Hit 9 – Air Defense Forward

From the BuShips damage report:

> 23. The wind and spray shield around air defense forward at frame 79 had one hole on the starboard side and two holes on the port side. It is possible that the two holes on the port side were caused by different projectiles. However, it appears more likely that the cap head of an 8-inch AP projectile broke off upon hitting the starboard side of the windshield and made the second hole in the port side of the windshield. Apparently the projectile or projectiles did not detonate.[49]

From *South Dakota*'s action report:

> Forward centerline section of wind and spray shield around search radar demolished. 3-17" holes.[50]

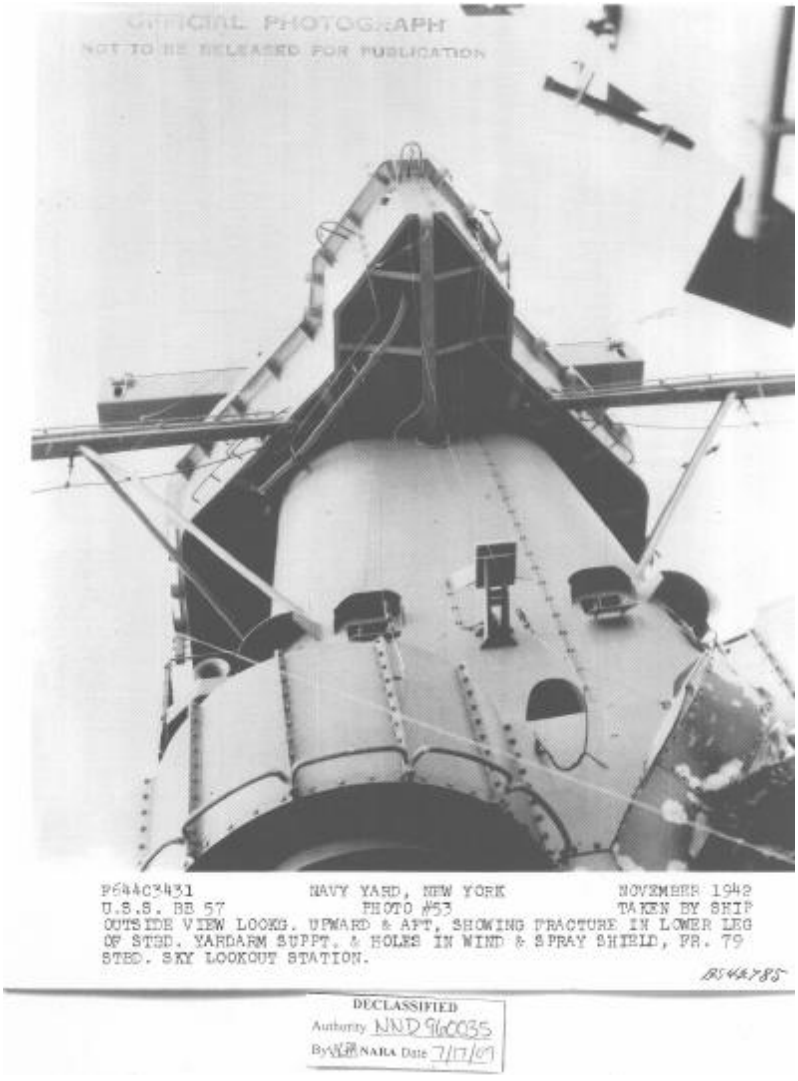

Figure 28 – Hit 9 – Sky Lookout Station

[49] BuShips War Damage Report # 57, page 6
[50] USS *South Dakota* Action Report, Enclosure D, page 8

