast wave, the after portion of the well deck being shielded by the superstructure. The weight of the wire rope reel at frame 63-64 and the existence of the centerline access hatch just forward also may have contributed. However, the hatch does not appear to have been a major point of weakness as is the case with doors in bulkheads. This is probably because the hatch structure is more thoroughly worked into the structure of the vessel than is the door assembly. The maximum permanent deflection of the deck is 25 1/2 inches at frame 64 on the centerline. As a consequence of the extreme deflection of the deck considerable stretching of the deck plating has taken place and a general failure of plating has occurred between stringers plates at the forward end of the well deck. On the starboard side, the plating has torn away from the stringer plate along a riveted seam (Photo Nos. 1754-11, page 97, 1767-3, page 98, 1758-1, page 99, 1767-4, page 100, 1767-7, page 101, and 1754-8, page 102). The failure occurs between the stringer of double-course 30# STS and the next inboard strake of single-course 10.2# M.S. The single-course strake is lifted about six inches above the stringer (Photo No. 1754-8, page 102). The length of the fore and aft failure is about twelve feet (frames 62 to 65). The failure stops short of frame 62 by about two feet. Another tear in the 10.2# plate occurs about two feet inboard of the joint and continues to the beginning of the wood decking at frame 62 (Photo No. 1754-8, page102). The failure then proceeds in a transverse direction inboard, the plate tearing along the deck rivets (Photo No. 1754-8, page 102). This failure extends along the after face of the engine room exhaust ventilator for about a foot. Beyond this point, the ventilator has lifted off the deck (Photo No. 1761-11, page 114). The failure then shifts along a seam to a butt joint in line with the after coaming of the access trunk at frame 63 (Photo No. 1754-9, page 115). The failure travels along the riveted butt to the hatch

coaming and then along the coaming. On the port side of the access hatch, two failures occur between the hatch and the engine room supply ventilator (Photo Nos. 1767-5, page 113, 1767-6, page 112). As shown in Photo No. 1767-6, page 112, the supply vent constitutes a strong point in the deck. There are no failures outboard of the ventilator. This constitutes the only major deck failure and does not involve the stringer plates.

The main deck is also badly buckled abreast mount 4, frames 115 to 120, port and starboard. The wood deck has been destroyed. This damage is the result of fires originating in special equipment mounted on the deck for purposes of test. Photo Nos. 1756-7, page 120, 1766-12, page 121, 1764-6, page 123, 1756-8, page 124, 1965-10, page 127, 1965-9, page 128, 1965-8, page 127 illustrate the condition of the deck in this area. Photo 2158-10, page 122 and 2158-9, page 132 show the area after debris has been cleared away. The maximum depth of buckling is about four inches at frame 117. The deck is normal at frame 120 near the centerline and dished about 3 inches near each deck edge.

Immediately aft of mount 4, the deck has sagged deeply. The depression begins at about frame 122 and extends aft to a minimum point of 1 1/2 inches at frame 132. The maximum deflection is about 18 1/2 inches at frame 127. The condition of the deck in this area is shown in Photos 1764-10, page 125, 1756-8, page 124, 1764-11, page 126, 2158-9, page 132, and 1764-5, page 136. The deck at the point of maximum deflection is seriously weakened by the existence of two hatches and two round ventilators which reduce the sectional area of the deck. The condition is further aggravated by the large crew space below.

Aft of bulkhead 132 (on the deck below) the main deck has suffered another major deflection. The deflection extends to the stern with a maximum of 9 1/2 inches at frame 137. This deflection is indicated in Photos 2158-11, page 141, 2158-12, page 142, and 1965-12, page 143. It appears that both depressions aft of mount 4 were caused by uniform loading of the deck by the air shock wave, resulting in panel failures.

(b) Usability of deck in damaged condition.

The weather deck is entirely usable except in the center portion of the well deck and in way of the two major depressions aft of mount 4. None of these areas should be subjected to heavy loading.

(c) Condition of equipment and fittings.

1. There is no damage to mooring gear. The towing bridle has been ruined by heat and blast. The strands are open and the core is charred.

2. The only boat aboard was a dingy used for side cleaning. It was stowed on the 01 level, frame 60, and is demolished (Photo 1967-9, page 58). Boat handling gear is slightly singed by the heat radiation. Three life rafts at frame 127, port and starboard, burned completely and rafts at frame 118, port and starboard, burned about 50% in connection with the fire in special materials. Three rafts at frame 55, starboard, are knocked loose from their support.

3. The reach rods for the airplane crane are frozen due to distorted decks and bulkheads. The crane and machinery are not damaged.

F. Exterior Hull (above waterline).

(a) The exterior hull plating is in good condition. Slight dishing of the shell plating is evident at the bow, frames 10 to 20. This may be a service damage. There is some evidence that the starboard shell from about frame 91 to frame 113 is pulled inboard slightly, possibly as a result of deflection of the main deck. Around the counter from frame 130 port to 130 starboard the shell plating is dished moderately between frames below the main deck level. Photo No. 4073-1, page 10, taken after test B shows this test A damage.

(b) No noticeable damage to hull fittings.

(c) No impairment of sheer strakes.

(d) No change in condition of belt armor.

G. Interior Compartments (above waterline).

(a) Damage to structure and causes.

Damage to interior compartments is almost entirely the result of flexure and permanent set of the main deck. Transverse and longitudinal deck beams are distorted and have failed in several locations. Some of the load placed on the main deck has been transmitted by means of stanchions to the second deck, causing some deformation, but in general the below-decks damage is limited to spaces on the second deck.

There are isolated instances of structural damage in the forward portion of the ship. Built-up frame brackets at frames 16 and 17, port, and frame 17, starboard, are cracked (Photo No. 1762-1, page 144). The damage results from flexure of the main deck. A deflection gage indicates a displacement of about 1/4 inch during the test across a relatively short span.

An area of moderate blast damage exists in way of the forward fire room uptakes in B-201-L, principally on the starboard side. Considerable damage has been done to joiner bulkheads and furniture but no structural failures are evident.

Major structural damage has occurred in crew's space, C-201-L (frames 60 to 72), under the well deck area. The damage is entirely the consequence of the extreme deflection of the main deck, the maximum permanent set being 25 1/2 inches at frame 64, centerline. The forward bulkhead of the compartment is a stepped bulkhead located on frame 60 at the centerline and on frame 62 in the wings. This bulkhead is buckled near the overhead because of the main deck deflection (Photo Nos. 2157-12, page 148, 1768-8, page 149, and 2158-4, page 156). The door to the engine room exhaust trunk on the starboard side has been blown off by blast down the ventilator (Photo No. 1768-8, page 149). Photo No. 1768-7, page 150, shows the door lying on the deck. Bulkhead 72, the after bulkhead of the crew's space, is buckled to a somewhat less extent.

The overhead between the forward and after bulkheads is supported transversely by two deep girders (18'' x 49#I) located at frames 65 and 68. The girder at frame 65 has been displaced downward about 23 inches at the centerline, wrecking the joiner bulkhead under. Stanchions supporting the beam have failed in compression and have tripped the beam (Photo Nos. 2158-1, page 153, 1767-12, page 154, 1762-7, page 155, 1768-9, page 165, 2157-11, page 167 and 2158-3, page 158). Transverse girder 68 has deflected about 15 1/2 inches and the flange has been tripped by the buckling of stiffeners. Typical damage to the girder and stanchions is shown in Photo Nos. 1768-4, page 151, 1768-11, page 163, 1768-10, page 164 and 1762-6, page 166. In addition several support stanchions not located in way of the two deep girders are buckled from the deflection of the overhead. These stanchions are shown in Photo Nos. 2158-3, page 158, 2158-4, page 156 and 1768-7, page 150.

The longitudinals under the main deck have been deflected and stretched by the movement of the deck (Photo Nos. 1768-7, page 150, 2158-1, page 153, and 1768-9, page 165). In way of the plating failure at frame 62 1/2, port, two longitudinals have failed completely. One longitudinal forms the port coaming of the centerline access trunk. The break occurred just inside the coaming near the after port corner. Photo No. 1767-11, page 161, shows the failure as seen from inside the hatch, looking to port. Photo No. 2158-2, page 162, shows the same break from outside the hatch. The next longitudinal outboard has also failed at the same frame (Photo Nos. 1762-9, page 157). These failures are located under the torn deck plating shown in Photo Nos. 1767-5, page 113 and 1767-6, page 112.

The damage caused by the depression of the well deck area extends for a short distance into the next compartment aft, B-202-E. A moderate amount of damage is also evident as the result of blast damage around the uptakes from the after fireroom. This damage is confined to joiner bulkheads and equipment. No structural damage is evident.

Frames and deck beams in crew's space, C-202-L (frames 85 to 104), show high stresses and failures under the loads imposed on the superstructure above. Frames 94, 97 and 100 are damaged most severely. Damage to frame 94 is shown in photo No. 574-10, page 171. Photo No. 574-12, page 172, shows the condition of frame 97 and stanchions. The condition is most apparent on the port side of the compartment.

There is no significant structural damage between frames 104 and 113. In the crew's space, D-203-L (frames 113 to 119), the overhead is wrinkled port and starboard by the fire topside. The deck is set down from one to four inches overall. As a result, beam brackets are stressed and cracked and the transverse bulkheads are crushed near the overhead. Transverse girder 116 is deflected and stanchions are buckled. (Photo Nos. 1766-4, page 173 and 1766-5, page 174). Longitudinals are generally distorted where the deck is buckled.

D-203-L (frames 119-128) has suffered heavy damage because of the extreme deflection of the main deck. The maximum deflection is 18 1/2 inches at frame 127. Bulkhead 128 is not a structural bulkhead. As a consequence, it did not limit the deck deflection appreciably. The non-structural portion of the bulkhead is wrecked (Photo Nos. 1765-9, page 196, 2178-12, page 197, 1765-10, page 198, 1765-11, page 199, 2179-1, page 200, 1765-12, page 201 and 2179-2, page 202). The flange of the web frame and girder which forms the structural portion of bulkhead 128 is tripped in the beam bracket, port and starboard (Photo Nos. 2178-12, page 197 and 2179-2, page 202). Stanchions supporting the girder are badly buckled. The forward bulkhead at frame 119 is crushed near the overhead and buckled. Two deep transverse web frames and girders at frames 122 and 125 support the overhead. These girders have been deflected and severely distorted. The flanges of the web frames are tripped at the beam bracket (Photo Nos. 2178-10, page 177, 2178-6, page 178, 2178-1, page 181, 1765-4, page 183 and 2178-5, page 185). All stanchions under the depressed beams have buckled and failed (Photo Nos. 2178-9, page 179, 2178-7, page 180, 2178-4, page 188, 2178-2, page 186, 1765-4, page 183, 1765-2, page 184, 2178-11, page 189, 1765-1, page 192 and 2178-3, page 194). All longitudinals are distorted and stretched

(Photo No. 1765-5, page 191). Photo Nos. 1766-3, page 175, 1766-2, page 176, 1765-2, page 184 and 1766-1, page 187 illustrate the condition within the compartment. The deck aft of the armored section is dished and distorted in way of stanchions and bulkheads.

The damage to second deck compartments attributable to the deck depression extending from 120 to 132 extends into the C.P.O. mess room D-203-L (frames 128-132). Bulkhead 132, a structural bulkhead, limited the deck deflection to 1 1/2 inches. Stanchions at frame 130 suffered failures similar to those in the compartment just forward. There is no web frame and girder in this compartment. The stanchions are buckled and crushed. The second deck is depressed locally under the stanchions at frame 130 (Photo Nos. 1766-6, page 203, 1755-5, page 204, 2179-3, page 205, 2179-4, page 206, 2179-6, page 207 and 1766-7, page 208).

Aft of bulkhead 132 in D-204-L, another deck depression which reaches a maximum of 9 1/2 inches at frame 137, has resulted in damage to structure supporting the deck. Web frames at frames 135 and 137 are tripped and buckled in the beam bracket. The deep transverse girders have failed around lightening holes and welds Photo Nos. 1768-8, page 210, 2180-1, page 214 and 2179-8, page 215). The stanchions supporting the girders are buckled (Photo Nos. 2179-12, page 212 and 1766-9, page 213). Bulkhead 139 1/2, separating the C.P.O. quarters from the washroom is buckled and has pulled away from the port shell (Photo Nos. 2179-11, page 211, 1766-10, page 216 and 1766-11, page 217).

(b) Damage to joiner bulkheads and causes.

Joiner bulkheads on the second deck are damaged extensively. In general, the damage is the result of the movement of structural units, particularly the main deck, which has crushed and distorted the joiner work connected to it. In way of the forward and after uptake spaces, however, considerable damage has occurred as the result of blast transmitted down the stacks.

In the forward part of the vessel, several joiner bulkheads are buckled and crushed near the overhead due to deflection of the main deck. This is most apparent over doorways which form hard spots. Photo Nos. 1761-10, page 145 and 1761-9, page 146 shows typical damage of this type in the wardroom country.

Moderate joiner bulkhead damage has occurred in the area surrounding the forward uptakes B-201-L, (frames 48 to 62) as the result of pressure entering through the stack and air intakes around the stack. The bulkheads, port and starboard, surrounding the uptake space are bulged out into the fore and aft passageways because of the pressure differential. The outboard passageway bulkheads are also bulged, particularly at the after end. This damage probably resulted from movement of the main deck. At frame 50, starboard, an air intake cover has been blown off and has pierced the inboard bulkhead of the passageway. As a consequence, a jet of air struck the outboard bulkhead in way of the door to the Marine Office, doing considerable damage as shown in Photo No. 1762-4, page 147. Photo No. 2157-12, page 148, illustrates the general condition of the starboard passageway. Damage is concentrated in way of joiner doors and door frames which are apparently considerably weaker, structurally, than the joiner bulkhead.

In the crew's space, C-201-L, the large deflection of the well deck has crushed and mangled joiner bulkheads in this area. The central area, containing ship's service store, radar spares and crew's head, is most severely damaged as shown in Photo Nos. 1768-4, page 151, 2158-1, page 153, 1767-12, page 154, 1762-7, page 155, 1768-6, page 168, 1768-5, page 169 and 1768-12, page 170. Photo No. 2158-3, page 158 shows typical joiner work damage along the outboard spaces.

Blast pressure through the air intakes has resulted in bulged bulkheads in B-202-E similar to that in B-201-L but of considerable less degree.

The extreme deflection of the deck in D-203-L has resulted in crushing and buckling of joiner work. Bulkhead 128 is a joiner bulkhead and is wrecked as shown in Photo Nos. 1765-9, page

196, 2178-12, page 197, 1765-10, page 198, 1765-11, page 199, 2179-1, page 200, 1765-12, page 201, 2179-2, page 202, 1766-6, page 203, and 1755-5, page 204. Other joiner enclosures are also buckled as shown in Photo Nos. 1766-3, page 175, 2178-9, page 179, 1766-1, page 187, 1755-2, page 190, and 1766-7, page 208.

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

Watertight doors below the weather deck are generally in good condition. Those in the immediate vicinity of the forward and after firerooms and machinery spaces show some dishing, as well as those leading into escape trunks, but all are capable of being dogged tight. The door to the engine room exhaust ventilator at frame 62, starboard, on the second deck has been blown from its hinges. Light joiner doors were distorted and inoperable where subjected to pressure as the result of movement of the overhead. The door to the marine office on the second deck, frame 50, starboard, has been wrecked by the blast.

(d) Condition of equipment within compartments.

There is little indication of shock damage to equipment below decks. Damage which occurred was that associated with the deformation of decks and bulkheads and crushing of joiner bulkheads due to the movement of the main deck.

(e) There were no fires.

(f) Damage to piping and cables are few and are confined to areas where extreme deck deflection resulted in pulled joints. The fire main is crushed at bulkhead 128. Damage to ventilation systems is extensive and resulted in incapacitating at least 50% of the systems as described in Item M. The principal areas of damage are the machinery spaces, C-201-L, D-203-L, D-203-2L, and systems leading from the vent trunk at frame 74, centerline.

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

Watertight subdivision is not reduced. The main deck is open in several places (frame 62 and frames 125 and 128, principally). The crews space, C-201-L, frame 60-72 is about 80% destroyed as to habitability and utility. The after compartments are habitable, but equipment in the CPO mess is not operable.

H. Armor Deck.

(a) The armor deck is intact except for several local and minor deflections under buckled stanchions.

(b) Spaces below were afforded complete protection from blast, heat and fire. Some slight distortion of structural items is evident as the result of loads transmitted through the deck.

(c) Armored hatches and armor gratings are undamaged by the test. Uptake bulkheads are not protected by ballistic plating on this vessel. There are no barbettes on this vessel. The 30# S. T.S. turret foundations are intact.

(d) The connections to all vertical armor are intact.

I. Interior Compartments (below waterline).

(a) Damage to structure and causes.

Compartment A-413-M flooded about one foot deep from the adjacent fuel oil tank, A-3-F through a riveted joint at the base of starboard bulkhead. The vessel reports that this bulkhead had many leaky rivets prior to test. The condition was evidently aggravated by violent motion of the vessel during test A.

Transverse watertight bulkhead 43 is buckled locally under the first platform level in way of the centerline leg of the foremast tripod. The center panel of the bulkhead is badly buckled, with buckling extending into the next panels outboard and damage occurring to the bulkhead stiffeners in this

area (Photo Nos. 1763-5, page 218, 1763-6, page 219, 1762-2, page 220, and 1762-3, page 221.

Photo Nos. 1763-1, page 222, 575-1, page 223, 1763-2, page 224, 575-4, page 225, and 575-3, page 226, taken in the after fire room, B-2, show the evidences of compressive loading of the 16" x 3/8" stanchion located on the centerline at frame 78 1/2, indicating that high loadings have been transmitted through the armor deck. Similar indications are found in the after engine room in the 12" x 3/8" centerline stanchion at frame 93 (Photo Nos. 574-2, page 229, 574-3, page 230, and 574-4, page 231). In addition, the transverse beam at frame 93 is slightly buckled on the port and starboard sides indicating that the second deck has been set down somewhat (Photo Nos. 574-9, page 227 and 574-7, page 228). A further indication that the second deck is depressed occurs at frames 95 to 96 near the after bulkhead where the flange of the centerline girder is distorted (Photo Nos. 574-6, page 232 and 574-5, page 233). It appears that the high stresses which occurred in this area were caused by loads transmitted from the after superstructure through the after main battery director tube which foots on the second deck at frame 94, centerline.

(b) Damage to joiner bulkheads and causes.

There is no evidence that any damage to joiner bulkheads occurred below the second deck.

(c) Details of damage to access closures.

None.

(d) Condition of equipment within compartments.

In B-1 and B-2, boiler casings are blown out as the result of blast down the stacks and blower openings. About twenty per cent of compartments below the waterline are filled with dust from damaged ventilation trunks topside.

(e) There is no flooding from external sources. A-413-M flooded to a depth of 1' 2" as the result of seepage from adjacent fuel oil tank A-3-F.

(f) No damage from flooding.

(g) There is no reduction in watertight subdivision. Habitability of compartments aft of frame 62 is seriously reduced because of damaged ventilation ducts and blowers. All spaces are usable except for minor damage in A-413-M, B-1 and B-2.

J. Underwater Hull.

There is no damage to the underwater hull.

K. Tanks.

(a) Condition of tanks in areas of damage.

No tanks are open to the sea as the result of test A. A riveted seam, reported to be leaky prior to test, has allowed water to seep from A-3-F (ballasted with salt water) into the 40mm stowage, A-413-M. Rate of previous flow is reported to have been about one inch of oil every three weeks. As a result of test A, 1' 2" of water and oil seeped into A-413-M in about four days. No other leakage has been found. The above damage is probably due to aggravation of existing leaky rivets by the violent motion of the vessel during test A.

(b) Contamination of liquids.

None.

L. Flooding.

No flooding has occurred from the sea. One case of minor leakage from a ballasted tank into a magazine is described in Item K.

M. Ventilation (exclusive of blowers).

(a) Damage to ventilation system and causes.

Superstructure.

1. Exhaust ventilation system 03-49-1. Ventilation duct between frames 48 and 49, starboard, on the emergency platform level is distorted slightly from bulging of bulkhead 49. There is no effect upon habitability as the system is still usable.

2. Exhaust ventilation system 03-49-2. Wire screen bulged slightly, one 3/8 inch bolt missing from screen and fan blades distorted from blast entering duct. No closure on system. Very slight effect on habitability of compartment. Exhaust is used principally when at action stations.

3. Exhaust ventilation system 02-45 (port). Screen bulged and torn due to movement of electric motor. Ventilation duct around fan ruptured from blades of fan being broken loose and driven through duct. No closure on system. Very slight effect on habitability of compartment. Principally used during action stations.

4. Exhaust ventilation duct at frame 41 on the superstructure deck has screws in bracket broken loose and bracket distorted. The cause of damage is undetermined. There is no effect on habitability.

5. Supply ventilation system 01-47. Ventilation duct on suction side of blower is distorted, cracked, and joints and brackets failed as a result of blast entering duct which has no closure topside. The habitability of stateroom is affected slightly as duct will not give a complete supply of air from outside. In addition, a joint in the ventilation duct has failed at frame 51, starboard, owing to the bulge of the overhead. There is no effect on habitability as the failure is in the stateroom supplied (W.R.S.R. "W").

6. Exhaust ventilation system 1-49. Ventilation duct at frame 50 on superstructure deck level is distorted and seams have failed (Photo No. 1761-8, page 44). The damage is probably due to blast pressure in the passageway and from the battery compartment below. The system cannot be used to exhaust the battery compartment as it would discharge noxious fumes into the staterooms on the superstructure deck level.

7. Natural exhaust duct from modulators in S.P. radar shack, superstructure deck level, frame 85 1/2, starboard, is damaged by distortion of forward bulkhead of radar room(Photo No. 1851-4, page 62). The damage affects only the modulators.

Below decks.

8. Exhaust ventilation system 2-36. Ventilation duct on suction side of blower, second deck, frame 36, has bulge and slight seam failure as a consequence of blast entering system which has no topside closure. Habitability is not affected as system is still usable.

9. Supply ventilation system 2-66. Ventilation ducts in forward machinery space at frame 62, port, and frame 66, port, are bulged and failed at seams because of blast entering system which has no closures topside. Habitability of forward machinery space is unimpaired as system is still usable.

10. Supply ventilation system 2-69. Ventilation ducts on discharge side of blower are blown down and demolished by the extreme movement of the main deck (Photo Nos 1763-4, page 151, 1762-8, page 152, 1767-12, page 154, 2158-1, page 158, 1767-10, page 160, 1768-11, page 163, and 1768-9, page 165). Habitability of B-201-L, C-201-L and C-202-E is reduced as system is inoperable.

11. Supply ventilation system 2-85-2. There is a joint failure in the ventilation duct in the after machinery space at frame 85, port because of blast entering the system from topside. There is no topside closure. The ventilation duct between frames

87 and 88 is bulged and moved down from depression of the overhead. The lowered section prevents one breaker on the after distribution board from opening all the way. Habitability is unimpaired as system is usable. Screens in the topside intake are blown in (Photo No. 1758-8, page 63).

12. Exhaust ventilation system 1-93. The ventilation intake at frame 93 on the main deck is bulged from blast entering the intake. There is no closure on the system topside. The system is still usable, therefore no effect on habitability.

13. Supply ventilation system 2-93-1. Seams and joints in the ventilation duct at frame 95, second deck, are damaged and broken leaving an appreciable opening on suction side of blower. The damage results from blast entering from topside through the intake which has no closure. Habitability is reduced as the blower will not take suction from topside.

14. Supply ventilation system 2-94-1. Ventilation duct in after machinery space at frame 93-94, centerline has failed at a seam and is dished in from blast entering from topside. There is no topside closure. No effect on habitability.

15. Supply ventilation system 2-99. The ventilation intake at frame 100, port, on the main deck is crushed and pulled away from the deck (Photo No. 1757-3, page 117). Closure is wrinkled but is effective. Blast traveled down through a ruptured duct, causing seams in ducts on second deck to fail. There is no effect on habitability as system is usable except in heavy weather when deck opening might ship water. Reinforcement of duct above main deck level may have averted damage.

16. Supply ventilation system 2-104-1. The ventilation ducts on the discharge side of the blower, second deck, frame 104-106, is distorted, cracked and failed in seams and joints. The damage resulted from blast entering system through the topside intake which has no closure. Habitability is somewhat reduced as air leaks from duct before reaching terminals.

17. Supply ventilation system 1-105-1. The ventilation duct at frame 104-105 is distorted slightly and cracked as a result of movement of bulkhead 104. No effect on habitability.

18. Exhaust ventilation system 1-105-1. Vent screen is torn loose and the housing around motor is ruptured from blast effect. Habitability of crew's washroom is slightly reduced.

19. Exhaust ventilation system 1-106-2. Ventilation duct housing motor is dented and the vent screen is torn off as blast moved motor and fan. System is inoperable.

20. Exhaust ventilation system 1-109-2. A ventilation duct at frame 109 on second deck is dished slightly from blast. A ventilation duct at frame 123, port, is distorted due to deflection of the overhead. System is still operable.

21. Supply ventilation system 2-113-1. Ventilation duct from closure 1-112-1 to main deck level is dished and distorted from movement of bulkhead. Ventilation runs on second deck, frame 114, have slight dish and small joint failures because of movement of overhead. Vent closure 1-113-1 is dished and distorted and will not close. System is still operable.

22. Supply ventilation system 2-125. Suction and discharge ducts at blower are demolished from extreme deflection of overhead (Photo Nos. 1766-3, page 175, 1755-2, page 190 and 2178-3, page 194). Habitability of living spaces serviced is reduced considerably.

23. Exhaust ventilation system 2-127-2. Ventilation duct on second deck between frames 127 and 132 is demolished because of extreme deflection of overhead (Photo Nos. 1765-9, page 196 and 1766-7, page 208). System is inoperable.

24. Supply ventilation system 2-132-2. Discharge run of duct has failed near blower at joint due to deflection of overhead. Air will not pass beyond break (Photo No. 2179-8, page 215).

25. Supply ventilation system 2-133. Suction run of duct failed in joints because of movement of overhead. Habitability of steering gear compartment, D-311-E, is reduced as system takes suction on second deck rather than atmosphere.

(b) There is no evidence that ventilation system conducted heat or fire below decks. Systems having no closures topside generally conducted blast to interior but damaged no structure other than ducts.

(c) No progressive flooding.

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

Ventilation systems are generally too flimsy to resist even minor blast effects. Methods of supporting runs of ducts are insufficient to survive blast and shock effects. Systems are not well laid-out and are too complicated. Each watertight subdivision should have an independent system so that watertight vertical boundaries are not pierced. Some sort of flapper valves on the suction side should be installed to protect blowers from air shock (blast). Topside ventilation should be reinforced and preferably built-in to the superstructure.

N. Ship Control.

(a) Damage to ship control stations and cau[illegible]s.

Damage to ship control equipment is confined to the superstructure where air shock disrupted electrical circuits and broke castings and foundation plates on equipment. Bridge wings, bulwarks and light metal lockers, etc., topside were distorted and demolished. All ship control spaces are usable with somewhat reduced efficiency.

(b) Constructive criticism of ship control systems.

Efforts should be made to eliminate bridge wings, overhanging platforms, etc., in the superstructures. Ship control stations should be modified to operate in a smooth streamlined superstructure. Necessary bridge wings should be of a folding type and

should be swung out during maneuvering and docking only. Lockers for signal and ship control equipment should be built in. All ship control personnel should be located inside a complete enclosure for protection against flash, radiation and blast.

O. Fire Control.

(a) Damage to fire control stations and causes.

1. Directors and elevated control positions.

The forward main battery fire control station was affected by the pressure wave. The deck is buckled and the rear bulkhead and door are dished. Equipment inside is undamaged. There is no evidence of damage from heat.

Protective bulwarks of anti-aircraft control stations are distorted but not ruptured.

The four protected directors were damaged by the blast. The two forward directors which were trained away from the blast received the greater damage. The rear plate of the forward A.A. Mk. 33 director is dished and the door in it will not close. The right side is dished and the door is blown through the door frame. The plating is torn on the hinge side at the upper fillet of the door frame. (Photographs 1759-9, page 24, 1760-12, page 22 and 1967-11, page 23). The tubes in the stable elements are broken. The rear plate and left side plate of the forward main battery Mk. 35 director is slightly dished. One holding down clip is loosened, and one leveling screw dropped out.

The after main battery Mk. 35 shield was very slightly distorted. The supply circuits for train and elevation motors are grounded outside the director. The after A.A. Mk. 33 director has considerable broken glass. The pointer's handwheel box has an oil leak. There is an open circuit in the amplifier for the filament supply to the C6A tubes for level operation of the stable element.

The starboard Mk. 51 director used with the Mk. 63 gun fire control system is demolished. The starboard Mk. 51 director used for auxiliary control of the starboard after 5"/25 guns has a ground in the supply circuit outside the director.

2. Plot rooms and protected spaces.

There is no plotting room on this ship. The fire control switchboard rooms and after main battery fire control station are undamaged.

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

The loss of personnel in the forward and after anti-aircraft control stations would have reduced the fighting efficiency of the anti-aircraft batteries even if protected gun mounts were provided. Local control of the individual mounts would have been required. Personnel and loose equipment such as telephones in these control stations would have had to be replaced. The reduced efficiency of the anti-aircraft directors, even if personnel were replaced, would have reduced the fighting efficiency against air attack especially in a moderate to heavy sea.

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

All fire control stations should be provided with shields for the protection of personnel against blast and heat. They should be manned by a minimum number of personnel. Exposed equipment should be at a minimum. The remainder should be in stations below the protected deck. Directors should be shaped to provide maximum strength against blast. Large flat areas should be eliminated wherever practicable. Plating should be as heavy as weight consideration will permit.

P. Ammunition Behavior.

During this test there were 392 tons of ammunition on board, which is 2/3 of war allowance. This included ammunition for 8"/55 caliber, 5"/25 caliber, 40mm and 20mm batteries, aircraft bombs, demolition charges, catapult charges, black powder, fuses, small arms ammunition, pyrotechnics and a small quantity of special test ammunition. None of this ammunition exploded or burned.

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

Ready service ammunition was stowed in the ready service rooms, clipping rooms, and ready service lockers for the respective gun batteries to approximately 2/3 normal capacity. The ready service spaces in general are uniformly distributed on the main deck and above. Special test ammunition including SPD and SPCG powder charges were exposed in the gun chambers of mounts 2 and 4, each of which had all doors open. Although fire burned Army Quartermaster's supplies adjacent to both sides of mount 4 and life rafts fastened to each side of this mount, the explosives inside are undamaged. In the 40mm ready service room, A-0403-M, the racks are broken and ammunition is disarranged. In the 20mm clipping room, C-0201-M, most of the magazines are knocked down from stowage racks on the bulkhead. One of the 20mm ready service boxes was torn loose from the deck and is lying on its side. Someof these boxes have the sun shields ripped off.

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

Each magazine contains the type of ammunition normally stowed there. No change occurred in any magazine except in A-413-M where ballast water and oil leaked in to a depth of about 14 inches. Prior to the test a small leak was present in this space. The test increased the amount of leakage. No damage to ammunition would have resulted had the crew been on board to keep these spaces dry.

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

There are no ammunition stowages insufficiently protected from an explosion such as that to which the ship was exposed during this test. The test apparently had no effect on ammunition in this ship. No change occurred in the methyl violet paper. The maximum thermometer reading during the test in an ammunition space below the main deck was 100° in the shell deck of turret 4, and 98° in several of the 20mm ready service boxes above the main deck. Similar readings existed during rehearsal of this test.

(d) Behavior of gasoline stowage facilities.

Fifteen per cent of stowage capacity of aviation gasoline was on board. The test had no effect on gasoline, gasoline stowage or handling facilities in this ship.

Q. Ammunition Handling.

(a) Condition and operability of ammunition handling devices.

With two exceptions all ammunition hoists are unaffected by the test. The right projectile hoist in mount 1 developed an open circuit in the protective resistor for the holding coil of the line contactor in the motor controller. The hoist can be operated only by continuously pressing the start button. The 40mm hoist at frame 46 amidship is inoperable due to a severed electric cable in the topside control circuit above the main deck. The hoist can be operated by disconnecting or repairing this cable. Repairs to the above hoists can be made in 30 minutes or less.

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

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

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

No comment.

R. Strength.

(a) Permanent hog or sag.

1. Hull evidence.

The deck survey on PENSACOLA indicates that the vessel is hogged slightly at the port sheer line and sagged slightly at the starboard sheer line. The amount of hog and sag is very small, being on the order of one inch throughout, and is considered the result of change of loading. It is not sufficient to indicate any permanent longitudinal deformation of the hull. There is no visible hog or sag.

2. Superstructure expansion joints.

None.

3. Local evidences of longitudinal stresses.

The weather deck is buckled lightly throughout its length, indicating that sometime during the test the vessel suffered a sagging condition which overstressed the deck in compression.

(b) Shear strains in hull plating.

There is no evidence of shear strains.

(c) Evidences of transverse or racking strains.

Some evidence of transverse strains is indicated by the working of more deck beam connections on the port side than on the starboard side.

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

No failures have occurred in main strength members in way of discontinuities. Several panel deflection topside were aggravated by structural discontinuities. The failure of light plating between stringer plates at frame 62-3 is attributable to a discontinuity of plating weights and the existence of ventilation and access openings in approximate alignment. A similar condition exists at frame 125-126 on the main deck where the existence of two access openings and two ventilation openings constitutes a discontinuity. This is shown in Photo Nos. 1764-7, page 133 and 2158-8, page 134. The damage to the galley skylight, frames 83-95 (Photo No. 1758-7, page 60) is in a measure due to the discontinuity caused by locating the skylight opening between two heavy foundations for 5 inch gun mounts.

(e) Evidence of panel deflection.

