Hit 19 – Damage to Searchlight No. 3

From the BuShips damage report:

> 29. No. 3 36-inch searchlight received a direct hit estimated to have been an 8-inch projectile that passed through without detonating.[77]

South Dakota's report lists the damage as follows:

> Searchlight 3 - pierced by projectile passing through lens, shutter and reflector.[78]

Figure 70 – Hit 19 – Damage to Searchlight No. 3

Analysis of impact

The amount of damage to the search light was minimal. The shell did not detonate, indicating that it was not a nose-fuzed projectile. It also does not appear to have been an 8-inch AP projectile as the light windscreen of that shell would have ripped-off and flattened, causing much more damage than was the case (for example, Hit 6 from an 8-inch AP projectile created an 18-inch wide hole in a 0.25-inch thick STS plate and Hit 9 made a 17-inch hole). An 8-inch AP projectile would thus have created a hole approximately half of the diameter of the 36-inch searchlight. A smaller base-fuzed 5.5-inch Type 2

[77] BuShips War Damage Report # 57, page 8
[78] USS *South Dakota* Action Report, Enclosure D, page 16

Common projectile or 6-inch Type 4 Common projectile would have nothing to come off and these are basically solid rounds. A hit by one of these projectiles would have gone right on through the searchlight, which is consistent with the damage as shown in Figure 70. Based upon examining this photograph; the hole is about 10 to 12 inches in diameter, which is consistent with the other 5.5-inch and 6-inch caliber hits. The timing of this hit is not known. Our conclusion is that Hit 19 was made by either a 5.5-inch Type 2 Common or a 6-inch Type 4 Common projectile.

Hit 20 – Supply Office and Storage Lockers

From the BuShips damage report:

> 30. An estimated 6-inch projectile hit the tank top at frame 85-1/2, penetrated the armor backing bulkhead between the main and second decks and detonated. Transverse bulkhead 85 was ruptured and distorted over an area 15 by 24 inches. Fragments sprayed lockers in supply office stores and started a small smoldering fire in stationery and clothing lockers.[79]

South Dakota's action report states:

> [From list of fires]
>
> A-207L. Repair 4A. Clothes in 2 lockers and 1 bedding bag in pea coat locker ignited from splinters from hit in starboard side. Quickly extinguished.[80]
>
> - - -
>
> [From list of damage in Enclosure D]
>
> 01 Super-deck, Starboard Side
>
> - - -
>
> Supply office – Shell struck top of fuel oil and ballast tank, B-39F, at frame 87 starboard (6½" hole). Shell exploded inside tank blowing hole in compartment B-207L (hole 10" x 18") piercing 2 lockers and gear locker.[81]

[79] BuShips War Damage Report # 57, page 8
[80] USS *South Dakota* Action Report, page 15
[81] USS *South Dakota* Action Report, Enclosure D, page 10