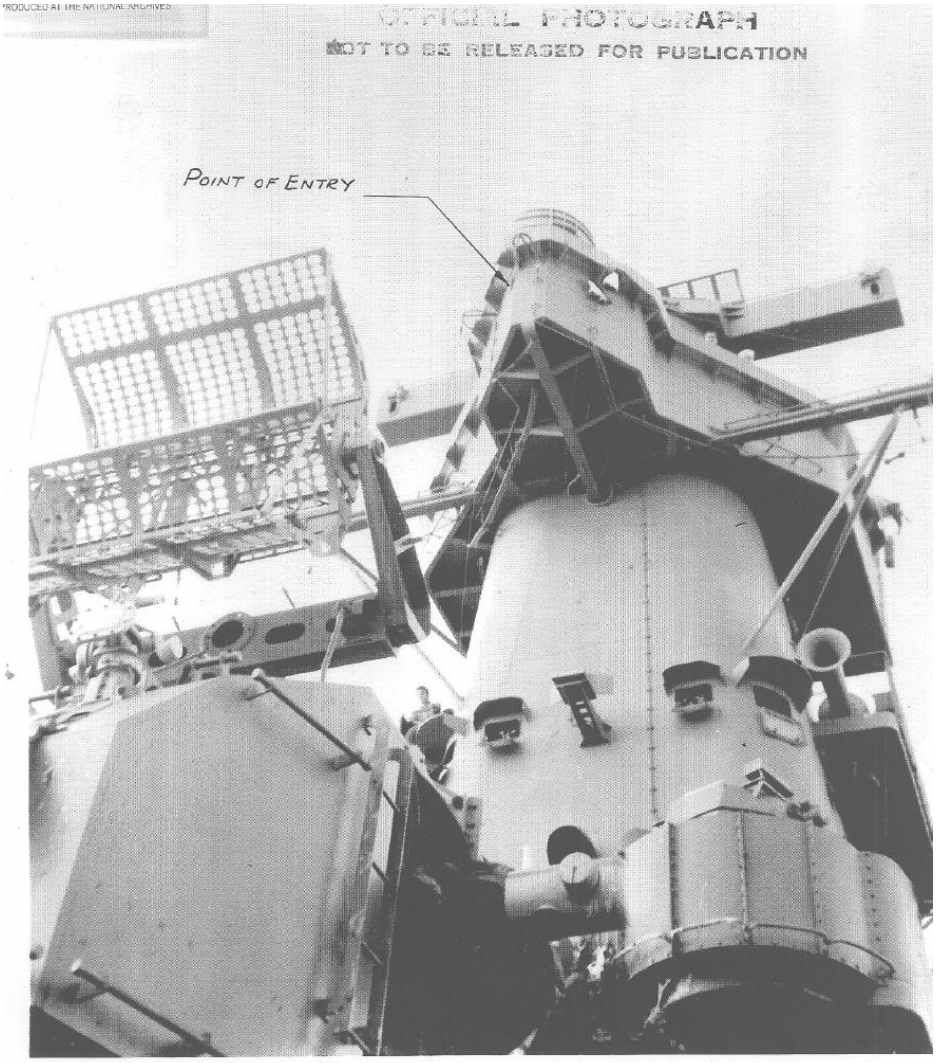

Figure 29 – Hit 9 – Entry Hole

In the left foreground of Figure 29 is the radar antenna atop Secondary Battery Director Number 1. This is not the search radar mentioned above as being damaged by Hit 9. This search radar antenna is not visible in the above two photographs.

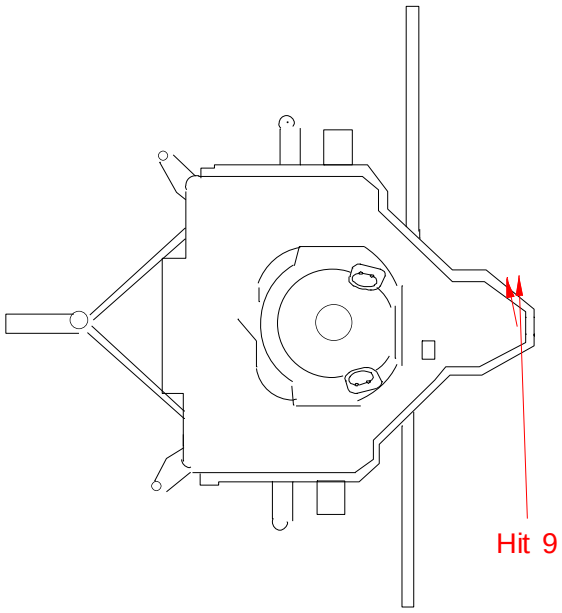

Figure 30 – Hit 9 – Path of Shell

Analysis of impact

This damage was documented in *South Dakota*'s report as occurring around 0102, so BuShips' estimate of an 8-inch AP projectile is possible. This is probably the best estimate due to the 17-inch entry and exit holes through the 0.25-inch STS plate. The cap head flying off estimate by BuShips also makes sense and accounts for the second exit hole. *Takao* opened fire at about this time, so she may be responsible for this damage.[51]

[51] *Takao* Brief Action Report JT1

Hit 10 – Starboard Structural Bulkhead at Frame 82

From the BuShips damage report:

> 24. A 10-inch hole was pierced in the starboard longitudinal structural bulkhead at frame 82 about 7 feet above the house top. The centerline bulkhead had a 10-inch hole about 30 inches above an 8-inch hole at frame 83. The port longitudinal structural bulkhead had a 10 inch hole about 6 feet above the first level above the house top at frame 84 and a 10 inch by 3 inch hole at the deck level. These holes were reported to have been caused by an 8-inch and a 5-inch projectile. It appears more probable that an 8-inch AP projectile cap head broke off the projectile upon penetrating the starboard bulkhead and made a second hole in the center line and port bulkheads, while the intact projectile made only one entry hole in the starboard bulkhead. The access ladders to the second level above the house top were damaged, and ventilation ducts demolished, but there is little evidence of a detonation associated with this hit.[52]

From *South Dakota*'s action report:

> 6TH LEVEL
>
> 1 10" shell hole through structural bulkhead and bulkhead stiffener, 6' above deck level, frame 82 starboard.
> Web of I beam frame 83 twisted and distorted 6' inboard of starboard side.
> 10" x 8" hole in centerline bulkhead, frame 83. Arch reinforcement twisted and broken.
> Gas radar tube fractured.
> Access ladder from 06 to 07 level demolished.
> Vent duct exhaust peppered with small bits of shrapnel.
> Coil spring tensioning device and brackets for watertight hatch 07-84-1 demolished.
> Natural vent exhaust duct through forward transversal structural bulkhead in #1 radar storeroom demolished.
> Supply vent duct demolished in B-103L, 06 level.
> Access ladder from 06 to -7 level demolished.
> Tensioning device and brackets for watertight armored hatch 07-84-2 twisted and inoperative.
> 3/4" circulating cooling water pressure gage and booster pump severed and demolished.
> W.R.S.R.[53] 0601. 2 1" holes in steel battle port.
> 10" hole 6' above deck level and frame 83 port.
> 1 bulkhead stiffener 8" torn and distorted throughout length.
> Shrapnel hole 10" x 3" at deck level.
> Insulation and sheathing on port longitudinal bulkhead entirely demolished.[54]

[52] BuShips War Damage Report # 57, page 7
[53] WRSR or W.R.S.R. = Wardroom Stateroom, i.e., officers' quarters
[54] USS *South Dakota* Action Report, Enclosure D, pages 6 and 7

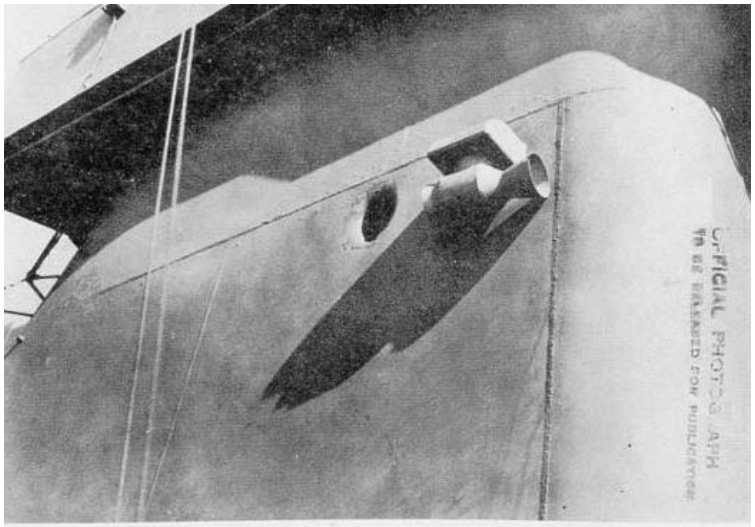

Photo 13: Point of entry of hit No. 10 in starboard longitudinal bulkhead.