The principal panel deflections occurred in the main deck between frames 60 to 71 and frames 119 to the stern. A minor main deck deflection occurred between frames 14 and 29 on the main deck.

The armored second deck is set down about one inch over the two after machinery spaces from loads transmitted through bulkheads and stanchions. The movement caused buckling of two heavy pillars in the machinery spaces.

Panel deflection of the main deck is described in Item E. Deflection of the second deck is described in Items G and I.

(f) Turret, machinery and gun foundations.

There is no evidence of damage to turret, machinery or gun foundations.

TECHNICAL INSPECTION REPORT

SECTION II - MACHINERY

GENERAL SUMMARY OF MACHINERY DAMAGE

I. Target Condition After Test:

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

No data taken by Machinery Group.

(b) Structural damage.

Both smokestacks were knocked over to port and severely crushed. Uptakes were distorted. Boiler casings were damaged structurally. Considerable damage was done to piping, and to the boat and airplane crane by deflection of supporting structures (bulkheads and decks).

(c) Damage, machinery.

The casings of all boilers were badly blown out. Smoke indicators, air doors, air door operating gear and brickwork of boilers were moderately damaged. Both stacks were blown over. Uptakes were distorted at their upper ends. Suction flaps in forced draft blower intakes were bent. The after deck winch was thrown out of alignment and its electric controller crushed by deflection of the main deck. The boat and airplane crane was damaged structurally. There was considerable damage to piping (mostly to fire main risers near the main deck, and to small water piping on the second deck).

II. Forces Evidenced and Effects Noted.

(a) Heat.

There was no evidence of heat in machinery spaces. There was some scorched paint on the starboard sides of deck machinery.

(b) Fires and Explosions.

There was no evidence of fires or explosions in machinery spaces or on exposed machinery.

(c) Shock.

Some small piping (already badly corroded) broke apparently from shock. There was no other direct evidence of shock on machinery. A contact finger in the controller of the port deck winch broke.

(d) Pressure.

Blast pressure caused the damage to boilers and stacks, forced draft blower flaps, and caused structural damage affecting the crane, after warping winch, and piping.

(e) Any Effects Apparently Peculiar to the Atom Bomb.

The high blast pressure at this range from an explosion is believed to be peculiar to the atom bomb.

III. Effects of Damage.

(a) Effect on Machinery and Ship Control.

All boilers were made inoperable, hence the ship was without steam power. It is estimated that approximately 96 hours would be required for temporary repairs by the ship's force to enable the ship to steam at very slow speed. Major repairs at a Naval Shipyard would be required before normal operation could be resumed. The forced draft blowers could not be operated until the bent flappers were straightened but this could be done by the ship's force within a few hours. The after warping winch would probably require a major overhaul. Temporary repairs to permit operation of the crane could be made by the ship's force within two days. Damage to piping is only of local effect except that to the firemain riser at frame 128. This supplies water to the

sprinkling system of the after 40mm magazines, and water to this system was cut off by this damage.

Insofar as machinery is concerned, the effect of the test on ship control was to reduce power available to that furnished by the emergency diesel generators.

(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 believed that all personnel in the firerooms would have been casualties if boilers had been steaming at the time of the test. It is not believed that any other personnel casualties would have occurred below decks. Habitability would have been greatly reduced by loss of steam power, and to some extent by damaged piping.

(e) Effect on Fighting Efficiency.

As the ship lost all steam power she was no longer an effective fighting unit.

IV. General Summary of Observers' Impressions and Conclusions.

It is believed that a modern cruiser, exposed as the PENSACOLA was, would also have been put out of commission, although damage to the boilers would not have been as heavy.

V. Any Preliminary General or Specific Recommendations.

(a) Boilers, uptakes, and stacks should be made more resistant to blast pressure.

(b) Deck machinery and piping should be supported in such a way that they are not likely to receive secondary damage from deflection of decks or bulkheads.

DETAILED DESCRIPTION OF MACHINERY DAMAGE

A. General Description of Machinery Damage.

(a) Overall condition.

All eight boilers of this vessel suffered severe damage tc casings and were rendered inoperable. All other important machinery below decks was undamaged. The airplane crane, after deck winch and some piping which was above or attached to the main deck were damaged. Both stacks were blown over to port.

(b) Areas of major damage.

The major damage was concentrated in the forward and after firerooms and on the smoke stacks.

(c) Primary causes of damage.

Blast pressure was the primary cause of damage. Secondary damage was caused by deflection of decks and bulkheads, which deflection was caused by blast pressure.

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

All steam would have been lost on this vessel and she would have been without main propulsion or any power other than that furnished by the diesel generators for at least 96 hours. (Note: The Commanding Officer estimated that temporary repairs could be made to one or two boilers in 54 hours). Main propulsion machinery and auxiliary machinery would have been able to operate at full load had not all steam been lost.

Note: After test A temporary repairs were made tc the boiler casings on Nos. 5 and 7 boilers permitting the limited operation of these boilers necessary to test out main and auxiliary machinery.

B. Boilers (S-51).

(a) Air casings.

The casings of the boilers of the PENSACOLA were severely damaged. This ship sustained greater damage to the boilers than any other ship in test A. All casings were similarly damaged but to a different degree. No boiler was operable after the test and considerable work(4-6 days for a temporary job; 20-30 days for a permanent job) would be required to place the boilers in working condition.

Outboard access panels of the boilers were blown out. On all but #3 boiler, the bolts on the lower flanges of these panels held and the panels remained partially in position but bent outward from this flange out into the fireroom. Those on #3 boiler blew out and fell to the deck. The casings panels immediately above these access panels were also blown out (with their upper flanges holding) and were badly distorted. Photo 1879-3, page 234.

Failure of the panel joints resulted when the bolts heads were pulled through the flanges by enlarging the bolt holes.

#1, #4 and #8 outboard boiler casings carried away some attachments to the ship's structure (ladders, gratings, etc.) when they blew out. Photos 1879-8, page 235, 1879-9, page 236, and 1879-12, page 237. In most cases the casings appear to have fallen back partially toward their original position from the position of maximum displacement.

Front casings on most boilers are bulged, especially the packed panels in way of the tubes. The burner front plates, being quite stiff, show very little effect from the blast but the packed panels above the burner fronts were distorted. Photos 1879-2, page 238, 1879-4, page 239. At some places the casings joints were ruptured.

Inboard side casings bulged out and, in some cases, failed at the removable panel joints. As motion of these casings was

restricted by the adjacent boiler and the ship's structure, the effect of the blast on them was not as great as on the outboard side casings. Photos 1879-5, page 240 and 1879-6, page 241.

(b) External fittings.

Smoke indicators suffered damage from the blast due to the breaking of mirrors in the reflecting units. These mirrors broke either by swinging open and slamming against the connecting pipe when the holding down bolt failed or from the sealing glass being blown against the mirror.

All pressure fittings and other external fittings appear to be undamaged. Hydrostatic test of boilers revealed no defects of fittings.

(c) Fuel oil burner assemblies.

Except for air doors and air door operating gear, no damage was sustained by the oil burners. All valves and piping appeared to be undamaged.

About 75% of the air doors were in good condition and operable. The other 25% had been jammed against the frame of the burner by the pressure and were inoperable. Repairs which would be required to put these burners back into operation are of minor nature and could be accomplished in a short time by the ship's force.

(d) Brickwork.

The brickwork in the majority of the boilers stood up very well although the supporting casings moved as much as 4 inches. As front and rear casings remained secured to the water drums, but moved relative to the steam drums, the movement of the casings and attached brickwork was negligible near the water drums and reached a maximum at the top of the wall. The plastic and some bricks at the peaks of the front and rear walls tended to be dislodged and in some furnaces the plastic corbels at the tubes

cracked off (Photo 1879-1, page 242) and fell to the furnace floor. Side walls were generally intact.

(e) Steam and water drums.

Pressure parts were apparently undamaged. Hydrostatic tests have been made and no defects were revealed by these tests.

(f) Tubes.

See (e) above.

(g) Foundations.

All foundations were intact.

Note: Boilers #5 and #7, to which temporary repairs were made after test A (Photos 2173-1, page 243, 2173-2, page 244) are the only ones that have been steamed after the test. They have been steamed only at light load.

(h) Stacks and uptakes.

Both stacks were blown over to port. A fold was made in the port side about 3 feet above the skirt at the base of each stack and the stacks were pushed over to an angle of 45 degrees. Division plates in stacks were squashed so that the gas passages were greatly restricted. On the after stack the joints in the inner and outer stacks failed about 8 feet above the 01 deck. Photos 1879-10, page 245, 1879-11, page 246, 1879-12, page 247, 1757-12, page 248, 1758, page 249, 1759-2, page 250, and 1760-4, page 251.

The cowling of forward stack was torn off and landed on deck to starboard. The cowling of the after stack remained in place.

The uptakes of all boilers were undamaged below the battle bars. The forward uptakes were distorted above the battle bars and this distortion became progressively worse toward the connection to the stack. Division plates carried away and distorted about 8 feet above the battle bars. Photos 1878-9, page 252, and 1878-10, page 253. Outer uptakes of #1 and #2 boilers were dished on the forward side. Photo 1878-8, page 254. This appears to have been caused by part of the blast coming down the space between the inner and outer stacks and exerting pressure on the outer uptakes. This condition was found only on #1 and #2 uptakes.

The after uptakes were intact up to about 6 feet above battle bars. Above this point inner and outer uptakes were ruptured and the joints failed on the division plates.

C. Blowers (S-53).

The blast pressure came down the blower intakes and bent several of the suction flaps and in several cases broke the balancing cables of the flaps. Repairs were quickly made by the ship's force. There was no other damage to the forced draft blowers, all of which have been operated under service conditions since test A.

D. Fuel Oil Equipment (S-55).

Undamaged.

All fuel oil equipment has been operated under service conditions since test A.

E. Boiler Feedwater Equipment (S-56).

Undamaged.

All feedwater equipment has been operated under service condition since test A.

F. Main Turbines (S-41).

Undamaged.

Nos. 2 and 3 turbines were operated at propeller speeds up to 94 RPM for 3/4 hour while the ship was shifting berths.

Nos. 1 and 4 turbines have been tested and spun in both directions. There has been no change in dummy clearances.

G. Reduction Gears (S-42).

Undamaged.

Nos. 2 and 3 reduction gears were inspected while the shafts were being jacked over one revolution.

Nos. 1 and 4 reduction gears have been inspected through the inspection holes but have not been turned.

H. Shaftings and Bearings (S-43).

Undamaged.

Shafting and bearings were inspected while the ship was underway shifting berths.

I. Lubrication System (S-45).

Undamaged.

All lubrication equipment has been operated under service conditions.

J. Condensers (S-46).

Undamaged.

All condensers have been operated under service conditions. Normal vacuum was maintained.

K. Pumps (S-47).

Undamaged.

All pumps have been operated satisfactorily under service conditions.

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

Undamaged.

All turbo-generators have been operated under service conditions.

M. Propellers (S-44).

Undamaged.

Propellers were checked with the ship underway but are not accessible for visual inspection.

N. Distilling Plant (S-58).

#1 main distilling plant was not damaged by test A and had been operated satisfactorily.

#2 main distilling plant could not be operated satisfactorily before test A. Its condition was not changed by the test.

The emergency distilling plant was not damaged by test A, and has been operated under service conditions since that test.

O. Refrigerating Plants (S-59).

Undamaged.

All equipment has been operated under service conditions.

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

The after warping winch is inoperable. The main deck beneath the winch was blown in by the force of the blast, throwing the winch out of alignment. The electric controller for this winch, which is mounted underneath the main deck, was crushed by the deflection of the main deck.

A contactor finger in the controller of the port deck winch broke. There was no damage to mechanical features of this winch.

There was no damage to other components included in this item (forward warping winch, starboard deck winch, capstan, windlass).

Q. Steering Engine (S-22).

Undamaged.

Both steering units have been operated from all stations under service conditions.

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

The airplane crane was rendered inoperative as a result of secondary damage as follows:

The after stack fell against and bent the port leg of the crane derrick. This caused misalignment and binding of the rotating gear and pinion.

The control shafting was inoperable due to binding where it penetrated bulkheads which were deflected, and binding where it was supported from the deck above which was deflected downward. Photo 2168-5, page 255.

It is believed that damage to the crane could have been temporarily repaired by the ship's force to make it operable in two or three days.

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

A small exhaust blower in the radio room was damaged by blast. The fan blades were broken and bent.

The motor of a small exhaust blower in the after crew's head was thrown out the vent duct.

There was no damage to any other ventilation machinery. There was extensive damage to vent ducts (see Hull report), but the vent sets are all operable except as noted above.

T. Air Compressors (S-49).

Undamaged.

All air compressors have been operated under service conditions.

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

Undamaged.

The two diesel generators, diesel fire pump, and diesel pump for centering the rudder have all been operated under service conditions since test A.

V. Piping (S-48).

The condition of piping is as indicated:

(a) Main steam.

All piping is intact and has been tested at design pressure.

(b) Auxiliary steam.

All piping, except as noted below is intact and has

been tested at design pressure.

1. The whistle and siren steam and drain lines were bent and ruptured at the base of the stack as a result of the bending over of the stack.

2. The bulkhead flange of the laundry steam supply line at bulkhead 85 is in a leaking condition due to distortion of the bulkhead.

3. Steam drain lines in way of damaged boiler air casings have been bent and ruptured.

(c) Auxiliary exhaust.

1. All piping in machinery spaces is intact and has been tested to design pressure.

2. The atmospheric exhaust and safety valve escape piping is intact below the main deck. However, it is badly bent and kinked above the main deck due to the bending of the stack. Since the lines are completely pinched shut, it was necessary to cut the forward pipe off at the base so that boilers could be operated.

(d) Condensate and feedwater.

All piping is intact and has been tested at design pressure.

(e) Fuel oil.

All piping is intact and has been tested at design pressure.

(f) Lubricating oil.

All piping is intact and has been tested at design pressure.

(g) Fire main, flushing and sprinkling.

All piping is intact and has been tested at design pressure except as follows:

1. The fire main riser at frame 62, starboard, was ruptured under the main deck by deflection of the deck. This riser serves fire plug 1-62-1 which has been made inoperative by the damage. This riser can be isolated.

2. The fire main riser at frame 128 was bent and kinked below the main deck to such an extent that water cannot be supplied to fire plugs 2-128-2, 1-125-2, and 2-132-1, or to the after 40mm magazine sprinkling system, which is connected to this riser. Damage was caused by deflection of the main deck and bulkhead 128. The riser can be isolated.

3. The flushing branch of the fire main in C.P.O. washroom and water closet was ruptured at the screwed connection on the inlet side of the branch line cut out valve. This damage was caused by deflection of the deck to which the piping is attached. It does not affect the operation of the fire main since the line can be isolated.

Fresh water.

1. The supply line in warrant officer's washroom and watercloset is broken off. It is believed that inadequate supports permitted the line to whip and break since there is no structural damage in this space.

2. The branch line at frame 70, port side, broke off at the screwed joint to the main line. This damage necessitated cutting off the supply to the entire ship aft of frame 64 since the damage could not be isolated locally. Damage was caused by deflection of the deck to which the piping is attached.

3. The branch line leading to the potato peeling room was broken off at the screwed union joint. Damage occurred at frame 87 as the result of deflection of the deck to which the piping was attached.

(h) Condenser circulating water.

All piping is intact and has been tested under operating conditions.

(i) Drain main.

All piping is intact and has been tested at design pressure.

(j) Hydraulic main.

All piping is intact and has been tested at design pressure.

(k) Gasoline.

All piping is intact and has been tested at design pressure.

W. Miscellaneous.

1. The soda fountain equipment was crushed by the well deck being pushed down on top of it and is probably beyond repair.

2. All other miscellaneous equipment is operable and has been used in service since test A.

TECHNICAL INSPECTION REPORT

SECTION III - ELECTRICAL

GENERAL SUMMARY OF ELECTRICAL DAMAGE

I. Target Condition After Test.

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

Drafts not observed. No flooding occurred.

(b) Structural damage.

Structural damage involving electrical equipment occurred mainly in the following areas:

1. Second deck in quarters aft at frame 127.
2. Main deck forward in battery charging station, frame 48.
3. Main deck starboard center at frames 85 and 100.
4. Superstructure at base of both masts.
5. On main mast and foremast.
6. On forward superstructure and lookout station.
7. After steering station.
8. All searchlight platforms.

(c) Other damage.

No damage to major electrical equipment occurred during the test. No damage to electrical equipment preventing the ship from performing combat duty occurred. Inoperably equipment is essentially as follows:

1. Circuits and equipment on masts and yard arms.
2. Searchlights, one 12", all 24", and all 36".
3. A few ship's service telephones on superstructure.
4. A few lights in superstructure.
5. A few ventilator sets in quarters aft.

6. After warping winch.
7. Emergency radio TBK transmitter, M. G. controller.

II. Forces Evidenced and Effects Noted.

(a) Heat.

Heat was evidenced by scorched paint and smoked surfaces on all vertical areas exposed to the direct blast from about 165 degrees relative. Effect on electrical equipment was noted as follows:

1. Cables on after side of main mast were scorched slightly by the radiant energy of the blast.

(b) Fires and explosions.

No electrical equipment was damaged by fires or explosions, except as follows:

1. Local lighting cables on second deck at frame 127 due to fire on main deck.

(c) Shock.

No electrical effect was noted which could be attributed to shock.

(d) Pressure.

A positive pressure of extremely high value and a negative pressure were noted. No damage to electrical equipment occurred except as follows:

1. A light metal cable covering on after side of main mast carried away.
2. Vertical cable at frame 47 main deck was broken by door carrying away.
3. Some ventilating systems were made inoperable due to collapsing impeller housing.
4. The after warping winch was made inoperable by the collapsing of the main deck at frame 128.

5. Two batteries in battery lock were knocked out of battery rack and demolished due to bulkhead bending.
6. The Emergency Radio motor generator controller for the TBK transmitter was cracked and made inoperable by bending of bulkhead.

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

No effects to electrical equipment occurred.

III. Effects of Damage.

(a) Effect on propulsion and ship control.

Electrical damage had a negligible effect on propulsion and ship control.

(b) Effect on gunnery and fire control.

No electrical damage occurred other than noted below.

1. The forward 40MM ammunition hoist is inoperable electrically due to the vertical control cable breaking on main deck frame 47 when door collapsed.

(c) Effect on watertight integrity and stability.

No effect occurred.

(d) Effect on personnel and habitability.

No effect occurred other than is shown below.

1. The loss of a few ventilating units.

(e) Effect on fighting efficiency.

Electrical damage had only a slight effect on fighting efficiency.

IV. General Summary of Observers' Impressions and Conclusions.

The only electrical equipment damaged by the test was either in the direct path of the blast or in the way of structural failures which caused secondary damage.

Searchlights were the major item in the direct path. They were the cast aluminum design. It is presumed that if they were of a late design, less damage would have occurred.

Cable and motor controllers suffered most damage due to structural failures. Suitable mounting arrangements such as now required by BuShips specification would have prevented most controller damage.

Cables and supports were mostly undamaged. A few cables were damaged due to failure of ship's structure and by exposure to radiant flash heat.

V. Preliminary Recommendations.

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

DETAILED DESCRIPTION OF ELECTRICAL DAMAGE

A. General Description of Electrical Damage.

(a) Overall condition.

The overall condition of the electric plant was in general, the same as before Test A. The electrical damage consists almost entirely of blast damage to topside equipment such as searchlights, exposed wiring and exposed instrument dials. No vital electrical machinery had been damaged in Test A.

(b) Area of major damage.

The main and second decks aft of frame 49 and the entire superstructure above the main deck are the areas of major electrical damage in Test A.

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

The buckling of the main deck was the cause of damage on second deck. The blast was the cause of damage to the main deck and superstructure.

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

Steam driven generator sets were rendered inoperative after Test A due to boiler casualties. Diesel driven generator sets were operable and not affected by Test A.

Engine and boiler electrical auxiliaries were operable and not affected by Test A.

Electric propulsion not applicable.

Interior communications were practically all operable after Test A. A few instruments on the topside were damaged by the blast.

Fire control circuits below the main deck were operable and undamaged. Above the main deck, a few leads to instruments on guns were damaged.

The electrical features of the vent system were approximately 95% operable after Test A. A few sets on the second deck were out of commission due to damage caused by warped or ruptured hull structural members.

Lighting was practically undamaged by Test A below the main deck. On the main deck and above about 5% of the fixtures were damaged. Damage was largely incidental to hull structural damage.

(e) Types of electrical equipment most affected.

Switchboards and switch-gear were practically undamaged.

Rotating machinery was largely undamaged. One warping winch was inoperable due to deflection of the supporting deck. A few vent sets were inoperable due to failure of supporting ship's structure.

Practically all motor controllers were undamaged and operable after Test A. One radio motor generator controller, one deck winch controller and one vent set controller were damaged due to failure of supporting hull structure.

B. Electric Propulsion Rotating Equipment.

Not applicable.

C. Electric Propulsion Control Equipment.

Not applicable.

D. Ship's Service Generator.

No damage occured. All generators were placed in service on return of steam supply.

E. Generators - Emergency.

No damage occurred. Both generators placed in service after test.

F. Switchboards and Distribution Panels.

Battery charging panel supporting frame was bent and panel displaced about 3" caused by bulkhead bending.

One circuit breaker for Turret Power in upper corner of aft main distribution switchboard was inoperable due to displaced ventilation duct.

Voltmeter on forward emergency Diesel Swicthboard failed in operation after test due to open resistor in meter.

G. Wiring, Wiring Equipment, and Wireways.

Local lighting cable, second deck aft, crew's quarters, frame 127 was slightly burned due to fire on deck above. Cable is serviceable but should be replaced.

Cables up after side of main mast are scorched due to radiant energy. Cable supports are bent and cable loose in straps due to blast. Sheet metal covering was carried away by the blast. Cables are serviceable. See Photograph 1761-3, Page 67.

Cable to P. A. speaker on main deck superstructure below No. 3 turret was broken by carrying away of vent pipe.

Vertical cable in ladder trunk main deck, frame 46-47, starboard, was broken by door due to blast pressure. See Photograph 1754-12, Page 257.

Numerous local cables on the superstructure were damaged and broken due to distortion and rupture of structural members. See photographs 1762-9, Page 256; 1760-6, Page 259; 1755-3, Page 260; and 1754-12, Page 257.

Recommendation pertaining to damage under Item G.

a. Exposed cable should be protected with a coating of suitable heat resistant paint or varnish.

H. Transformers.

No damage occurred.

I. Submarine Propulsion Batteries.

Not applicable.

J. Portable Batteries.

A 5'' gun battery box was torn from the bulkhead due to being hit by a flying object and a battery jar was cracked, losing electrolyte.

Two batteries fell out of the rack in the battery locker, main deck, approximately frame 48, breaking jars and spilling electrolyte.

Recommendations pertaining to damage under Item J.

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

K. Motors, Motor Generator Sets and Motor Controllers.

No motor damage occurred. Those vent sets inoperable after the test were damaged by the collapsing of the impeller housings.

No motor generator damage occurred.

The aft warping winch contactor panel on second deck has bent supports due to caving in of deck above at frame 128. This pannel is in two sections and visibly operable. Mounting is of deck to deck construction. See photograph 1765-10, Page 198 and Photograph (resistor units), Page 261.

Support for contactor panel 2-62 ventilator on second deck aft port, broken at weld, due to movement of deck above. The support was of deck to deck construction. Contactor panel was operable.

Motor generator contactor panel for TBK radio in emergency radio room is cracked across middle due to bending of bulkhead and cabinet being flush mounted. See photograph 1755-12, Page 262.

One contactor finger of cast iron drum controller for port deck winch was broken due to shock.

The Shunt coil protective resistor on control panel for turret No. 2 shell hoist was open, cause unknown.

The control circuit for 40MM ammunition hoist forward was disrupted because of a broken cable at frame 46, main deck. See photograph 1754-12, Page 257.

Recommendations pertaining to damage reported under Item K.

a. Motor controllers and switch-gear should be supported by a framework which will allow a considerable distortion of the supporting deck or bulkhead without excessive strain on the mechanism of the controller or switch-gear.

L. Lighting Equipment.

No failure of any lamps below the second deck occurred. On the second deck a total of four lamps were broken in areas of the greatest damage. Between frames 60 and 130 on the main deck and above approximately 5% of the lamps installed were broken.

A few fixtures were broken due to flying objects. Example: Ceiling fixture in movie locker was broken due to being hit when bulkhead gave away.

Note: Standard globes stood the shock as well as Hi-impact.

M. Searchlights.

The starboard 12'' signal searchlight lifted out of the standard due to blast and fell on deck. Cable was burned due to fire on deck. Visably, no damage was done to glass, reflector, shutter or lamp.

The port 24'' searchlight had both cast aluminum yokes broken. Drum was lying on deck. Cable was disconnected, light inoperable. Shutters were displaced and badly damaged and glass was broken. See photograph 1968-3, Page 265.

The starboard 24'' searchlight had one yoke cracked and bent out of shape, otherwise operable. See photograph 1968-4, Page 264.

The port 36'' searchlight was completely inoperable due to blast. The iris shutter is dished in approximately 3''. The shutter operating mechanism is frozen, also are the train and elevation locks, although the light remained in place.

The starboard 36'' searchlight aft has both cast aluminum yokes broken due to blast and light is lying on superstructure deck. Drum is bent, glass and shutter broken and mechanism inoperable. See photograph 1758-7, Page 263.

Recommendations pertaining to damage reported under Item M.

a. Searchlight design should require built-up trunnions of steel to replace brittle castings.

b. King pin arrangement of 24'' search lights should be strengthened.

c. All obstructions outside the drum should be removed or smoothed out.

Note: Some steel box type yokes used on APA's were bent by the shock. None of them were broken. Some were lifted off the training track.

N. Degaussing Equipment.

No damage.

O. Gyro Compass Equipment.

No damage occurred to either master compass. Repeaters had damage as follows:

1. Glass broken on the open bridge, secondary control and Captain's cabin, repeaters. Both steering repeaters have broken king pins. (These pins appear to be made of cast bronze.

Recommendations pertaining to damage reported under Item O.

a. Supports for gyro repeaters and magnetic compasses should be designed to provide greater resistance against shock and blast.

P. Sound Powered Telephones.

No damage.

Q. Ship's Service Telephones.

No damage.

R. Announcing Systems.

The transmitter on quarter deck aft appears to be scorched by heat. One has inner section displaced.

The speaker on main deck aft superstructure, starboard below No. 3 gun turret is caved in and broken loose due to bent vent pipe.

The speaker forward of ship's service store, frame 65, was broken due to collapse of deck forward of mainmast. No other damage occurred.

S. Telegraphs.

(a) All engine order telegraphs operable.

The starboard engine order telegraph on flying bridge has glass broken.

The port engine order telegraph on after conning station has glass broken.

Note: Those with glasses broken have no indication making operation hazardous.

Recommend that indication be arranged in such a way that when glass is broken, the proper lever position is evident from indications on the rim or from a suitable number of notches in the ratchet.

T. Indicating Systems.

No damage occurred.

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

No damage occurred.

V. F. C. Switchboards.

No damage occurred.

W. Misscellaneous (Special 660 Material).

No damage occurred.

APPENDIX

SHIP MEASUREMENT DATA

TEST ABLE

SHIP MEASUREMENT DATA

A. GENERAL CONSIDERATIONS.

A deck survey method was developed to determine the twist and longitudinal bending of each target vessel's hull girder resulting from an air or underwater burst of the atomic bomb. The procedure is as follows:

1. Select transverse sections. The maximum number of transverse sections used on any ship was six.

2. At each transverse section, select stations at which rod readings are to be taken. Center punch these stations in the deck. A minimum of five stations were used at each transverse section.

3. Establish throughout the length of the ship, by use of a surveyor's transit, a reference plane approximately parallel to the deck.

4. Take rod readings at every station on each transverse section.

5. Plot rod readings relative to a straight line representing the reference plane.

(a) Readings at each transverse section are plotted in order to obtain the configurations of individual sections and also to establish the relationship between sections.

(b) Readings at desired distances from the centerline are plotted in order to establish sheer lines. On most ships the actual readings are corrected for changes in sections resulting from local damage. Such corrections were not made in the PENSACOLA plot. Ordinarily the sheer of the centerline and of the port and starboard deck edges is plotted.

6. Repeat steps 3, 4 and 5 after the test using the stations established in steps 1 and 2.

7. Superimpose the after test plots on the before test plots in order to compare the conditions existing at the times of the two surveys.

The reference planes used in the before test and after test surveys are not necessarily parallel. Their relationship can not be accurately determined because bench marks established before the test may be affected by local damage or by changes in hull alignment. Therefore it is possible only to determine relative movement between sections. It is not possible to measure the absolute movement of any one section. The reference planes are disregarded after completion of the initial plots.

Twist of the hull girder is determined by superimposing one after test transverse section on the similar before test section and comparing the configurations of the remaining sections. Hog or sag is determined by superimposing before and after test plots of sheer.

The camber curves indicated in all plots are faired lines and do not show local deformation which may exist between the five station points.

B. MEASUREMENTS.

The original survey of the main deck of PENSACOLA was conducted 4 March 1946, at Terminal Island Naval Shipyard. Deck house structures prevented establishment of a continuous line of sight and necessitated use of several instrument setups. The second survey was conducted after Test A on 9 July 1946, at Bikini. During this survey, working of the ship's structure in the well deck area was observed. Transits set on the main deck, Frame 64, 17 feet to port and starboard of the centerline, were sighted on a bench mark at frame 71, centerline. A sight from either transit indicated between 1/8 and 1/4 inch relative vertical motion of the bench mark and other transit. This movement was probably the result of local damage to the deck structure. Data included are as follows:

(a) Transverse Sections.

Transverse sections used in the survey of the main deck were as follows: (See Sheer Lines-Profiles Drawing Page 98).

15 inches forward of frame 29.
12 inches forward of frame 48.
0 inches forward of frame 71.
24 inches aft of frame 97.
21 inches aft of frame 113.

There was no change in the relative positions of sections at frames 48 and 71 as a result of the test. (See Transverse Sections Drawing Page 99). These two sections were held when the two survey section plots were superimposed. The following changes in the hull girder are indicated:

1. There is a torsional rotation, counter-clockwise when viewed from aft, of approximately 18 minutes between frames 48 and 29, a distance of 76 feet.

2. There is a torsional rotation, counter-clockwise when viewed from aft, of approximately 29 minutes between frames 97 and 29, a distance of 272 feet.

3. There is local deflection between the deck edges at frame 48.

(b) Sheer Lines - Profiles (Page 98).

No significant change in the shape of the hull girder is apparent in the sheer line plot. The small change in shape of the sheer lines is no more than would be expected to result from the changes in temperature and load condition between the two surveys. The faired sheer lines on the plate are accurate at the five sections only. Local deflections not in way of the survey sections are not indicated. As noted in the transverse plot, the local deflection of the centerline is responsible for a major portion of the change in the centerline contour.

(c) Scratch Gage Data.

The scratch gages on this vessel were installed between the main and second deck as shown on Page 100 . As the

second deck is an armor deck and was apparently undamaged, the scratch gage record has been interpreted as movement of the main deck. They indicate downward movement of the main deck throughout the ship's length with permanent set averaging approximately fifty per cent of the maximum deflection. A tabulation of all scratch gages with maximum readings and amount of permanent set is on Page 101 . The deck movement at frame 63 was greater than the gage length (28 inches) and the maximum reading aft was 16 5/8 inches at frame 124 1/2 with 11 7/8 inches permanent set.

Several gages were removed from the PENSACOLA. Records of the deck movement recorded on these gages are on Pages 102 to 106 .

(d) Deck Deflection Data (Pages 107 - 108).

Special measurements were taken to determine the deflection of the main deck in the well deck area and at the stern. These areas were selected for special study due to the severe deck deflection caused by the air blast.

To obtain the actual contour of the deck a theoretical plane was established using a surveyor's transit. Rod readings were taken as necessary. A plot indicated no change in the deck edge readings, therefore, it was possible to superimpose several sections by holding the deck edge stations. To show the actual amount of movement the original design camber has been sketched in over the damage contours.

