MAIB
MARINE ACCIDENT INVESTIGATION BRANCH

SAFETY BULLETIN

SB1/2023 MARCH 2023

Extracts from The United Kingdom Merchant Shipping (Accident Reporting and Investigation) Regulations 2012 Regulation 5:
"The sole objective of a safety investigation into an accident under these Regulations shall be the prevention of future accidents through the ascertainment of its causes and circumstances. It shall not be the purpose of such an investigation to determine liability nor, except so far as is necessary to achieve its objective, to apportion blame."

Regulation 16(1):
"The Chief Inspector may at any time make recommendations as to how future accidents may be prevented."

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NOTE
This bulletin is not written with litigation in mind and, pursuant to Regulation 14(14) of the Merchant Shipping (Accident Reporting and Investigation) Regulations 2012, shall be inadmissible in any judicial proceedings whose purpose, or one of whose purposes is to attribute or apportion liability or blame.

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Potential fire hazards from flexible hose installations identified following a fire on board the roll-on/roll-off cargo ship *Finnmaster* in Hull, England on 19 September 2021

Finnmaster's fire-damaged compartment

MAIB SAFETY BULLETIN 1/2023

This document, containing safety lessons, has been produced for marine safety purposes only, on the basis of information available to date[1].

The Merchant Shipping (Accident Reporting and Investigation) Regulations 2012 provide for the Chief Inspector of Marine Accidents to make recommendations at any time during the course of an investigation if, in his opinion, it is necessary or desirable to do so.

The Marine Accident Investigation Branch is carrying out an investigation into the fire on board the roll-on/roll-off cargo ship *Finnmaster* in Hull, England, on 19 September 2021.

The MAIB will publish a full report on completion of the investigation.

Captain Andrew Moll OBE
Chief Inspector of Marine Accidents

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[1] A previous safety bulletin, issued by MAIB in March 2022, focused on separate safety issues arising from this accident: https://www.gov.uk/maib-reports/safety-warning-issued-after-discovery-of-blocked-fixed-co2-fire-extinguishing-system-pilot-hoses

BACKGROUND

On 19 September 2021, a fire broke out in the auxiliary engine room on board the Finland registered roll-on/roll-off cargo ship *Finnmaster* while departing Hull, England. The fire was contained and subsequently extinguished without injury to the crew, but the equipment in the auxiliary engine room suffered serious damage **(Figure 1)**.

Figure 1: Damage sustained to auxiliary engine room

Finnmaster's auxiliary engine room was equipped with two main alternators. These were driven by marine gas oil (MGO) fuelled engines and named as auxiliary engine 1 (AE1) and auxiliary engine 2 (AE2). Each auxiliary engine comprised 12 cylinders in a v-shaped configuration and was rated at 1100 kilowatts.

A fuel supply pump supplied the MGO to both auxiliary engines. The fuel supply pipe was then routed to an inboard and outboard set of cartridge filters[2] and a high-pressure fuel injection pump, which were mounted on either side of each engine **(Figure 2)**.