Figure 71 – Hit 20 – Interior Damage to Transverse Section

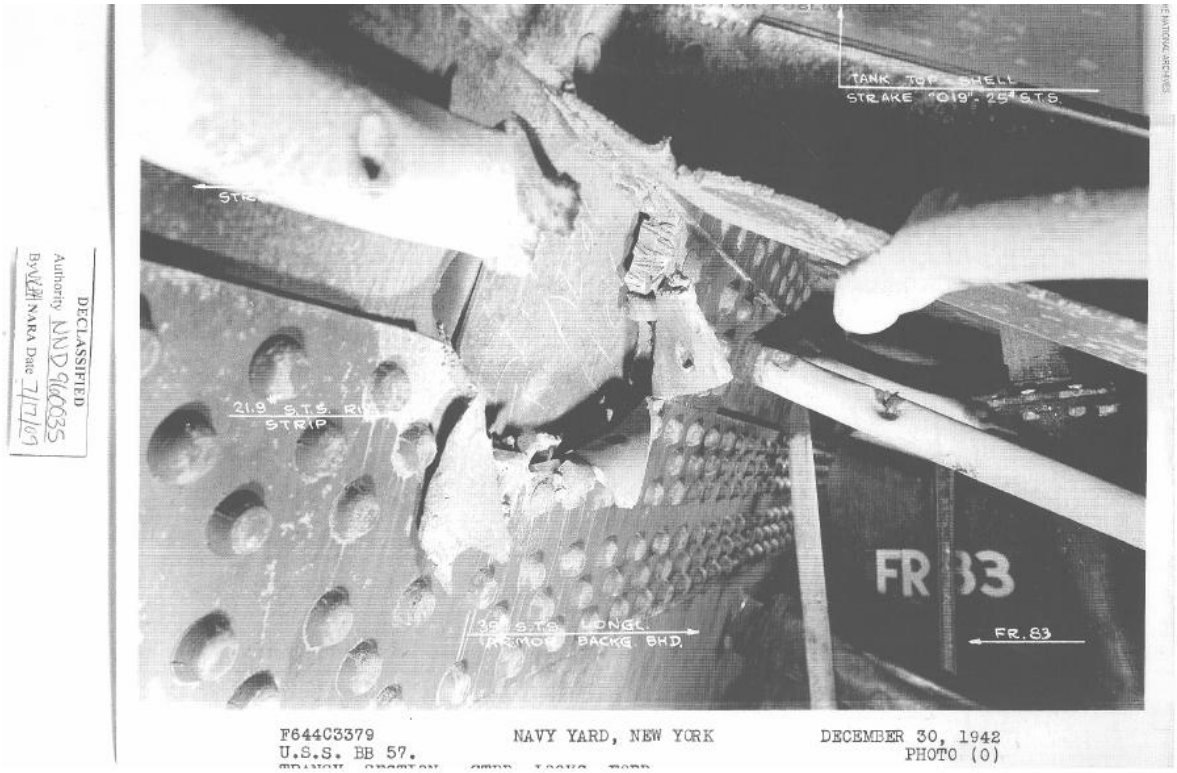

Figure 72 – Hit 20 – Interior Damage near Frame 83

Analysis of impact

There are no inconsistencies with this estimate and the best estimate is by a 6-inch Type 4 Common projectile from *Kirishima*. The base fuze allowed the shell to penetrate the outer layer and it exploded on the next bulkhead.

Hit 21 – Strike on Shell at Frame 87

From the BuShips damage report:

> 31. An area of the 50-pound STS shell 24 inches in diameter at frame 87 starboard between the second and third decks was indented to a depth of six inches. It was reported this was a glancing hit by an 8-inch projectile. If so, the performance of this 50-pound STS plate was most unusual. Another possibility is that this indentation was made by the windscreen or cap head of hit No. 11 or No. 20.[82]

South Dakota's action report states:

> One 14" hole in ship's side at frame 72 starboard, 5 feet above waterline. Dented in over a 6' diameter area.[83]

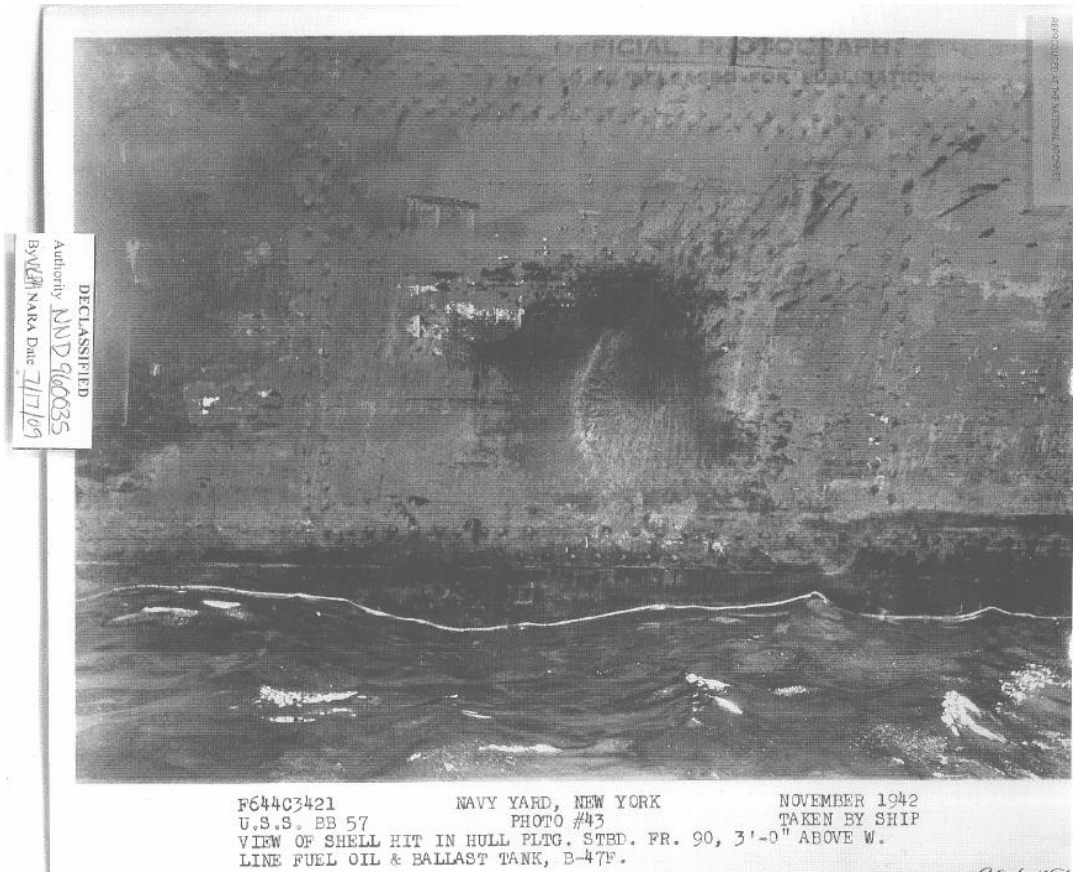

Figure 73 – Hit 21 – Damage to Hull Plating

[82] BuShips War Damage Report # 57, page 8
[83] USS *South Dakota* Action Report, Enclosure D, page 10