C. SUMMARY OF CHANGES IN SHAPE OF HULL.

1. Longitudinal Sheer - Negligible.
2. Shape of Individual Sections - Negligible.
3. Torsional Rotation of Sections - 29 Minutes in 272 feet.
4. Deck Deflection Scratch Gages -

Maximum Deflection - 28 Inches Plus

$$\frac{\text{Permanent Deflection}}{\text{Maximum Deflection}} = .5 \text{ (Approximately)}$$

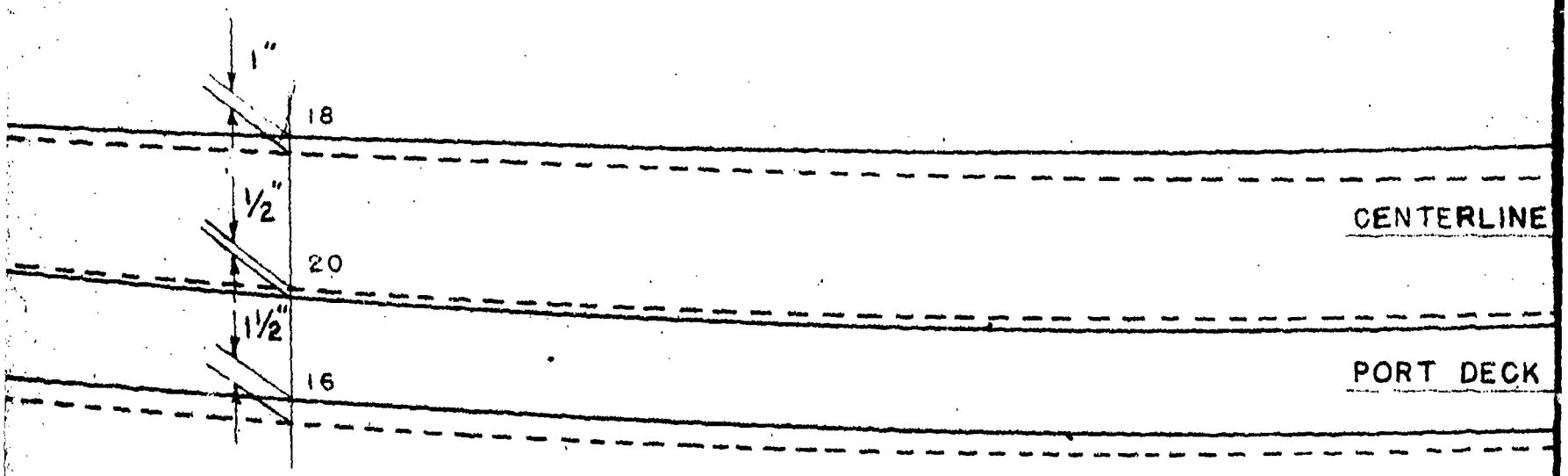
SECRET

FRAME 113

21

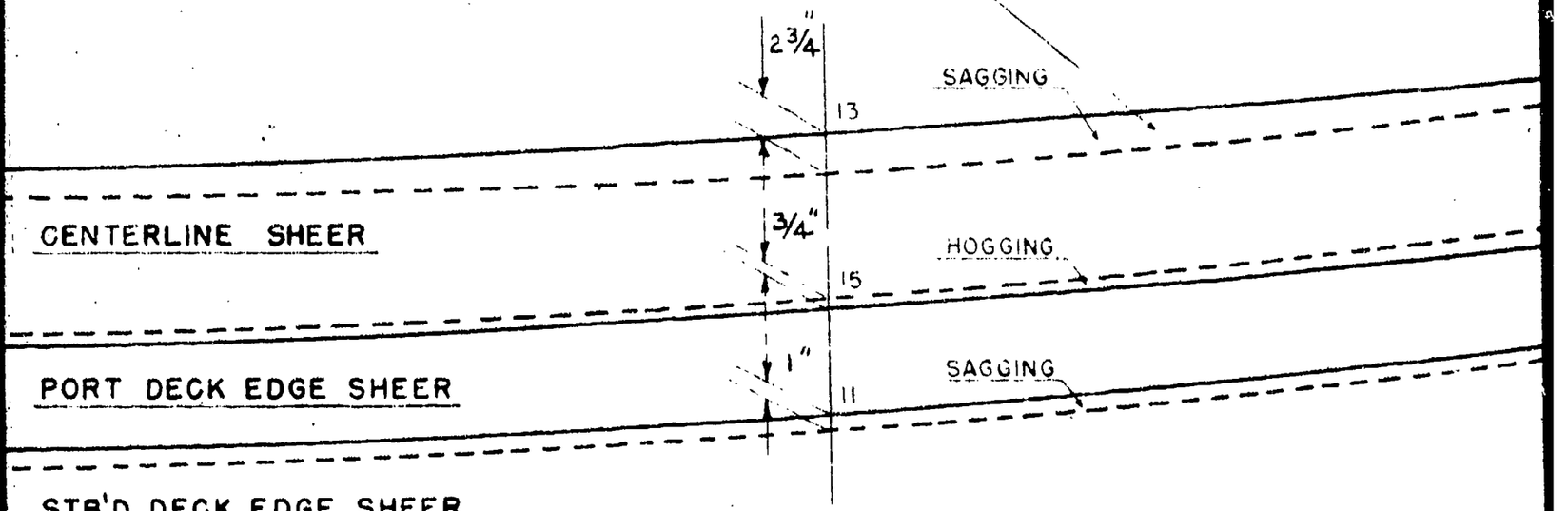
25

23



FRAME 97

SAGGING OF CENTERLINE, AS SHOWN, IS PARTLY ATTRIBUTABLE TO LOCAL DECK DEFLECTION, SEE PLOTS OF TRAN'S SECTIONS AND SPECIAL SURVEY

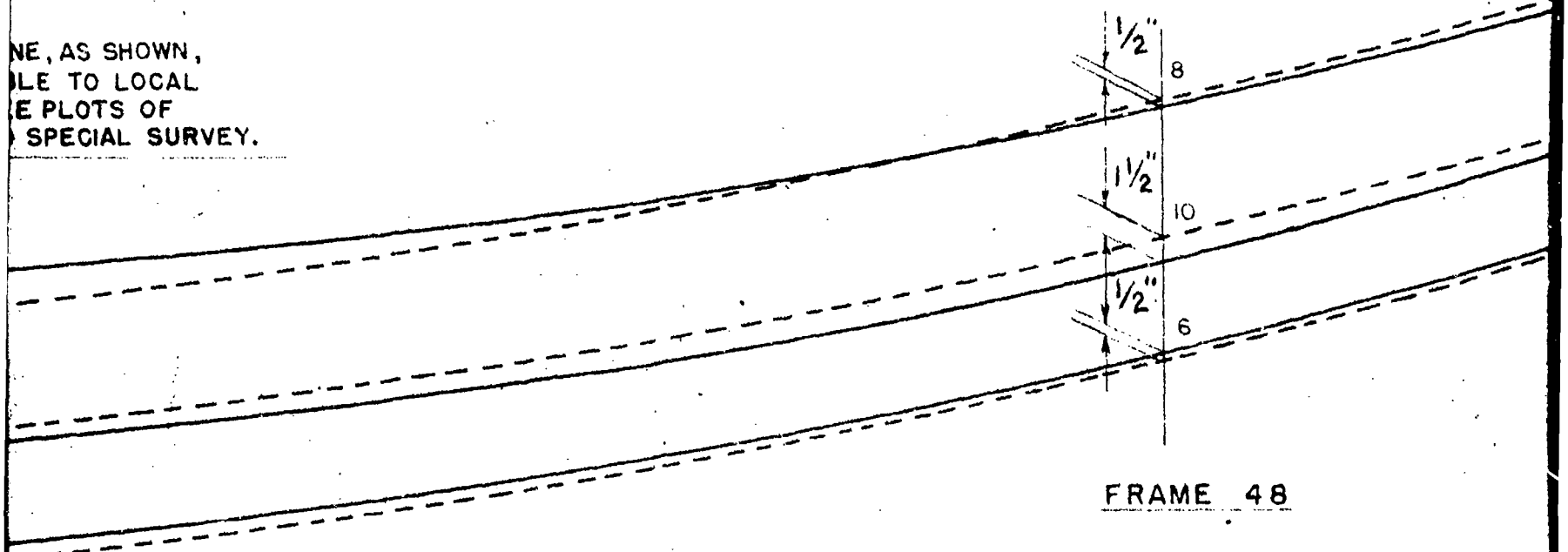


FRAME 71

SHEER LINES · PROFILES

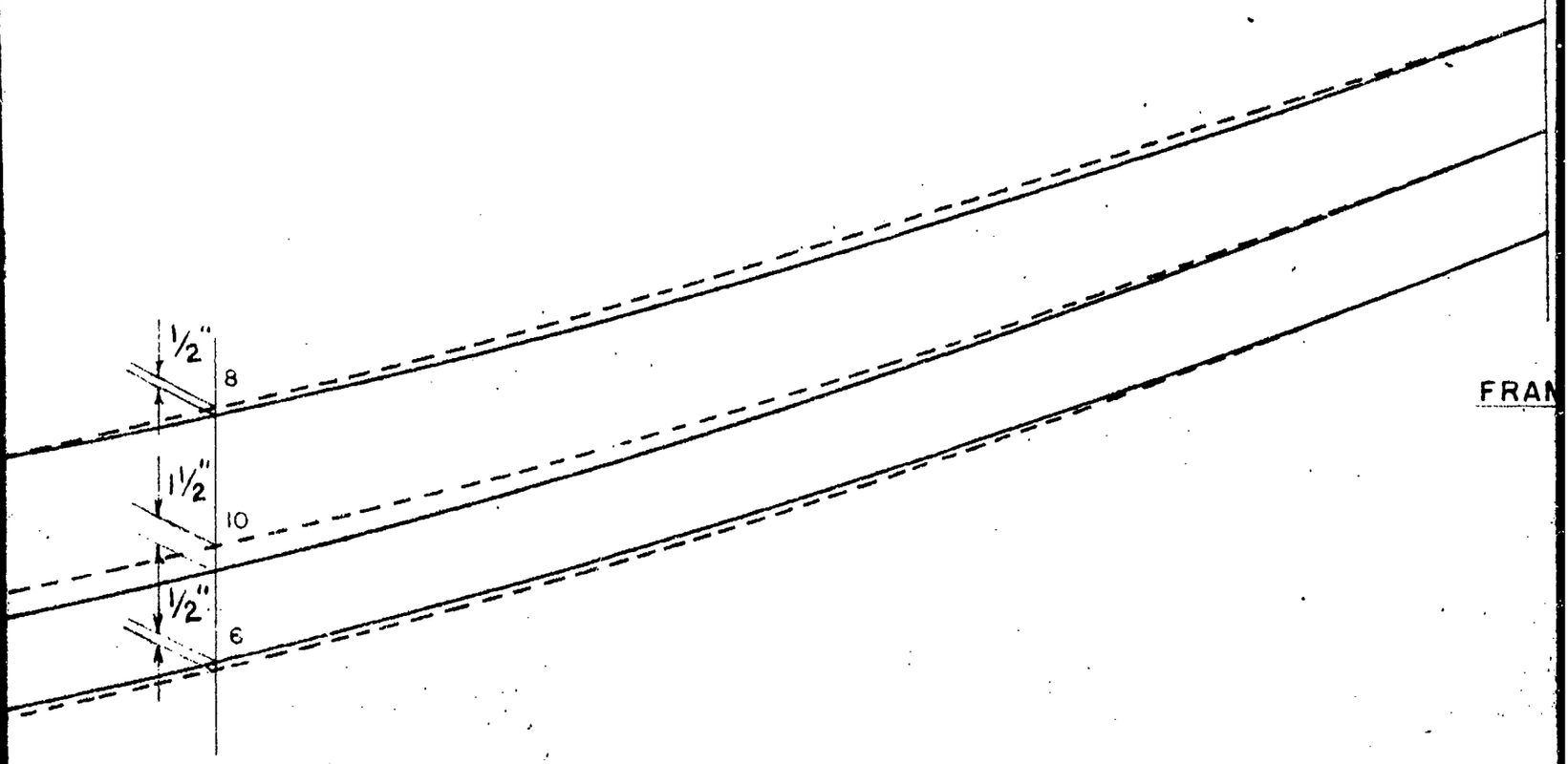
3

NE, AS SHOWN,
LE TO LOCAL
E PLOTS OF
SPECIAL SURVEY.



FRAME 48

4

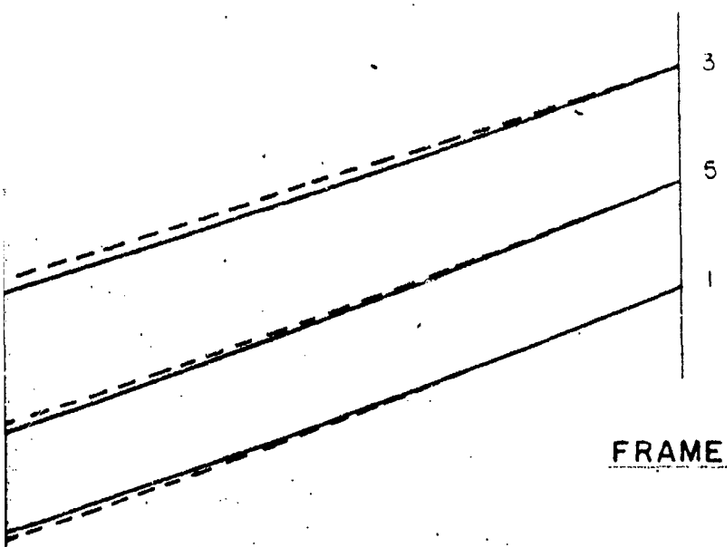


FRAME 48

FRAM

——— BEFORE TEST

- - - - - - - - AFTER TEST



FRAME 29

TEST

TEST

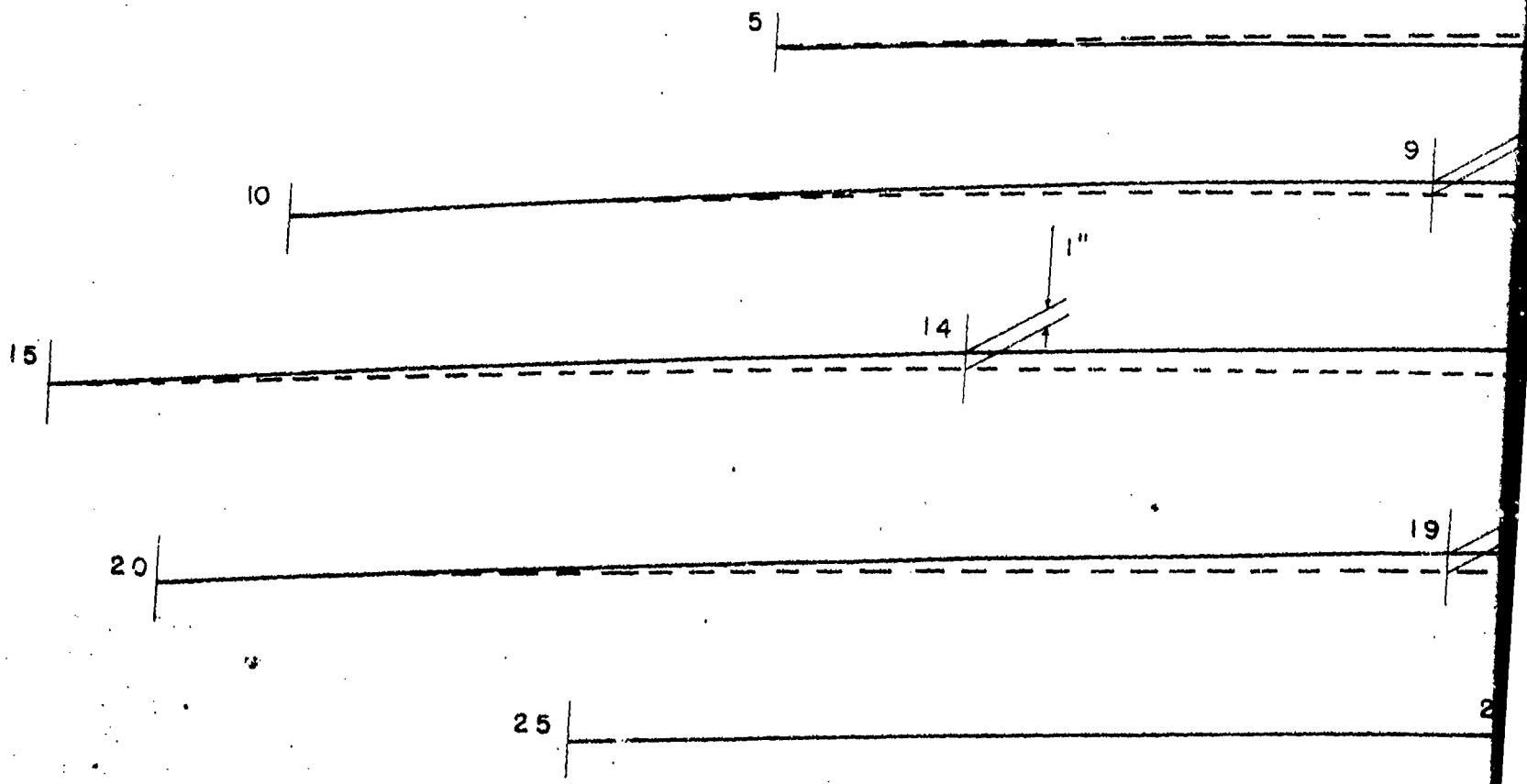
6

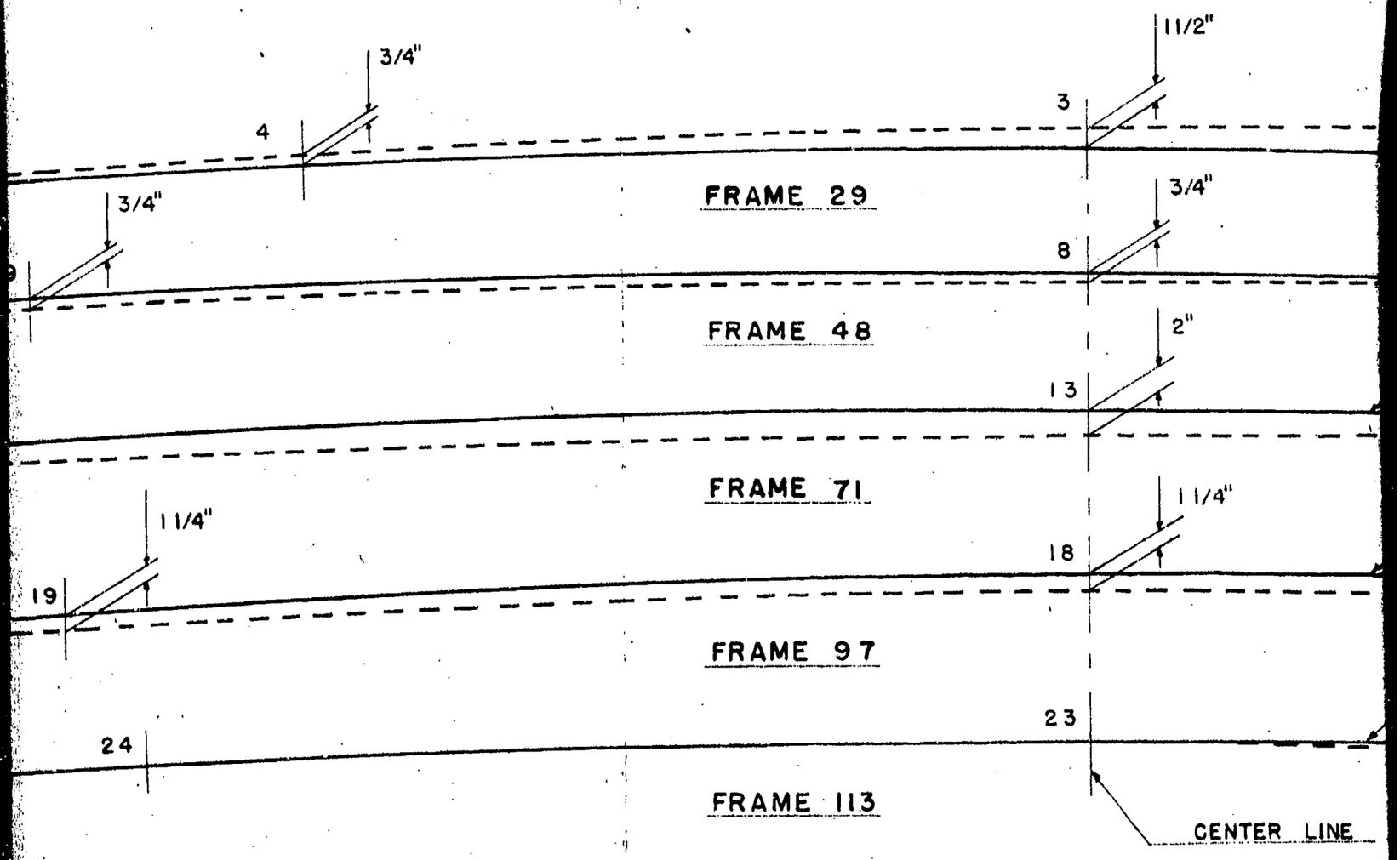
SECRET

U.S.S PENSACOLA CA 24
TEST ABLE

DECK SURVEY

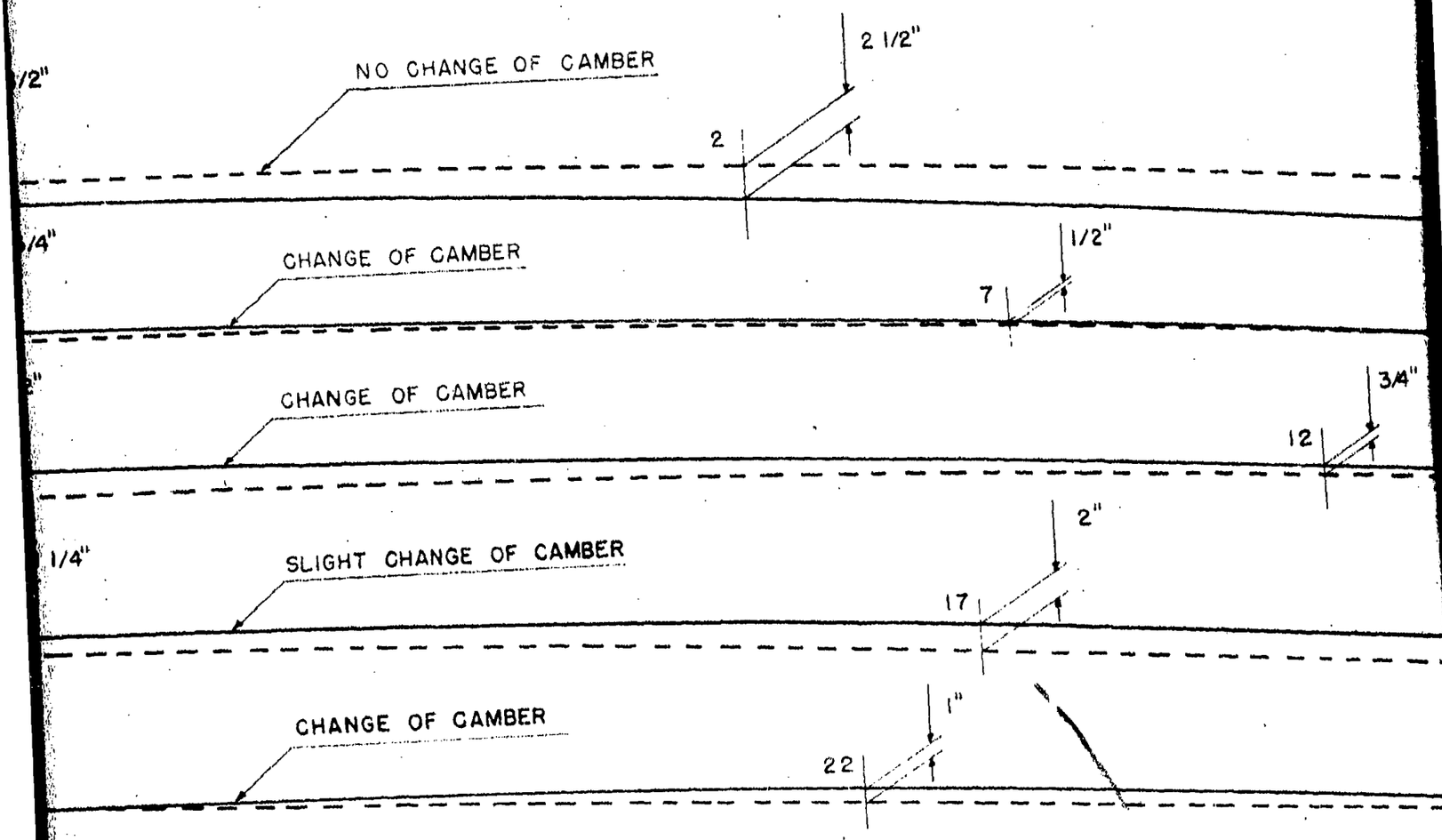
NAVY DEPT. BUREAU OF SHIPS


5
9
10
1"
14
15
19
20
25



TRANSVERSE SECTIONS - LOOKIN

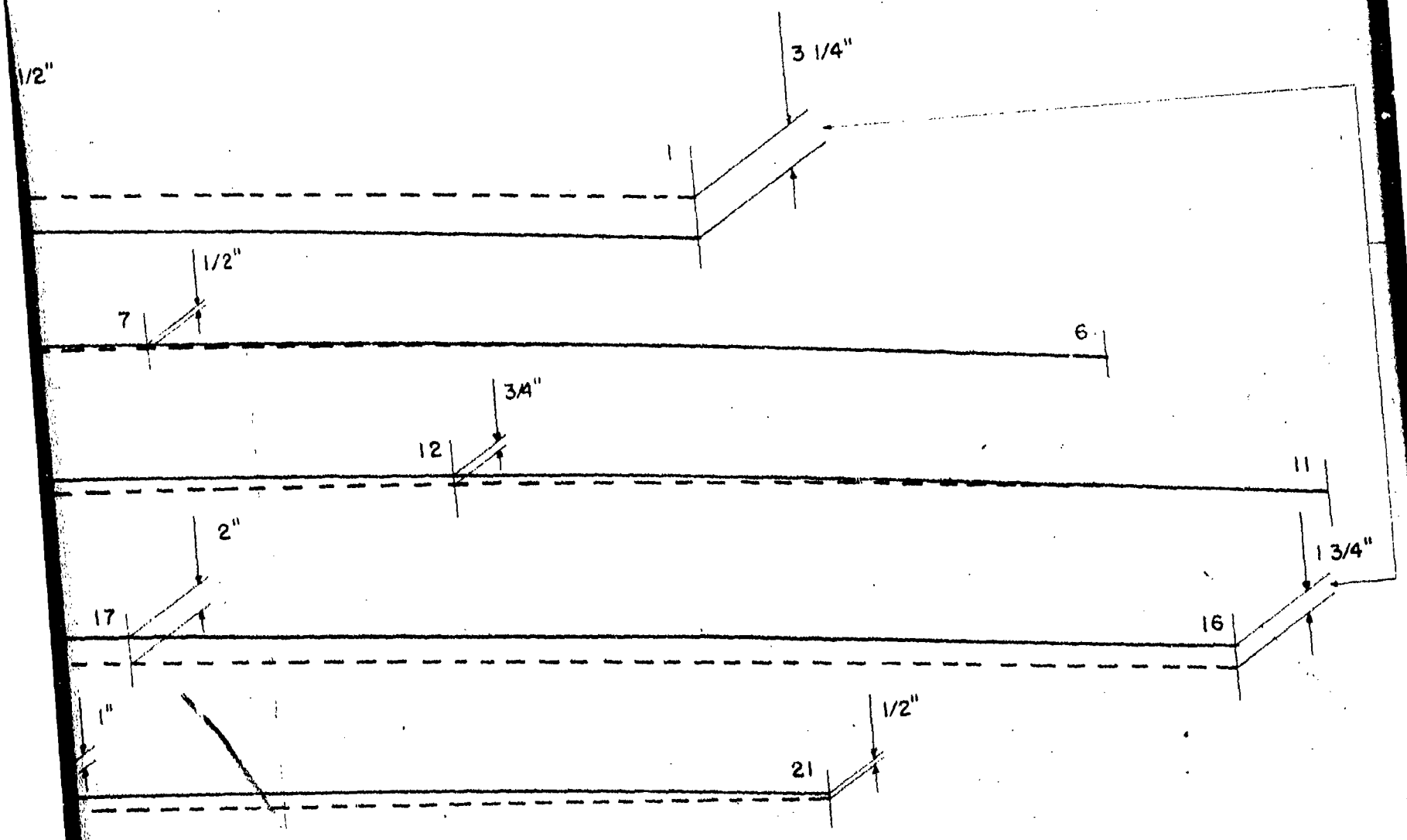
7



CENTER LINE

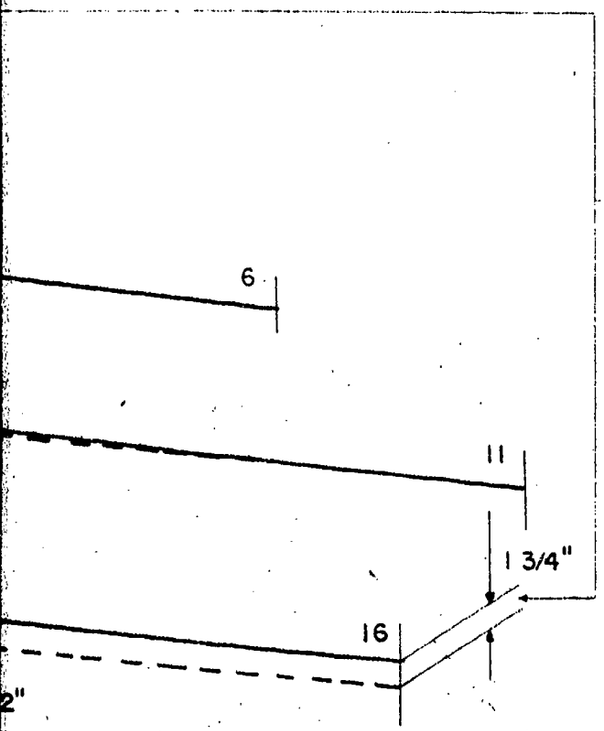
S - LOOKING FWD.