For illustrative purposes only: not to scale

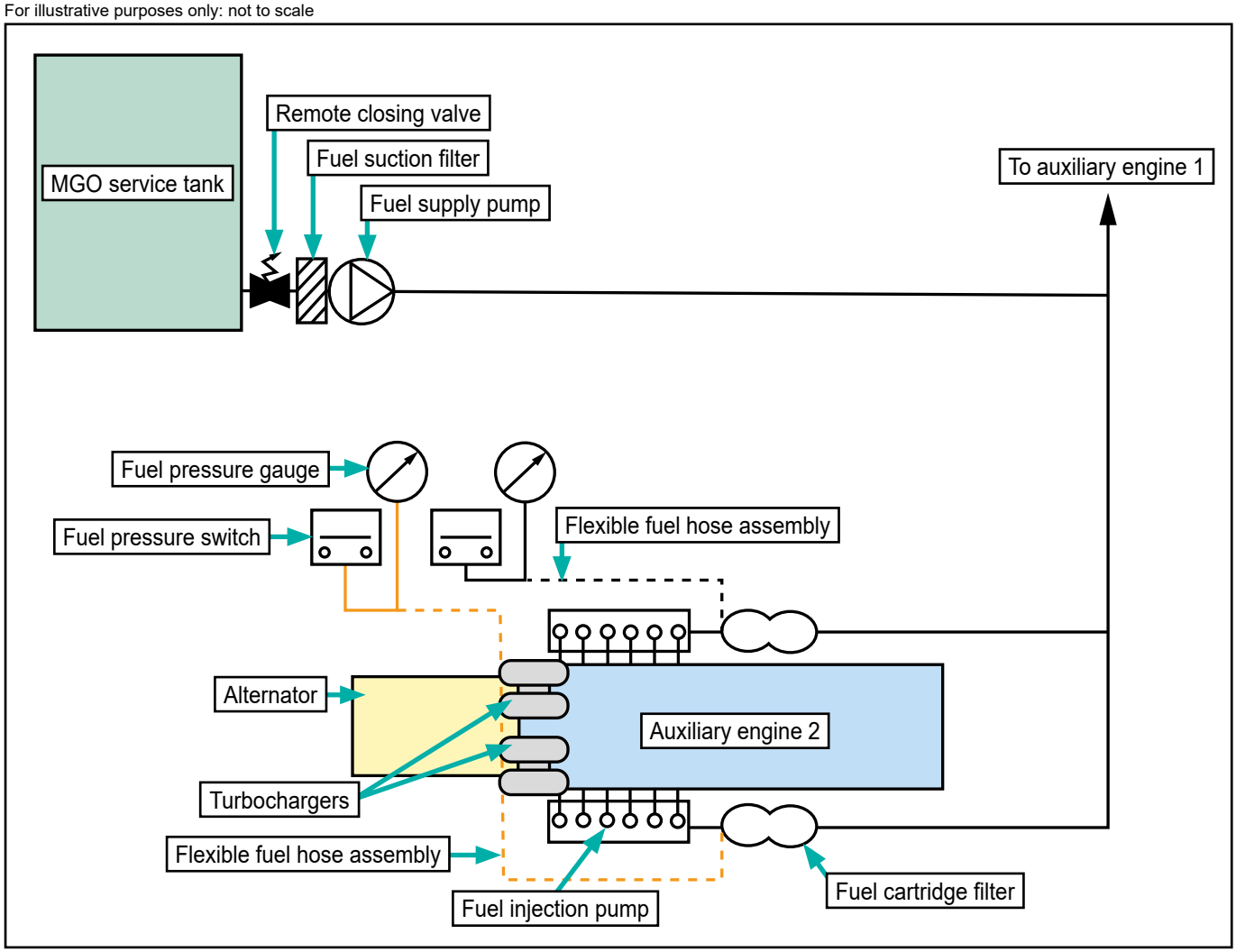

Figure 2: Schematic diagram of auxiliary engine fuel supply system

[2] A disposable filter insert contained within a housing.

INITIAL FINDINGS

The MAIB investigation identified that the fire started below the outboard turbocharger of AE2 when a small-bore flexible fuel hose failed. Exhaust gas had leaked from the outlet of the turbocharger and caused the fuel hose to overheat and fail allowing MGO to spray onto a high temperature surface, where it ignited and a significant fire developed.

Auxiliary engine alarm system modifications

Maintenance records showed that the alarm system for both auxiliary engines had been modified between April 2003 and July 2006, when *Finnmaster* was under different ownership. Low pressure fuel alarm pressure switches and gauges had been installed to both AE1 and AE2 to alert the ship's engineers should the fuel cartridge filters become blocked.