Figure 31 – Hit 10 – Entry Hole

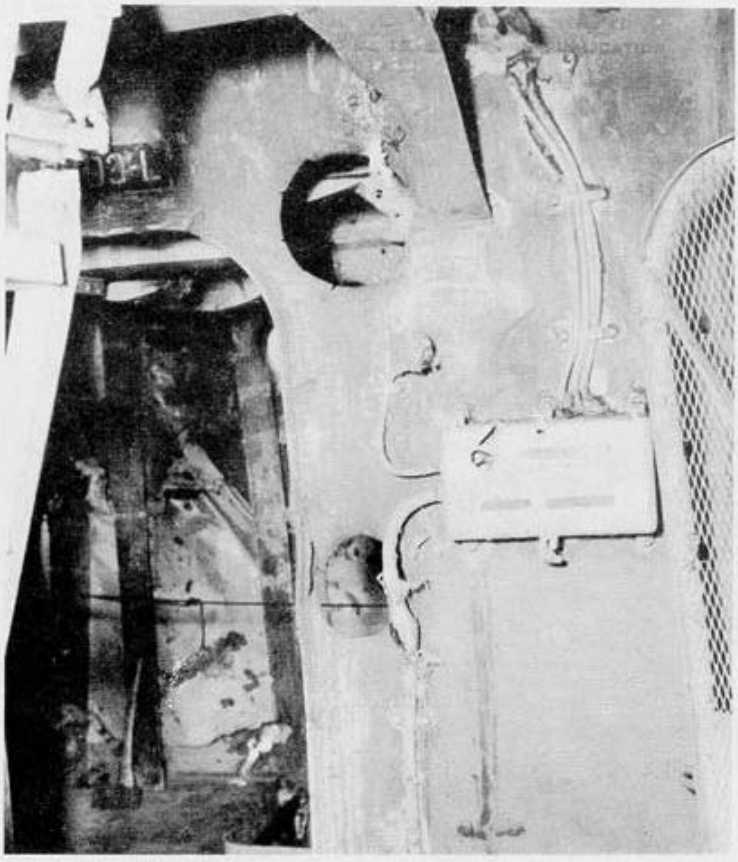

Photo 14: Hit No. 10. Holes in centerline bulkhead.

