Office of the Chief Investigator
Transport Safety

Marine Safety Investigation
Report No 2017/05

Engine fire

Hire and Drive vessel MB22M

Lakes Entrance

03 October 2017

THE CHIEF INVESTIGATOR

The Chief Investigator, Transport Safety is a statutory position under Part 7 of the *Transport Integration Act 2010*. The objective of the position is to seek to improve transport safety by providing for the independent no-blame investigation of transport safety matters consistent with the vision statement and the transport system objectives.

The primary focus of an investigation is to determine what factors caused the incident, rather than apportion blame for the incident, and to identify issues that may require review, monitoring or further consideration.

The Chief Investigator is required to report the results of an investigation to the Minister for Public Transport or the Minister for Ports. However, before submitting the results of an investigation to the Minister, the Chief Investigator must consult in accordance with section 85A of the *Transport (Compliance and Miscellaneous) Act 1983*.

The Chief Investigator is not subject to the direction or control of the Minister in performing or exercising his or her functions or powers, but the Minister may direct the Chief Investigator to investigate a transport safety matter.

SAFETY SUMMARY

WHAT HAPPENED

On 3 October 2017, a family on holiday at Lakes Entrance hired a small self-drive boat for a cruise within the Gippsland Lakes. About 20 minutes after departing the berth, the boat's engine stopped and could not be restarted. The manager of the hire company attended the boat and during attempts to restart the engine, there was a flash fire. The manager suffered burns and a member of the hirer's family sustained minor injuries.

WHAT WAS FOUND

The fuel source for the fire was petrol vapour that had accumulated around the engine and been contained within the engine cover. This accumulation was probably the result of overflow from the carburettor or a leak within the fuel system.

The ignition source for the fire was probably the high-tension ignition lead and the generation of an exposed spark during hand cranking of the engine. It was found that the connection between high-tension lead and spark plug was loose, producing conditions conducive to the creation of a spark.

It was found that this and similar boats had been permitted to operate with an inboard-petrol engine configuration. Boats powered by inboard petrol engines present additional hazards due to the relatively low flash point of petrol and the potential for fuel vapour to accumulate. As a result, national construction standards released in 1979 specified limited use of inboard petrol engines in commercial vessel applications and exclusion of their use on hire and drive vessels. However, this engine configuration was permitted on this boat (built in 1982) and similar craft operating at Lakes Entrance. The permissions would have been first granted by the Marine Board of Victoria during implementation of the 1979 construction standards although documentation detailing the rationale, processes, and any conditions associated with these permissions were not available.

It was also found that removal of the regulator's annual survey of this type of boat probably increased risk. Following the introduction in 2012 of the *Marine Safety Act 2010* (Vic) and the survey of this fleet of boats in early 2013, the requirement for their annual survey by the regulator was removed and certification issued valid for five years (to February 2018). National Law and a new regulatory framework was then introduced in July 2013 and the status of these vessels remained unchanged until this incident.

WHAT HAS BEEN DONE AS A RESULT

Action was taken by Transport Safety Victoria to halt the operation of Lakes Entrance hire and drive boats that were fitted with inboard petrol engines. The inboard engines on these boats have since been removed and replaced with outboard engines.

SAFETY MESSAGE

Boats powered by inboard petrol engines present additional hazards and require appropriate risk mitigation measures.