The flexible fuel hose that failed in the accident was connected to the outlet from the inboard set of AE2 cartridge filters **(Figure 3a)**; the hose was routed aft along the engine and passed over the top of the flywheel cover under the turbochargers **(Figures 3b** and **3c)**. It then connected to a pressure sensor on an instrument panel mounted outboard of the AE2 alternator. Both this hose and the matching hose on AE1 were 3.4m in length. No isolation valve was installed at the connection to the cartridge filters.

The thermal insulation that covered the auxiliary engine turbochargers had also been modified by the installation of bespoke insulation pads over the existing insulated box structure. The flexible fuel hose from the AE2 inboard fuel cartridge filters was routed under these insulation pads.

Regulation and guidance

SOLAS Convention[3] Chapter II-2: Construction – Fire protection, fire detection and fire extinction, permitted the restricted use of flexible hose assemblies *in positions where the Administration is satisfied that they are necessary*, and that, *oil fuel lines shall not be located immediately above or near units of high temperature*.

The International Maritime Organization (IMO) provided guidance on compliance with SOLAS on the use of flexible hose assemblies through its Maritime Safety Committee (MSC). In June 1994, the committee issued circular MSC/Circ.647 – Guidelines to Minimize Leakages from Flammable Liquid Systems. This stated that flexible hose assemblies *should be in as short lengths as practicable and only used where necessary to accommodate relative movement between fixed piping and machinery parts*. In June 2009, the MSC consolidated the IMO's guidance on fire safety into circular MSC.1/Circ.1321 – Guidelines for Measures to Prevent Fires in Engine-Rooms and Cargo Pump-Rooms. This circular stated that, in addition to the requirements of MSC/Circ.647, flexible hoses *should not, in general, exceed 1.5m in length*. It further advised that *hoses should be constructed to a recognized standard and be approved as suitable for the intended service, taking into account fire resistance, pressure, temperature, fluid compatibility and mechanical loading including impulse where applicable*.

[3] The International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended.

The IMO guidance on flexible hose installations, including the limitation of length, were incorporated into the rules of the two classification societies that provided oversight of *Finnmaster* during the period that the flexible hoses were in place on the vessel.

