Dust explosion in Bow thruster motor

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Upon activation of the bow thruster, there was a loud explosion within the forward section of the workboat.

What happened?

During the approach of a workboat to the mother vessel, the workboat coxswain started the bow thruster to assist with positioning the boat for safe recovery. Immediately upon activation, there was a loud explosion within the forward section of the workboat. The explosion damaged sections of the forward deck and displaced the deck matting, with some sections being ejected overboard. There were no personnel positioned in the forward section of the workboat at the time. No physical injuries were sustained by the two personnel onboard; however, mild tinnitus and headache were reported following the incident.

The workboat was subsequently recovered safely, and both personnel involved underwent a medical examination, with no further treatment required. The relevant authorities and the client representative onboard were notified of the incident. The other workboat in the fleet with the same bow thrusters was required to disconnect the bow thrusters until the investigation could determine the root case.

What went well?

The crew onboard responded in a calm and professional manner and the primary concern was to ensure none on the personnel onboard the workboat had been injured. Thereafter the organization’s actions ensured relevant evidence and the workboat in question was quickly returned to the workshop for further analysis. Subject matter experts were also called in to help assess the data and determine what was the cause. There was excellent multi-departmental / stakeholder co-operation in a short space of time.

What went wrong?

Investigation concluded that the most probable cause of the incident was the ignition of a localized airborne carbon-brush-dust atmosphere within the enclosed bow-thruster motor, most likely initiated by electrical arcing at the brushes or commutator during activation. The resulting rapid deflagration and pressure rise fractured the motor housing and transmitted force into the forward deck area, causing structural damage and ejecting the floor mats overboard.

What was the cause?

The underlying causes were found to be:

- Carbon brush wear resulted in carbon dust accumulation around the brushes and commutator inside the enclosed electric motor. During operation, some of the dust likely became airborne, creating a localized explosive dust atmosphere within the housing. Electrical arcing at the brushes or commutator provided the most credible ignition source for the airborne carbon dust.

The following root causes were identified:

- The planned maintenance system did not include defined intervals or criteria for inspecting, cleaning and assessing the bow-thruster brush gear.
- The bow-thruster motor housing was designed as a watertight space, with limited air exchange to disperse any accumulated contaminant.
- The risk associated with carbon-brush dust accumulating within the motor—and its potential to form an explosible atmosphere and contribute to electrical flashover or deflagration—was not known or identified by the manufacturer.

What lessons were learnt?

Electric motors fitted with carbon brushes generate carbon dust as a normal consequence of brush wear, particularly where the motor is used frequently. Carbon brush dust should not be treated only as a cleanliness issue. In enclosed electric motors, accumulated carbon dust can become airborne and, if ignited by electrical arcing, may create an explosible atmosphere and significant pressure event. Inspection, cleaning and brush-replacement requirements should therefore form part of the planned-maintenance regime.

Actions

- Although the batteries did not have direct or indirect impact on the incident occurring, an opportunity was identified to reduce the likelihood of a combustible atmosphere (hydrogen gas from a damaged battery) from forming in the bow thruster compartment was identified. Workboats with the same type of bow thruster room would be retrofitted with an integrated external venting system, designed to safely vent any flammable gas.
- Bow thruster motors on similar workboats were overhauled, including replacement of the motor carbon brushes and removal of accumulated carbon dust, or if required, replaced completely. This was done in cooperation with the bow-thruster manufacturer or specialist.
- Appropriate changes were made to planned maintenance schedules for all electric bow thruster motors across the workboat fleet.
- Consideration was given to the viability of replacing the existing carbon brush electric motors with a suitable brushless electric motor.

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