

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



DCA22FM022

MATERIALS LABORATORY

Fire Factual Report 22-101

July 20, 2023

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A. ACCIDENT INFORMATION

Location: Norfolk, VA
Date: June 7, 2022
Vehicle: Spirit of Norfolk
Investigator: Michael Karr

B. COMPONENTS EXAMINED

On-scene examination of MV Spirit of Norfolk

C. EXAMINATION PARTICIPANTS

Group Chair Joseph Panagiotou
National Transportation Safety Board
Washington, DC

Marine Engineer David Flaherty
National Transportation Safety Board
Washington, DC

D. ACCIDENT SUMMARY

See accident docket for summary.

E. DETAILS OF THE EXAMINATION

The initial examination of the vessel began on June 14th, 2022. A follow-up visit on June 22nd, 2022, was also conducted.

Overall, the entire vessel sustained fire damage throughout all the decks. As witnessed from the exterior there appeared to be more thermal discoloration and charring of the exterior paint on the starboard side than on the port side (Figures 1, 2). This was likely a consequence of the prevailing winds while the ship was burning at the pier. From the exterior, the engine room exhaust vents were visible. These vents exhibited soot around the vent outlets and patches of charred and burned off paint above the vent outlets (Figures 3, 4). On the port side exterior there was an area of charred/burned-off paint at the height of the engine room vent inlet. A similar area was not observed on the starboard side.

The below deck compartments that sustained fire damage were the engine room and galley. The below deck steering gear compartment aft of the engine room

did not sustain any fire damage or exhibit any evidence of soot. Forward of the galley, the restroom compartment did not sustain fire damage but did exhibit sooting.

The forward portion of the main deck was completely consumed on the interior (Figures 5, 6). There were portions of the aft section of the interior main deck with less damage than the forward section but did exhibit some sooting. Exterior areas on the stern of the main deck were not fire damaged but did exhibit some sooting.

The second deck in a similar manner to the main deck was consumed on the interior from bow to stern (Figures 7, 8). Exterior areas on the stern of the second deck were not fire damaged but did exhibit some sooting.

The third deck consisted of an open seating area on the aft portion, a partially enclosed bar area in the middle and a wheelhouse at the forward portion. The open seating area of the third deck was mostly undamaged by fire except for buckling of the decking from the effect of the fire inside the second deck compartment (Figure 9). The bar area was consumed by fire, the decking was buckled with the paint burned off (Figure 10). The wheelhouse was completely consumed by fire (Figure 11).

The interior stairwells connecting the decks were also entirely consumed by the fire (Figures 12, 13, 14)

The focus of the fire investigation was directed at the engine room compartment. This was due to prior knowledge of the fire having originated within that compartment. A loss of communication with the port engine throttle controls prompted the captain to instruct crew members to check the engine room. The crew members reported that they observed fire towards the aft port side of the engine room. At that time, none of the other areas of the ship exhibited any fire involvement. A passenger captured a photo of smoke and flames exiting the port side engine room vent outlet (Figure 15). Additionally, photographic evidence of the ship while still in the channel and while at the Navy pier during the first few hours of the emergency response also suggest that fire was not present on any of the visible decks and that smoke was only emanating from the engine room vents. The fire which originated in the engine room eventually spread throughout the entire ship. It was approximately 4 days before the fire was declared extinguished.

The engine room was a large compartment in the below deck area of the ship accessible through a watertight hatch at the aft part of the galley compartment. The engine room also had an escape hatch in the ceiling of the aft starboard corner which led to the main deck. The engine compartment of this ship was not equipped with any fire detection or suppression systems¹. Additionally, there were no provisions for

¹ The Spirit of Norfolk was exempt from having fire detection and suppression in the engine room due to the age of the ship.

sealing the exhaust vents beyond shutting down the powered ventilation. The interior of the engine room consisted of a mostly open compartment with two partial bulkheads extending perpendicularly from the exterior bulkheads towards the center of the compartment. These partial bulkheads created two alcoves closed on three sides with the open sides facing the generators at the center of the compartment. The exterior bulkheads and ceiling of the engine room were covered with thermal insulation. A diagram of the engine room layout is depicted in Figure 16. The engine room contained two propulsion engines in the aft portion of the compartment. One on the port side and one on the starboard side. Towards the middle of the engine room there were two engine generators with one on the port side and one starboard. A hydraulic power unit was located on the port side forward and outboard of the port side generator. The port and starboard fuel tanks were located in the two forward corners of the engine room.