Figure 32 – Hit 10 – Centerline Bulkhead Damage

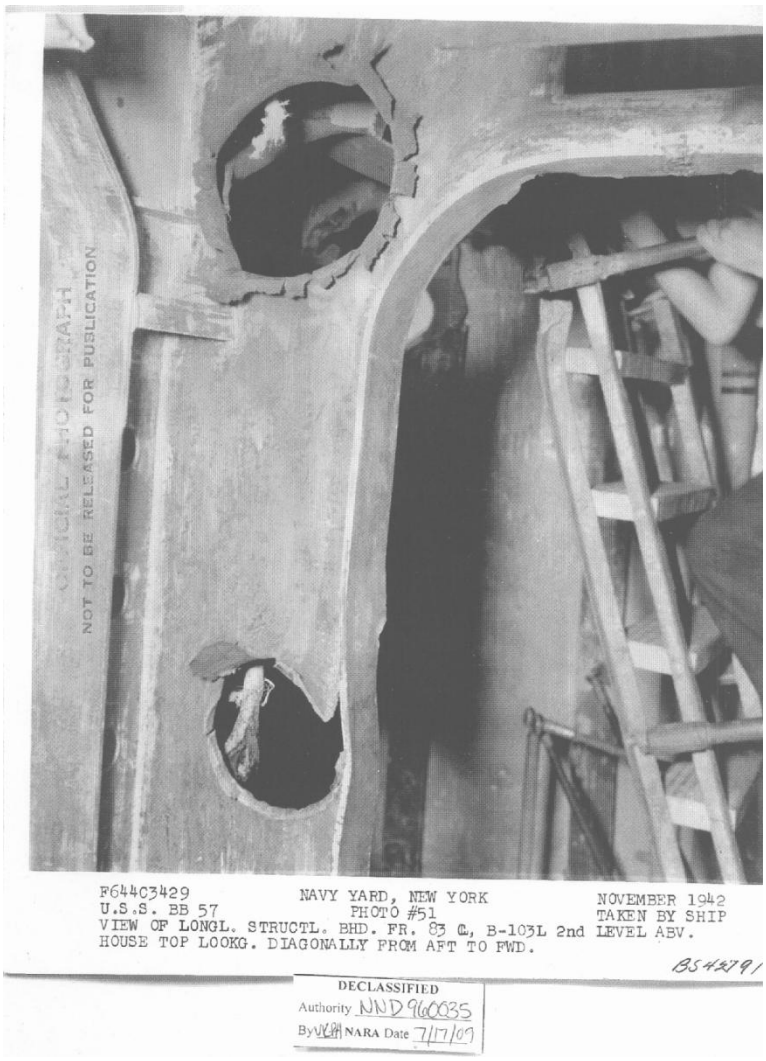

Figure 33 – Hit 10 – Longitudinal Structural Bulkhead Damage

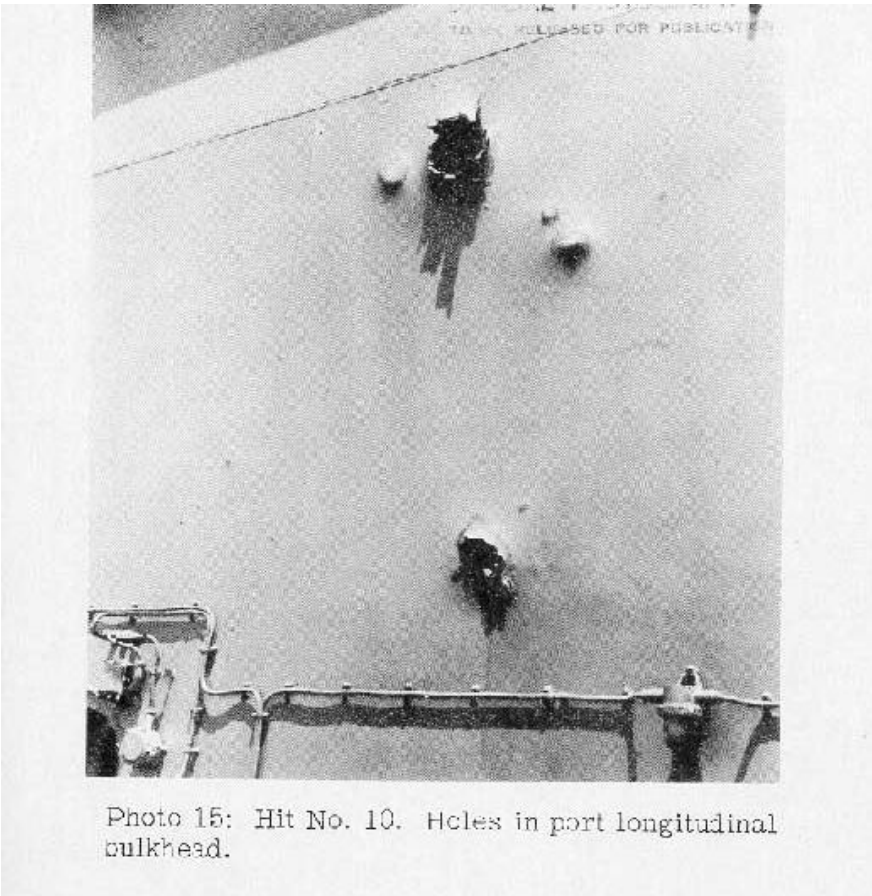

Figure 34 – Hit 10 – Port Longitudinal Bulkhead

Analysis of impact

There are no inconsistencies with BuShips' estimate of an 8-inch AP projectile. At high velocity, the rather blunt end of this kind of shell (flat if the cap head is gone) would shear out very thin plating more like a paper punch than a wedge, keeping the hole narrow with only some minimal widening around the hole as the plate bent back in a ring of truncated petals around the hole (the center area of the plate under the nose that usually forms the upper end of the petals in a pointed-nose impact is sheared off as a disk/plug; round if at right angles, oval otherwise). A 5-inch hole for the cap head sounds about right, though it cannot penetrate much due to its light weight – perhaps an inch of steel, but that would stop it. The timing of this hit is unknown.

Hit 11 – Strike on Shell near Frame 83

From the BuShips damage report:

> 25. An estimated 5 or 8-inch projectile detonated upon contact with "N" strake of the shell just aft of frame 83 between the second and third deck levels. A hole about 3 by 2 feet was blown in the shell and torpedo bulkhead No. 2 was holed in numerous places by fragments. A tear in the shell plating extended forward to about frame 81-1/2. The rivets in the "N" strake were loose or missing between frames 82-1/2 and 84-1/2. Transverse bulkhead 83 was ruptured and distorted between the shell and torpedo bulkhead No. 2 from the second deck to the third deck. As a result of this hit tanks B-23-F, B-31-F, and B-39-F were flooded.[55]