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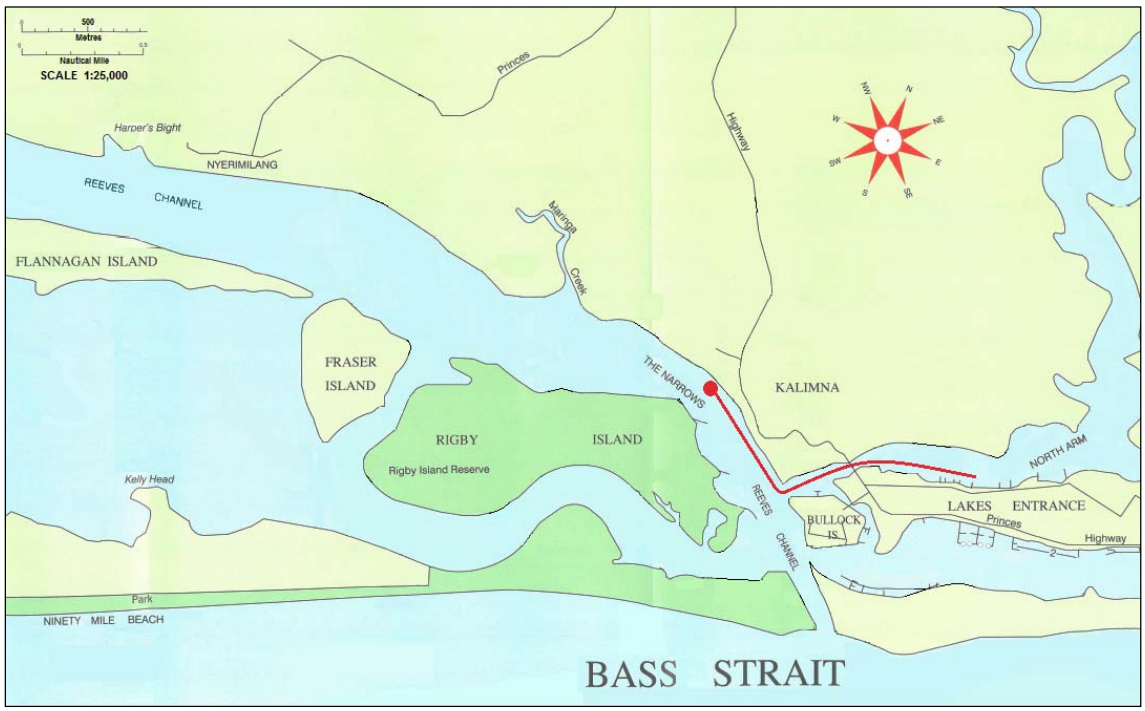
1. THE OCCURRENCE

On 3 October 2017, a family on holiday at Lakes Entrance hired a self-drive boat for two hours. The local manager[1] of the boat hire business (who was also the mechanic) provided the family with a briefing on the area of permitted operation and safety equipment, and instruction on how to start the boat's engine.

At about 1030, the family motored from the company jetty out of North Arm and turned right into Reeves Channel (Figure 1).

Figure 1: Locality of Lakes Entrance showing route taken by the incident vessel



Source: Gippsland Ports, modified by Chief Investigator, Transport Safety

About 20 minutes into the trip, the engine began to lose power and then stopped. The family had travelled approximately 2 km from their point-of-departure and the boat was in that portion of Reeves Channel known as The Narrows.

One of the family telephoned the boat hire business, and were advised that a boat would be sent to assist. However, there was a delay in attending to the disabled vessel because the rescue boat was in use assisting another of their boats that had also suffered an engine failure. After about 30 minutes the family became concerned about their tidal drift toward the ocean entrance and they telephoned again. Using the boat's oars, they rowed towards the rock wall at Kalimna and tried to hold themselves there.

The boat hire manager arrived about five minutes later and tied up alongside the disabled boat. He boarded and attempted to restart the engine using its crank handle.[2] When this was unsuccessful, he changed the spark plug, then again cranked the engine, and the engine started. The manager drove the boat briefly, then switched off the engine, disembarked to his boat, and asked the hirer to start the engine.

[1] Responsible for the day-to-day operation of the business, including hiring and maintaining the boats.
[2] The device used to rotate the engine to start it. This was the only mechanism for starting this engine.

A member of the hiring family cranked the engine, but could not start it. The boat-hire manager got back on board, and again cranked the engine at which point there was a flash fire. The manager sustained burns to the front of his body, and jumped overboard. The four members of the family were still on-board.

At this point the fire was still burning beneath the engine cover, and the family moved to board the rescue boat. However, the two vessels were beginning to drift apart and one of the family fell partly into the water, sustaining a chest injury. This family member was then pulled into the rescue boat and the boat-hire manager also climbed back into the rescue boat.

The crew of a dredge working in the area became aware of a problem when they noticed the activity aboard MB22M, and moved to help when they saw one person jump into the water. Using a tender, the dredge crew motored across to assist, and as they got close they saw the smoke. One of the crew boarded MB22M and extinguished the fire. They then took MB22M in tow to recover the vessel back to North Arm. During the tow, the dredge crew noticed a fuel smell and one of them went aboard MB22M and turned off the fuel.

The boat hire manager transported the family back to the company jetty on North Arm, where they were met by paramedics. The injured family member was transported to Bairnsdale hospital and the boat hire manager was flown to a burns unit in Melbourne.

2. CONTEXT

2.1 Victor Boat Hire

2.1.1 Ownership and management

The boat was owned by Victor Boat Hire, operating out of the North Arm at Lakes Entrance (Figure 2). The business operated a fleet of 12 boats (nine similar to the incident boat plus three others). Its hire operations could be intermittent and was dependent upon suitable weather conditions and customer demand.