3



4

STATION	DISTANCE OFF CENTERLINE
1-S	20.80'
2-S	10.25'
3-℄	——
4-P	10.20'
5-P	20.80'
6-S	26.50'
7-S	13.50'
8-℄	——
9-P	13.50'
10-P	26.50'
11-S	28.61'
12-S	17.35'
13-℄	——
14-P	18.51'
15-P	28.63'
16-S	27.19'
17-S	12.95'
18-℄	——
19-P	13.09'
20-P	27.21'
21-S	22.25'
22-S	11.70'
23-℄	——
24-P	11.70'
25-P	22.25'



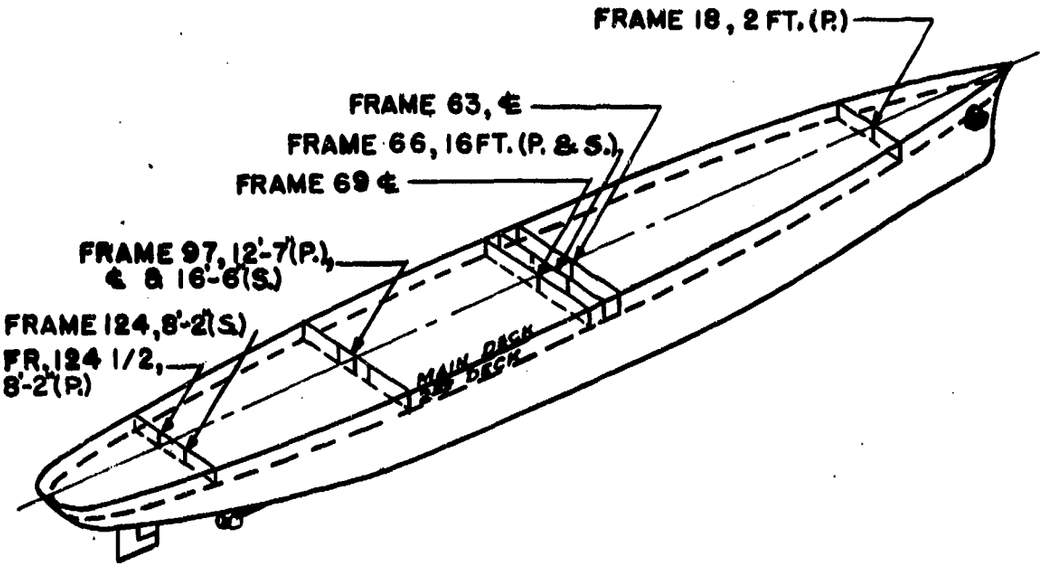
MAX. TWIST IS THE SUM RECORDED AT FR. 29 & 97
TOTAL TWIST = 5"

- - - - AFTER TEST
——— BEFORE TEST

5

SECRET

U.S.S. PENSACOLA CA 24
TEST ABLE
DECK SURVEY
NAVY DEPT BUREAU OF SHIPS



TEST ABLE

U.S.S. PENSACOLA, - CA-24

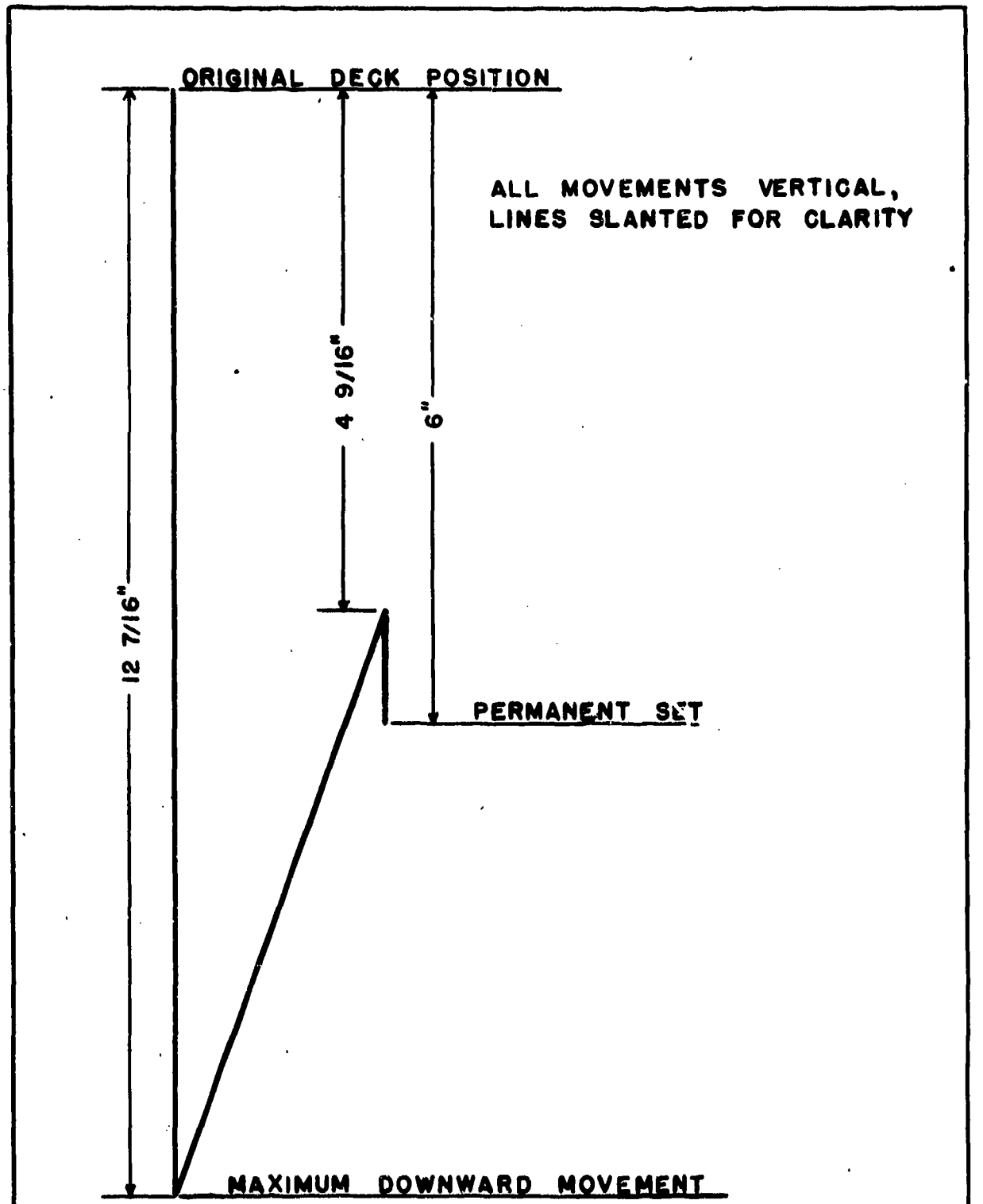
SCRATCH GAGE LOCATIONS

DECK DEFLECTION GAGES

SHIP CA24 TEST "ABLE"

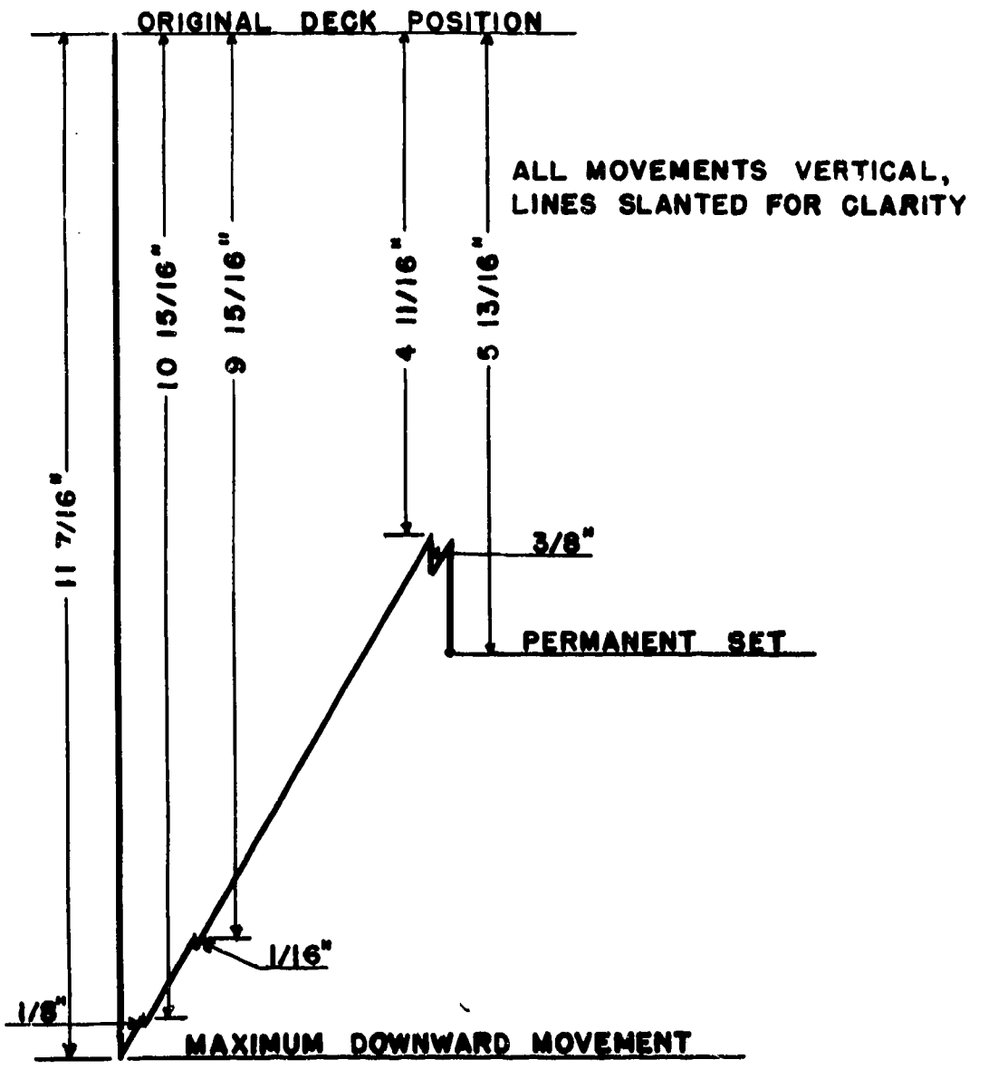
LOCATION			MAXIMUM COMP.	MAXIMUM EXP.	PERMANENT SET		REMARKS
FR. NO.	DECK	DIST. OFF ℄			DISTANCE	EXP./COMP.	
18	SECOND	1'-10" (P)	5/16"	3/16"	3/16"	EXP.	
63	"	(℄)	2'-4 1/16" SEE NOTE	MAXIMUM GREATER	DECK MOVEMENT THAN GAGE LENGTH		
66	"	16'-0" (P)	1'-0 7/16"	0	6"	COMP.	SEE PAGE NO.102
66	"	16'-0" (S)	0'-11 7/16"	1/16"	5 13/16"	"	SEE PAGE NO.103
69	"	(℄)	1'-1 5/8"	0	8 1/4"	"	SEE PAGE NO.104
97	"	12'-7" (P)	2"	0	1"	"	
97	"	6" (S)	1 1/2"	0	1"	"	
97	"	16'-6" (S)	1 1/2"	0	7/8"	"	
124	"	8'-2" (S)	1'-4 1/8"	0	11 7/16"	"	SEE PAGE NO.105
124 1/2	"	8'-2" (P)	1'-4 5/8"	0	11 7/8"	"	SEE PAGE NO.106

NOTE: SCRATCH GAGES LOCATED BETWEEN MAIN AND SECOND DECKS.

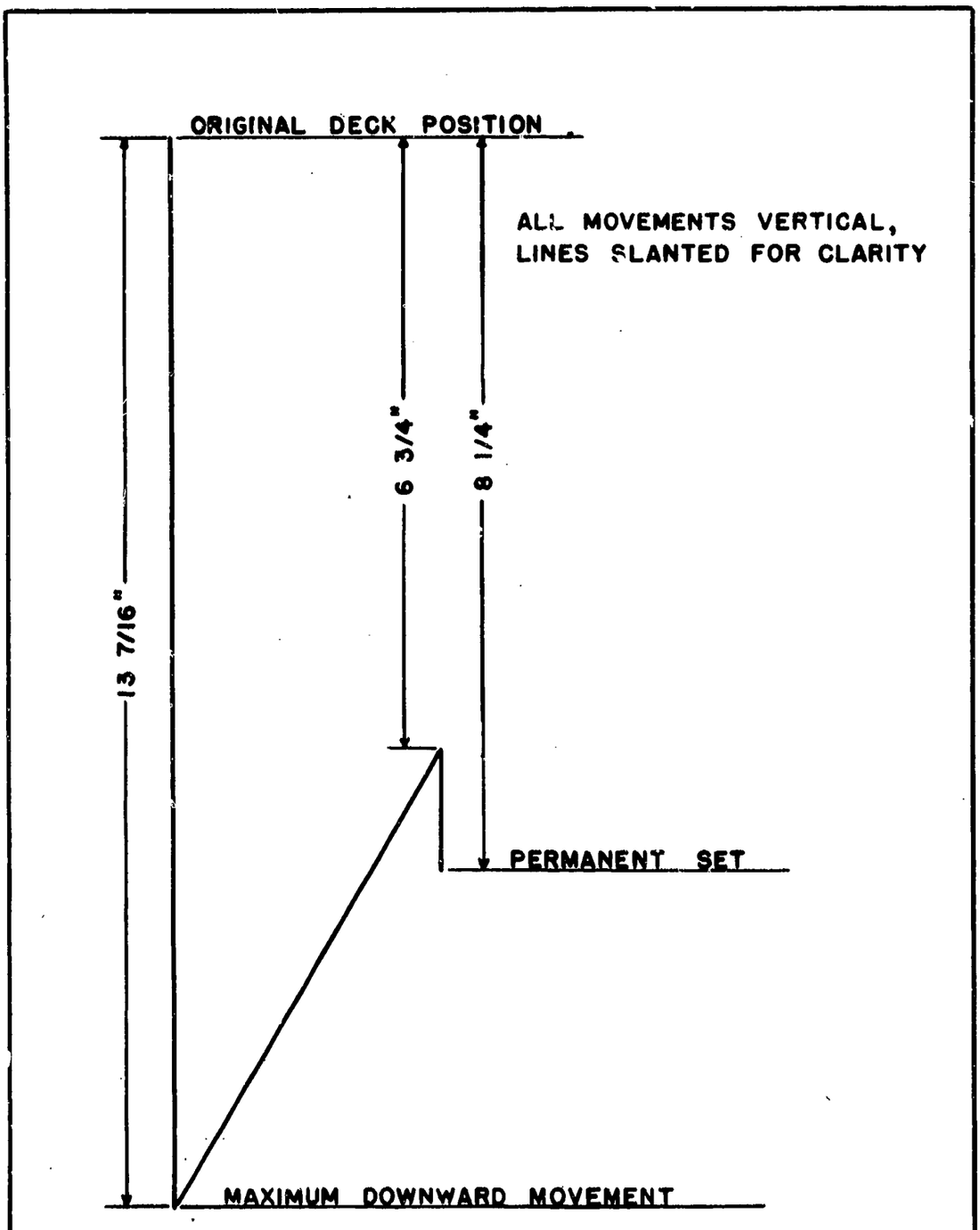


U.S.S. PENSACOLA, TEST ABLE, PLOT OF MAIN DECK MOVEMENT. SCRATCH GAGE LOCATION, 2 ND. DECK FRAME 66 PORT 16'-0" OFF CENTER LINE.

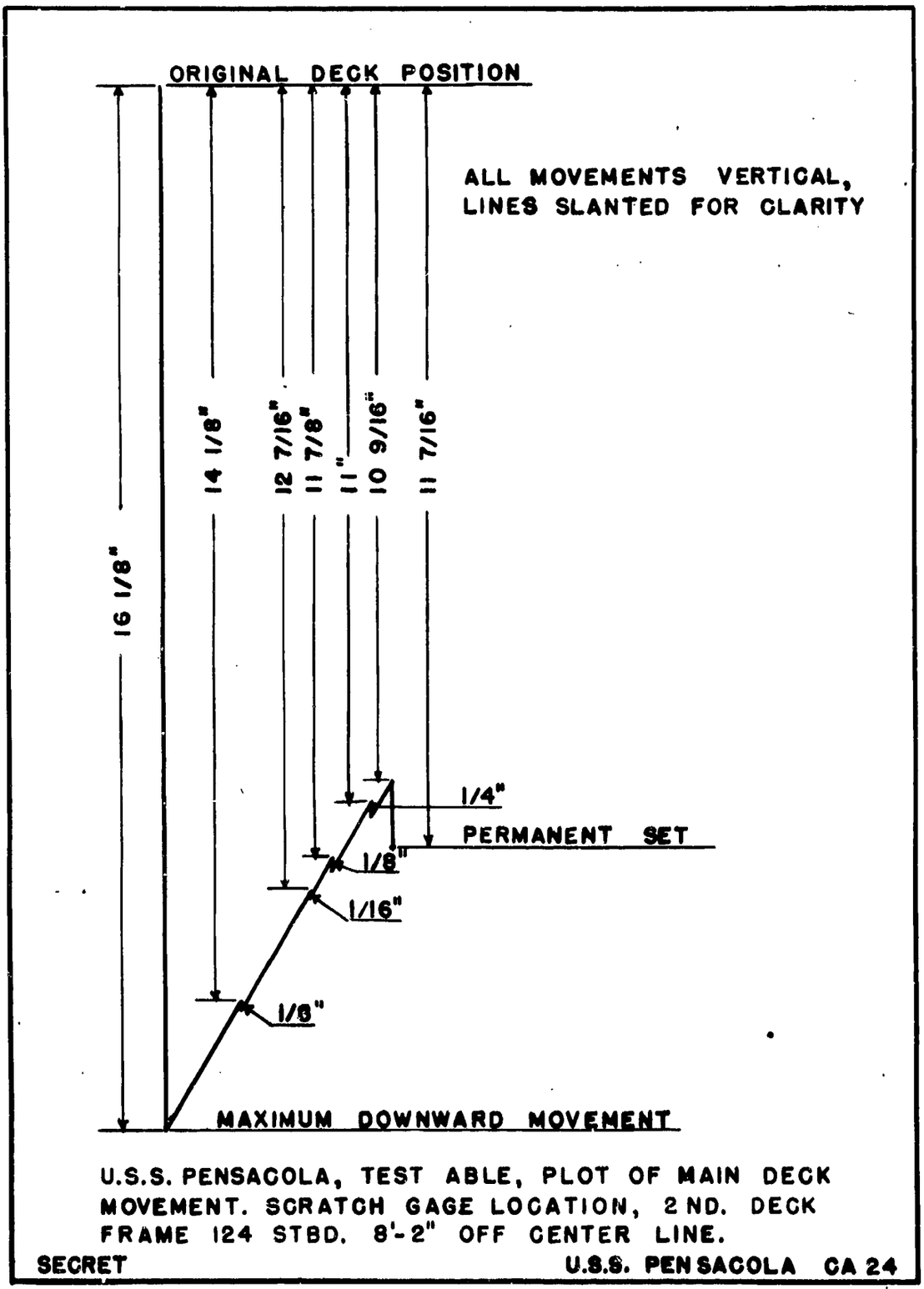
SECRET U.S.S. PENSACOLA CA 24



U.S.S. PENSACOLA, TEST ABLE, PLOT OF MAIN DECK MOVEMENT. SCRATCH GAGE LOCATION, 2 ND. DECK FRAME 66 STBD. 16'-0" OFF CENTER LINE.

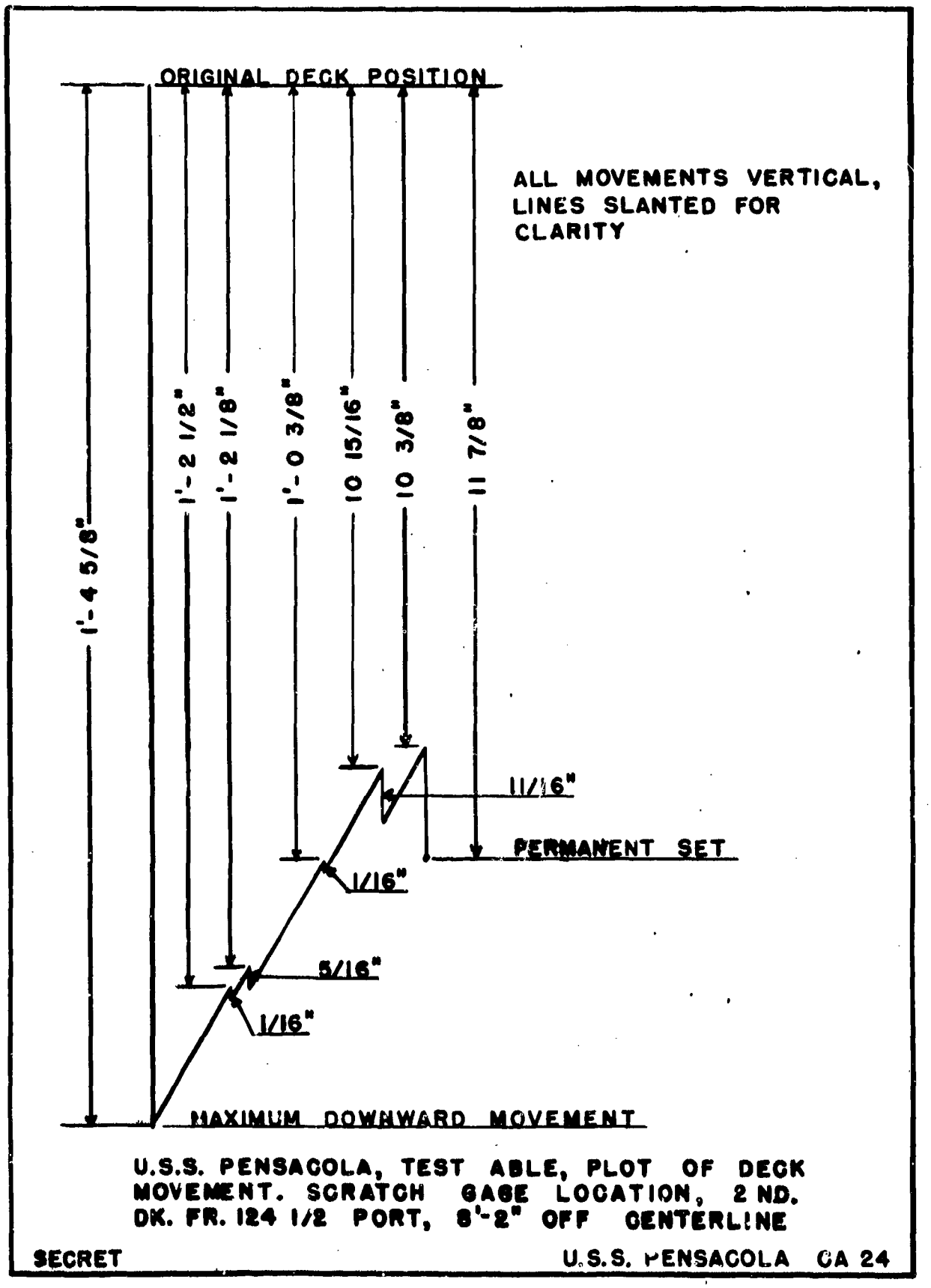


U.S.S. PENSACOLA, TEST ABLE, PLOT OF MAIN DECK MOVEMENT. SCRATCH GAGE LOCATION, 2ND. DECK FRAME 69 CENTER LINE.

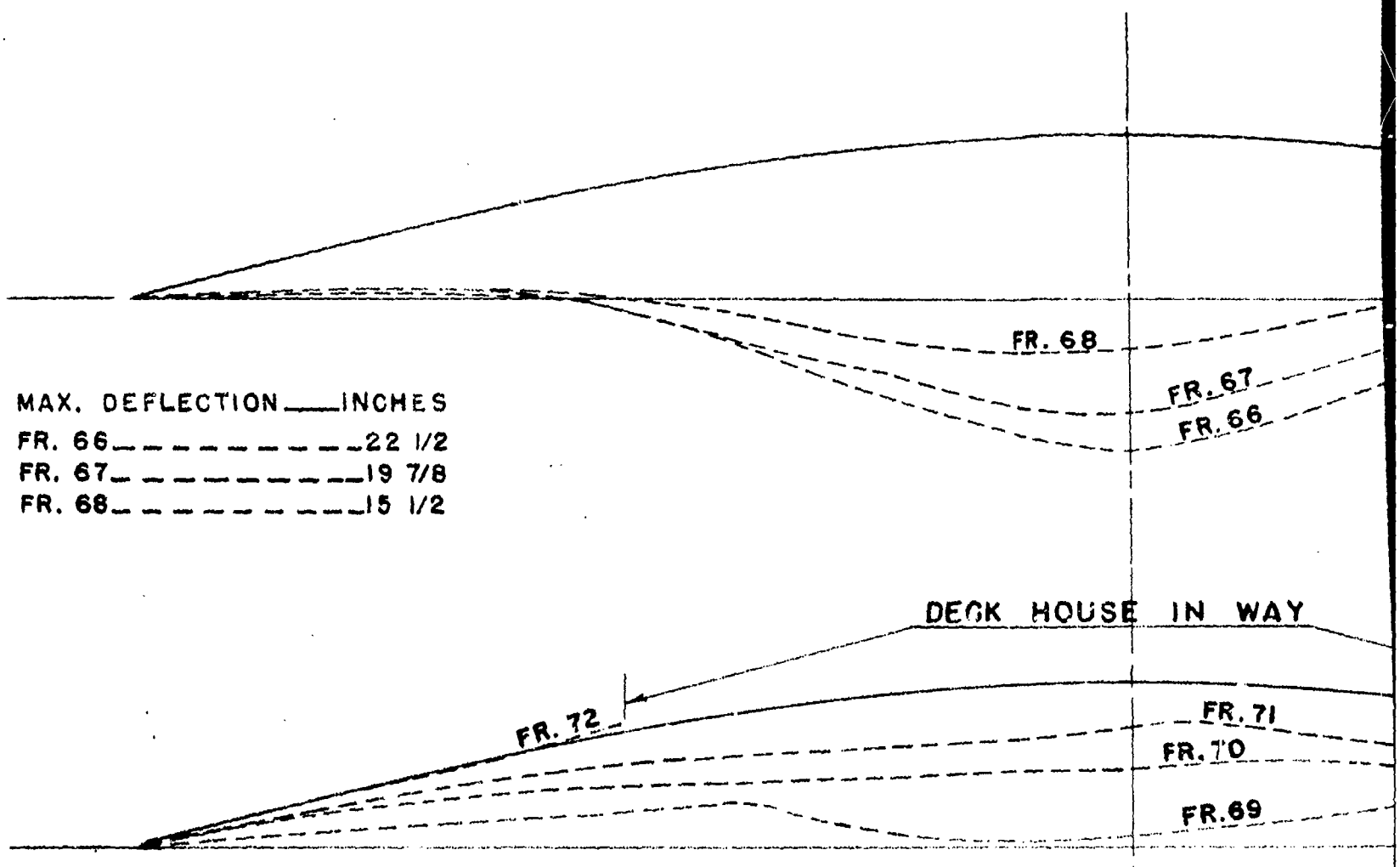


U.S.S. PENSACOLA, TEST ABLE, PLOT OF MAIN DECK MOVEMENT. SCRATCH GAGE LOCATION, 2 ND. DECK FRAME 124 STBD. 8'-2" OFF CENTER LINE.

SECRET U.S.S. PENSACOLA CA 24



U.S.S. PENSACOLA, TEST ABLE, PLOT OF DECK MOVEMENT. SCRATCH GAGE LOCATION, 2 ND. DK. FR. 124 1/2 PORT, 8'-2" OFF CENTERLINE



MAX. DEFLECTION ____ INCHES

FR. 66	22 1/2
FR. 67	19 7/8
FR. 68	15 1/2

MAX. DEFLECTION ____ INCHES

FR. 69	10 1/8
FR. 70	6 1/4
FR. 71	4

SECRET

FR. 67
FR. 66

SE IN WAY

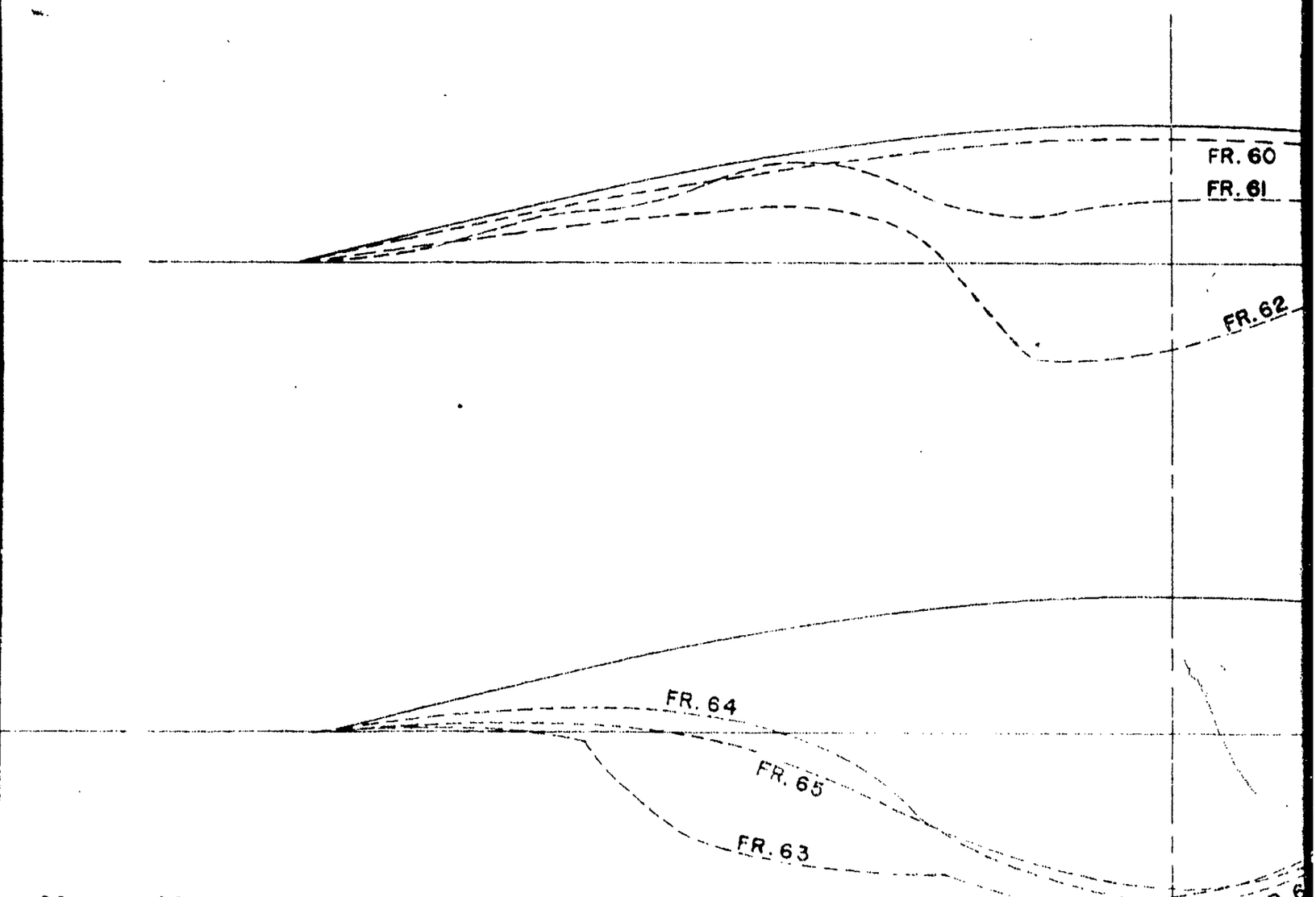
FR. 71
FR. 70
FR. 72
FR. 69

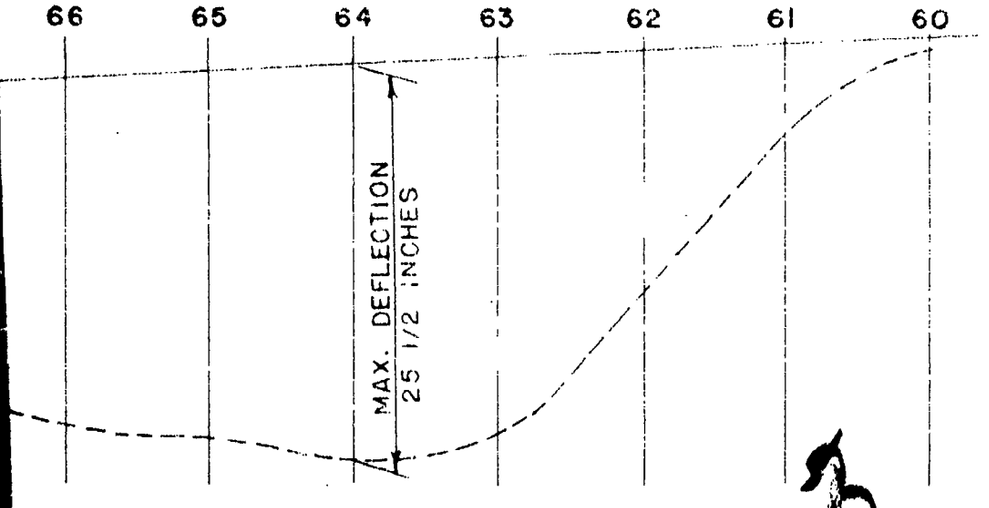
71 70 69 68 67 66 65 64

MAX. DEFLECTION
25 1/2 INCHES

2

CENTER LINE PROFILE





ER LINE PROFILE

NOTE:

AL

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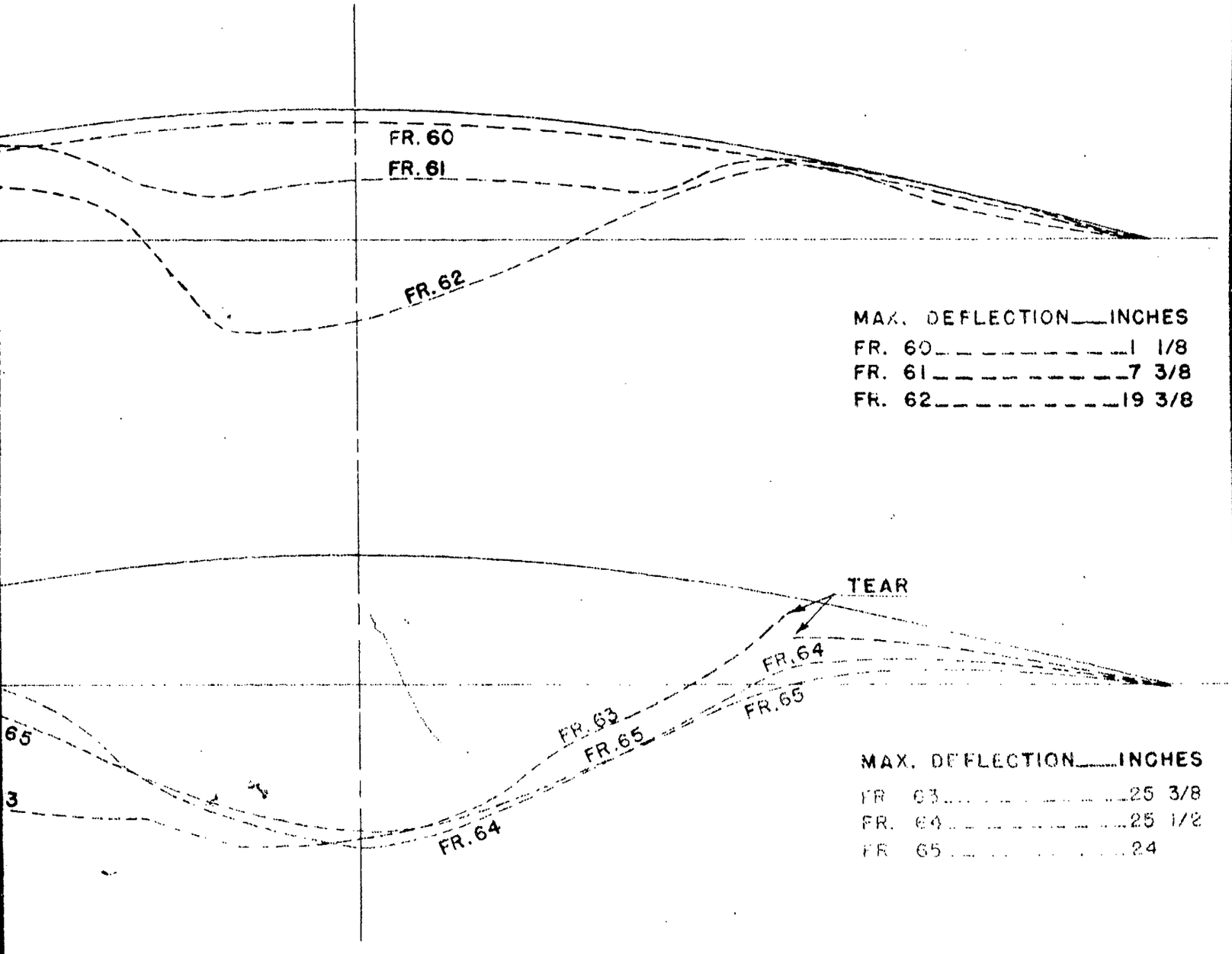


_____ BEFORE TEST

_ _ _ _ _ _ _ _ _ _ AFTER TEST

NOTE:

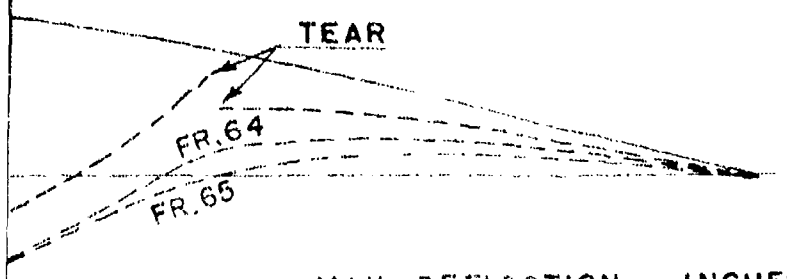
ALL SECTIONS SHOWN LOOKING FORWARD.

VERTICAL SCALE 1"=1'-0"
HORIZONTAL SCALE 1"=5'-0"

4

MAX. DEFLECTION___INCHES

FR. 60_ _ _ _ _ _ _ _ _ _1 1/8
FR. 61_ _ _ _ _ _ _ _ _ _7 3/8
FR. 62_ _ _ _ _ _ _ _ _ _19 3/8



MAX. DEFLECTION___INCHES

FR. 63_ _ _ _ _ _ _ _ _ _25 3/8
FR. 64_ _ _ _ _ _ _ _ _ _25 1/2
FR. 65_ _ _ _ _ _ _ _ _ _24

ORE TEST
ER TEST

SHOWN LOOKING FORWARD.