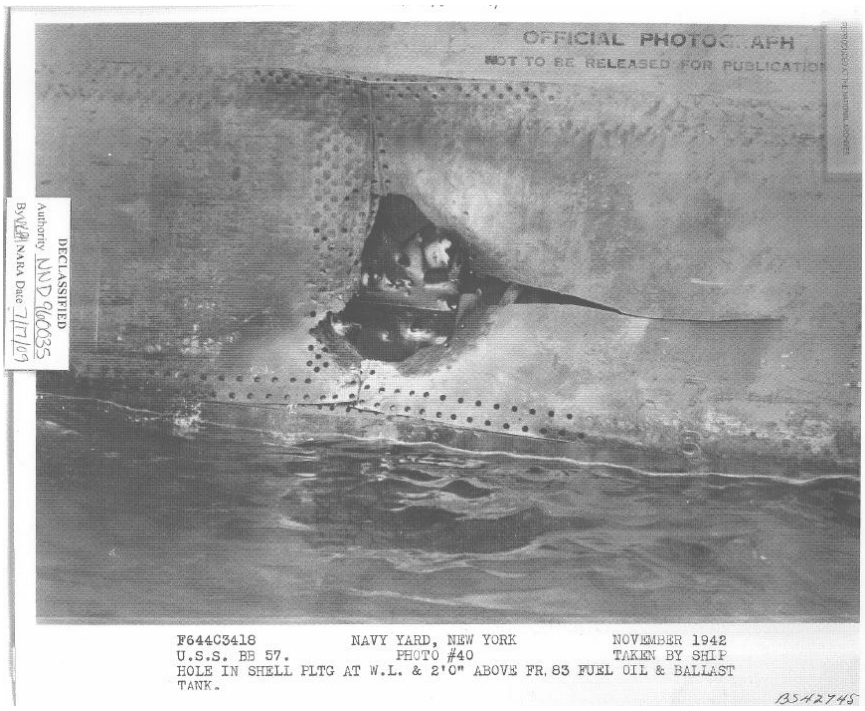

Figure 35 – Hit 11 – Damage to Shell Plating near Frame 83

[55] BuShips War Damage Report # 57, page 7

Figure 36 – Hit 11 – Another View of Damage to Shell Plating

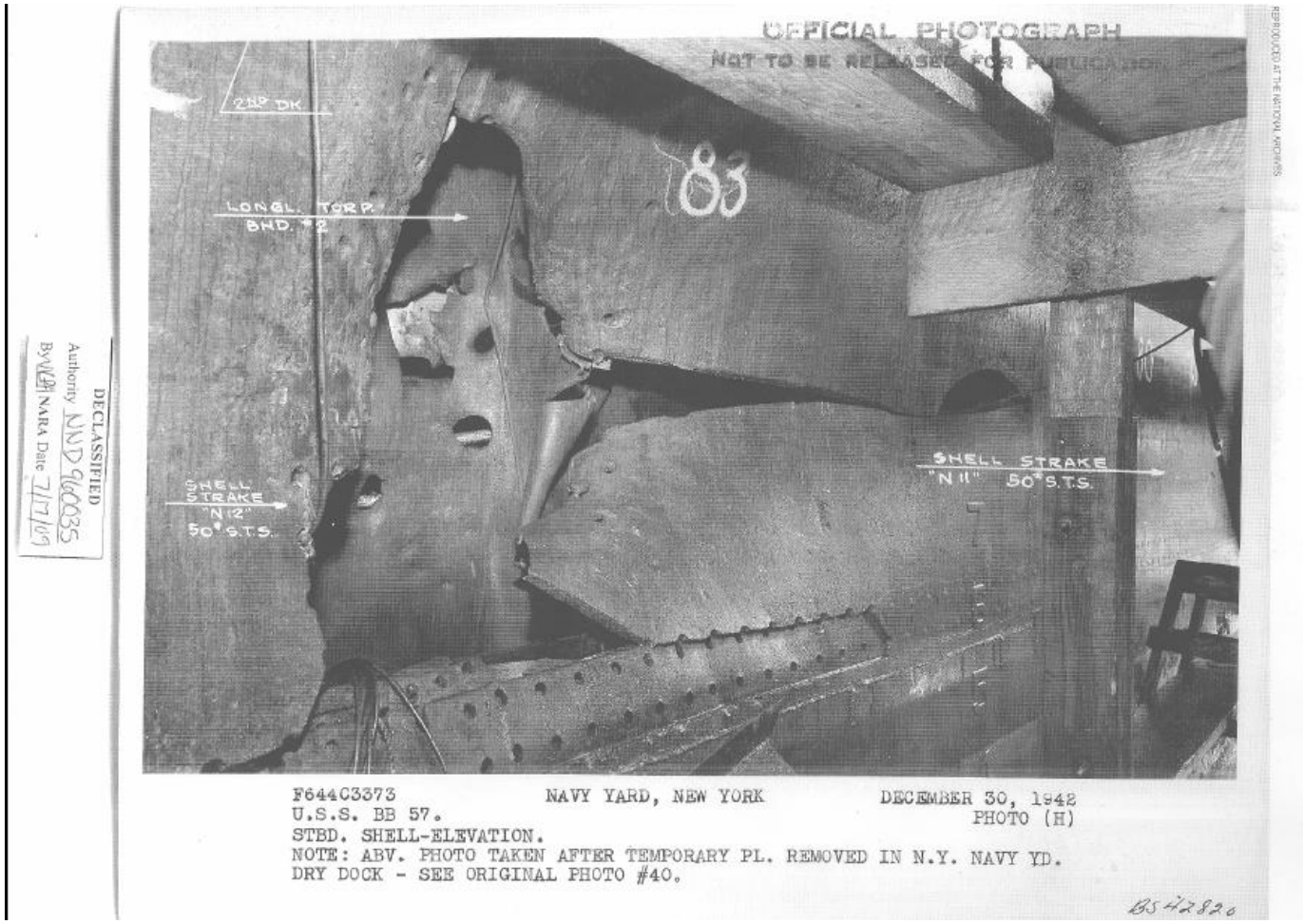

Figure 37 – Hit 11 – Close-up of Damage to Shell Plating

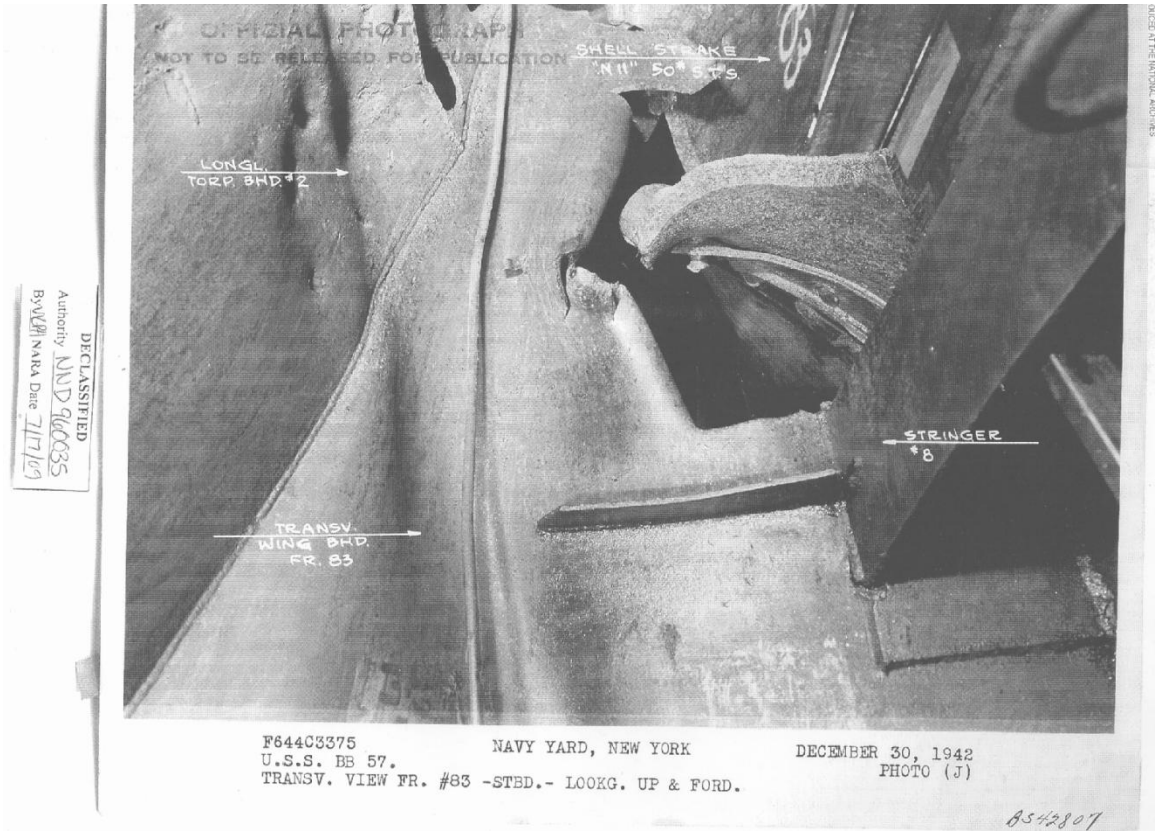

Figure 38 – Hit 11 – Internal Damage

Analysis of impact

The STS plate at this point was 1.25 inches thick. The long tear in the plate to the right implies that the projectile hit at a quite high velocity and was coming from the right at a rather high angle of obliquity (about 45 degrees or so from the normal). The detonation blast split the plate, possibly due to a pre-existing lamination or other weakness (the crack is very straight and probably is parallel to the rolling direction used when the plate was manufactured). There are few deep pits in the plate around the big hole, although there are no other holes other than those made by torn-out rivets and bolts. The hit was up against a vertical seam between two of the STS plates where the plates are reinforced by doubling plates and straps and braced from behind by girders, using rather a lot of rivets and bolts. A number of large holes, tears and folds were made in the thin bulkhead representing the upward continuation of the first inboard anti-torpedo bulkhead in front of the armor belt, most probably by chunks of the 1.25-inch hull armor punched out by the projectile impact.

The shell exploding on impact indicates a nose-fuzed projectile. Using the same figures for a typical World War II HE shell as established for Hit 2; an 8-inch HE projectile was calculated as being able to produce a caliber-size hole in a 2.14 inch STS plate. For the thinner 1.25 inch plate found here, we can use Equation 2 to derive the hole size:

Hole Diameter = 8 x (2.14 / 1.25) = 13.7 inches

This is significantly smaller than the documented damage.

Using the same figures as established in Hit 2; for a non-Japanese World War II HE projectile, a caliber-size hole would be produced in a 3.86-inch thick STS plate. For the thinner 1.25 inch plate found here, we can use Equation 2 to calculate the hole size as follows:

Hole Diameter (for an HE shell) = 14 x (3.86 / 1.25) = 43.23 inches

As noted in the Hit 2 analysis, the smaller explosive filler in the 14-inch Type 0 HE projectile means that we should treat it as a SAP projectile:

