

**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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The sinking of the DUKW amphibious vehicle **WACKER QUACKER 1** in Salthouse Dock, Liverpool on 15 June 2013



and

The fire on board the DUKW amphibious vehicle **CLEOPATRA** on the River Thames, London on 29 September 2013



MAIB SAFETY BULLETIN 3/2013

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

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 investigations into the sinking of the DUKW amphibious vehicle *Wacker Quacker 1* on 15 June 2013 and the fire on board the DUKW amphibious vehicle *Cleopatra* on 29 September 2013.

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



STEVE CLINCH
CHIEF INSPECTOR OF MARINE ACCIDENTS

Background

In 1998, World War 2 DUKW amphibious vehicles, modified to carry passengers on sightseeing tours, were certified by the Maritime and Coastguard Agency (MCA) to operate on the River Thames, England. The vehicles were required to comply with the stability criteria set out in Merchant Shipping Notice (MSN) 1699 (M)¹. In order to provide 110% buoyancy, the owner inserted buoyancy foam in the void spaces around the hull of each vehicle. In 2000, a similar operation was introduced in Liverpool.

On 30 March 2013, the Yellow Duckmarine Ltd (YDM) DUKW *Wacker Quacker 4 (WQ4)* sank in Salthouse Dock, Liverpool. After the accident, the MCA discovered that the hulls of all four of YDM's vehicles did not contain the 9.7m³ of buoyancy foam required to keep them afloat if flooded. The YDM's waterborne operations were suspended for 2 months while the company inserted additional buoyancy foam.

The sinking of *Wacker Quacker 1*

On 15 June 2013, *Wacker Quacker 1 (WQ1)* sank in Salthouse Dock, Liverpool, resulting in the DUKW's 31 passengers and two crewmen abandoning into the water; fortunately all were recovered without serious injury. After *WQ1* was recovered ashore, it was apparent that the vehicle had flooded because two large holes had been torn in the hull as a result of the forces generated when the vehicle's propeller became fouled by a tyre (**Figure 1**). As was the case with *WQ4*, *WQ1* sank because the volume of buoyancy foam fitted was insufficient to keep it afloat when flooded.

Following the sinking of *WQ1*, the MCA identified that YDM's other DUKWs in service again had insufficient foam fitted and suspended the company's operations in Liverpool dock. The company has subsequently entered into administration and there are no DUKW vehicles currently operating in Liverpool.

¹ MSN 1699 (M) – The Merchant shipping (Passenger Ship Construction: Ships of Classes III to VI(A)) Regulations, 1998. MSN 1699 (M) was superseded in April 2010 by MSN 1823 (M) – Safety Code for Passenger Ships Operating Solely in UK Categorised Waters.



Figure 1: Holes torn into *WQ1*'s hull after the propeller was fouled by a tyre

The MCA then checked the DUKWs operated by London Duck Tours Ltd (LDT) on the River Thames and identified that those vehicles were also deficient in reserve buoyancy. LDT voluntarily suspended its operations while it fitted additional buoyancy foam to its vehicles to achieve the 110% buoyancy required.

Post-accident tests and trials

During 30 and 31 July 2013, the MAIB conducted a series of stability tests and a flooding trial on *WQ1*. In preparation for the tests and trials, MAIB oversaw the foam insertion process. The aim was to:

- Establish if it was physically possible to fit the required volume of buoyancy foam within the vehicle's designated void spaces.
- Identify potential adverse consequences presented by the foam that might affect the safe operation of the vehicle.

The MAIB's contractors were unable to fit sufficient foam into the hull spaces to give 110% buoyancy. In total, they fitted 8m³ of foam, and only then by ignoring the need to provide the clearances required for the vehicle's moving and rotating parts. Some of the potential adverse outcomes identified were:

- fouling and overheating of moving parts
- overheating of the engine
- lack of access for routine maintenance
- inability to visually inspect the internal steel hull
- blocking of bilge pumps
- contamination of foam by oils, greases and sea water
- acceleration of hull corrosion.

These observations, made during the foam fitting process prior to the tests and subsequent trials, raised serious questions about whether the operators of DUKWs could fit sufficient foam internally to comply with the current requirement for 110% buoyancy without compromising the safe operation and the practical day to day maintenance of these vehicles.

Therefore, on 5 August 2013 the Chief Inspector of Marine Accidents recommended the Maritime and Coastguard Agency to:

2013/221 Require operators of DUKW passenger vessels in the UK to demonstrate that they are able to provide 110% effective residual intact buoyancy in their vessels, and where buoyancy foam is fitted for this purpose, the quantity installed is measured by volume and the foam does not impede the operation or maintenance of key equipment.

The fire on board *Cleopatra*

On 29 September 2013, a fire broke out inside the hull of the DUKW *Cleopatra*, an amphibious vehicle operated on the River Thames by LDT. The master was able to beach the vehicle prior to ordering the evacuation of his passengers and crewman. There were no serious injuries.

At the time of this accident, LDT had still to demonstrate to the MCA that its DUKWs could be fitted with sufficient buoyancy foam and still be operated safely.

The ongoing MAIB fire investigation has established that the seat of the fire was located under the crew seating platform close to a drive shaft coupling. Foam in the area was found to be heavily contaminated with grease and had fuelled the fire, generating thick black smoke.

A report commissioned by the London Fire Brigade and completed by Bureau Veritas' Fire Science Department concluded that:

"There was no obvious ignition source in the vicinity of the buoyancy foam, and therefore the most likely cause of fire was the action of the rotating drive shaft (or other moving parts) on the oil contaminated surfaces of the buoyancy foam blocks."

Other related accident

On 12 July 2013 LDT's DUKW, *Elizabeth*, was towed from the River Thames following the failure of a drive shaft universal coupling in her engine bay. The company's own investigation identified that the temperatures within the engine bay and surrounding areas were higher following modifications made to accommodate the insertion of the additional foam. This had caused the universal joint to overheat and run dry of lubricant. In an effort to combat this, LDT undertook to use high temperature grade grease to lubricate these joints.

Conclusion

The MAIB identified significant difficulties in fitting a DUKW with the volume of foam required to meet the buoyancy standards set out in MSN 1699 (M). Further, the nature of these old amphibious vessels, specifically their weight in relation to their size and the complexity of their propulsion arrangements, makes it difficult for operators to comply with the standards applicable to more conventional craft by solely using internal foam buoyancy. An alternative standard, ensuring that DUKWs have the necessary level of damage survivability, therefore needs to be established if they are to be operated safely.

Recommendation S2013/233

The **Maritime and Coastguard Agency** is recommended to:

In addressing recommendation 2013/221, ensure that the means used by DUKW operators to achieve the required standard of buoyancy and stability for their vessels does not adversely impact on their safe operation. Furthermore, these vessels should not be permitted to operate until satisfactory levels of safety can be assured under all feasible operating conditions.