ALE 1"=1'-0"
SCALE 1"=5'-0"

4

5

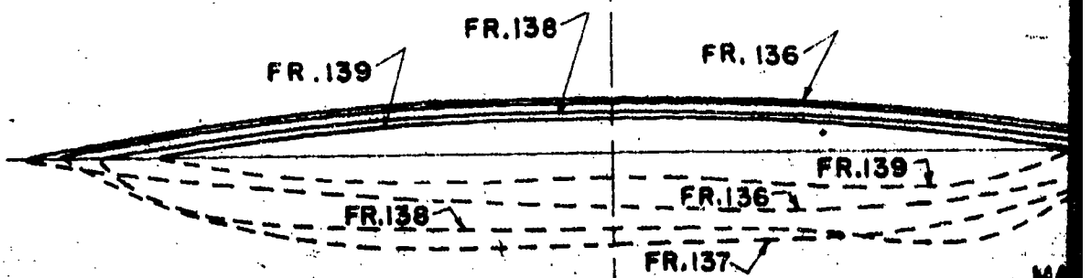
SECRET

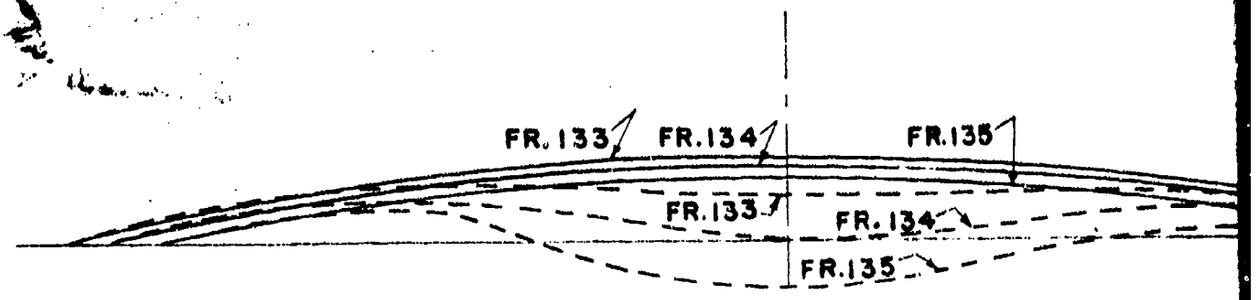
U.S.S. PENSACOLA CA 24

DEFLECTION OF MAIN DECK, FRAMES 60-72

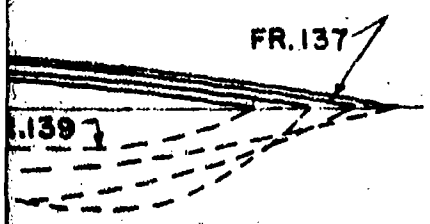
TEST ABLE

NAVY DEPT. BUREAU OF SHIPS


FR.139
FR.138
FR.136
FR.139
FR.136
FR.138
FR.137

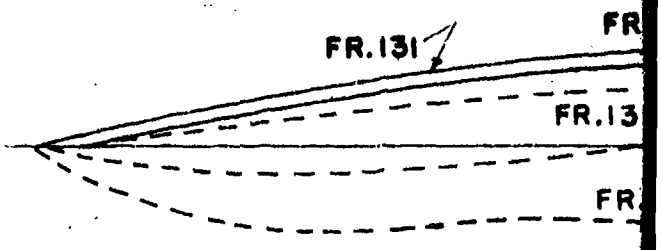

FR.133
FR.134
FR.135
FR.133
FR.134
FR.135

SECRET



MAX. DEFLECTION --- INCHES

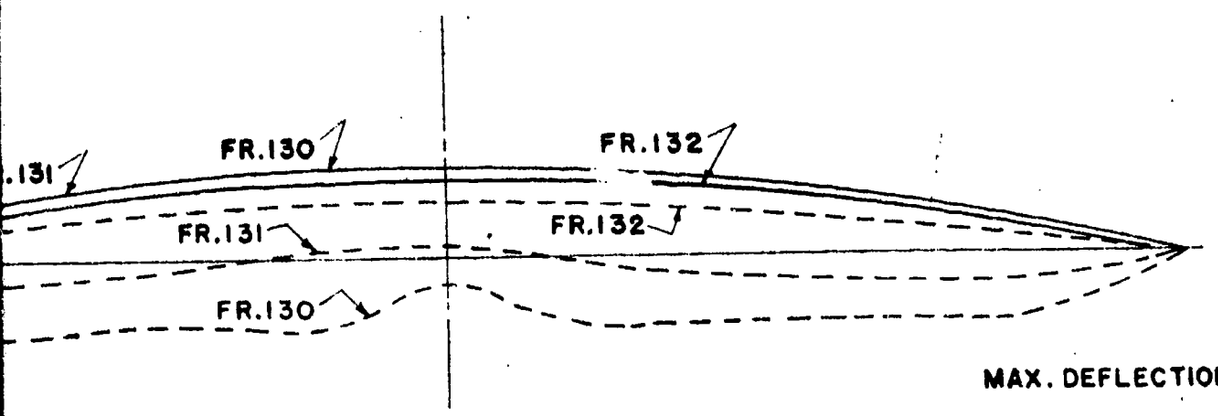
FR. 139 ----------	4
FR. 138 ----------	7 3/4
FR. 137 ----------	9 1/2
FR. 136 ----------	7 1/4



MAX. DEFLECTION --- INCHES

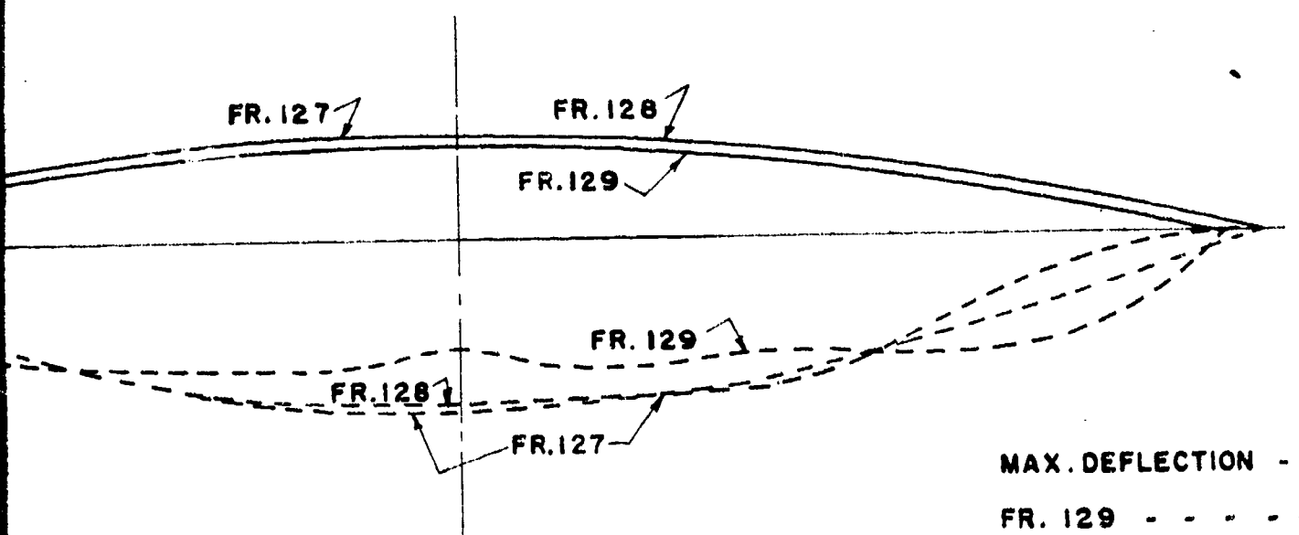
FR. 135 ----------	7 1/4
FR. 134 ----------	4 3/4
FR. 133 ----------	2 1/2

2



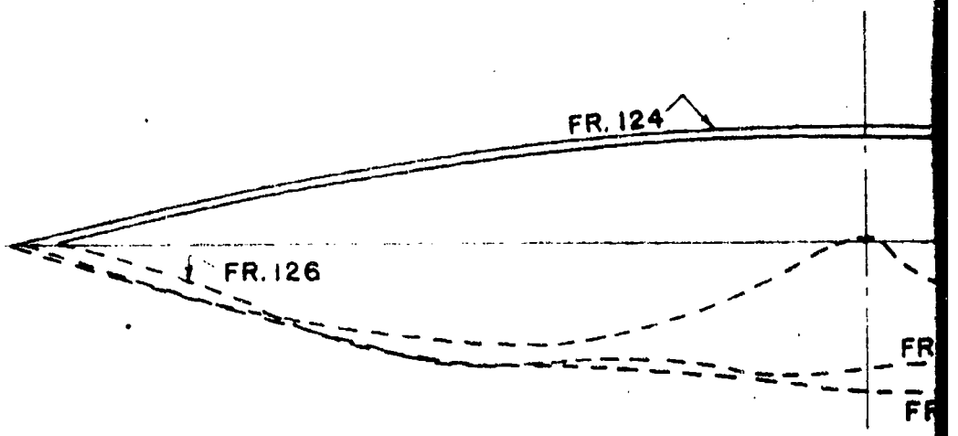
MAX. DEFLECTION - - - INCHES

FR. 132 - - - - - - -	1 1/2
FR. 131 - - - - - - -	6 1/2
FR. 130 - - - - - - -	10 3/4



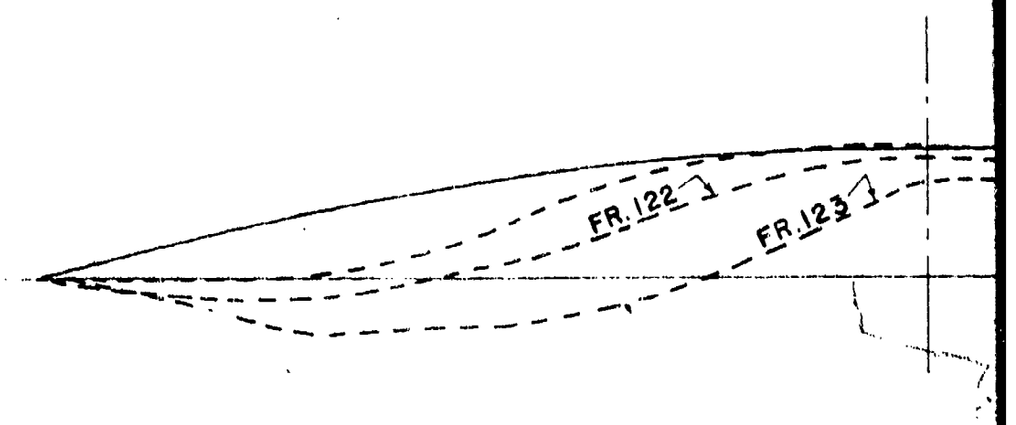
MAX. DEFLECTION - - - INCHES

FR. 129 - - - - - - -	14 3/4
FR. 128 - - - - - - -	18
FR. 127 - - - - - - -	18 1/2



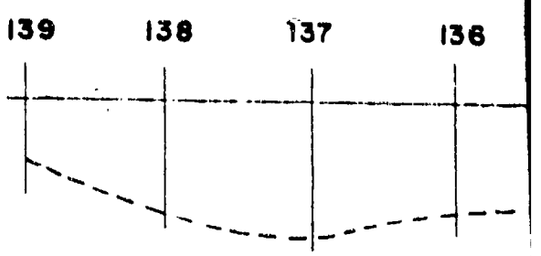
- - - INCHES

- - 1 1/2
- - 6 1/2
- - 10 3/4



N - - - INCHES

- - - 14 3/4
- - - 18
- - - 18 1/2



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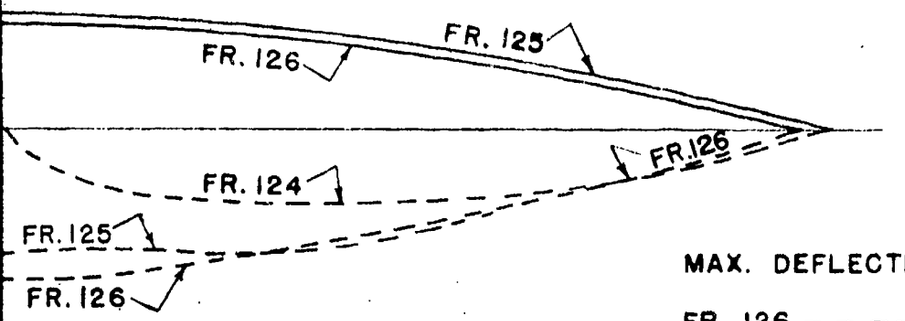
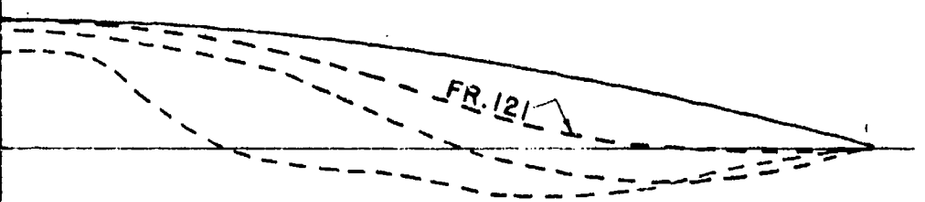


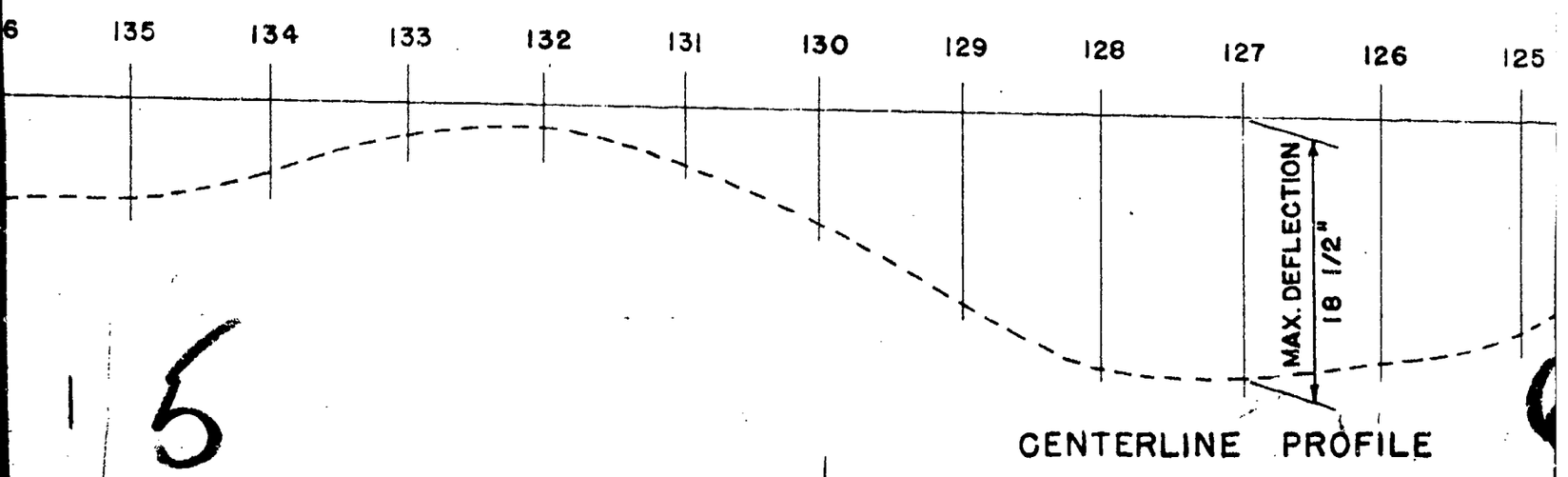
MAX. DEFLECTION----INCHES

FR. 126 ----------17
FR. 125 ----------15
FR. 124 ----------13 1/2



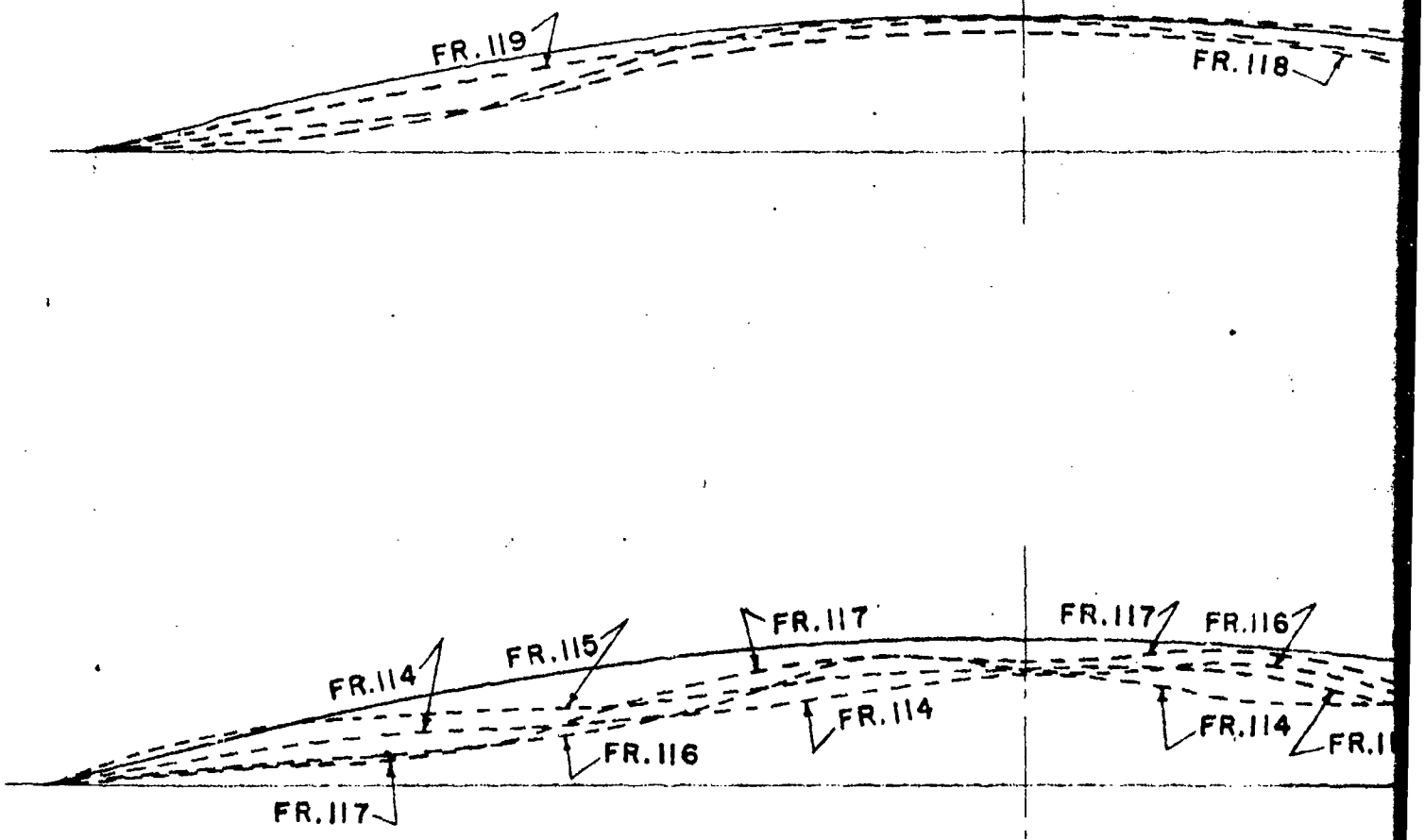
MAX. DEFLECTION----INCHES

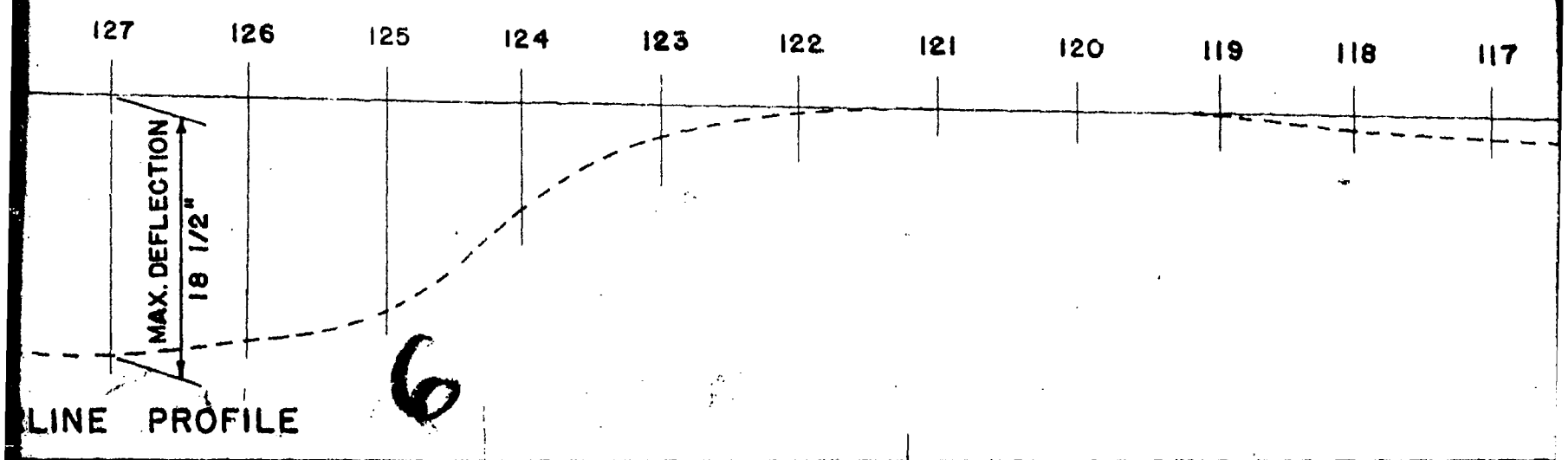
FR. 123----------10
FR. 122----------6 1/2
FR. 121----------4 1/2



15

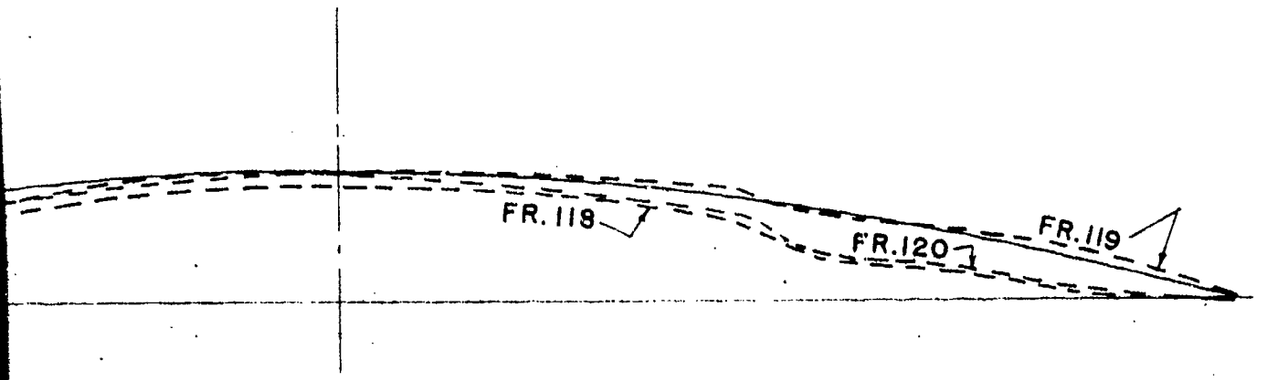
CENTERLINE PROFILE





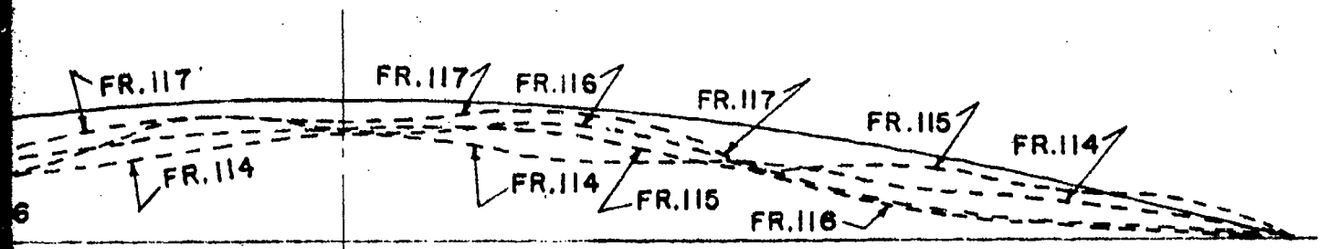
LINE PROFILE

6



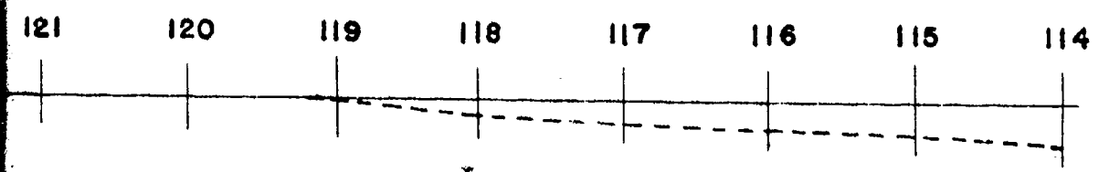
MAX. DEFLECTION----INCHES

FR. 120----------3
FR. 119----------1
FR. 118----------3



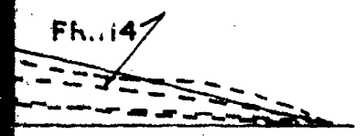
MAX. DEFLECTION---INCHES

FR. 117---------- 4 1/2
FR. 116----------4 3/4
FR. 115----------3
FR. 114---------- 3 1/2



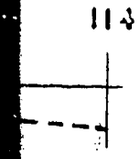
X. DEFLECTION - - - - INCHES

120	3
119	1
118	3



X. DEFLECTION - - - - INCHES

117	4 1/2
116	4 3/4
115	3
114	3 1/2



NOTE:

ALL SECTIONS SHOWN LOOKING FORWARD.

VERTICAL SCALE — 1" = 1'-0"
HORIZONTAL SCALE — 1" = 5'-0"