Fire damage was observed throughout the engine room compartment. The most severe damage was concentrated at ceiling height where structural members were deformed and, in some instances, fractured due to thermal expansion. The thermal damage at ceiling height was mostly uniform throughout the engine room. The thermal damage to the engine room exhibited a gradient of thermal damage from the ceiling towards the deck with the most severe damage at ceiling height. The gradient of thermal damage also exhibited a sharp line of demarcation below which the thermal damage abruptly stopped. This line of demarcation was at about waist height. An example of this line of demarcation can be seen on the electrical cabinet in the aft portion of the engine compartment (Figure 17). The electrical cabinet exhibited melted breaker switches, completely consumed gauges, and burned off paint in the upper portion while the portion of the cabinet below the line of demarcation remained intact with switches, labels, and paint. The alcove forward of the port main engine (Figure 18) also exhibited this sharp line of demarcation where materials below the line of demarcation did not exhibit the damage that was present above. At the starboard aft portion of the engine compartment the same condition exhibited by a sharp line of demarcation to the thermal damage was also observed (Figure 19). The starboard main engine was thermally damaged along the top portion but below that did not exhibit evidence of fire damage. This line of demarcation was consistent with a water line resulting from the firefighting efforts. The firefighting efforts began early with the responding vessels introducing water into the engine room through the vents. Any thermal damage found below the overall line of demarcation would be indicative of damage occurring early in the event. The areas of the engine room that did not exhibit this sharp line of demarcation and instead exhibited thermal damage from the ceiling down to the deck plates were the bulkheads outboard, aft, and forward of the port main engine as well as the outboard and forward sides of the port main engine. Additionally, the structural members in the bilge area below the port main engine also exhibited charring of the paint (Figure 20). The bulkhead forward of the port main engine exhibited charring of the paint from the ceiling all the way down to the

deck with an increase in severity downward towards the outboard side (Figure 21). The engine controller which was the first indication to the crew that there was a problem in the engine room was mounted to the bulkhead forward of the port main engine. Similar thermal damage pattern could be seen on the bulkhead aft of the port main engine (Figure 22). The bulkhead outboard of the port main engine had a storage shelving system. This shelving system and its contents had been completely consumed by the fire from the ceiling level down to the deck. It is unknown what exactly had been stored on those shelves but a photo from a marine survey on 6/2/2022 showed cardboard boxes and plastic totes on those shelves (Figure 23). The photo from the marine survey also showed that the insulated exhaust pipe from the port generator was routed through the top shelf of the storage rack and in contact with the materials on the shelf. On the outboard side of the port engine, near deck level, the fuel/water strainer was found to have a melted sight bowl. The gearbox at the same level but further aft showed no signs of thermal damage (Figure 24). The crankcase portion of the port main engine on the outboard side appeared to have an oily residue all over its surface. Additional areas of low-lying charring were observed on structural members below deck underneath the port main engine (Figure 25). The on-scene examination of the port main engine did not reveal any obvious preexisting failures with the fuel delivery system or lubrication system. The turbochargers did not exhibit any obvious signs of failure.

The two fuel tanks in port and starboard forward corners of the engine room exhibited evidence of having sustained overpressure conditions. The port fuel tank walls were bowed outwards but appeared to remain intact. The starboard fuel tank exhibited outward bowing as well a tear along one of the seams that extended from the ceiling down to the deck (Figure 26). The damage to both fuel tanks was consistent with the ignition of ullage space fuel vapors.

Examination of the hydraulic steering system revealed three failure points in the hydraulic oil distribution system (Figure 27). One of the failures was associated with the high-pressure hose from the hydraulic pump (Figure 28) and the other two were associated with the iron pipes leading to the hydraulic rams in the steering gear compartment aft of the engine room. One fractured iron pipe was located at ceiling height outboard of the port main engine (Figure 29). The other fracture was also located at ceiling height but in the area near the hydraulic power unit as shown in Figure 30. The fractured hose and sections of the pipes containing the fractures were retained for laboratory examination. The details of these examinations are contained in the accident docket².

² See docket item Materials Laboratory Factual Report 22-080

Submitted by:

Joseph Panagiotou
Fire Protection Engineer



Figure 1. Port side exterior.



Figure 2. Starboard side exterior.



Figure 3. Starboard side engine room vent outlet.



Port vent inlet
area in E/R

Figure 4. Port side engine room vent outlet.



Figure 5. Main deck interior looking aft.



Figure 6. Main deck interior looking forward.



Figure 7. Second deck interior looking forward.



Figure 8. Second deck interior looking aft.



Figure 9. Third deck open seating area looking forward.



Figure 10. Third deck bar area.



Figure 11. Wheelhouse interior.