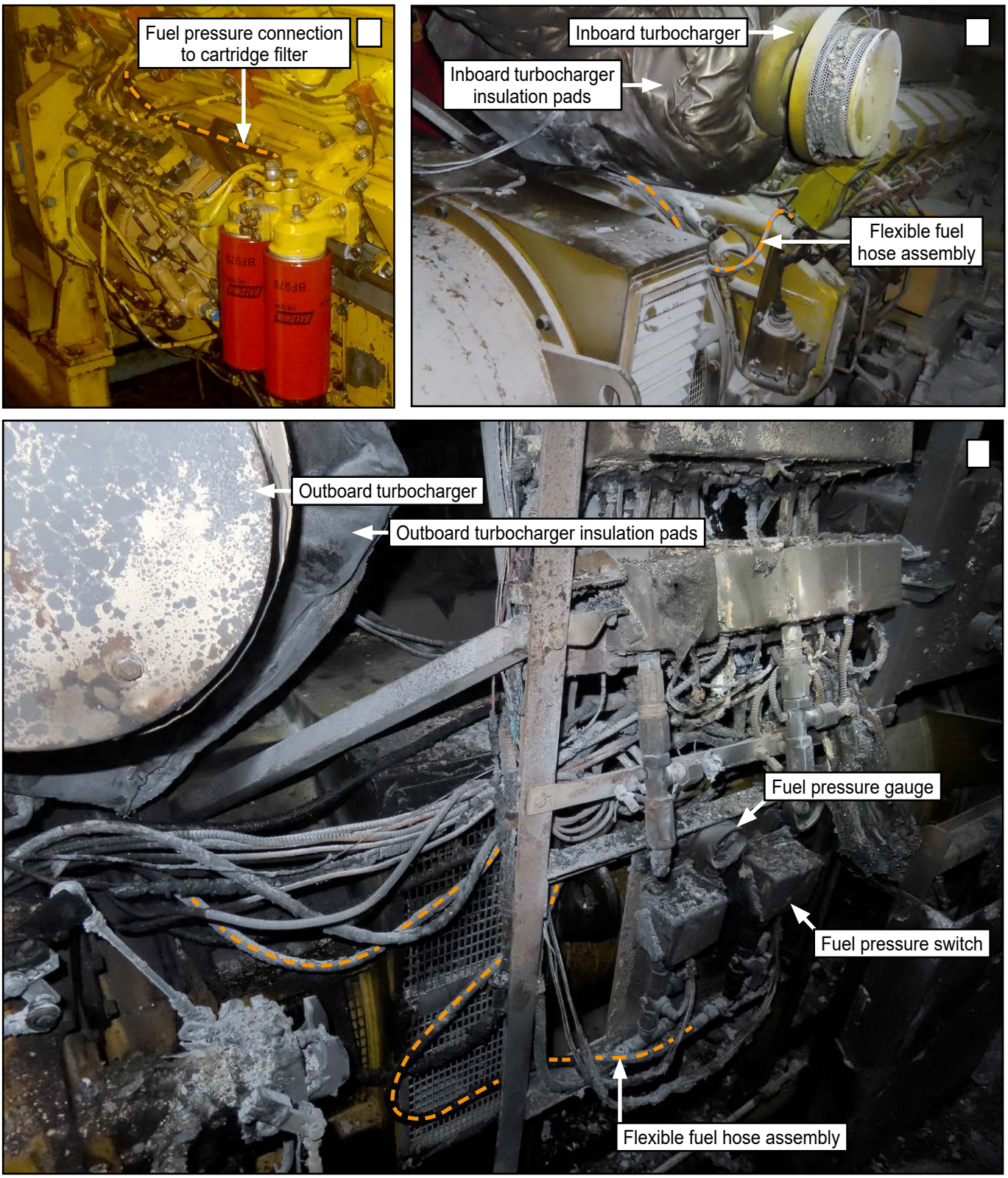

Figure 3: Small-bore flexible fuel hose assembly on AE2, as indicated by dashed orange line

FINDINGS

In this case, the flexible hose assemblies were not needed to accommodate relative movement between fixed piping and machinery parts over their entire length between the cartridge filters and the instrument panel. Furthermore, the routing of the hoses under the turbochargers covered by the insulation pads exposed them to the risk of contact with high temperatures and also made them difficult to inspect.

SOLAS, IMO guidance, and classification society rules all provided the means to ensure that systems are designed, installed and maintained so as to reduce the risk of fires in machinery spaces. The MAIB investigation into the modifications to the auxiliary engine alarm system is ongoing, but has established that the initial proposal to modify the system on board *Finnmaster* had not been submitted to the classification society for approval and the installation was not surveyed on completion. Although the flexible fuel hose was subsequently replaced a number of times during the period of over 15 years before the accident, its material, length and routing had remained the same throughout. Furthermore, the risk that the flexible fuel hoses posed to the safety of the vessel had not been identified or mitigated.

SAFETY LESSONS

- The risks associated with a modification on safety critical equipment should be considered before and during the work being completed. In this case, the positioning of the fuel pressure gauges and pressure switches required the pressure signal to be transferred from one side of the engine to the other. The relocation of the pressure switch closer to the cartridge filters would have removed the need for a long hose; if this was not possible, a rigid metal pipe secured with clamps and routed at an appropriate distance from the engine's exhaust might have been a safer option.
- Flexible hoses are recognised as having a higher risk of failure than a properly fitted metal pipe. An isolation valve fitted at the point of supply allows a flexible hose to be safely isolated in the event of leakage.
- Flag state administrations, ship operators, classification societies, marine surveyors and port state control officers are advised of the risks posed by flexible hose assemblies used in systems that carry flammable liquids if they are not installed and maintained in accordance with IMO MSC.1/Circ.1321.

Issued March 2023