———— BEFORE TEST

- - - - - - - - - - - - AFTER TEST

SECRET

U.S.S. PENSACOLA CA 24

DEFLECTION OF MAIN DECK, FRAMES 114-139 TEST ABLE

NAVY DEPT. BUREAU OF SHIPS

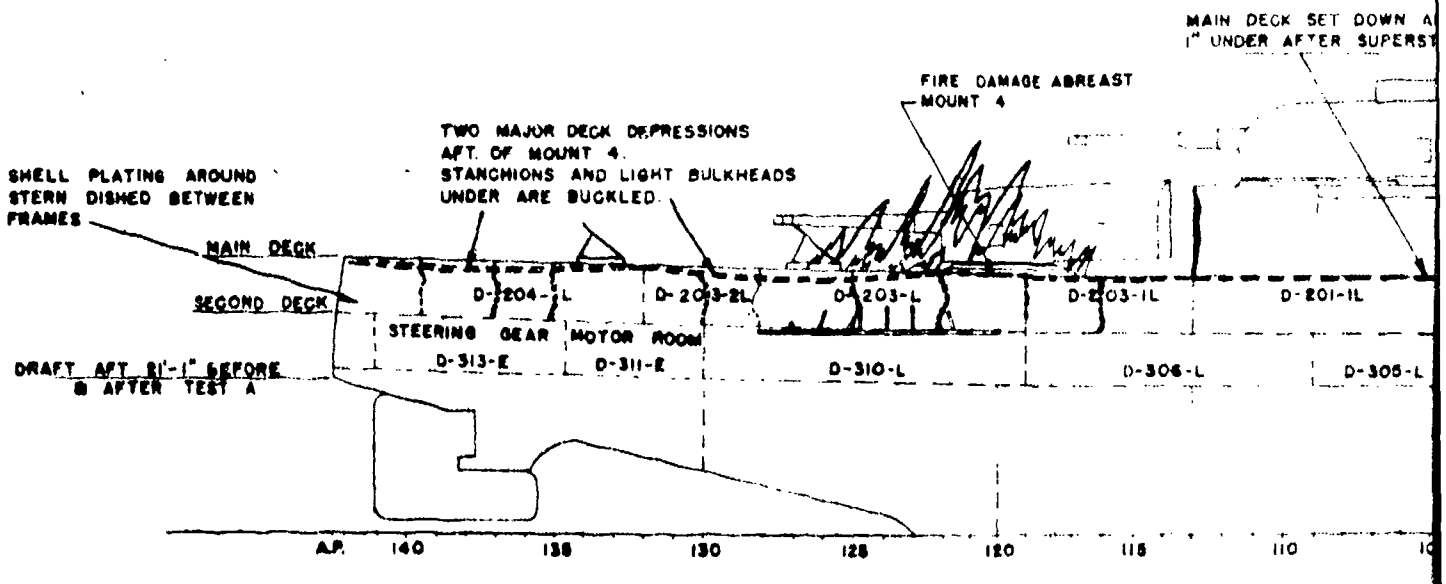
4

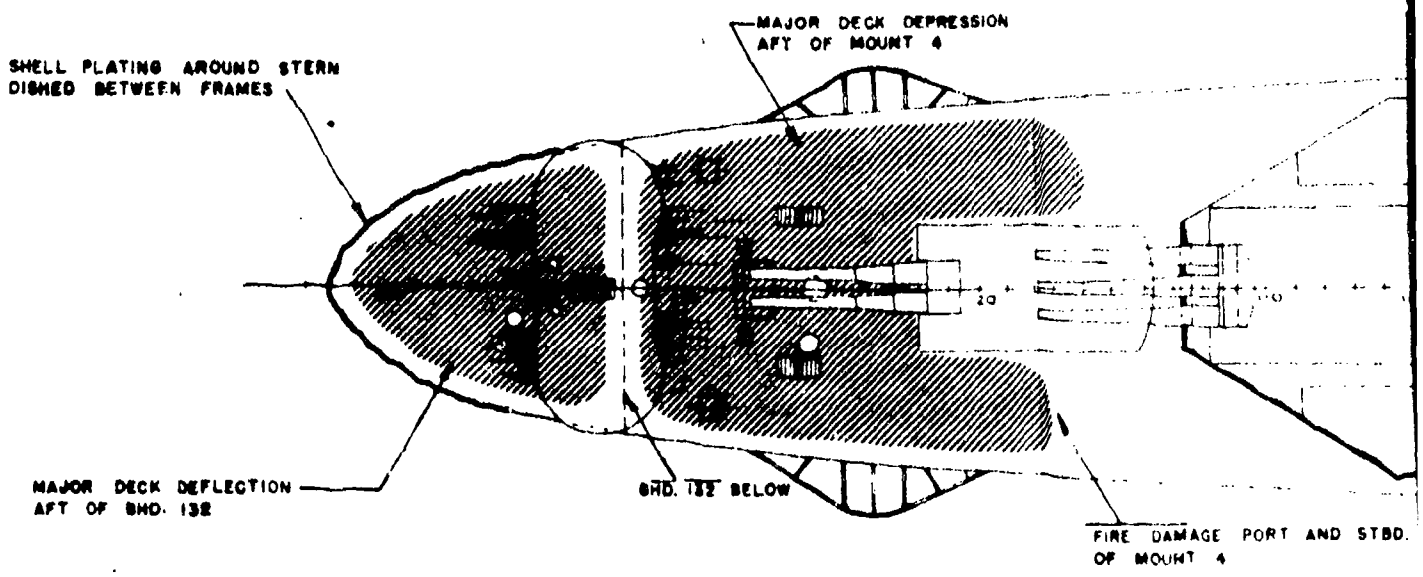
5634

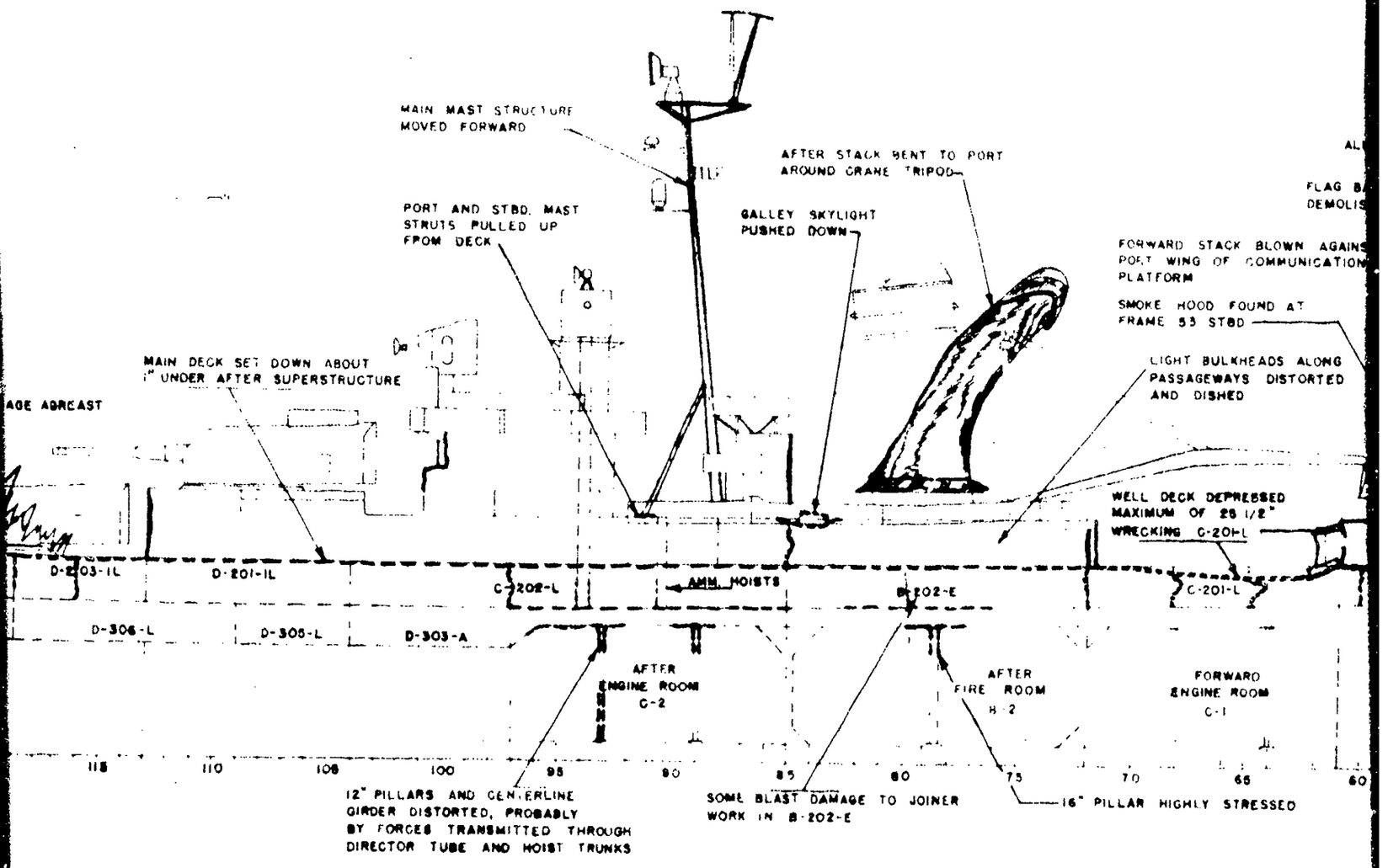
APPENDIX

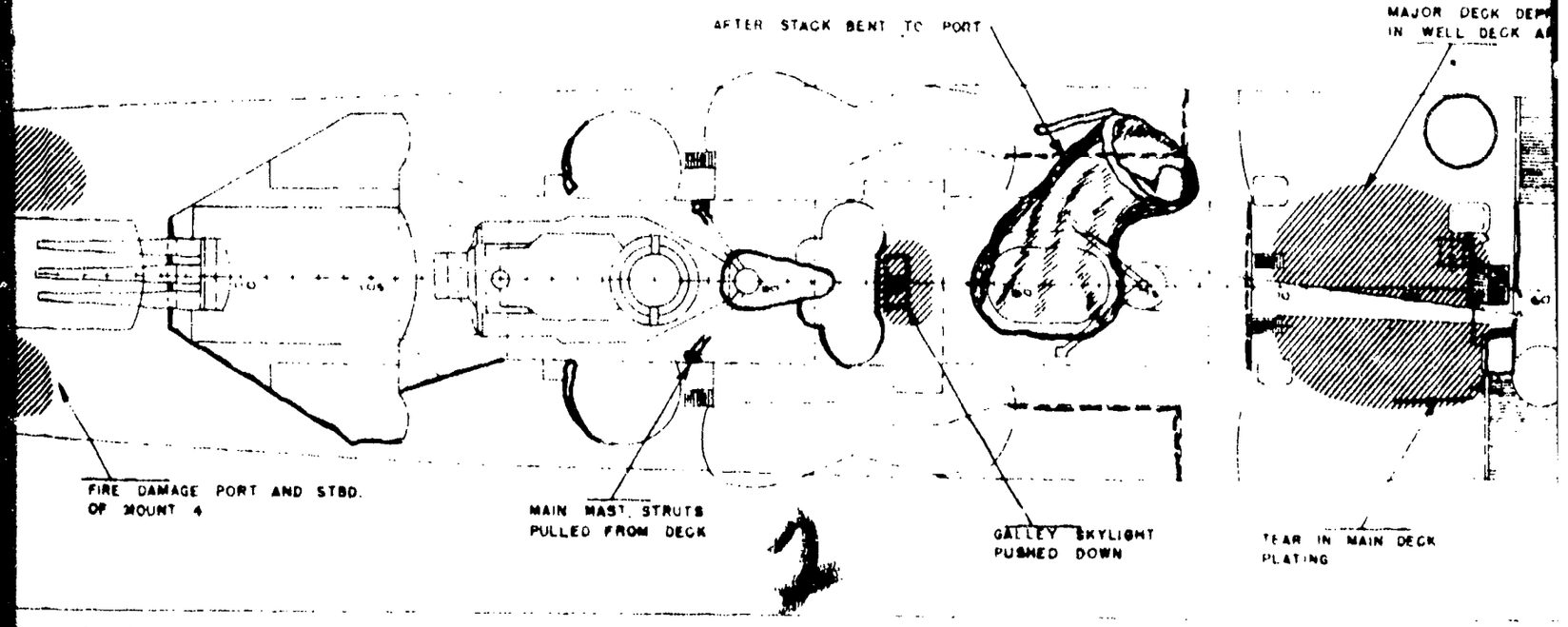
DAMAGE DIAGRAM

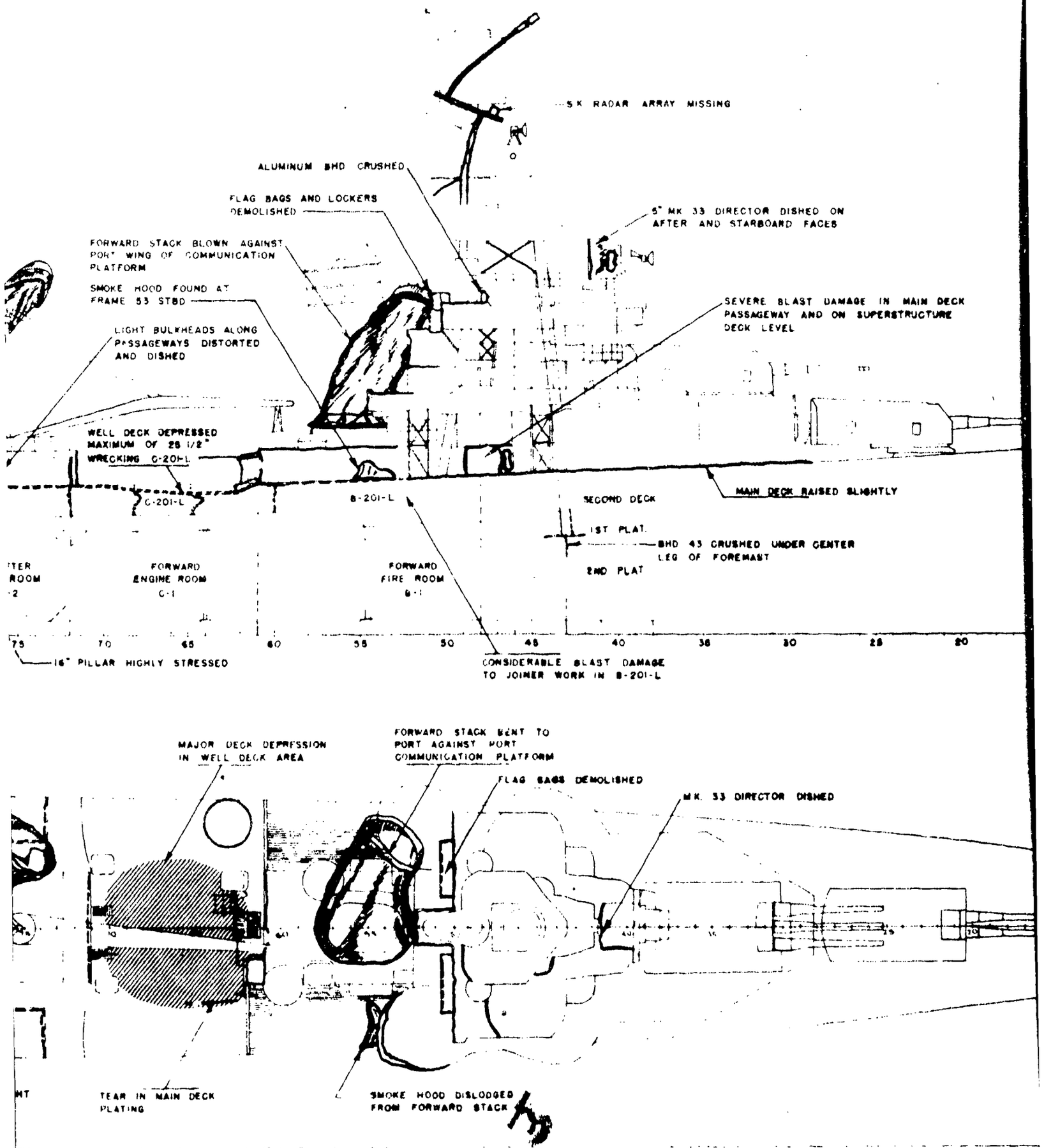
TEST ABLE


MAIN DECK SET DOWN A
1" UNDER AFTER SUPERST
FIRE DAMAGE ABREAST
MOUNT 4
TWO MAJOR DECK DEPRESSIONS
AFT. OF MOUNT 4.
STANCHIONS AND LIGHT BULKHEADS
UNDER ARE BUCKLED.
SHELL PLATING AROUND
STERN DISHED BETWEEN
FRAMES
MAIN DECK
SECOND DECK
D-204-L
D-203-2L
D-203-L
D-203-1L
D-201-1L
STEERING GEAR
D-313-E
MOTOR ROOM
D-311-E
D-310-L
D-306-L
D-305-L
DRAFT AFT 21'-1" BEFORE
& AFTER TEST A
A.P.
140
135
130
125
120
115
110


MAJOR DECK DEPRESSION
AFT OF MOUNT 4
SHELL PLATING AROUND STERN
DISHED BETWEEN FRAMES
MAJOR DECK DEFLECTION
AFT OF BHD. 132
BHD. 132 BELOW
FIRE DAMAGE PORT AND STBD.
OF MOUNT 4


MAIN MAST STRUCTURE MOVED FORWARD
AFTER STACK BENT TO PORT AROUND CRANE TRIPOD
PORT AND STBD. MAST STRUTS PULLED UP FROM DECK
GALLEY SKYLIGHT PUSHED DOWN
FORWARD STACK BLOWN AGAINS PORT WING OF COMMUNICATION PLATFORM
SMOKE HOOD FOUND AT FRAME 53 STBD
MAIN DECK SET DOWN ABOUT " UNDER AFTER SUPERSTRUCTURE
LIGHT BULKHEADS ALONG PASSAGEWAYS DISTORTED AND DISHED
WELL DECK DEPRESSED MAXIMUM OF 25 1/2" WRECKING C-20H-L
D-203-1L
D-201-1L
C-202-L
AMM. HOISTS
B-202-E
C-201-L
D-306-L
D-305-L
D-303-A
AFTER ENGINE ROOM C-2
AFTER FIRE ROOM B-2
FORWARD ENGINE ROOM C-1
118
110
108
100
95
90
85
80
75
70
65
60
12" PILLARS AND CENTERLINE GIRDER DISTORTED, PROBABLY BY FORCES TRANSMITTED THROUGH DIRECTOR TUBE AND HOIST TRUNKS
SOME BLAST DAMAGE TO JOINER WORK IN B-202-E
16" PILLAR HIGHLY STRESSED

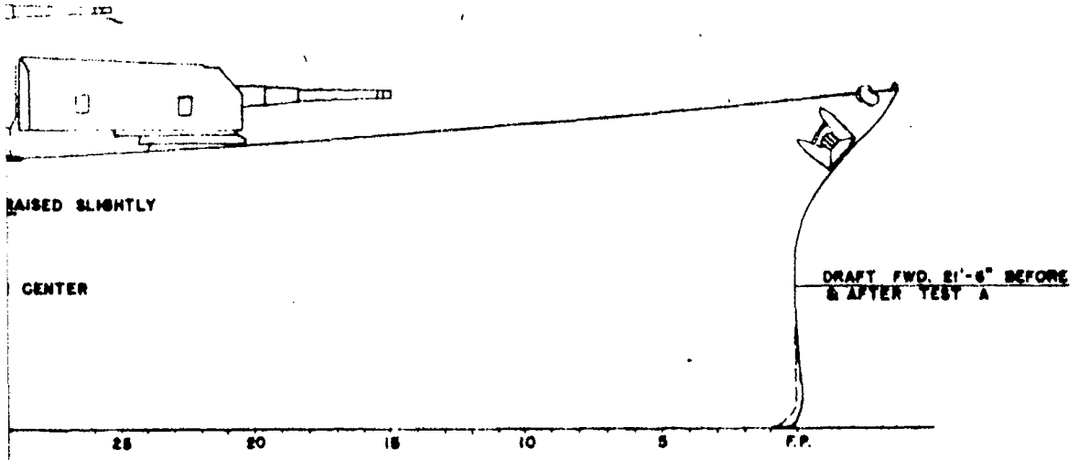

AFTER STACK BENT TO PORT
MAJOR DECK DEP IN WELL DECK A
FIRE DAMAGE PORT AND STBD. OF MOUNT 4
MAIN MAST STRUTS PULLED FROM DECK
GALLEY SKYLIGHT PUSHED DOWN
TEAR IN MAIN DECK PLATING


SK RADAR ARRAY MISSING
ALUMINUM BHD CRUSHED
FLAG BAGS AND LOCKERS DEMOLISHED
5" MK 33 DIRECTOR DISHED ON AFTER AND STARBOARD FACES
FORWARD STACK BLOWN AGAINST PORT WING OF COMMUNICATION PLATFORM
SMOKE HOOD FOUND AT FRAME 53 STBD
SEVERE BLAST DAMAGE IN MAIN DECK PASSAGEWAY AND ON SUPERSTRUCTURE DECK LEVEL
LIGHT BULKHEADS ALONG PASSAGEWAYS DISTORTED AND DISHED
WELL DECK DEPRESSED MAXIMUM OF 28 1/2" WRECKING C-201-L
C-201-L
B-201-L
MAIN DECK RAISED SLIGHTLY
SECOND DECK
1ST PLAT.
BHD 43 CRUSHED UNDER CENTER LEG OF FOREMAST
2ND PLAT
FORWARD ENGINE ROOM C-1
FORWARD FIRE ROOM B-1
75 70 65 60 55 50 45 40 35 30 25 20
16" PILLAR HIGHLY STRESSED
CONSIDERABLE BLAST DAMAGE TO JOINER WORK IN B-201-L

MAJOR DECK DEPRESSION IN WELL DECK AREA
FORWARD STACK BENT TO PORT AGAINST PORT COMMUNICATION PLATFORM
FLAG BAGS DEMOLISHED
MK. 33 DIRECTOR DISHED
TEAR IN MAIN DECK PLATING
SMOKE HOOD DISLODGED FROM FORWARD STACK

IED ON
FACES

ST DAMAGE IN MAIN DECK
AND ON SUPERSTRUCTURE

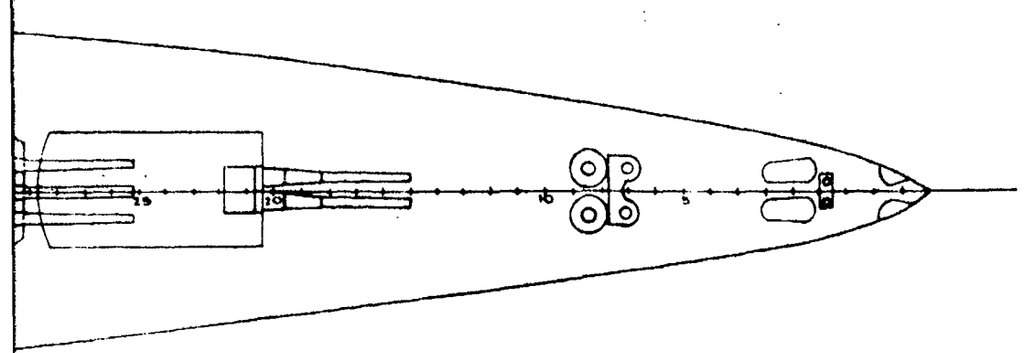


LEGEND

FIRE

FLOOD DEFLECTION

BMED



SECRET

NAVY DEPT. BUREAU OF SHIPS

DAMAGE TEST A

U.S.S. PENSACOLA CA 24

APPENDIX

COMMANDING OFFICERS REPORT

TEST ABLE

PART A - GENERAL SUMMARY

I. Target Condition After Test.

(a) The drafts before and after the test were the same. After the test the ship developed a 1 1/2° list to port, due to the toppling of the stacks to port. There was no flooding from outside sources although one magazine took in about fourteen inches of ballast from an adjacent fuel oil tank. These compartments were located on the starboard side forward on the fourth deck and leakage was due to the opening of seams and rivet holes. This is the only evidence of any leakage.

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

1. The superstructure took the brunt of the blast and sustained the most damage. The forward superstructure was struck on the after port side. The major damage in this area was done to the forward stack which was blown forward and to port and is now leaning against the gun shields on the port side at an angle of about 50°. It is ruptured and collapsed.

2. In this area also, the signal bridge is demolished and the after bulkheads to the Captain's and Navigator's sea cabins blown in and ruptured. Minor damage occurred on the forward part of the navigating bridge. The plexiglass windows were blown out and the canvas covering ripped and torn. Glass in one gyro steering repeater, the engine order telegraph, and the rudder angle indicator was broken but all instruments except the gyro repeater are usable. One pelorus stand on the port side was cracked, throwing the lubber's line approximately one degree off center.

3. The port 24" searchlight on the 05 deck was blown off and was found on the port side of the bridge. Several light metal gear lockers were torn loose from the bulkheads and were found on deck. The top of the foremast was bent forward and the SK radar antennae was carried away. All ladders from the main

deck to the fore top on the starboard side were demolished and all rigging was carried away.

4. The after bulkhead of the fire control workshop and of the "Crossroads" office on the main deck at frame 60 was blown inward and forward.

5. All decks of the forward superstructure were rippled and on one deck the plating was torn loose from the rivets.

6. The after superstructure showed evidence of a pressure wave hitting it from all directions. The after stack was ruptured, collapsed and leaning at about a 40° angle to port. The mainmast was bent slightly forward and to port and both legs of the tripod ruptured the deck. Bulkheads were dished in all directions and doors on both port and starboard sides were dished. All rigging and antennae were carried away. The starboard 36" searchlight was blown off its platform, crushed the galley skylight and dished in the overhead of the galley.

7. The hull, itself, showed the effect of a downward and forward pressure wave. The main deck between frames 60 and 72 and from frame 110 aft was crushed. Stanchions and deck beams were seriously bent and materially weakened. At intervals throughout the length of the hull ripples were evidenced which was due in all probability to a whipping and twisting of the hull by the pressure wave. Exterior hull plating was dished around frames from frame 130 aft on both port and starboard sides of the fantail. The dishing was greatest at the stern and became progressively less to frame 130. Sheer strakes, armor belt and external hull fittings were undamaged.

8. The interior of the hull was affected but slightly. Stanchions and transverse deck beams of the main deck were bent and crushed downward in the places where the main deck gave way. The armored deck was dished slightly over the after fireroom at frame 77 and also over the after engine room at frame 97. The seams of A-3F, a ballasted fuel oil tank, opened slightly and allowed ballast to enter A-413-M to a limited extent.

(c) Operability: machinery, electrical, ship control, fire control, gunnery, electronics.

1. The overall operability of the machinery immediately following the blast was completely impaired. This was due directly to the failure of the boilers. The pressure wave descended the stacks and blower ducts causing the boiler casings to be blown apart. Hence no boiler was immediately available for steaming. Main engines, reduction gears, shafting, bearings, condensers, lubrication systems and auxiliaries suffered no damage and if steam had been available all machinery could have been operated.

2. The operability of the electrical equipment immediately succeeding the test was good. No vital piece of electrical equipment was damaged. Non-vital pieces of equipment such as ventilation blowers, fans and so forth were in some sections damaged.

3. In general ship control equipment remained in good condition. Both steering engines and motors were operable. Both forward and after gyroscopes were operable and only an error of one degree was found in one bearing repeater, an error not present prior to the test. Interior communications to the vital ship control stations were unimpaired. It may be noted, however, that the standard magnetic compass, which was removed for the test, when reinstalled with the identical compensations, showed a deviation as large as 60° on one heading.

4. The major portion of the ordnance installation except fire control radar was operable at reduced efficiency immediately following the explosion. The forward main battery director and nine major caliber guns were operable. The after main battery director gun train and elevator circuits were useless due to a ground in the cable between the director and the switchboard. The left gun of turret three was out of action because of a broken diaphragm in the counter-recoil system. These diaphragms frequently failed during normal conditions and may not have been due to the test. The alignment of the main battery after the test was fair, being slightly outside of allowable limits.

5. Both directors and the four 5''/25 caliber guns of the AA battery were operable. The alignment of this battery was poor, especially on the port side where the deck had been buckled. The shock wave dished in the back of the forward AA director and would have crushed personnel inside but did not seriously damage the equipment inside except by breaking the electron tubes in the stable element. Similar tubes in the after AA director were undamaged. The after AA director was facing the blast while the forward director was facing forward. It is to be noted that the operable stable elements were sluggish and slow in settling out. This would have reduced the efficiency of the fire control especially in a moderate heavy sea.

6. The starboard MK51 director for auxiliary control of 5'' battery had a grounded supply circuit. The port director was undamaged. All fire control radar were inoperable.

(d) Heat; fires; estimated personnel casualties.

1. The greatest cause of damage to the ship was caused by the shock and pressure waves. The effect of heat was surprisingly small. The overall effect of heat was evidenced on the starboard side and on surfaces facing aft. The paint was scorched on every surface facing the blast and the wooden deck in direct line with the blast was slightly scorched and blackened. The scorched areas were clearly outlined and those areas not in a direct line with the blast were clear.

2. The heat produced was in the nature of a flash and not sustained. Enclosed areas as well as areas not directly exposed to the blast were not noticeably affected. Maximum - minimum thermometers in ready service boxes - some of which were directly in line with the burst - showed no rise in temperature, showing that the heat produced, although great enough to scorch paint and wood, was not sustained long enough to penetrate enclosed structures nor to be conducted from other surfaces.

3. There were two fires started on board. The largest had its origin apparently in the Army Quartermaster equipment exposed on the fantail. This equipment contained army

clothing, tents and food. The entire equipment on both the port and starboard side, the wood deck beneath the equipment, as well as balsa life rafts on each side burned. Paint on the sides of turret four blistered from sustained heat of this fire. A second minor fire occurred in the main deck forward under the overhang of turret one, where several lengths of fire hose were destroyed. This fire evidently was started by oil drippings from turret one as it was shielded from the direct path of the blast. No structural or other damage, save for the destruction of the above articles was caused by either of these fires.

4. Exposed personnel on the topside would have been 100% casualties, it is believed. This would include ship control personnel on the bridge, gun crews at the five inch guns, fire control personnel at topside fire control stations and repair parties. This would account for about thirty-five to forty percent of wartime allowance of personnel. Personnel in the firerooms would have been also 100% casualties, which would bring the total casualties to about fifty or sixty percent of wartime allowance. In addition, personnel in enclosed spaces where structure would not withstand the pressure would also have been casualties if not from the heat then from the terrific pressure wave. In all, it is estimated that seventy-five percent of the ship's complement would have been casualties, exclusive of effects of radioactivity.

II Forces Evidenced and Effects Noted.

(a) Heat: apparent direction (if any); extent longitudinally, transversely, penetration, significant behavior of structure or equipment.

1. The apparent direction of the heat from the explosion came from about fifteen degrees on the starboard quarter. Longitudinal extent was the entire length of the ship, becoming progressively less toward the bow. Transverse extent on the fantail was complete. However, the effect of the heat was noticed on the starboard side on surfaces and equipment facing toward the stern.

(b) Fires and Explosions: situation; nature of combustible or explosive; normal stowage; cause of ignition; extent and result.

1. Penetration was almost nil; the effect was only to scorch and sear paint and wood decks. However, on the fantail where the heat was greatest, army quartermaster material, consisting mainly of clothing, tents and food, was completely destroyed by fire. The fire was evidently started in the canvass and cardboard boxes. This caused a secondary fire which consumed a large area of wood deck beneath these stores and two banks of balsa life rafts on both the port and the starboard sides, as well as the army equipment. Aside from this fire and the scorching of exposed surfaces, heat had no other effect. Electrical insulation was normal and even exposed smokeless powder in open gun chambers was not affected. Army material is not generally on board and it is believed that no fire would have been started if this material had not been on board.

(c) Shock: apparent direction (if any); areas affected; critical scantlings; nature of joint failures; effect on machinery and equipment; significant behavior of structure or equipment.

1. The direction of the shock wave appeared to be from about 15° on the starboard quarter and from quite an altitude. The general areas affected by the shock wave were the masts. These whipped sufficiently to cause radar antennas on each mast to break off and fall. Glass windows in both the forward and after main and secondary battery directors were blown out, glass face plates on the engine order telegraphs, one gyro repeater and the rudder angle indicator were demolished. Other top-heavy equipment such as one 36" and one 24" searchlight was snapped off at the base. Inclined ladders of steel and aluminum were bent downward, twisted, and had most of the treads entirely broken out. Lockers and equipment attached to bulkheads were blasted off. From indication of the ripples in the main deck from the stern to the bow, the entire hull was whipped by the shock wave. Ten-inch stanchions at frames 60 to 72 and from frame 110 to the stern were buckled. As a consequence, 18" transverse "I" beams and ten-inch longitudinal

chanel beams in these areas dished down from 12'' to 18''. In those areas of the main deck riveted seams in several places pulled loose and failed. The same whipping and buckling effect was noticed on the 01 deck where the rivet seams were also pulled loose. It is interesting to note that welded seams held up whereas riveted seams in several cases failed. The same effect was noted but to a much smaller extent on the armored second deck. At frame 78 over the after fireroom 12'' stanchions had buckled and transverse and longitudinal beams were dished down about 1''. The 10'' stanchions in the after engine room at frame 96 were also buckled and the armored deck dished about an inch.

2. The effect on machinery and equipment other than those mentioned above was not apparent.

(d) Pressure: apparent direction (if any); areas affected; critical scantlings; general nature of failures; significant behavior of structure and equipment.

1. The direction of the pressure wave was the same as that of the heat and shock waves, about 15° on the starboard quarter and downward. The main areas affected were both the forward and after superstructure, the stacks, the main deck and the extreme after end of the hull plating. The general nature of the failures to the superstructure was the light metal of the signal bridge being twisted, bent and ruptured. Bulkheads were pulled loose from the deck and pressed forward and in general all light metal was demolished. Structures of heavier metal remained intact. Several light doors in both the forward and after superstructure were dished in and in some cases pushed completely off the hinges.

2. Both the forward and after stacks were seriously damaged by the pressure wave. Both stacks were bent, twisted, ruptured and collapsed - leaning forward and to port at large angles.

3. The most serious damage due to the pressure wave occurred to the boiler. The pressure wave descended the stack

through the uptakes and blower ducts into the boiler casing. This pressure caused the casings of all boilers to bulge outward and in many places to rupture or fail. Some firebrick was cracked due to the shock wave and some plastic was pulled loose.

(e) Any effects apparently peculiar to the Atom Bomb.

1. The greatest effect apparently peculiar to the Atom Bomb, of course, was the large area affected by the blast and the overall extent of damage. The damage effects of the usual bomb depends not only on the pressure produced but also on the effect of shrapnel. In the use of the Atom Bomb, terrific damage was affected by shock and pressure. And those forces are many times greater and more far-reaching than any damage done by the usual bomb.

III Results of the Test on the Target.

(a) Effect on propulsion and ship control.

1. The major damage to main propulsion was the damage to the boilers. These were all entirely put out of commission by the downward pressure wave through the stacks. As the situation stood at the time of the test, the fires were secured and the burner registers closed as well as the blower ducts. This fact caused the pressure wave to burst the casings. It is possible that in action with the registers and blower flaps open that these may have afforded enough area to allow the blast to escape into the fireroom. In that case, it is possible that only the fires may have been blown out and personnel present in the fireroom burned. It might still have been possible to light off the boilers again with new crews and continue to keep the main propulsion plant in operation.

2. No other damage to machinery was experienced. Ship control would have been momentarily paralyzed by the lack of electric power caused when steam was cut off from the main generators. The auxiliary diesel, however, could furnish immediate power to the steering engine and gyro compass, and the paralysis

would not have continued. All ship control units in themselves were undamaged and sound powered interior communications were unimpaired.

(b) Effect on gunnery and fire control.

1. The effect of the test on gunnery and fire control was to reduce seriously the operation, efficiency and accuracy of the gunnery equipment. Although the material of the main battery withstood the shock and pressure waves to a large extent, topside fire control personnel in the main battery directors and other fire control stations would undoubtedly have been casualties. Immediately after the test the forward main battery director and nine of the ten guns were found to be in operating condition. The after main battery director had several transmission cables grounded. These conditions could be overcome in a short period of time. However, due to the distortion of the hull, alignment in the main battery was slightly inaccurate and the stable elements of all the directors were sluggish and unsatisfactory.

2. The five-inch battery was operable in director control but due to buckling of the decks in vicinity of the guns, alignment was very poor. The stable elements of these directors also were seriously affected.

3. As electric power failed, however, the fire control system for all batteries was out of commission. The five-inch battery and 40MM mounts could have fired effectively in local control but the turrets could not. Hand train and elevation is cumbersome and painfully slow. It would have been impossible to fire accurately at a target.

(c) Effect on watertight integrity and stability.

1. The air burst of the atom bomb did not seriously affect the watertight integrity and stability of the ship. The underwater hull was undamaged. Watertight compartmentation below the main deck was not seriously affected. There was no flooding except where the rivets and seams of fuel oil ballast tank A-3-F allowed seepage into magazine A413-M. The free board, hence was not

reduced. However, failure of the steel main deck rivet seams in several places opened fairly large holes in the main deck.

2. No large topside weights were shifted except the two stacks which altered the stability but little. However, due to the weakening of the hull from the shock and pressure waves the ship could not withstand a heavy sea way.

(d) Effect on personnel and habitability.

1. The damage had no noticeable ill effect on personnel who returned aboard. In fact, the spirit was good and most men and officers preferred living on the PENSACOLA to living on the transport.

2. The principal damage affecting habitability was partial loss of ventilation and cooking facilities. The diesel generators supplied some power for electrical hot plates, but not until a boiler and main generator were back in commission were cooking facilities adequate. Broken ventilation ducts prevented adequate circulation in various living spaces.

3. The chief petty officer's quarters were not habitable. Officers country was in good condition.

(e) Effect on fighting efficiency.

1. The fighting efficiency of the ship would have been seriously reduced by six factors:

(a) Boiler failure causing the ship to come to a complete stop.

(b) Electrical failure causing gunnery efficiency to drop to about twenty percent of its normal.

(c) Electrical failure causing momentary loss of ship control.

(d) Failure of all radars causing a twenty percent drop in gunnery efficiency.

(e) Weakening of the hull causing a reduction of speed in a sea way.

(f) Estimated personnel casualties causing reduced efficiency in ship control, ship propulsion and gunnery.

2. It is estimated that the fighting efficiency of the ship immediately after the detonation of the bomb would have decreased to about twenty percent of its normal. Only the main battery would have been able to continue to fire. The diesel emergency generators would have been able to furnish power to run the main battery, one director, one steering unit and gyroscopic compass. The ship would have been dead in the water and nearly all the topside personnel would have been casualties.

3. However, it is estimated that within fifty-four hours, at least one boiler and possibly two would have been repaired, the ship could have gotten underway at a speed of 10 to 16 knots and normal electrical power restored. This would increase the fighting efficiency, exclusive of personnel, to about sixty or seventy percent. Because of the weakening of the hull and misalignment of the gunnery systems, the ship could not expect to increase its efficiency above this point.

IV. General Summary.

1. No combatant ship in the U.S. Navy today could withstand the effects of the bomb and keep operating if it were within the range of the PENSACOLA from the bomb. At the distance of the PENSACOLA the primary reason for this was the failure of the boiler casings. Otherwise, the propelling machinery could have been kept in operation. Battleships and cruisers could probably operate some or all of the main battery in local control with the possibility of one director remaining in operation without radar. Disregarding radiological effects, it is believed that personnel might survive in some enclosed spaces such as engine rooms, magazines,

and turret mounts. Some personnel might have survived on the second deck if equipped with helmets, otherwise they would be catapulated against the overhead. Damage resulting in the puncturing of the main deck amidships and aft was the result of vertical surfaces reflecting pressure downward. Any obstacle in the path of the pressure wave deflects usually with damaging effect which is particularly true in passageways.

V. Preliminary, General and Specific Recommendations.

1. Provision must be made for keeping the pressure out of boilers between installation of flapper valves; or the pressure must be vented in some way. It is recommended that all new construction be either diesel drive, diesel electric drive or some type of gas engine propulsion. Present type shape of smoke stacks are utterly useless in withstanding pressure created. Cowlings to deflect smoke merely serve to deflect pressure with increasing force into the boilers.

2. Existing ships must be redesigned to provide spherical streamlined surfaces without projections of any sort. Vital areas such as control stations must be armored. Radar and radio antennaes must be retractable or permanently installed in a protective housing. All vertical surfaces must be eliminated.

3. Some method of venting enclosed spaces which have been punctured, such as soft patches, must be installed.

4. Stowage must be provided for materials which react to the rays of the bomb and become radio active.

5. Personnel below decks must wear head gear or some form of protection. Protection must be provided to protect personnel violently thrown around.

6. Although turret roller paths appear to have stood up satisfactorily on this ship, some consideration must be given to the forces which have been found to act on the ship's structure.

7. Auxiliary masts similar to conning towers on submarines should be provided and it's strongly recommended that ships presently in commission be fitted with such devices now.