Figure 12. Stairwell from main deck to second deck including passenger boarding area.



Figure 13. Stairwell from second deck to the third deck.



Figure 14. Stairwell on the third deck looking forward towards wheelhouse door.



Figure 15. Photo of smoke and flame exiting port side engine room vent. (Source: Passenger Jason Sleeth).

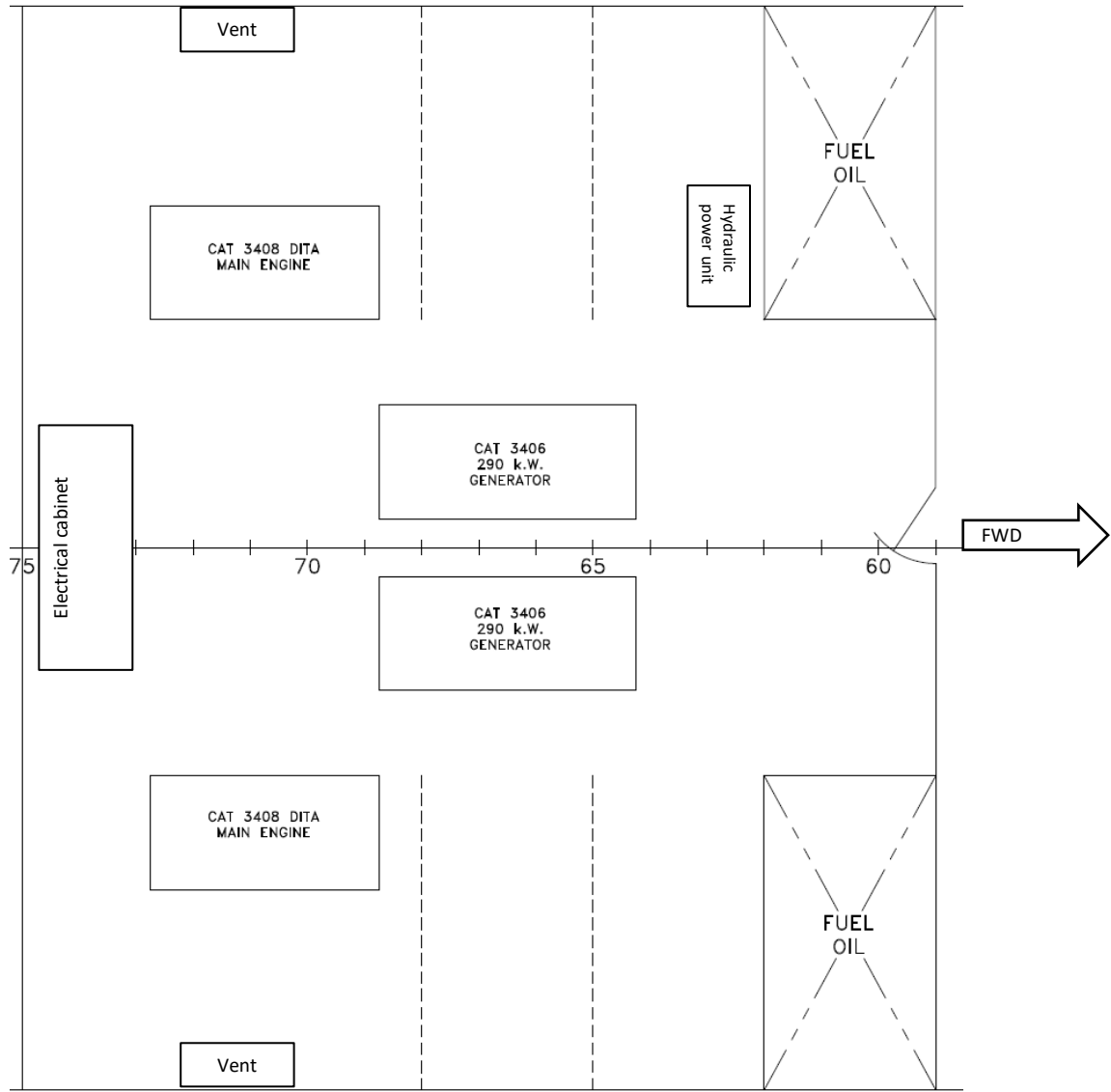


Figure 16. Engine room layout (not to scale).



Figure 17. Electrical Cabinet with demarcation line.



Figure 18. Alcove forward of port main engine exhibiting demarcation between thermally damaged and undamaged area.



Figure 19. Starboard main engine exhibiting demarcation between thermally damaged and undamaged area.



Figure 20. Bilge area below port main engine with some charring on the red paint.