Hole Diameter (for a SAP shell) = 43.23 x 0.864 = 37.35 inches

This is extremely close to the 3 foot hole documented in South Dakota's damage report. Thus, the best estimate for this damage is that it was made by a 14-inch Type 0 HE shell.

Hit 12 – Sky Control

From the BuShips damage report:

> 26. Another projectile, probably 8-inch AP, hit frame 83-1/2 about 8 feet above the deck of air defense forward. The projectile passed through two 60-pound STS bulkheads and shattered the top of the port spray shield at about frame 84 without detonating. Two 3-inch fragment holes were blown in the director tube.[56]

South Dakota's time line in her action report describes this hit as follows:

> [From "Chronological Log of the Battle" section of Action Report]
>
> 0055 Director 1 unable to train forward of 040 degrees relative, probably shell hits.[57]

In addition, *South Dakota* also reported the following damage for this hit:

> 011 Level
>
> Sky Control – 10" shell hole through 1¼" STS bulkhead frame 83 starboard.
> 10" hole through 1¼" STS bulkhead frame 83½ port.
> 12" battle cover and port frame broken at frame 83 starboard.
> All insulation blown out.
> 2-3" shrapnel holes through protection casing center column of forward main battery director.
> 3/8" STS splinter shield around port target indicator is demolished.
> Three swivel seats and brackets demolished.[58]
>
> - - -
>
> GUNNERY DAMAGE
>
> 1) Main Battery
> (a) Director 1.
> Electrical cables cut to the following:-
> Pointers firing key
> Salvo light
> Battle order indicator
> Range transmitter
> Ships course input to director
> Train designation transmission
> Bearing on light
> 2JD8 telephone, selector switch – spot one
> Radar inoperative, screen damage, frame cracked, transmission unit shot away.
>
> 2) Secondary Battery
> (a) Sky Forward (air defense station)

[56] BuShips War Damage Report # 57, page 7
[57] USS *South Dakota* Action Report, page 7
[58] USS *South Dakota* Action Report, Enclosure D, page 8

This station received three direct hits, two 8" and one 6", none exploded.
Damage follows:-
JY selector switch inoperative.
20MC and 21MC speakers destroyed.
Five telephone cables out to director 1.
Director tube pierced cutting 23 cables.
Battle ports carried away.
Electric heater destroyed.
Port target designator damaged.
5JP selector switch damaged.
Numerous cables cut, and lookout seat damaged.[59]