8. In general superstructure construction must be uniform in strength as the blast tends to seek out weak points.

SECTION 1 - HULL

A. General Description of Hull Damage.

(a) Overall condition of vessel.

1. Damage sustained as a result of Test A with the exception of the firerooms and slight damage in a few other compartments, is all above the second deck (armored deck). The main deck between frames 60 and 72 and also from frame 110 to the stern was crushed by the blast and in numerous places failed. Stanchions and deck beams in afore mentioned areas supporting the main deck were very seriously damaged. The frames in these areas were materially weakened - enough so that the ship twists constantly even while laying at anchor. Although stability and watertight integrity have not been seriously impaired, the ship is not able to withstand much additional damage and there is the possibility of her failing in a sea way.

(b) General areas of hull damage.

1. From frame 48 to the bow there was slight damage in isolated places and is not worthy of comment. Damage to the hull is with afore noted exceptions, entirely aft of frame 48. Particularly heavy damage was suffered between frames 60 and 72, and from frame 110 to the stern. In these two areas the main deck is dished, cracked and riveted joints failed. Beams and stanchions supporting the deck are twisted and buckled. Frames throughout these areas have been materially weakened, proof of which is the twisting of the ship, very noticeable when transit observations were made.

(c) Apparent causes of hull damage.

1. In all cases with the following exceptions, damage was caused by the pressure wave. At frame 28, main deck, there was a small fire which burned the wood deck. Between frames 115 and 129 on either side of turret #4, fire burned the wooden deck. These fires were extinguished before they caused any structural damage.

(d) Principal areas of flooding and sources.

1. In A-413-M the riveted joint in the lower, after, outboard corner failed, allowing salt water in A-3-F, which is immediately outboard, to enter. At the time of inspection, 4 days after Test A, the water in A-413-M was 14" deep.

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

1. Even though the watertight integrity and stability were not seriously reduced, the weakened condition of the framing prevents the ship from operating as an effective, efficient, fighting unit. Because of the twisting mentioned in paragraph (a) 1, this ship would have to undergo an extensive yard period before she could be considered safe to take to sea and fight.

B. Superstructure (Exclusive of gun mounts).

(a) Description of damage with important dimensions.

1. Forward superstructure.

(a) The after and starboard surfaces on the forward superstructure were the only ones damaged to any great extent. The major damage in this area was to #1 stack. It is leaning 51° to port and against the port 5" gun shield and is collapsed, ruptured and failed. The gas deflector was blown from the top of the stack to the main deck and was found lying at frame 53 (S).

(b) The signal bridge (04 level) was demolished as well as the Captain's and Navigator's sea cabin. The after bulkheads of the fire control workshop and "Crossroads" office were demolished and blown inward and forward.

(c) The port 24" searchlight (05 level) was blown down to 04 level. Two gear lockers on 05 level were demolished and blown away. Several other gear lockers were blown off their foundations and found 10 to 15 feet forward.

(d) Inclining ladders on the starboard side with aluminum treads were demolished.

(e) The foremast was bent forward and the SK radar antennae carried away. All rigging on the mast was carried away.

(f) Gas tight doors facing aft were dished throughout the superstructure.

(g) The deck plating on all decks was rippled and on the 01 deck at frame 47 (P and S) it was bulged and pulled loose from the rivets.

2. After superstructure.

(a) The after superstructure shows evidence of a pressure wave hitting it from all directions. The main pressure wave came from the starboard quarter which is indicated by # 2 stack leaning 37° to port. The major damage in this area was to the stack which was twisted by a clockwise torque as well as being collapsed, ruptured and failed.

(b) The mainmast was nearly ripped loose from its foundation as both port and starboard legs of the tripod ruptured the deck. The mainmast is bent slightly forward and to port.

(c) The decks in the area are rippled but there are no depressions greater than three square feet.

(d) The bulkheads from the main deck to 01 deck are dished throughout and it appears the pressure exerted itself in all directions. Doors on both port and starboard sides were dished.

(e) Antennae and rigging were carried away. Life-lines on the 01 level were also carried away or sagging.

(f) The galley skylight and overhead were demolished by the starboard 36" searchlight falling upon it.

(b) Causes of damage in each area.

1. In the forward superstructure the majority of the damage was a direct result of the pressure wave. No. 1 stack caused some insignificant damage with relation to the initial blast by falling forward into the superstructure.

2. A fire in 4 lengths of 2 1/2" fire hose (frame 28C) caused some rubber wash deck hose in A-101-2 (blower room) to catch fire by conduction. The fire smothered itself through lack of oxygen before any other material burned.

3. In the after superstructure, again, the major damage was a direct result of the pressure wave, however, the starboard 36" searchlight fell onto the galley skylight and demolished it.

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

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

1. Various plating thickness.

(a) The heat of the blast did not affect any thickness of plating other than blister the paint.

(b) Plating heavier than 15 pounds was not affected by the blast. No armor plate was damaged by the pressure wave. Nearly all plating that was distorted was 10 pound plating or less.

2. Various shaped surfaces.

(a) The blast caused the worst damage to angular and sharply defined shapes. Surfaces that offered any resistance to the flow of air were damaged throughout the superstructure. Gun shields for the most part were damaged and bent away from the blast. The masts were also bent away from the blast.

3. STS compared to MS;

(a) Special treated steel held up under the blast. The

gun shields bent but did not rupture, whereas, mild steel of corresponding thickness was ruptured and distorted. The STS used as bulwarks around the bridge and fire control platforms were bent slightly but showed no other damage. In most cases where violent pressure hit an STS shield, a weld gave way before the shield ruptured.

4. Aluminum structures (where fitted).

(a) A majority of the joiner bulkheads and joiner work in the compartments made of aluminum were ruptured and distorted. These structures failed when steel objects in same area were not damaged.

(b) The aluminum treads in several inclining ladders were demolished, while the steel treads in nearby ladders showed no damage.

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

1. Sharply defined shapes bore the brunt of the blast. Structures such as the masts, stacks, gun shields, cranes, davits and ladders were wholly or partially destroyed. If the air had a smooth armored surface to flow over, chances of damage would have been less. As an example, the turrets which are armored and partially streamlined were undamaged.

2. The well deck and fantail were badly dished showing that large flat surfaces were severely affected by the pressure wave. The elimination of large flat surfaces and their replacement by contoured surfaces would lessen the chance of heavy damage.

3. The rigging and small fittings or equipment located topside were either carried away or demolished. The wind instruments, antennae and other light equipment were demolished.

C. Turrets, Guns and Directors.

(a) Protected mounts.

1. The only enclosed mounts on this ship are four 8''/55

caliber mounts. They were all operable and the damage from the bomb was negligible. The right projectile hoist in turret one could be operated only by holding the starter button closed due to open circuit in the controller contactor holding coil protective resistor. The shell port sliding covers between the rangefinder booth and auxiliary shell trays in the gun chamber in turret two were jammed due to distorted bulkhead. Equipment for supplying projectiles from the shell deck was undamaged. The covers for the rangefinder windows in turret three were jammed closed. Turret four was in condition Yoke during the test and the pointers pit door, which was open, was torn off.

2. The protection afforded by the turrets was adequate.

(b) Unprotected mounts.

1. None of the open mounts suffered any appreciable mechanical damage. Distortion of the deck under these mounts caused them to be out of alignment with the directors. Damage to the electric cables rendered some mounts inoperable by power.

2. The crew shelters were useless for protection of personnel against this explosion. Although the fragmentation and splinter shields were undamaged or only slightly distorted, they provided no protection against the blast which would have killed the personnel outright or blown them overboard. No evidence of fragmentation existed.

(c) Directors and range-finders.

1. Enclosed directors were insufficiently protected. The Mark 33 director and the Mark 35 director facing away from the blast suffered the greatest damage. In the after directors, flying glass was a great hazard. Both Mark 33, both Mark 35 and 3 out of 4 Mark 51 directors were operable with certain limitations. The stable elements were sluggish in operation and would have been unsettled in a heavy sea. The range-finders and range-keepers were operable at reduced accuracy. The range-finder window covers were jammed closed in the after main battery director, after AA director and turret 3. The optics in general were in useable condition.

The Mark 51 director on starboard side for auxiliary control of 5"/25 guns was inoperable due to a grounded supply circuit. The Mark 51 director for the starboard Mark 63 GFCS was demolished.

2. The instruments within the directors were operable except the stable element in the forward Mark 33 director which had all the C6A tubes broken.

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

1. Heavier shields must be used on directors similar to Mark 33 and Mark 35 directors. Heavier decks and supports should be used under AA mounts that are director controlled to prevent disturbance of battery alignment. Electron tubes for stable elements should be located within the director tube for better protection. Unprotected directors and gun mounts should be replaced with protected equipment having a protective shield of one-half steel plate or equal. Better protection must be devised for anti-aircraft control stations.

D. Torpedo Mounts, Depth Charge Gear.

(a) Not applicable to this ship.

E. Weather Deck (F1 BK) (Main Deck Only).

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

1. Steel decks - frame 60 to 71 - Well deck: Deck was badly dished, ruptured, cracked and punctured due to blast. Deck failed in many places along rivets and seams. Center of dish was at frame 63. Deck beams were badly distorted below the deck as well as beam supports, however, the deck was safe for use by personnel but not for supporting any large amount of weight.

2. Frames 88 - 92 - Port passageway: Deck was slightly dished due to blast. It was completely usable in this condition.

3. Frames 131 - 136: Deck was dished and distorted producing a ripple effect. Damage was caused from blast and

longitudinal whipping effect of ship's hull. Deck was completely usable and safe.

4. Wood Decks:

(a) Frame 12, port. Deck was slightly dished apparently from whipping effect of hull more than from blast effect. Deck was completely usable.

(b) Frame 16, port and frame 25 to 27 port and starboard: Same as "a" above.

(c) Frame 28: Deck was burned in a small area around the centerline where a 2 1/4" fire hose had been stowed on the bulkhead. Deck was burned due to the fire caused by the deck hose which was completely consumed.

(d) Frames 98 S, 102 S, 114 P and S, 116 S: Deck was dished, forming a ripple effect. This was due to blast and whipping effect of hull. Deck in this area was completely usable.

(e) Frames 120 to 131: Deck was badly dished, distorted and demolished by fire. Fire was started by life floats and Army Quartermaster's gear stowed on deck. Deck was punctured in many places and failed badly at frame 123 where blast pushed deck down and ruptured it around top of ammunition trunk. Deck in this area was about 30% usable and entirely safe from a strength stand point.

(f) Frame 136 to 142: Deck was badly dished due mainly to blast. At frame 139, P and S, wood cracked and failed. Deck was completely usable.

(b) Condition of equipment and fittings.

1. Mooring fittings - no damage.

2. Towing fittings - Towing bridle was completely ruined due to intense heat and blast. Strands were open and core was charred. Preventer was carried away.

3. Boats - Only one boat was on board, stowed at frame 60, a dingy used for side cleaning. It was completely demolished from blast.

4. Boat handling gear - Boat falls port and starboard were slightly singed from heat of blast. Lines were dried out and unsafe for use.

5. Life rafts - Three rafts at frame 127 port and starboard completely burned. One raft at frame 118 port and starboard burned about 50%. Three rafts, frame 55, starboard, were knocked loose from frame support.

6. Airplane crane - Reach rods were frozen due to distortion of deck and bulkheads. Machinery was not damaged.

F. Exterior Hull.

1. Exterior hull plating was dished around frames from frame 130 aft on both sides due to blast. Dishing was progressively worse to fantail which was very badly dished. There was no damage to sheer strakes, armor belt or external hull fittings.

G. Interior Compartments (above the waterline or armored deck).

(a) Damage to structure and causes.

1. A-203-2L. Overhead bulged compressing deck beam at frame 26 due to pressure wave.

2. A-203-3L. Bulkhead and stiffener between centerline and starboard doors bulged due to descent of blast in uptakes.

3. B-201-L. After bulkhead distorted to starboard due to descent of well deck.

4. C-201-L. This compartment is probably the most thoroughly damaged of those classified under Item G. The overhead, namely the main deck, was distorted, ruptured and punctured when the blast forced it downward. Very many joints failed. The forward

structural bulkhead was distorted; so also was the bulkhead aft, but in addition it was ruptured and its joints failed. Every stanchion was badly buckled by compression caused by bulged overhead. Both longitudinals and frames were distorted.

5. No. 1 and 2 uptakes - Overhead in this area was distorted.

6. C-202-L. Overhead and deck beams in this compartment bulged causing the distortion of nearly all stanchions and the failure of one at frame 97 P. Forward bulkhead bulged on starboard side by blast down engine room escape hatch.

7. B-202-L. The deck and forward bulkhead in this passageway was dished and distorted.

8. No. 3 and 4 uptakes - The deck and port and starboard bulkheads are dished in this area due to admittance of the blast.

9. D-101-L. Forward and starboard bulkheads bulged slightly. The latter occurred at frame 109 and was caused by compression wave.

10. D-106-A. This starboard gear locker was severely damaged; joints failed in starboard bulkhead and overhead due to buckling of stiffeners; the forward bulkhead was bulged and the starboard bulkhead was by bulging, rupture and failure. All damage here was caused ultimately by the pressure wave.

11. D-108-A. The forward and port bulkheads of this port gear locker were bulged causing the distortion of bulkhead stiffeners.

12. D-102-L. Again the forward and port bulkheads of the crew's head were bulged by the compression wave.

13. D-201-3L. Overhead, longitudinal and after bulkhead bulged on starboard side due to downward movement of main deck.

14. D-203.1L. The severe damage to the after section of the ship begins in this compartment. Here the overhead failed at

Joints on starboard side and together with longitudinals was generally distorted. The forward bulkhead was dished, causing the distortion of two bulkhead stiffeners, one to port and one to starboard. The deck beam at frame 116 was distorted and cracked causing the distortion of the supporting stanchions. The forward starboard corner of the forward powder transfer box for turret #4 barbette was cracked at the riveted joint at this same frame.

15. D-203-2L. This area is the second most damaged compartment in this classification. Of the structure, only the port and starboard bulkheads were unharmed. The deck failed at joints, was distorted by fire main and watertight vent pipe at frame 178 P, and was punctured by a stanchion at frame 126 P. The overhead was bulged, ruptured, cracked, and failed from frame 122 to 132; this resulted in distorting all the longitudinals. Frames 122, 125 and 128 and their respective deck beams were subjected to joint failure, were bulged, distorted and cracked. This nearly demolished the stanchions in this region. The after bulkhead was dished at centerline.

16. D-204-L. The deck here was generally distorted due to the movement of the rest of the structure; the overhead was cracked in addition to being thoroughly distorted. All bulkheads were bulged; the forward one by the depression of the main deck by the blast and the port and starboard bulkhead by the direct action of blast indicated by the extremely noticeable dishing of the skin of the ship between frames. Stiffeners, frames, deck beams, longitudinals and stanchions were therefore bulged, distorted and cracked throughout the area. The joint at frame 140 P also failed.

17. D-310-L. The overhead here was damaged by failure of joints, distortion and rupture, which in turn caused the distortion of deck beams and stanchions at frames 125, 126 and 128.

18. D-312-L. The overhead bulged at frames 130 and 135 causing a slight buckling of the forward and after bulkheads.

19. D-312 1/2-L. Same as D-312-L.

20. D-314-A. The overhead and forward bulkhead at frame 135 were bulged here from frame 136 aft to the stern, the port bulkhead of the ship's side was bulged between every frame by the blast, thus distorting the stiffeners.

21. D-315-A. Same as D-314-A, except the bulge in the starboard bulkhead begins at frame 140 and continues aft to the stern.

(b) Damage to joiner bulkheads and causes.

1. A-203-2L. The inboard and forward joiner bulkheads of Warrant Officer's pantry were dished and distorted due to bulging of overhead in this area.

2. B-201-L. Joiner bulkheads of the various offices in these two passageways were badly damaged by punctures and distortions caused by the down rush of the pressure wave through the louvres topside to the blower rooms and through the bulkheads to the passageways.

3. C-201-L. Joiner bulkheads in this area were punctured and distorted throughout due to the extreme depression of the overhead.

4. No. 3 and 4 uptakes. Bulkheads at #5 and #6 blower rooms, frame 73, dished because of access of pressure wave through opening along stack.

5. D-106-A. Joiner bulkheads here thoroughly distorted due to bulging of starboard bulkhead.

6. D-108-A. Same as D-106-A, but caused by bulging of port bulkhead.

7. D-102-L. Light screen at forward door distorted by slight bulge in bulkhead at frame 104.

8. D 203-2L. The joiner bulkhead extending athwartships at frame 128 between the C.P.O. mess and the crew's berthing space was so badly damaged as to be considered demolished. The same applies to those bulkheads that formed the C.P.O. pantry on the starboard side and a large locker on the port side of the mess. All damage was caused by the depression of the main deck on the fantail.

9. D-204-L. The joiner bulkheads from frame 139 aft in the C.P.O. head were distorted and failed at the joints

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

1. B-201-L.

(a) Joiner door to Gunnery Office was blown off and damaged by distortion, failure of joints and misalignment.

(b) Joiner door to Log Room was very slightly dished.

(c) Joiner door to First Lieutenant's Office was distorted but the frame was distorted even more.

(d) Joiner door to M.A.A. Office was distorted but the frame was distorted even more.

(e) Joiner door to Marine Office was distorted, misaligned and failed at the joints; the frame was torn loose and badly distorted.

(f) Joiner door to Photography Shop was distorted, misaligned and failed.

(g) Joiner door to Supply Office failed at joints, was distorted and misaligned.

(h) Joiner door to Disbursing Office failed at joints, was distorted and misaligned. The corner section of this door was completely blown off.

2. C-201-L.

(a) Watertight door 2-60-CL is difficult to close because of misalignment.

(b) Watertight door 2-62-1 and watertight door 2-70 were distorted so badly by force of explosion as not to be inoperable.

3. B-202-L.

(a) Watertight door 2-72-2 was bulged and distorted but is operable.

4. No. 3 and 4 uptakes.

(a) Watertight door to #6 blower room was dished but is operable.

5. D-101-L.

(a) Watertight door 1-104-1 was bulged slightly but is operable.

(b) Watertight door 1-109-1 (quick closing) was bulged so badly as to be inoperable.

6. D-106-A.

(a) Watertight door 1-111 1/2 was bulged, misaligned and therefore inoperable.

7. D-108-A.

(a) Watertight door 1-112 was bulged, misaligned and therefore inoperable.

8. D-203-2L.

(a) Watertight hatch 1-25-1. Gasket was burned due to heat from fire in Army equipment on display.

(b) Watertight hatch 1-25-2. Gasket was burned. There was also a leak around rivet in bounding angle joined to coaming.

(c) Joiner doors to C.P.O. mess were demolished.

(d) Joiner door to C.P.O. pantry was demolished.

9. D-204-L.

(a) Watertight hatch 1-134-CL and watertight scuttle 1-134 was slightly misaligned but operable. The coaming of the hatch was ruptured in two after corners.

(b) Watertight ammunition scuttle 1-135-1 was distorted and inoperable.

(c) Watertight door 2-133-2 was slightly dished but is operable.

(d) Condition of equipment within compartments.

1. B-201-L. In offices slight damage was evident to file cabinets.

2. No. 1 and 2 uptakes. Uptakes from boilers #1, 2, and 4 were distorted slightly. Blower flaps for all blowers were forced down parting the supporting cables. Flaps in #1 and #4 blower rooms were blown off completely.

3. C-201-L. The soda fountain equipment in this compartment was about twenty percent damaged. A drive wheel to the ice cream machine was distorted by a falling beam. Feed lines to the carbonating equipment were torn loose. Soft drink dispenser was smashed.

4. No 3 and 4 uptakes. Blower flaps were all blown downward parting supporting cables with the exception of those to #12 blower.

5. D-101-L and D-102-L. Both exhaust blowers were completely demolished, impellers missing.

6. D-203-1L. Bunk stanchions and a fire hose rack were distorted.

7. D-203-2L. Equipment in this compartment was about thirty percent damaged. The large blower CL was inoperable due to distorted housing. The control panel for the warping winch was knocked off its frame. The power cables on the overhead in the areas subjected to the fire topside were all damaged, thus putting out of commission the equipment to which they led. The fire hose rack was distorted. Portable steel plates were knocked to the deck. The coffee urn in C.P.O. mess was blown across the compartment.

8. D-204-L. Numerous lockers were slightly distorted throughout this area and nearly all mirrors were smashed.

(e) Evidence of fire.

1. There was no evidence of fire. Paint only was scorched in areas subjected to fires topside.

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

1. This material has been covered under Items M and V.

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

1. It is estimated that the watertight subdivision of these compartments was reduced about thirty percent.

2. The habitability of the after living compartments was reduced to an absolute minimum due to leaks and ruptures in the overhead, lack of ventilation, the danger of electrical fires due to damaged cables and the depression of the overhead.

3. The utility of the compartments subjected to damage was, in general, about three-quarters reduced because of injury to equipment and the reasons mentioned above.

H. Armored decks.

1. No armored deck, bulkheads or side belts was fractured, overheated or otherwise damaged except for slight distortion of the second deck (40 lb. STS armor) and the strength plates (30 lb. STS plate) of the main deck.

2. Buckled stanchions and cracked paint indicate that the second deck was permanently pushed downward at about frame 78 amidships and from about frame 90 to 97 amidships in the neighborhood of one inch. The main deck strength plates (two outboard plates on each port and starboard side) were depressed along the inboard edge about one or two inches from about frame 62 to 70. This was undoubtedly due to insufficient support and the fact that the amidships plates which are much lighter mild steel were pushed down until they ruptured.

3. Adequate protection was afforded spaces below.

4. No change in conditions around openings in armor such as doors, hatches or gratings in horizontal or vertical armor including uptakes and barbettes occurred during the test.

5. All connections to vertical armor are still good.

I. Interior Compartments (below waterline).

1. Compartment A-413-M flooded to 1' 2" with salt water and a thin coat of oil on the surface. This was caused by the whipping effect on the hull from the blast. The riveted joint along the lower starboard bulkhead failed allowing ballast water from A-3-F to enter. This bulkhead had many leaky rivets before the test. 40MM ammunition was stowed in this magazine and a first layer was submerged in oil and water.

2. Boiler casings were blown outward due to blast down stack and through blower trunks.

3. B-2. Boiler casings were blown outward as in B-1. Stanchion at frame 97 CL was distorted and armored deck slightly bulged.

4. C-1. Watertight door 2-62-1 was distorted with bulkhead.

5. C-2. Waterline stanchion and longitudinal at frame 96 slightly distorted and armored deck slightly bulged.

6. About twenty percent of compartments below the waterline were filled with dust where vent covers had been demolished topside and ducts ruptured.

7. There was no reduction in watertight subdivision. Habitability of compartments aft of frame 62 was seriously reduced due to damaged vent ducts and blower motors and panels.

8. All spaces could be used for original purpose except as noted in B-1, B-2 and A-413-M.

J. Underwater Hull.

1. There was no apparent damage to the underwater hull.

K. Tanks.

1. There was no apparent damage to any tanks, voids or cofferdams, except as noted in A-3-F. The inboard bulkhead between this oil tank and A-413-M failed around rivets allowing ballast water and a thin coat of oil to flood A-413-M to 1' 2''. Slight seepage around rivets were noticeable before the test.

L. Flooding.

1. None, except as noted in "K" above.

M. Ventilation.

(a) Damage to ventilation systems and causes.

1. Exhaust ventilation system 03-49-1. Ventilation duct between frame 48-49 (S) on 03 deck was distorted slightly due to bulkhead at frame 49 (S) being bulged. Has no effect on habitability, system is still usable.

2. Exhaust Ventilation System 03-49-2. Wire screen distorted slightly, one 3/8" bolt missing from screen and fan blades distorted due to blast entering duct. No closure on system. Very slight effect on habitability of compartment. Exhaust needed mostly when compartment is closed for General Quarters, etc.

3. Exhaust Ventilation System 02-45 (P). Screen bulged and torn due to electric motor being pushed in. Vent duct around fan ruptured from blades of fan being broken loose and driven through duct. No closure on system. Very slight effect on habitability of compartment, exhaust needed when compartment is closed for General Quarters, etc

4. Exhaust Ventilation duct at frame 41, 01 deck (P). Screws in bracket broken loose and bracket distorted. Undetermined as to cause of damage. No effect on habitability of compartment.

5. Supply ventilation system 01-47. Vent duct on suction side of blower was distorted, cracked and joints and brackets failed due to blast entering duct which has no closure. Affected slightly the habitability of stateroom supplied as duct failure will not give a complete supply of air from outside.

6. Exhaust Ventilation System 1-49. Vent duct at frame 49 on 01 deck distorted and seams failed leaving opening due to blast demolishing door to compartment exhausted and entering duct through

suction side of blower. This will effect the habitability of compartments and staterooms on the 01 deck as the compartment exhausted is a battery locker. It is not advisable to use the system as it would discharge fumes and gases through the duct opening into the compartments and staterooms on the 01 deck.

7. Supply Ventilation System 01-47. Vent duct joint failed at frame 51 (S) due to bulge in overhead. No effect on habitability as failure is in stateroom supplied.

8. Natural exhaust from modulator. 01 deck frame 85 1/2 (S). Vent duct joints failed due to bulkhead at frame 85 being bulged. No effect on habitability. Effects only the modulators.

9. Exhaust Ventilation System 1-93. Vent duct at frame 93 first deck bulged due to blast entering duct. No closure on system No effects to habitability of compartment. Exhaust system is still usable.

10. Supply Ventilation System 2-93-1. Vent duct at frame 95, second deck, damaged and seams and joints failed leaving appreciable opening on suction side of blower. Damage due to blast entering duct which has no closure. This would affect the habitability of compartment supplied (messing compartment) as it would recirculate air in compartment without addition of fresh air from atmosphere.

11. Supply Ventilation System 2-99. Vent duct at frame 100 (P), first deck is damaged, dished badly and joint failed at deck. Vent ducts on second deck, frame 99 on discharge side of blower failed in seams. Damage due to blast damaging duct on first deck and entering system to damage ducts on second deck. No effects on habitability of compartments supplied as system is still usable, unless in heavy sea when opening at first deck level would have to be blocked off to prevent sea from entering. Reinforcement of duct at first deck and above approximately six feet to closure may have averted said damage.

12. Exhaust Ventilation system 1-106-2 Vent duct housing motor is dented and screen torn off due to blast jarring loose motor and fan. Has effect on compartment exhaust as it is crew's head which needs exhaust to remove odors. System is not usable.

13. Exhaust Ventilation System 1-105-1. Vent duct housing motor ruptured and screen torn loose due to blast jarring loose motor and fan. Has slight effect on habitability of compartment exhaust. This is crew's washroom which allows exhaust to remove odors and heat created by hot water.

14. Supply Ventilation System 2-113-1. Vent duct from closure 1-113-1 to first deck level is dished and distorted due to dish and distortion in bulkhead. Vent ducts on second deck frame 114 has small dish and slight joint failure due to dish in overhead. Vent closure 1-113-1 is damaged, dished and distorted and will not close due to bulkhead being dished and distorted. No effects on habitability of compartment supplied as system is still usable.

15. Supply Ventilation System 2-125. Vent duct suction and discharge at blower demolished due to large bulge in overhead. Effects habitability of compartment supplied which are living spaces and system is not usable.

16. Supply Ventilation System 2-132-2. Vent duct on discharge near blower failed in joint due to overhead being bulged leaving appreciable opening. Effects habitability of compartments supplied as air will pass through duct beyond joint failure.

17. Exhaust Ventilation System 1-109-2. Vent duct on second deck frame 109, dished slightly due to blast entering duct. Vent duct at frame 123 (P) distorted due to bulge in overhead. No effect on habitability as system is still usable. No closure on suction side of blower.

18. Exhaust Ventilation System 2-127-2. Vent duct on second deck, frame 128-132, damaged, distorted, cracked and seams and joint failure due to bulge in overhead. Effects habitability of living space exhausted as system is not usable.

19. Supply Ventilation System 2-133. Vent duct on suction side of blower failed in joints due to bulge in overhead. Effects habitability of steering gear compartment D-311-E which it supplies as it will take suction on second deck instead of first deck atmosphere.

13. Exhaust Ventilation System 1-105-1. Vent duct housing motor ruptured and screen torn loose due to blast jarring loose motor and fan. Has slight effect on habitability of compartment exhaust. This is crew's washroom which allows exhaust to remove odors and heat created by hot water.

14. Supply Ventilation System 2-113-1. Vent duct from closure 1-113-1 to first deck level is dished and distorted due to dish and distortion in bulkhead. Vent ducts on second deck frame 114 has small dish and slight joint failure due to dish in overhead. Vent closure 1-113-1 is damaged, dished and distorted and will not close due to bulkhead being dished and distorted. No effects on habitability of compartment supplied as system is still usable.

15. Supply Ventilation System 2-125. Vent duct suction and discharge at blower demolished due to large bulge in overhead. Effects habitability of compartment supplied which are living spaces and system is not usable.

16. Supply Ventilation System 2-132-2. Vent duct on discharge near blower failed in joint due to overhead being bulged leaving appreciable opening. Effects habitability of compartments supplied as air will pass through duct beyond joint failure.

17. Exhaust Ventilation System 1-109-2. Vent duct on second deck frame 109, dished slightly due to blast entering duct. Vent duct at frame 123 (P) distorted due to bulge in overhead. No effect on habitability as system is still usable. No closure on suction side of blower.

18. Exhaust Ventilation System 2-127-2. Vent duct on second deck, frame 128-132, damaged, distorted, cracked and seams and joint failure due to bulge in overhead. Effects habitability of living space exhausted as system is not usable.

19. Supply Ventilation System 2-133. Vent duct on suction side of blower failed in joints due to bulge in overhead. Effects habitability of steering gear compartment D-311-E which it supplies as it will take suction on second deck instead of first deck atmosphere.

20. Supply Ventilation System 2-104-1. Vent ducts on discharge side of blower, second deck, frame 104-106, damaged, distorted, cracked and failed in seams and joints leaving appreciable openings in iucts. Damage due to blast entering system which has no topside closure. Effects habitability of living compartments supplied and also some magazines as air will not pass beyond openings in ducts.

21. Supply Ventilation System 1-105-1. Vent duct at frame 104-105, first deck, is distorted slightly with small crack due to bulkhead at frame 104 being bulged. No effect on habitability as system is still usable.

22. Exhaust Ventilation System 2-36. Vent duct on suction side of blower, second deck, frame 36, has bulge and slight seam failure due to blast entering system which has no topside closure. No effects on habitability as system is still usable.

23. Supply Ventilation System 2-69. Vent duct on discharge side of blower, second deck, frame 67-68 (P) to (S) demolished from large bulge in overhead. Effects habitability of living spaces supplied as system is not usable.

24. Supply Ventilation System 2-94-1. Vent duct in after machinery space, frame 93-94 (CL) failed in seam and dished in due to blast entering system which has no closure. No effect on habitability of after machinery space as system is usable.

25. Supply Ventilation 2-85-2. Vent ducts in after machinery space, frame 85 (P), joint failure and damaged due to blast entering system which has no closure, also vent duct, frame 87-88 bulged and moved down due to bulge in overhead of compartment. The section prevents one breaker on after distribution board from opening all the way. No effects on habitability of after machinery space as system is usable.

26. Supply Ventilation 2-66. Vent ducts in forward machinery space. Duct at frame 62 (P) bulged also duct at frame 66 (P) bulged and seam failure due to blast entering system due to no closures.

No effects to habitability of forward machinery space as system is usable.

(b) No evidence that ventilation system conducted heat, blast or fire below.

(c) No evidences that ventilation system allowed progressive flooding.

(d) The ventilation system on this ship is improperly designed. There should be separate ventilation systems for each section of the ship with vent ducts running vertically through the decks of one watertight subdivision of the ship. Where the ducts pierce the deck they should have a watertight closure on them. In this ship the ducts weave in and out through watertight decks and bulkheads without any closures at all in about 90% of the compartments.

N. Ship Control.

(a) Damage to ship control stations and causes.

1. Damage to the bridge area was superficial. The shock and pressure waves demolished the signal bridge and broke glass faces in one gyro-steering repeater, engine order telegraph and rudder angle indicator, but did not damage the mechanisms, except for the steering repeater. Plexiglass windshields were blown out and several small instruments such as the barometer and psychrometer, were blown off the bulkheads. However, no major damage to the structure or to ship control units was suffered.

2. C.I.C. in itself was undamaged but was useless because all radar antennae were destroyed.

3. The gyro-compass equipment withstood the shock, pressure and heat waves very well. One steering repeater on the bridge, both bearing repeaters on the wings of the navigating bridge and all four repeaters in the pilot house, one deck immediately below the navigating bridge, were in good shape. No error was induced in the master gyro and only one bearing repeater on the port side of the

navigating bridge had a 1° error from the master and other repeaters. This was due to the pelorus stand being cracked causing the lubber's line to be off-set.

4. There was no damage to the steering gear.

5. Sound powered interior communications were unimpaired. Engine order telegraph, revolution indicator, rudder angle indicators and all electrical telephones and P.A. systems were in operation.

(b) Constructive criticism of ship control systems.

1. The layout and arrangement of the ship control stations could be improved by doing away with the open navigating bridge and providing for a well protected conning tower. As the arrangement is at present, it is believed that all ship control personnel exposed on the open bridge would have been casualties. Reverting to a well protected conning tower would do much to improve effective ship control as well as to improve the fighting efficiency of the ship as a whole.

O. Fire Control.

(a) Damage to fire control stations and causes.

1. The forward main battery fire control station was shaken considerably, although equipment inside was undamaged. The deck was buckled and the door adjacent bulkhead was dished in. It is doubtful if personnel inside would have survived the shock. There was no evidence of heat

2. Both anti-aircraft control stations showed evidence of blast but the fragmentation shields were not ruptured. It is believed that no personnel could have survived the blast in these stations. Similar conditions prevailed at unprotected director stations.