Figure 21. Bulkhead forward of port main engine with low lying damage towards the outboard side. Demarcation line shown (blue) and location of throttle controller (Red).



Figure 22. Bulkheads aft and outboard of port main engine.



Port generator
exhaust

Figure 23. Photo from survey on 6/2/2022 showing storage shelf and port generator exhaust.



Figure 24. Gear box aft of port main engine with intact paint.



Figure 25. Outboard side of port main engine. Consumed fuel/water strainer bowl and low-lying charring to the deck level and below.



Figure 26. Starboard fuel tank fracture.

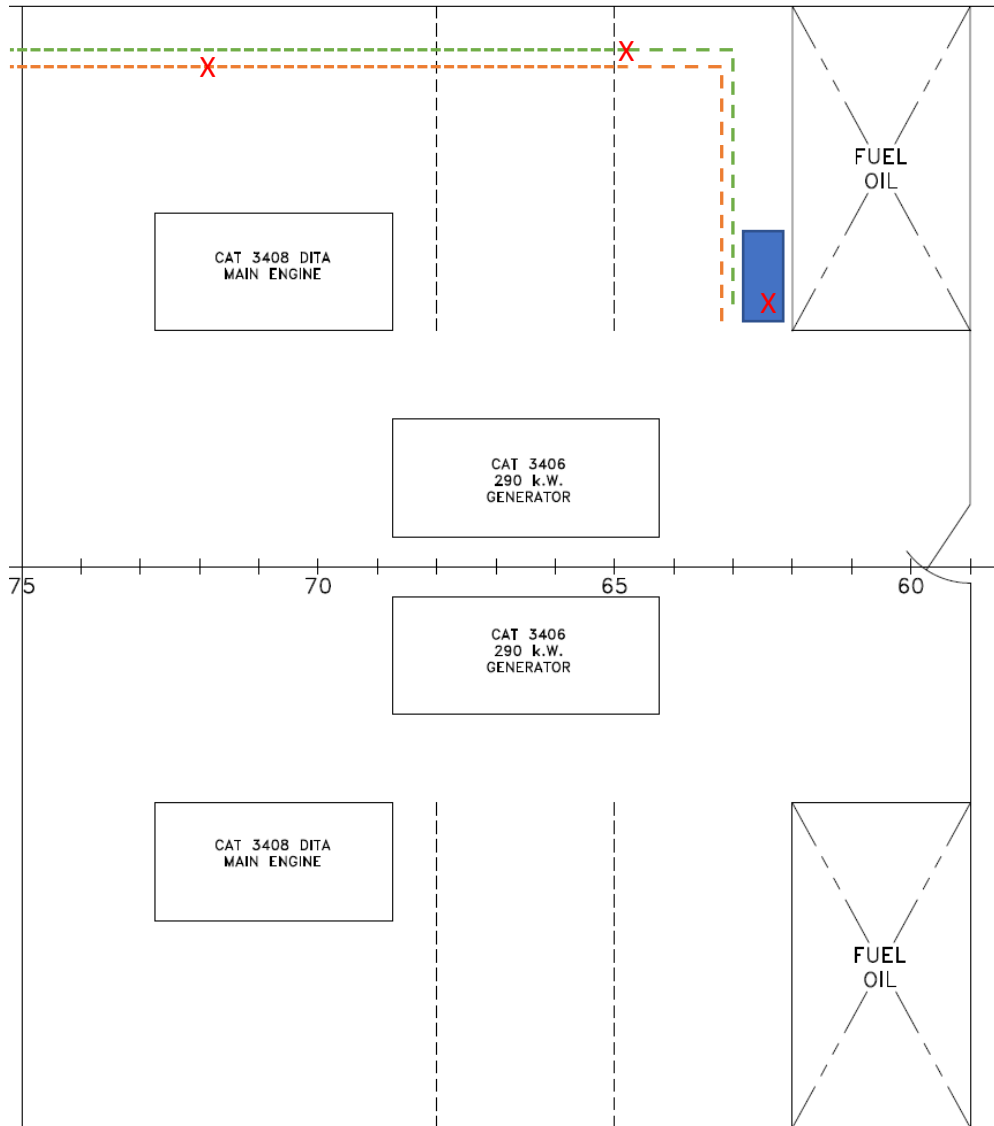


Figure 27. Locations of hydraulic system failures.



Figure 28. Hydraulic hose failure at pump outlet.



Figure 29. Hydraulic pipe fracture at ceiling height near port main engine.



Figure 30. Hydraulic pipe fracture at ceiling near hydraulic power unit.