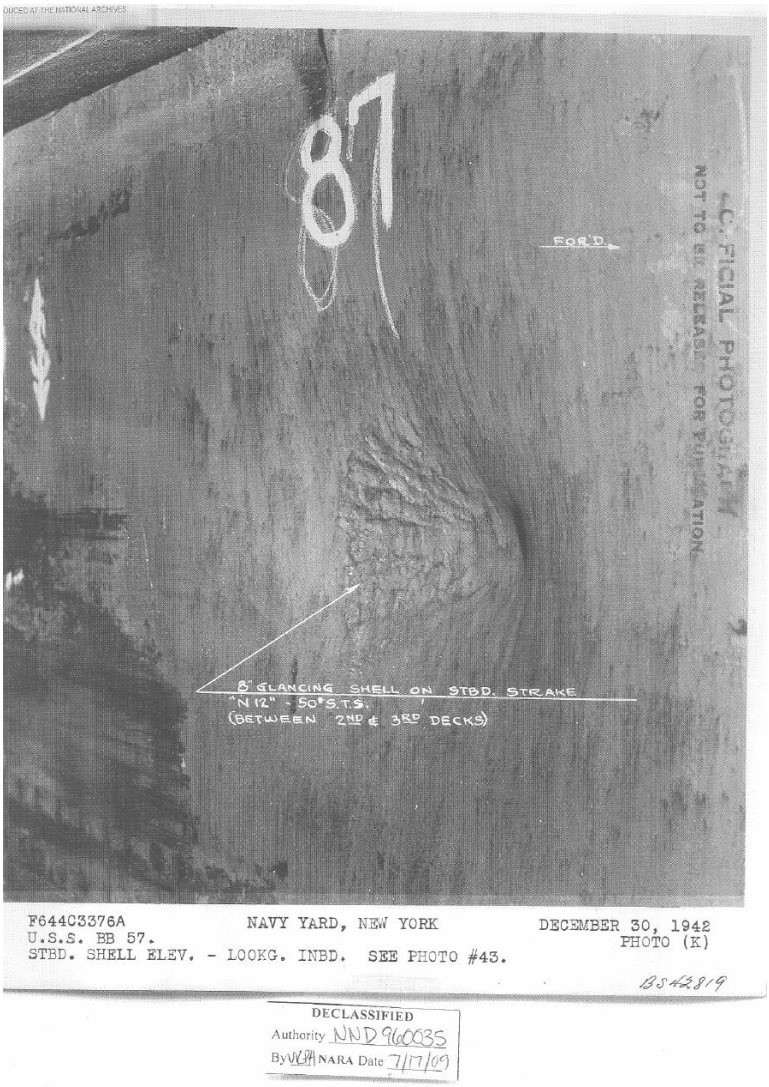

Figure 74 – Hit 21 – Damage to Hull Plating – Side View

Analysis of impact

This impact was estimated by BuShips to be either a glancing hit from an 8-inch shell or the windscreen and cap head of an 8-inch shell. We believe this estimate to be incorrect. Hit 4 showed that at these ranges that even an 8-inch shell traveling underwater could penetrate the outer shell. Next, most nose-fuzed HE shells exploding on impact at a small angle would have punched a hole into the plate rather than denting it as was the case for this hit. That this blow was at a small oblique angle can be seen in Figure 73. A 5.5-inch nose-fuzed shell would punch a hole in any plate less than 1.36 inches thick, which means that the actual 1.25 inch plate is too thin to have prevented this from happening. A 5-inch shell fired from a 5"/40 would have only left a dent, but we believe that this projectile is too small to have caused the size of dent actually made in this plate.

In BuShip's original report, the authors proposed that this damage may have come from the windscreen and cap head from either Hit 11 or Hit 20. However, these two hits came from a forward direction while Hit 21 came from astern, which therefore eliminates any relationship between Hit 21 and the other two

hits. After eliminating these other possibilities, what we are left with is that this damage appears to have been caused by the impact of a cap head and windscreen from an AP shell. Further work is needed to determine the size of this projectile.

Looking at the two types of AP cap heads fired during this battle; the 8-inch AP projectile has a thick cap head that comes to a rather blunt, but distinct point, and is more like a blunt projectile nose tip than any of the other cap heads used in other sizes of Type 91 AP projectiles. This design was intended to allow the 8-inch shell to better penetrate the homogeneous armor that most US cruisers were armored with during the 1930's when this shell was developed. By contrast, the cap head of the 14-inch AP projectile has a forward face that is flatter with no point, being more discus- or mushroom-top-shaped. Examining other information about these projectiles brings out these values:

8-inch Windscreen – 16.6-inches long
8-inch Cap head – 5.5-inches in diameter and about 5-inches thick weighing 7.9 lbs.