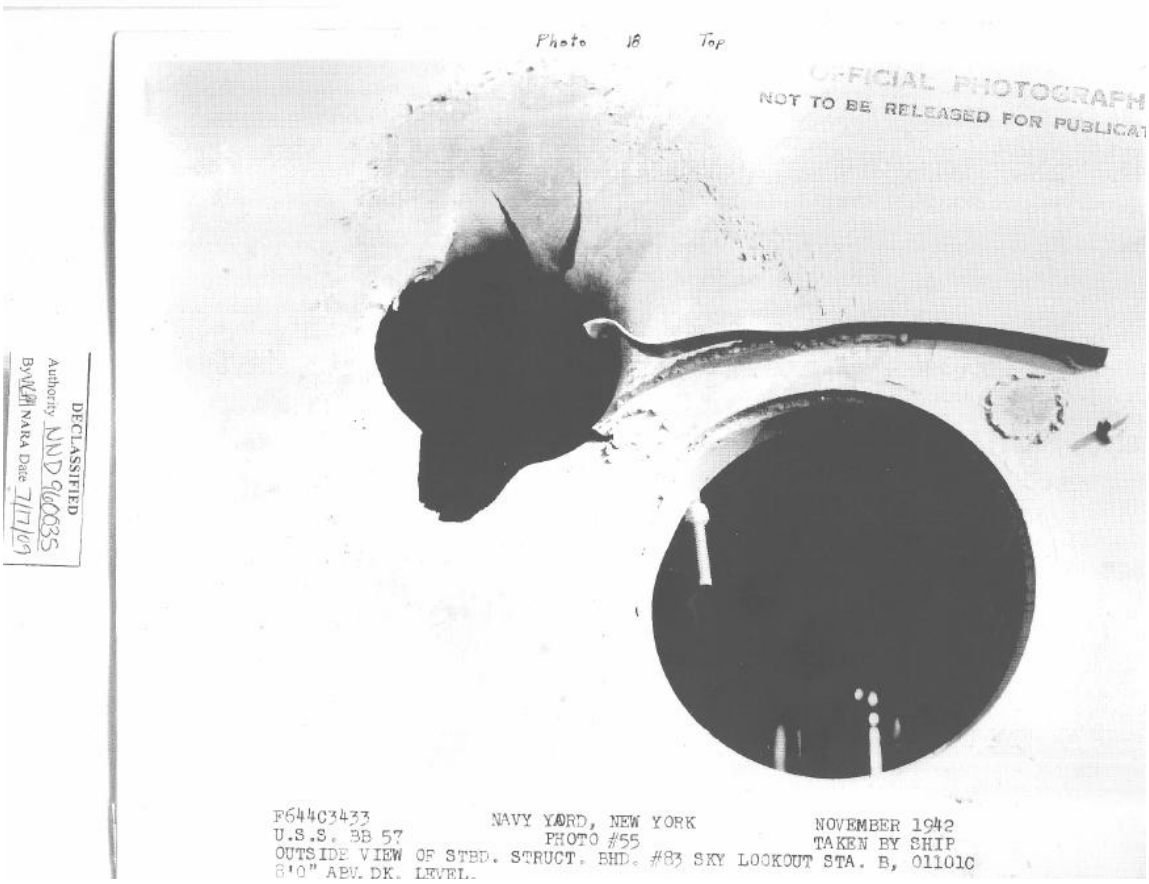

Figure 39 – Hit 12 – Entry Hole

[59] USS *South Dakota* Action Report, Enclosure D, page 14

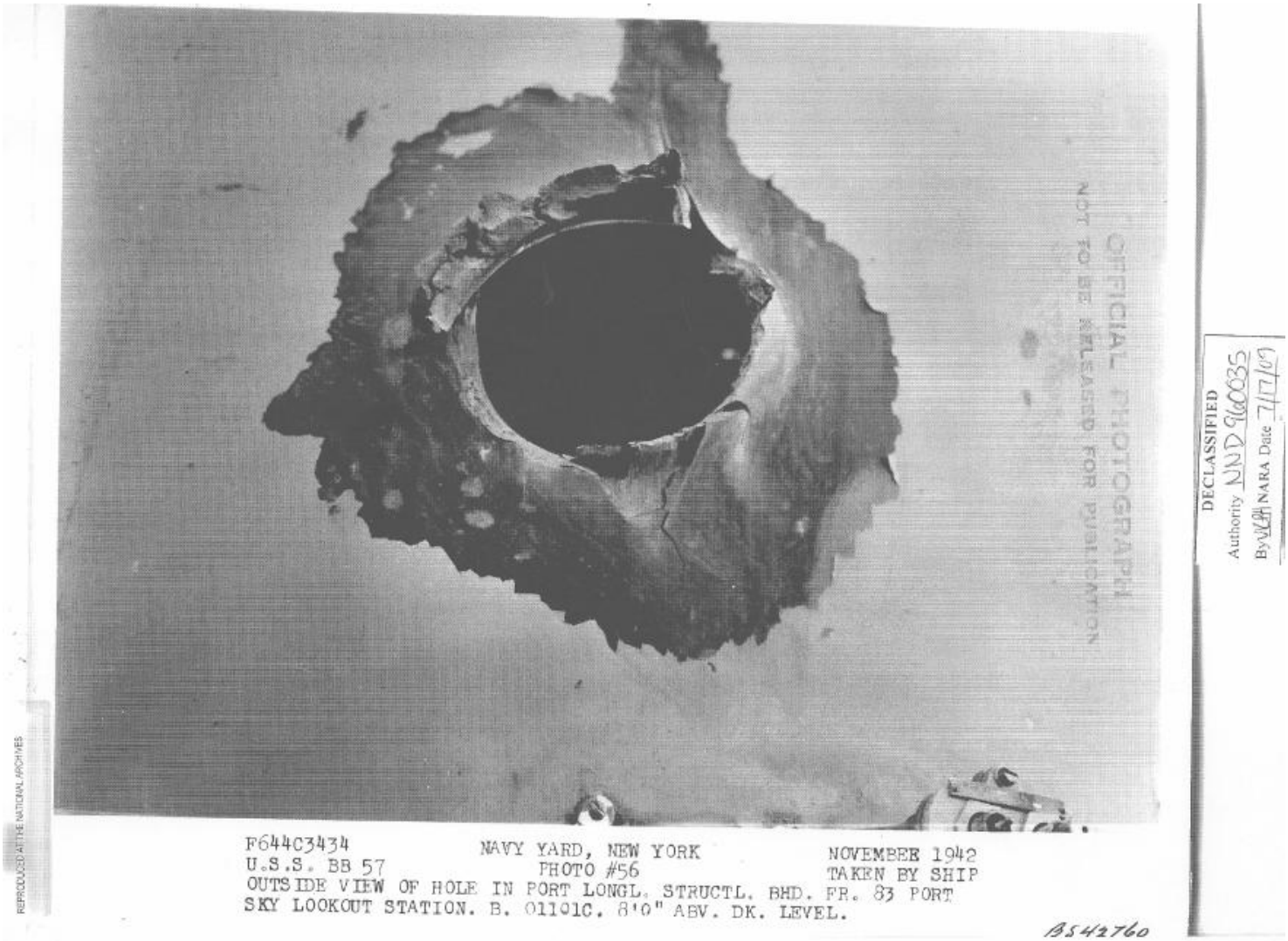

Figure 40 – Hit 12 – Exit Hole

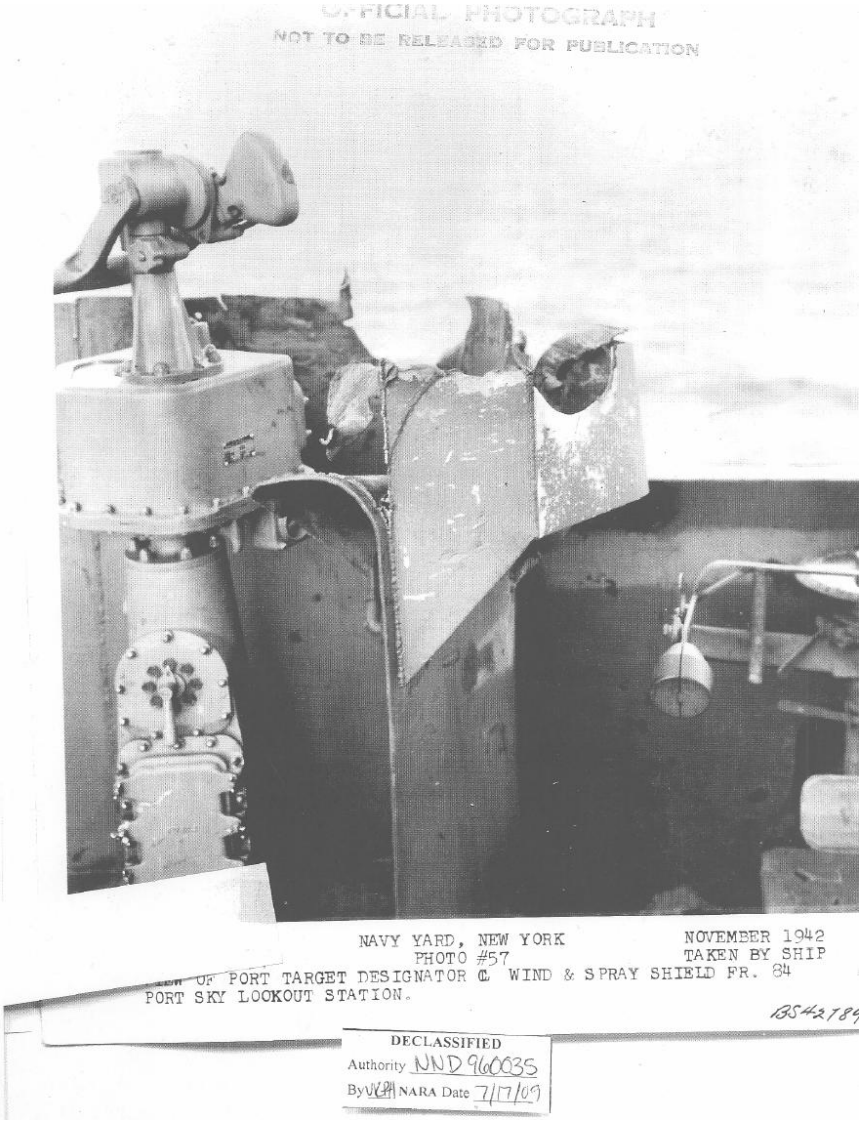

Figure 41 – Hit 12 – Damaged Area

Analysis of impact

The key to determining which projectile caused this damage is the time that director one was first documented as being unable to train due to shell hits, which was at 0055. At this point in the battle, the Japanese reports show that only the light cruisers were firing on *South Dakota* and that this damage occurred some seven minutes before the heavy cruisers opened fire. This means that this hit cannot have been from an 8-inch projectile. Turning then to look at the 5.5-inch Common projectiles fired by the light cruisers; normally the Type 13, Mark 1, Mod 1 base fuze used in the 5.5-inch Common would detonate these shells approximately 0.003 seconds after the initial impact (there is always a slight delay before ignition even with an instantaneous fuze due to the inertia of moving parts). However, the US Naval Technical Mission reported that this fuze gave many blinds, so this hit could have been made by a dud passing through the superstructure.[60] The shell trajectory matches the position of the light cruisers during this timeframe as the heavy cruisers are well ahead of *South Dakota* and are in the process of turning

[60] U.S. Naval Technical Mission to Japan Report O-17 Japanese Projectile Fuzes

around between 0052 and 0055 (see Figure 69). *Takao* will be the first heavy cruiser to open fire at 0102, long after this damage is documented to have occurred.[61] Therefore, the best estimate for this damage is that it is from a dud 5.5-inch base-fuzed projectile fired by one of the light cruisers.

[61] *Takao* Brief Action Report JT1