3. The four protected directors showed the effect of the blast, especially the two forward directors which were trained

away from the direction of the blast. The backside of the forward MK33 director was considerably dished in. The tubes in the stable element were broken. The backside and left side of the forward MK35 director was slightly dished in. One holding down clip was loosened.

4. The after main battery director MK35 shield was very slightly distorted. The supply circuit for train and elevation circuits was grounded externally to the director. The after MK33 director suffered considerable broken glass. An oil leak occurred in the pointer's handwheel box. There was an open circuit in the amplifier for the filament supply to the C6A tubes for level operation of the stable element.

5. The starboard MK51 director used with the MK63 gun fire control system was demolished by the blast. The starboard MK51 director used for auxiliary control of the starboard after 5''/25 guns had a ground in the supply circuit external to the director.

6. There is no plotting room on this ship. The fire control switchboard rooms and after main battery fire control station were undamaged.

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

1. The loss of personnel in the forward and after anti-aircraft control stations would have materially reduced the fighting efficiency of the anti-aircraft batteries even if protected mounts were provided. Local control of individual mounts would have been required. Loose equipment such as telephones in these control stations as well as personnel would have had to be replaced.

2. Although equipment inside the forward main battery fire control station was not seriously affected, it is believed few if any of the personnel would have survived the blast. Their loss would have only slightly reduced the fighting efficiency of the ship since the after main battery fire control station was intact.

3. Loss of the after main battery director would not have appreciably affected the fighting efficiency except against multiple targets.

4. The reduced efficiency of the AA directors even if personnel were replaced would have somewhat reduced the fighting efficiency against a heavy air attack especially in a moderate to heavy sea.

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

1. Fire control stations should be arranged so that only a minimum number of personnel and amount of equipment are located in elevated control stations. The remainder should be in stations below the protected deck. It is believed that directors would be designed having only a pointer, trainer, rangefinder operator, control officer and a minimum of equipment inside of spherical or cylinderical shield. Elevated fire control stations should be similarly shaped and provide for only a control officer and the necessary communication. These structures should be as heavily armored as weight considerations permit.

P. Ammunition Behavior.

1. During the test there were 392 long tons of ammunition on board, which is two thirds of war allowance. This included ammunition for 8"/55 caliber, 5"/25 caliber, 40MM and 20MM batteries, aircraft bombs, demolition charges, catapult charges, black powder, fuses, small arms ammunition, pyrotechnics and a small quantity of special test ammunition. None of this ammunition exploded or burned.

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

1. Ready service ammunition was stowed in the ready service rooms, clipping rooms, and ready service lockers for the respective gun batteries in the amount of approximately two-thirds normal capacity of all space. The ready service stowage spaces in

general are uniformly distributed on the main deck and above. Special test ammunition including SPD and SPCG powder charges were exposed in the gun chambers of turrets two and four, each of which had all doors open. Although fire extensively burned Army Quartermaster's supplies adjacent to both sides of turret four and life rafts fastened to each side of this turret, the explosives inside were untouched. In the 40MM ready service room A-0403-M the racks were broken and ammunition shook up some. In the 20MM clipping room C0201-M most of the magazines were knocked down from their normal stowage in racks on the bulkhead. One of the 20MM ready service boxes was torn loose from the deck and laid on its side. Some of these boxes had the sun shield covers ripped off. This was a result of corroded rivets and bolts.

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

1. Each magazine contained the type of ammunition normally stowed there. No change occurred in any magazine except in A-413-M where ballast water and oil leaked in to a depth of about 14 inches. Prior to the test a small leak was present in this space. The test only slightly increased the size of the leak and no damage to ammunition would have resulted had the crew been on board to keep these spaces cleaned out.

(c) List of stowage which is insufficiently protected and effects on ships survival of explosion of each stowage.

1. There are no ammunition stowages insufficiently protected from an explosion such as that to which this ship was exposed during this test.

2. The test apparently had no effect on ammunition in this ship. No change occurred in the methyl-violet paper. The maximum thermometer reading during the test in an ammunition stowage space below the main deck was 100° in the shell deck of turret 4, and in ready service stowages above the main deck was 98° in several of the 20MM ready service boxes. Similar readings existed during rehersal of this test. No change in readings were caused by the atomic bomb.

(d) Behavior of gasoline stowage facilities.

1. Fifteen percent of stowage capacity of aviation gasoline was on board. The test had no effect on gasoline, gasoline stowages or handling facilities in this ship.

Q. Ammunition Handling.

(a) Condition and operability of ammunition handling devices.

1. In general all ammunition hoists were unaffected by the test, with two minor exceptions. The right projectile hoist in turret one developed an open circuit in the protective resistor for the holding coil of the line contactor in the motor controller. The hoist could be operated only by continuously pressing the start button. The 40MM hoist at frame 46 amidships was inoperable due to a severed electric cable above the main deck used in the topside control circuit. The hoist could be operated by disconnecting or repairing this cable. Repairs to the above hoists could have been made in 30 minutes or less.

2. In general all ammunition passing scuttles were unaffected by the test with one minor exception. In turret two the slide doors in the shell scuttles between the rangefinder booth and the gun chamber were jammed due to dished bulkhead. They were in the open position before the test. After the test the right scuttle was closed, the center half closed and the left open.

(b) There was no evidence that ammunition handling devices contributed to the passing of heat, fire, blast or flooding water.

(c) From the results of this test no constructive criticism of design or construction of ammunition handling devices can be offered.

R. Strength.

1. There is no visible evidence of any permanent hog or

sag. However, it is believed that the hull suffered a terrific shock tending to whip the ship longitudinally, torque progressing from the stern. The weather decks are rippled from the stern to about frame 12 and it is believed that this has been caused in some small degree to the whipping effect as well as the overall blast effect or pressure wave. As mentioned in Item A, the deck beams and frames have been materially weakened in the more extensively damaged areas and the ship twists constantly even while laying at anchor.

S. Miscellaneous.

No comments.

SECTION 11 - MACHINERY

A. General Description of Machinery Damage.

(a) Machinery damage consisted entirely of damage to the eight boilers. No other machinery damage occurred.

(b) The areas of major damage occurred in numbers one and two fireroom where all eight boilers had their casings ruptured to varying extent.

(c) Primary cause of damage in those areas was due entirely to the pressure wave descending both forward and after stacks, through the uptakes into the boiler casing and through the closed blower flaps. It is considered that as the wave of pressure descended the stacks and uptakes, the wave hit the solid wall of metal formed by the tube banks and expanded itself by blowing through the boiler casing, rupturing the metal and splitting the seams. The air also coming through the uptake, burst through the closed blower flaps. It is believed that if the fireroom had been in operation that the force of the pressure would have expended itself inside the boiler casing and equalized by the air through the open blower ducts that no serious damage to the boiler casing would have resulted and that possibly only the fire would have been blown out causing total personnel casualties but allowing the boilers to be lighted off again in a short length of time.

(d) The total effect of the target test was to completely inactivate the entire machinery plant due to the damage to all boilers.

B. Boilers.

1. Boiler #1, outside. The boiler front was bulged out approximately three inches. Boiler casing adjacent to the steam drum was bulged outward. There is a hole about 6'' in diameter in the port casing adjacent to the steam drum, which enables tube bank to be seen. The boiler casings lower paneling on the starboard side was completely blown out, exposing the entire tube bank. The casing adjacent to this paneling is bulged outward approximately 18''. The casing flanged surfaces were destroyed. The back casing was bulged and touched that of boiler #3. The mud drum casings touch those of #3 boiler. The port side casing was bulged out approximately 8''.

Boiler #1, inside. The plastic front about one foot below the tube bank was loose. The plastic peak and side along the front of the firebox was not serviceable (loose and falling out). The deck of the firebox was undamaged. Brickwork in the sides of the firebox was undamaged. The lower section of the back wall was moved about 1". The center section of the back wall was moved slightly forward and the bricks cracked. The top three rows of bricks were moved forward 2". The peak of the boiler has fallen out. There was no apparent damage to pressure parts.

2. Boiler #2, outside. The stack door was blown off the fireroom uptakes. There was a slight bulge on the starboard side of the uptakes but the uptakes are serviceable. The boiler casing was bulged out in forward, starboard side one foot; and on the port side was bulged out 8 to 10 inches. The casing on the port side was blown out completely exposing the tube bank for it's entire length. The back casing was bulged out about 8". The mud drum casings in back were bulged so as to touch those of #4 boiler. The starboard side lower section paneling was bulged out slightly.
Boiler #2, inside. The plastic on the port side of the boiler front, running from the peak to the mud drum, has fallen out considerably. The starboard side was intact. Brickwork and cones in the firebox front were intact and serviceable. Plastic on the port side, next to the mud drum are loose, but serviceable. Both side walls of the firebox were in good condition. The back of the firebox was in good condition.

3. Boiler #3, outside. There was a slight bulge in the uptake on the port side, but it was serviceable. The front casing on the starboard side was bulged out about one foot and had a 6" hole that exposed the tube bank. The back casing was bulged, touching that of #1 boiler. The starboard casing was bulged out. The lower three panels were blown out completely, exposing the tube bank from front to back. The mud drum casings were touching those of #1 boiler. The inboard side of the boiler casing was blown outward but not badly enough to render it unserviceable.
Boiler #3, inside. The boiler front was bulged outward about 10". The plastic along the tube bank, half way down from peak on starboard side of the boiler front had fallen out. The port side was still intact. The brickwork was loose by the inspection hole. Plastic

cones were intact except one between burners 4, 8 and 10 on the port side. The front wall was moved out about 1/2'' from the deck and about 1'' from each side wall. Both side walls were intact. Plastic along mud drums were intact, and the firebox deck was serviceable. The back wall was bulged back about two inches and numerous cracks were noted in the back wall. The three top rows of bricks were forward of the rest of the back wall. Boiler front was separated from the steam drum.

4. Boiler #4, outside. The front casing on the starboard side was bulged out about 6'' and a 3'' hole exposed the tube bank. The boiler uptake was in good condition. The starboard side casing (lower panels) touched casing of #3 boiler. The back casing touched that of #2 boiler. However, neither of the above casings (side or back) were damaged to such a degree as to render them unserviceable. The lower panel on the port side was blown outward exposing the tube bank front to back. The upper panels of the port side were also blown outward. Boiler #4, inside. The front wall had moved outward about 4''. All plastic was intact on the boiler front and the rest of the boiler except for a piece about 4'' long adjacent to the tube bank directly over the inspection door that had fallen out. Both side walls were satisfactory. The back wall bulged outward about 3/4'' and slightly cracked. The three top rows of brick were loose in the back wall. The boiler front was torn from its fastenings on the steam drum. The firebox deck was satisfactory.

5. Boiler #5, outside. The casing was bulged outward at the top front. The top, port side was bulged outward and the joints showed signs of stress. The lower panels of the port side were bulged outward but appears to be serviceable. The starboard side was bulged out about two feet. The seams were broken on the lower inspection panels, starboard side, exposing the tube bank from front to back. The back casing was bulged outward and touching that of #7 boiler.
Boiler #5, inside. The front was bulged out about 5'' clear of tubes. The plastic was pulled loose from the bottom center register. The back wall was warped and the brickwork was loose. The side walls and deck were in a satisfactory condition.

6. Boiler #6, outside. The top front on the starboard side was bulged with small seam ruptures. The port side upper casing was bulged out approximately three feet. The inspection panels on the port side were blown out, exposing the tube bank from front to back. The starboard side of the casing was bulged out but appeared serviceable. The back casing was bulged out and touching that of #8 boiler.
Boiler #6, inside. The front was blown clear of the tube bank about six inches. The brickwork in the sides, back and deck was satisfactory.

7. Boiler #7, outside. The front casing was bulged outward slightly. The seams in the casing showed signs of stress but were intact. The port side lower panelling was bulged outward but was serviceable. The starboard side of the lower paneling was blown out exposing the tube bank from front to back. The upper sections of the panel up to the steam drum on both port and starboard side were intact but the seams showed signs of strain. The casing in front had been torn from its fastenings on the steam drum. The back casing was bulged outward but was serviceable.
Boiler #7, inside. The boiler front was bulged clear of the tube nest about 6". The plastic arch between tubes and front were intact. The side wall brickwork was good. Plastic work between the drum and the side wall on the port side was loose, on the starboard side it was serviceable. The deck was in good condition. The back wall had been pushed back about 1 1/2" leaving the back peak intact. The top two rows of brick were loose.

8. Boiler #8, outside. The top sections of the front casings were bulged out and the seams showed signs of strain. The port side casing was bulged out approximately three feet. Inspection doors on the port side were blown outward exposing tube bank from front to back. The side casing on the starboard side was bulged out and the seams showed signs of strain. The lower paneling on the starboard side was bulged slightly but it appeared to be serviceable. The back casing was bulged out and touched that of #6 boiler. No. 4 soot blower element was damaged.
Boiler #8, inside. The front was bulged about 6" clear of the tube bank. Approximately 200 pounds of plastic fell out at the center. Both side walls and deck were intact. The back wall was bulged out near the top.

9. On all boilers the visual inspection indicated that the pressure fittings did not suffer as a result of the blast; all pressure fittings were intact.

C. Blowers.

1. All blowers operated satisfactorily after the test, although the blower flaps in the uptakes were blown downward by the pressure wave so that the supporting cables were parted. The drain lines to several blowers were slightly distorted by the distended boiler casings but were not ruptured.

D. Fuel Oil Equipment.

1. No damage.

E. Boiler Feedwater Equipment.

1. No damage.

F. Main Turbines.

1. No damage.

G. Reduction Gears.

1. No damage.

H. Shafting and Bearings.

1. No damage.

I. Lubrication System.

1. No damage.

J. Condensers and Air Ejectors.

1. No damage.

K. Pumps.

1. No damage.

L. Auxiliary Generator (Turbine and Gears).

1. No damage.

M. Propellers.

1. No damage.

N. Distilling Plant.

(a) Evaporators - no damage.

(b) Distilling condensor - no damage

(c) Evaporator feed heater - no damage.

(d) Miscellaneous.

1. Salt water cooling #2 unit between cooler condenser and circulating pump distorted in outboard direction. Caused by air blast out of boiler casing ruptures.

2. Gage glass of second effect #2 unit shattered. Caused by being struck by ruptured boiler casing.

3. Salinity indicator jack box of #2 unit knocked loose. Caused by air blast and shock.

O. Refrigerating Plant.

1. No damage.

P. Winches, Windlasses and Capstans. After warping winch was the only unit of this group damaged. This winch not operable.

(a) Foundations and bed plates.

1. Deck collapsed lowering unit about six inches with bed plates forming an angle with the horizontal of about 4°, after end low but there was no misalignment.

(b) Motors.

1. The insulation was burned from the electrical leads to the motor and jack box.

(c) Brakes and brake lining.

1. Brakes and brake lining were frozen in secured position. This was caused by heat from the bomb.

Q. Steering Engine.

1. No damage.

R. Elevator, Ammunition Hoists, etc.

1. No damage.

T. Air Compressors.

1. No damage.

U. Diesels. (Generators and Boats).

1. No damage.

V. Piping.

(a) Main steam piping.

1. No damage.

(b) Auxiliary steam piping.

1. No damage.

(c) Auxiliary exhaust piping.

1. No damage.

(d) Condensate and feed water.

1. No damage.

(e) Fuel and feed water.

1. No damage.

(g) Fire Main.

1. Main deck - frame 62 - Riser bent with shock but did not rupture.

2. 01 deck - frame 80 - Salt water line to spark arrester sheared off and fell to the deck.

3. Second deck - frame 26-A203-2L - Warrant Officer's head - flushing water line broke off at outboard W.C.

4. Second deck - frame 128-D203-2L - Pipe distorted and ruptured between first and second deck.

5. Second deck - frame 140-D-204-L - Flushing water pipe cracked in screw joint forward of cut out valve.

6. Main deck - frame 104-D-102-L - Flushing water pipe cracked in screw joint at valve.

Fresh Water.

1. Main deck - frame 89 - Vegetable preparation room 3/4" pipe sheared at elbow.

2. Main deck - frame 86 - Issue room - 3/4" pipe sheared at fore and aft bulkhead.

3. Main deck - frame 84 - Aero shack - 3/4" pipe had a small rupture in it.

4. Main deck - frame 86 - Galley - 3/4" pipe had a small leak in elbow on the starboard side of galley.

5. Second deck - frame 26-A-203-2L - Warrant Officer's head - 3/4" pipe broken off at "T" joint.

6. Second deck - C-201-L - 3/4" pipe supply to P.O. head from main ruptured at the nipple.

(h) Condenser circulating water piping.

1. No damage.

(i) Drainage.

1. 04 deck - frame 46 (P) - Line pinched flat by flying debris.

2. 01 deck - frame 92 (S) - Line severed.

3. Main deck - frame 46 (S) - Line severed at union due to dishing of bulkhead.

4. Main deck - frame 61 (P) - Line pinched by flying debris.

5. Main deck - frame 97 1/2 (S) - Six foot section severed found lying on the deck.

6. Main deck - frame 106-D-102-L - Crew's head - trap pulled loose from urinal tail piece.

(j) Compressed air piping.

1. No damage.

(k) Hydraulic piping.

1. No damage.

(l) Gasoline piping.

1. No damage.

(m) Not applicable.

SECTION 111 - ELECTRICAL

A. General Description of Electrical Damage.

(a) The overall condition of the electrical apparatus as a result of test A is good. No piece of vital electrical gear was damaged beyond repair by the ship's force. One 40MM hoist and one 8" projectile hoist temporarily out of commission because of damage to control circuits of motors. All 24" and 36" searchlights out of commission beyond repair by ship's force.

(b) Major damage was found on weather decks where equipment was exposed to blast, and subjected to smashing by pieces of hull structure adrift.

(c) Primary causes of damage were blast and damage by hull structure.

(d) Electrical plant was approximately ninety-five percent operable.

1. No damage to any main or emergency ship service generator plant.

2. No damage to engine or boiler auxiliaries.

3. Electrical propulsion, not applicable.

4. Sound powered telephone communication not disruptured.

5. Searchlights not operable and aft main battery director grounded. Starboard MK63 F.C. system grounded.

6. Ventilation motors all operable, except a few small motors exposed to blast.

7. Approximately ten percent of ships lighting out but no area totally without light.

(e) Types of equipment most affected.

1. No damage to switchboards and switch gear except minor.

2. Only rotating machinery damaged was small vent motors exposed to blast.

3. Port deck winch controller damaged. Warping winch controller damaged. Control circuit disrupted on 40MM hoist at frame 46 amidships. Control circuit open in right projectile hoist in turret #2.

4. Cable supports generally not damaged, a small number bent or broken as results of hull structural damage. One broken cable noted.

B. Not applicable.

C. Not applicable.

D. No damage.

E. No damage.

F. Switchboards Distribution and Transfer Panels.

(a) Battery charging panel frame work bent and panel displaced about 3'' caused by bulkhead being bent in.

(b) No damage to electrical connections or wiring on any switchboard.

(c) No damage to bus bars.

(d) One circuit breaker for turret power on after upper corner of after main distribution board unable to be closed because of ventilation line being displaced.

(e) No damage to rheostats or resistors.

(f) No damage to mechanical operation mechanism or interlocks.

(g) No insulation damage.

(h) Voltmeter was not operable on the forward emergency diesel switchboard because of open resistor in meter.

(i) No damage to fuses.

(j) No damage to voltage regulators.

G. Wiring, Wiring Equipment.

(a) One cable was severed on the main deck by a door being driven into the cable. On the after part of the ship, topside, damage to cable by heat was noted.

(b) Several cable supports were displaced and bent on the second deck at frame 63.

(c) Two percent of the receptacle boxes on the main deck and above were damaged by the hull structure being displaced.

H. No damage to transformers.

I. Not applicable.

J. Portable Batteries.

(a) 5'' gun battery box was torn from the bulkhead at frame 70, main deck. The starboard battery jar was broken and the electrolyte was shipped.

(b) Two jars in the battery locker fell from the stowage shelf and broke, the electrolyte spilled.

(c) No damage to cell or cable connections.

(d) Acid was spilled from broken jars only.

K. Motors MG Sets and Motor Controllers.

(a) Rotating equipment.

1. The warping winch on the fantail was displaced because of the dip in the deck but no damage to the unit frame work was noted.

2. No damage to commutator or slip rigs.

3. No damage to brushes or brush rigging.

4. No damage to bearing.

5. No damage to speed regulators.

(b) Control equipment.

1. The warping winch control panel mounting was twisted and dished.

2. The control curcuit for the 40MM ammunition hoist forward was disrupted because of a broken cable on the main deck at frame 46, amidships.

3. One contact finger in drum controller of port deck winch was broken off by shock.

4. The protective resistor (shell hoist turret #2) for shunt coil in control panel was open.

5. No damage to insulating materials.

6. No damage to pilot circuit devices.

7. No damage to brakes.

L. Lighting Equipment.

(a) No failure of any lamps below the second deck. On the second deck a total of four lamps were broken in areas of greatest damage frames 60 and 130 on the main deck and above approximately 5% of the lamps installed, were broken.

(b) No damage to reflectors.

(c) No damage to fixture mounts.

(d) No damage to shock mounts.

(e) No damage to pendant bolders.

(f) No damage to globes except approximately four broken by hull structure adrift.

M. Searchlights.

(a) The yoke on number one 36'' and number two 24'' searchlight was broken and drum was on the deck. Number one 24'', one arm of the yoke was broken but the drum was still in place. The 12'' signal searchlight on the starboard side of the signal bridge was missing.

(b) Number one 36'' and number two 24'' searchlight had front glass broken.

(c) Number one 36'' and number two 24'' searchlight shutters were displaced and badly damaged. Number two 36'' searchlight, iris shutter dished in approximately 3'', and the shutter operating mechanism frozen. On number one 24'' searchlight the signal shutter and iris shutter were undamaged.

(d) Number two 36'' searchlight - both the train and the elevation locks were frozen.

(e) Arc lamp feed rods were not damaged.

(f) 12" incandescent lamps were undamaged.

(g) There was no damage to rheostats.

N. Degaussing Equipment.

1. No damage.

O. Gyro-Compass Equipment.

(a) No damage to master compasses.

(b) Repeaters damaged as follows: Starboard open bridge steering repeater glass crushed in on dial. Secondary control glass broken and both steering repeaters broken off mount. Captain's emergency cabin repeater glass smashed.

(c) No damage to D.R.T. or D.R.A.

P. Sound Powered Telephones.

(a) Headsets undamaged.

(b) Hand sets approximately eight damaged, breakage due to falling or hull structure adrift.

(c) No damage to jack on switch.

(d) Stowage undamaged.

Q. Ship Service Telephones.

(a) Exchange undamaged.

(b) None damaged by shock; one type A telephone smashed by door being driven into it.

R. Announcing System.

(a) Portable electric megaphone exposed on open bridge undamaged.

(b) Amplifier racks undamaged.

(c) Control racks undamaged.

(d) Transmitter on quarterdeck aft appears to be scorched by heat, one has inner section displaced.

S. Telegraphs.

(a) Both port and starboard engine order on open bridge glass smashed, an instrument not operable from that station.

T. No damage to indicating systems.

U. No damage to I.C. or A.C.O. boards.

V. No damage to F.C. switch boards.

SECTION IV - ELECTRONICS

A. General Description of Electronic Damage.

(a) Overall condition after test.

1. Immediately after the test, the overall condition of the electronic equipment was poor. This was due principally to the descruction of antennae and the breaking of tubes in most of the units. In many cases, however, by replacing broken tubes and by rigging emergency antennae many of the communication transmitters and receivers were put back in operation within a few hours.

(b) Areas of major damage.

1. Practically all damage to electronic equipment occurred to units located on the topside, principally antennae. Of these, the only ones not damaged by the blast were the uhf (30-200 mc) dipole type used with radio transceivers and IFF equipment. Units on the topside, but placed in protected compartments, such as the SG and Mark 28 equipment located on the 03 deck of the foremast structure and on the Navigating Bridge, were only slightly damaged. The only damage occurring in these places were a few tubes broken by shock. The most vulnerable single item was the string wire type radio antennae, both vertical and flattop. All of these were carried away by the shock wave. Whip type intermediate frequency radio antennae and the parabolic wire mesh type radar antennae reflector were next in vulnerability and all of these were considerably damaged.

(c) Primary cause of damage in each area.

1. The primary cause of damage was the shock wave which broke antennae and tubes. The pressure wave also bent and distorted several antennae which were not completely broken off. Damage due to heat was of no consequence. Plexiglass face plates on Mark 28 dipole assemblies was scorched and cracked but insulation and other vital parts were not affected.

(d) Operability of electronics equipment.

1. All radar equipment was found to be inoperable immediately after the test due mainly to damage to the antennae. In some cases tubes had been broken by the shock but in general there was no electrical damage to any of the units.

2. All radio equipment was found to be inoperable immediately after the test. Again the damage was due primarily to damaged antennae and in a few cases broken tubes.

3. Fathometer was in all respects normal.

4. The DAS-Loran equipment was blown from its supports and lay on the deck. The damage caused by this fall was too great to place equipment in operation readily.

B. Fire Control Radar.

1. Mark 28-3 located on 03 deck forward was damaged by having four tubes broken by shock and having antennae reflector badly bent. Simple repairs were made and the unit placed in operation.

2. Mark 28-3 radar in transmitter room on Navigating Bridge had one side of the antennae reflector badly damaged, the magnetron was broken and the condenser short-circuited. Repairs were made and the unit placed in operation.

3. Mark 28-3 radar located in main battery control aft: The antennae dipole assembly was scorched by heat and plexiglass was cracked in two places. The parabola was folded back and all supports to the antennae were broken. Two tubes in the main frame were damaged by shock. The equipment was repaired except for antennae parabola and operates normally except for target resolution.

4. Mark 28-3 radar - CIC aft - Antennae located on after AA director: The antennae was bent slightly and the dummy load, mounted in place of the dipole assembly, was broken off.

Two tubes in the main frame and one in the transmitter were damaged by shock. Operation after repairing is normal except for the antennae.

5. Mark 28-3 located on main deck at about frame 100: The antennae and transmitter located on 01 deck aft at frame 95 (S): The antennae dipole section was badly bent and the plexiglass scorched and broken. The parabola is missing. The Mark 51 director containing the remote scopes was demolished.

6. Mark 28-3 located on main deck frame 100: Antennae and transmitter is located on the port 40MM quad mount frame 95 (P). The parabola antennae was badly bent and damaged the plexiglass dipole assembly. The unit operates normally.

C. Surface Search Radar.

1. The SG-B consol located in CIC aft (03 deck) transmitter is located in the transmitter room on the nagivating bridge and antennae on the top of the foremast. The principal damage was to the mast, which was bent forward at an angle of about 60° to the vertical, however, the wave guide and cables were not damaged. A tube was broken in the transmitter and fuse was blown in the indicator. The equipment operates normally after making repairs except for the plane of antennae rotation. The antennae is evidently ruggedly constructed and mounted as there is no damage to the antennae and the drive motor still functions. Good operation is obtained out to about 10,000 yards with the antennae in its bent position.

2. SP Radar - The consol is located in CIC forward (01 deck), the transmitter is located in the after superstructure (01 deck aft) and the antennae is located on the mainmast. The pressure wave dished in the after bulkheads of the transmitter room pushing all the equipment toward the center of the room. The open wave guide coupling from the transmitter was knocked out of line producing a bad mis-match to the guide. The magnetron current meter in the transmitter was broken. Compartment units inside the transmitter were knocked out of position but were not damaged electrically. The antennae reflector on the main mast was badly damaged. In spite of the severe shock which all units sustained, the equipment operated normally electrically. The transmitter was moved back

into position in order to realign the wave guide sections. The antennae drive system suffered mechanical damage but will operate partially in elevation and train. The stable element unit, itself, is undamaged but the antennae will not stabilize. Good echoes are received to about 5 miles.

D. Air Search Radar.

1. The SK console is located in CIC forward in the foremast structure on the 01 deck, the transmitter is located in the forward superstructure on the 03 deck and the antennae on the foremast. The entire antennae except the pedestal was carried away by the blast and is entirely missing. There was no electrical damage and using a dummy load the equipment operated normally.

E. Radar Repeaters.

1. A VD-2 model located in the open navigating bridge was slightly dished by the pressure wave. Two sections of the range selector were damaged thus. The equipment operates normally on the lower range scales.

2. The VD-2 located in the forward part of sky forward (05 deck) was dished as the previous one was, but no range scale will operate. Otherwise the equipment is normal.

F. Radar Counter Measure Equipment.

1. TDY - Located in RCM room main deck forward, antennae located on main mast: The low frequency antennae on the mast was carried away. The three microwave antennae were damaged beyond repair. The equipment operated normally using a dummy load.

2. DBM - Located in RCM room: Two antennae on the port and starboard yardarms of the main mast were carried away by the shock wave. Otherwise the equipment appears to be operable.

G. Radar and Radio Beacons.

1. Not applicable to this ship.

H. IFF Equipment.

1. BN located on transmitter room on navigating bridge and the antennae on the yardarm of the foremast: None of this equipment was damaged except for a blown fuse and a cracked insulator.

2. BM transmitter is located on the transmitter room in the foremast structure 03 deck level. The antennae was the SK antennae on the foremast. The antennae was carried away by the shock wave. There was no other damage to the equipment.

3. BM-1 transmitter is located in the SP transmitter room in the mainmast structure on the 01 deck. The antennae is located on the mainmast. The antennae coaxial cables were broken by the shock wave. It is inadvisable to repair the coaxial cable, hence the unit is inoperable.

I. Communication Transmitters (Radio).

1. The TBK-5 is located in the emergency radio room main deck frame 72 (C). Antennae is of the whip type on the port side of #2 stack. One tube in the transmitter was broken by shock wave, the antennae trunk was ruptured and the lead in the cable broken. The whip antennae was snapped off at the base. After replacing the tube and rigging an emergency antennae the equipment operated satisfactorily.

J. Communication Receivers (Radio).

1. RBB-1 located in Main Radio foremast structure 02 deck. A type 68B ballast tube was broken by the shock wave. Equipment operated normally after replacing the tube.

K. Communication Antennae (Radio transmitting and receiving).

1. Location is general topside. All were antennae vertical and flat-top and were carried away by the shock wave. In most cases the wire and not the insulator broke. Whip antennae (transmitting) of the intermediate frequency type were badly damaged, some broke cleanly, and some bent nearly double. The bend in most cases occurred

just above the insulator where the antennae has the greatest cross section.

2. UHF dipoles were in general only slightly damaged. The lower frequency ones (TBS. SCR-608) were bent somewhat but only the main antennae was broken although fair reception is obtained. The metal housing of all transmitter lead-ins were ruptured and bent and fire lead-ins shorted. By rigging three emergency antennae and all transmitters and receivers operate satisfactorily.

L. Radio Transceivers.

1. MAN located in CIC forward, foremast structure 01 deck and antennae on the yardarm of the foremast was damaged by having top of the antennae snapped off, impairing the efficiency greatly.

2. TBS-2 located in the Main Radio room, foremast structure 01 deck. Damage sustained was one tube broken. Operated satisfactorily upon replacing the tube but did not as efficiently as before. This is probably due to the antennae being bent out of shape.

M. Sonar Ranging and Listening Equipment.

1. Not applicable.

N. Sonar Echo Sounding Equipment.

1. No damage.

O. Loran Navigation Equipment.

1. Located in the chart house in the foremast structure on the 03 deck. This instrument was knocked from its rack to the deck by the shock wave, a drop of four feet. Two tubes were broken and the electrical adjustment was upset. Operation after repairs was only fair.

P. Power Supply Sets.

1. No damage.

Q. Television and Teletype Equipment.

1. Not applicable.

R. Test Equipment.

1. LR frequency meter located in main radio room in the foremast structure on the 02 deck, damaged by a fan dislodged from the bulkhead and penetrated top. Repaired and operated satisfactorily.

S. Instrumentation.

1. Not applicable.

T. Telephone Equipment.

1. (See section III, item "Q".)

U. Direction Finders (Radio).

1. Not applicable.

V. Spare Parts.

1. No damage.

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

TRC

10 April 1997

MEMORANDUM FOR DEFENSE TECHNICAL INFORMATION CENTER
ATTENTION: OMI/Mr. William Bush

SUBJECT: Declassification of Reports

The Defense Special Weapons Agency (formerly Defense Nuclear Agency) Security Office has reviewed and declassified the following reports:

AD-366718	XRD-32-Volume 3
AD-366726	XRD-12-Volume 2
AD-366703	XRD-16-Volume 1
AD-366702	XRD-14-Volume 2
AD-376819L	XRD-17-Volume 2
AD-366704	XRD-18
AD-367451	XRD-19-Volume 1
AD-366705	XRD-20-Volume 2
AD-376028L	XRD-4
AD-366694	XRD-1
AD-473912	XRD-193
AD-473891	XRD-171
AD-473899	XRD-163
AD-473887	XRD-166
AD-473888	XRD-167
AD-473889	XRD-168

AD-366705

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TRC 10 April 1997

SUBJECT: Declassification of Reports

AD-B197749	XRD-174
AD-473905	XRD-182
AD-366719	XRD-33 Volume 4
AD-366700	XRD-10
AD-366712	XRD-25 Volume 1
AD-376827L	XRD-75
AD-366756	XRD-73
AD-366757	XRD-74
AD-366755	XRD-72
AD-366754	XRD-71
AD-366710	XRD-23 Volume 1
AD-366711	XRD-24 Volume 2
AD-366753	XRD-70
AD-366749	XRD-66
AD-366701	XRD-11
AD-366745	XRD-62.

All of the cited reports are now **approved for public release; distribution statement "A" applies.**

Ardith Jarrett

ARDITH JARRETT
Chief, Technical Resource Center

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E.W