14-inch Windscreen – 26-inches long
14-inch Cap head – 12-inches in diameter and 8-inches thick weighing 63 lbs.

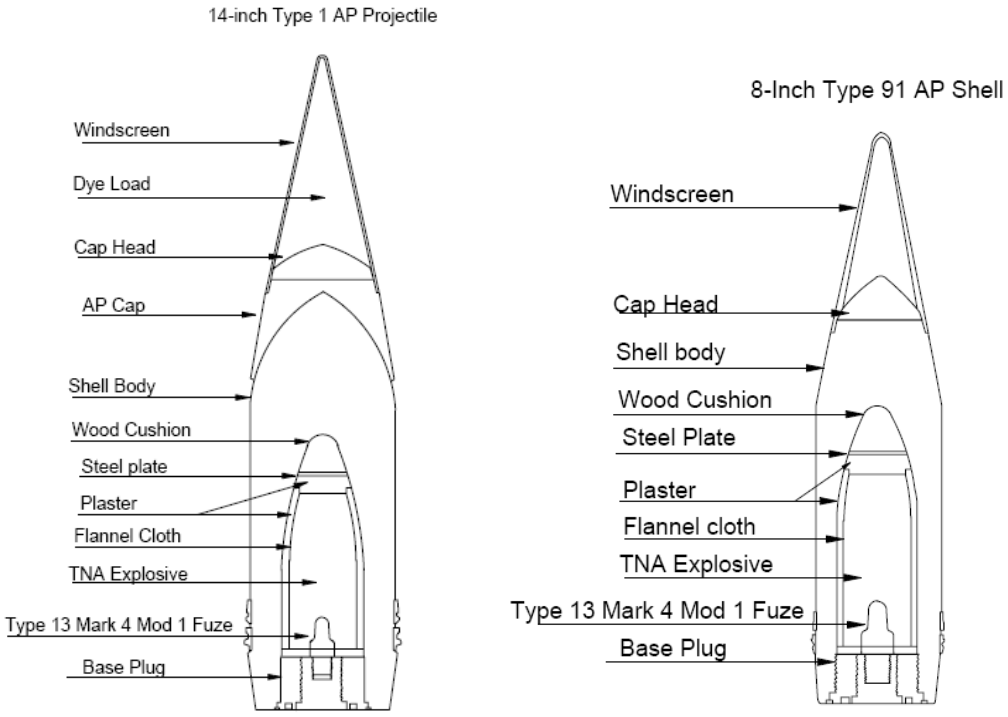

Figure 75 – Hit 21 – Comparison of Japanese 14-inch and 8-inch AP Projectiles

These size differences between these two projectiles is also significant in that the 8-inch cap head is only 5.5 inches in diameter, is 5 inches thick and weighs 7.9 lbs. The 14-inch cap head is 12 inches in diameter by 8 inches thick and weighs 63 lbs. The struck plate is 1.25 inches thick, which is not an insignificant thickness. An area in this plate over 24 inches in diameter was pushed in to a depth of 6 inches. The shape of this dent matches the oval shape of the 14-inch cap head and the heavier cap head is

by far more capable of pushing in this amount of steel than the much lighter cap head of the 8-inch shell. This damage largely matches the dimensions of the 14-inch cap head. Our conclusion is that Hit 21 was the result of a 14-inch Type 1 AP cap head and windscreen.

The shell itself seems to have missed *South Dakota*, either by going under her hull, if it could dive at the shallow angle of fall at these close ranges (circa 7 degrees is the minimum entry angle even for these specially-made diving shells), or after it skipped off the water itself, if not. This shell obviously came fairly close to *South Dakota* either way and, if it skipped off the water, perhaps it caused some of the less-than-well-defined superstructure damage noted (punching through as solid shot or as shell splinters after exploding in the air nearby due to fuze action after the ricochet). If so, it would be only the second 14-inch AP round to have hit *South Dakota*. Another possibility is that the shell ran parallel to *South Dakota*'s hull as she turned away from *Kirishima* at 0110. For that possibility, the shell would have entered the water around frame 87 and loss its windscreen and cap head, which deflected into *South Dakota*'s hull, and then dove and detonated around frame 56 near the bottom of the ship, causing seam damage to her hull.[84]

[84] USS *South Dakota* Action Report, Enclosure D, page 13

Hit 22 – Foremast Housing Tube

From the BuShips damage report:

> 32. This hit was just above the second level and above the house top at frame 87 on the starboard side of the structural longitudinal bulkhead and was estimated as a 5-inch projectile. This projectile pierced the foremast housing tube and passed through the port longitudinal structural bulkhead near frame 86. The port bulkhead stiffeners at frame 86 were distorted and the first aid locker was penetrated by three fragments. Five panels of sheathing and insulation in the first aid station were damaged.[85]

South Dakota's action report lists the following damage:

> 1 8" hole, through after side of structural bulkhead, frame 87.
> 1 10" hole through both sides housing tube for radar mast, frame 87.
> Lowering wire for foremast damaged.
> 1 4" hole through bulkhead plating at frame 86 port.
> Bulkhead stiffener frame 86, punctured, twisted and distorted.
> 5 panels of sheathing and insulation torn out.
> 2-3" shrapnel holes at base of bulkhead just above bounding angles, frame 87 starboard.
> 3 shrapnel holes, through medical locker. Doors distorted beyond repair.
> 2" shrapnel hole through back of wash basin.[86]

Figure 76 – Hit 22 – Damage to Structural Bulkhead, Frame 87

[85] BuShips War Damage Report # 57, page 9
[86] USS *South Dakota* Action Report, Enclosure D, page 7

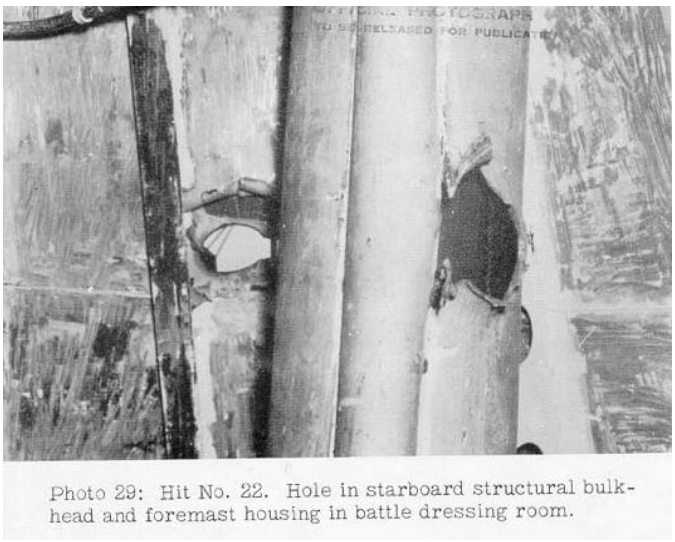

Photo 29: Hit No. 22. Hole in starboard structural bulkhead and foremast housing in battle dressing room.

Photo 30: Hit No. 22. Damage to port structural bulkhead in battle dressing room.

Figure 77 – Hit 22 – Views of Interior Damage

Analysis of impact

This shell detonated on impact, indicating a nose-fuzed projectile. The bulkhead is probably 25 lbs. or 0.625-inches STS or HTS plate based on similar hits on the exterior superstructure of the forward mast such as Radar plot. The timing of the hit is unknown, so the exact range and velocity of the shell is also unknown. The following analysis is meant as a rough estimate.

Using Equation 1, the calculations show that a 5.5-inch projectile striking at 1,300 fps would produce a 14-inch hole in STS plate 0.625 inches thick while a 5-inch projectile at the same velocity would produce a 9-inch hole in the same STS plate. This latter figure is closer to the size of the exterior hole in Figure 76 and slightly under the 10 inch hole seen in Figure 77. A 5-inch Type 0 HE projectile appears to be the best estimate for this damage and this is consistent with BuShip's original estimate. This shell came from either the 5"/50 caliber guns on the destroyers or one of the 5"/40 caliber secondary battery guns on *Kirishima*, *Atago* or *Takao*.

Hit 23 – Radar Antenna of 5-inch Director No. 3

From the BuShips damage report:

> 34. An estimated 8-inch AP projectile hit the radar antenna of 5-inch director No. 3. Fragments of the windscreen and cap head broke off and sprayed the starboard side of the stack hood in the vicinity of frame 89. The projectile pierced the stack hood and continued on through the radar antenna of 5-inch director No. 2.[87]

South Dakota's action report lists the following damage:

> [From list of fires]
>
> 12. Stack covers, base of stack. Repair 1 and 4. CO2 by repair party 1 would not put out this canvas but extinguish enough to double ignited portion of canvas underneath until Repair 4 arrived with hose. Paint on stack did not ignite.
>
> - - -
>
> 16. Mount 7. A report was received in damage control that the upper handling room was on fire. Repair party 1 investigated; upper handling room was found flooded. No fire was found in this mount. A piece of wood from deck was burning outside, also parts of life jacket and mount bloomers. Those were quickly extinguished. This mount received a direct hit and first report was probably result.
>
> 17. Mount 3. Several reports were received at different times that mount 3 was on fire. No fire was discovered near this mount though at each report some small burning fragments would be found on deck.
>
> - - -
>
> 23. There were numerous small fires on both the first and second superstructure decks on both sides mainly burning pieces of life jackets which re-occurred several times. Water would quickly extinguish but some small piece would flare up again.[88]
>
> - - -
>
> [From list of damage in Enclosure D]
>
> STACKHOOD AT FRAME 88
>
> Forward Face – Shell hole 12" by 30" part of shell continuing through 4 partitions inside hood and out port side. All holes approximately 15" in diameter. Part of shell broke off after entering hood and went through 1 partition aft with a hole of 23" by 14".

[87] BuShips War Damage Report # 57, page 9
[88] USS *South Dakota* Action Report, pages 15 and 16

Shell entered 2" from starboard side hood 4' above 07 superstructure deck. There were also other holes in forward face of hood of the following size: 6" diameter, 6" by 18", 2 holes 3" by 6", four holes about 2" in diameter, 2 holes approximately 3" by 8". Also 10 dents about 1" deep by 6" in diameter in forward face of hood.
Stack cover jack-stay on forward side carried away.
Deck in vicinity of frame 87 and 88 of 07 superstructure deck has 9 dents.[89]

S.B. [Secondary Battery] Director #3

Radar elevation gear carried away.
2 legs of base carried away on left hand side.[90]

- - -

Starboard side of stack hood between frames 90-96 – 4 holes approximately 4" x 6" between 05 and 07 superstructures.
Forward steam exhaust escape frame 96 between 06 and 07 superstructure. 8 holes 2" in diameter.
20 mm gun shield on 05 superstructure deck at frame 92 – 1 hole 2" in diameter near base.
Drainage line from Director 3 platform cut at frame 89 on the 04 level – hole 2" in diameter.
Athwartships bulkhead at frame 90 on 02 level – 5 holes approximately 2" in diameter. Also 5 bad dents.
Ready service box 20 mm at frame 91, 02 level – 5 holes approximately 2" x 8".
Ready service box 20 mm at frame 92, 02 level – hole 4" x 8".
Deck has 2 bad dents at frame 95 near stack – 02 level.
#1 motor whaleboat has 15 shrapnel holes.
Boat repair shop at frame 97-99, 02 level has two holes in overhead, 1 3" in diameter and 1 4" by 10".
Heater steam lines and ventilation supply duct B-0203E are cut by 4 shrapnel holes.
Nitrogen antenna lines T-12, T-13, and T-9 are cut by shrapnel.
Radio transmitter trunk T-7-H – 2 holes 2" in diameter.
Bulkhead 97 – 4 shrapnel holes in insulation and sheathing. 4 shrapnel dents in bulkhead.
WT door 02-98 has 2 holes through door approximately 2" in diameter.
Natural exhaust B-0205E at frame 100 has 2 2" holes.
Watertight door 02-100 to B-0205E (Battery Charging Room) has 3 holes, one 2" by 8", one 2" by 1" near top of door; and one 3" by 4" forward edge near the hinge.
B-0205E – hole in deck approximately 1" in diameter at frame 100.
Steam line pierced by shrapnel embedded in lagging or steam line, frame 100.
Many dents in deck, bulkhead, and overhead in compartment B-0205E.
Brass drain line for 03 deck level has hole approximately 1" in diameter at frame 100.[91]

- - -

[89] USS *South Dakota* Action Report, Enclosure D, page 9
[90] USS *South Dakota* Action Report, Enclosure D, page 9
[91] USS *South Dakota* Action Report, Enclosure D, pages 9 and 10

01 Superdeck Starboard Side.

Right-hand side of Mount #7 – Deck has been dished in 2" over a 20" area. Center of area 2' from after edge and 1½' from lower edge of plate. Seam out after right corner of mount opened up 3/8". Shows signs of intense heat. Armor is 2" thick.[92]

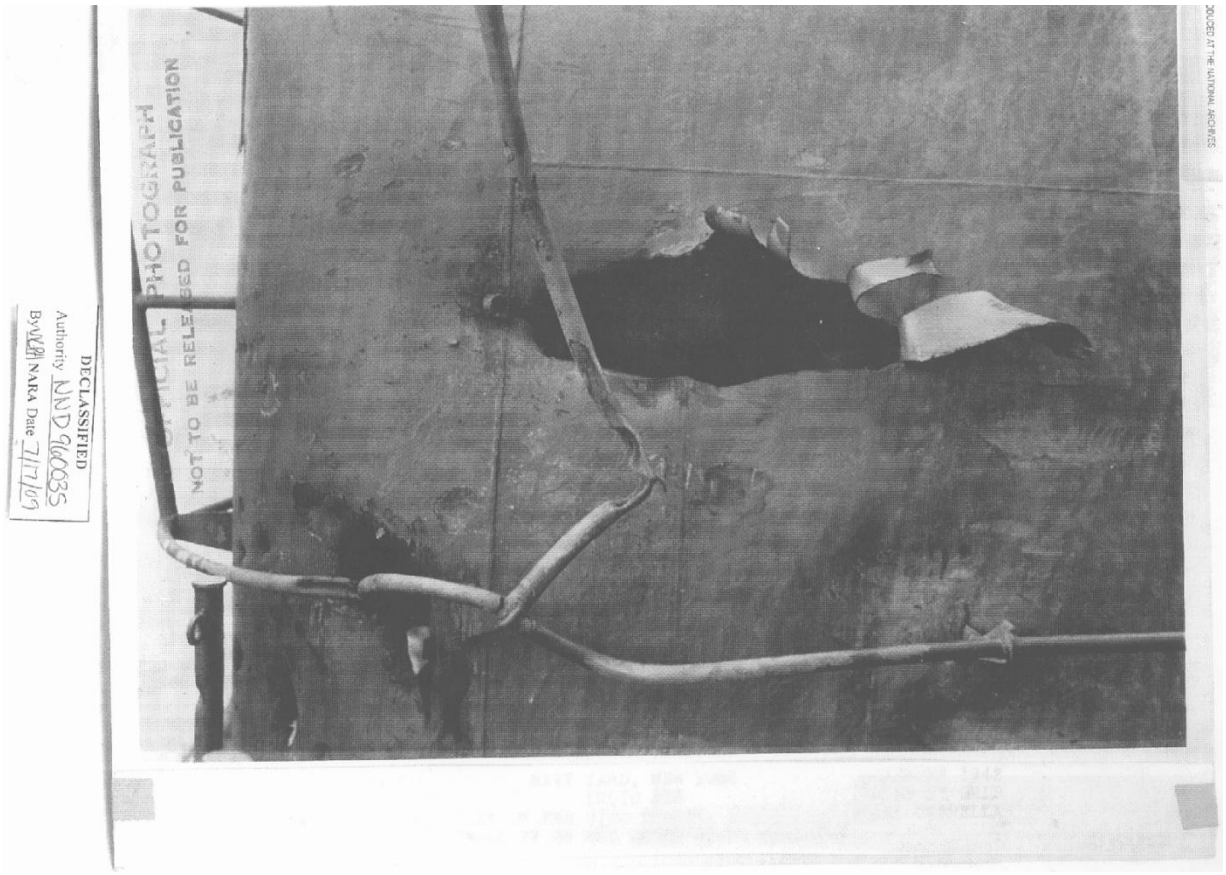

Figure 78 – Hit 23 – Stack Damage on Starboard Side

[92] USS *South Dakota* Action Report, Enclosure D, page 10

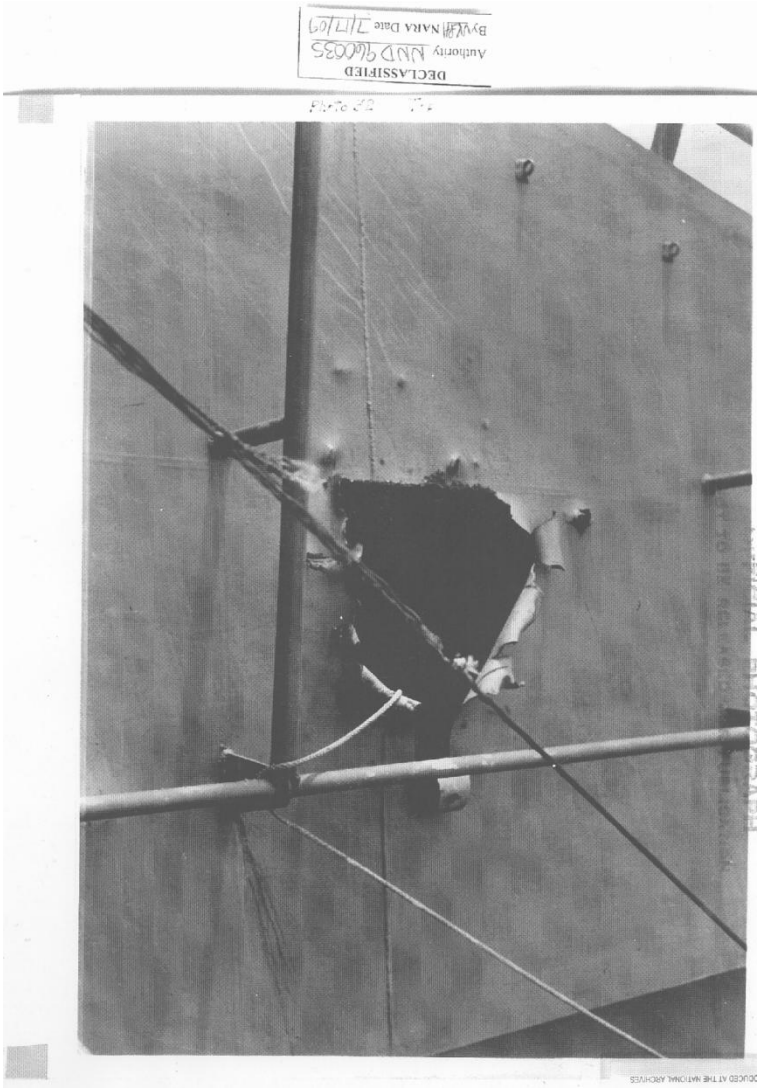

Figure 79 – Hit 23 – Stack Damage Exit Hole on Port Side

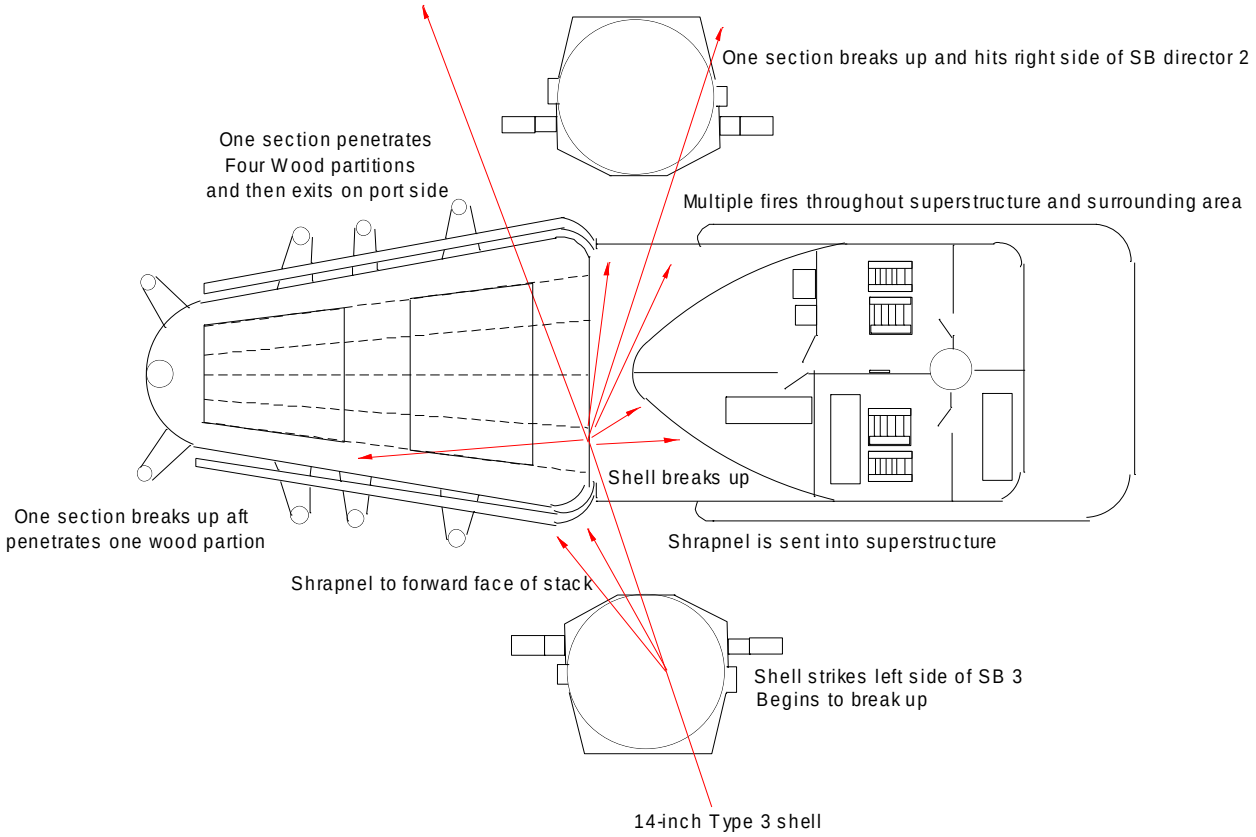

Figure 80 – Hit 23 – Path of Shell and Fragments

Analysis of impact

This damage is very inconsistent with an 8-inch AP shell especially as the shell did not detonate. This shell disintegrated on impact which sent large numbers of small pieces of shrapnel into the surrounding structures. This type of damage is more typical of a 14-inch Type 3 incendiary projectile. The only ship to fire this shell type was *Kirishima*. The shell began breaking up on Secondary Battery (SB) director 3 which sent some of the stays and incendiary tubes into the stack. Some of the incendiary tubes ignited at the base of the stack and around 5-inch mounts 3 and 7. The nose of the shell entered into the stack and then the shell probably broke in half and continued to break up within the stack with parts hitting SB director 2 and sent shrapnel all over the superstructure. We believe that what is being described in the damage report as pieces of life jackets are actually the small rubber thermite incendiary tubes from the Type 3 shell which are 1 by 3 inches in size. These tubes burned at low-order as the shell did not detonate properly. CO_2 fire extinguisher gas would have had no affect on them due to their magnesium filler and they could burn as hot as 3,000 degrees Fahrenheit (1,650 degrees Centigrade), but for only 5 seconds. These tubes were quite capable of starting these small fires throughout the superstructure as described in the report. 5-inch Mount 7 reported that the armor shield had been exposed to extreme heat and 5-inch Mount 3 was reported on fire, but when fire fighters arrived they only found burnt-out fragments. Fires at the base of the stack but not at the point of impact are also an indication of incendiary tubes. For these reasons, we have concluded that the best estimate for this damage is that it was from a 14-inch Type 3 incendiary shell.