Figure 2: Victor Boat Hire fleet and company jetty, North Arm, Lakes Entrance

Source: Chief Investigator, Transport Safety

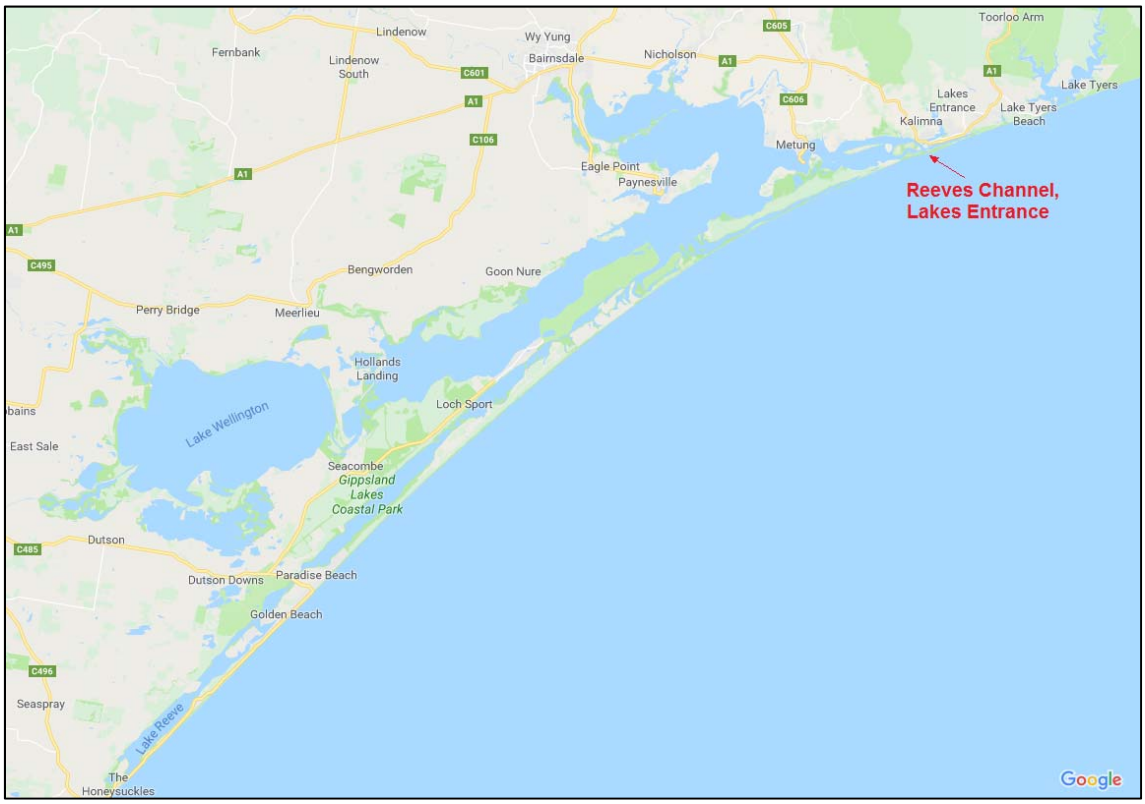
The local manager of day-to-day operations had been with the business for about three years and had been working with the hire-and-drive fleets at Lakes Entrance for a total of about 10 years. His role included hiring of boats, operational support to hirers, and maintaining the boats.

The business owner was not actively involved in day-to-day operations.

2.1.2 Operation

The Gippsland Lakes are a network of lakes, marshes and lagoons in East Gippsland, Victoria, covering an area of about 354 sq. km. Lakes Entrance is a seaside resort and fishing port on the Gippsland Lakes approximately 320 km east of Melbourne (Figure 3).

Figure 3: Gippsland Lakes located on the south-eastern coast of Victoria



Source: Google Maps. Annotated by Chief Investigator, Transport Safety

The hire boats were located in North Arm off Reeves Channel. Upon leaving North Arm and entering Reeves Channel, the boats were required to turn right (north) and proceed through The Narrows. Reeves Channel in the direction of the ocean entrance was a 'no-go' area for these vessels. Operations were permitted in daylight hours only, in good visibility and with wave heights less than half a metre.

Customers of Victor Boat Hire were instructed to operate within the defined zone and were not permitted to operate near the ocean entrance. The current at the entrance to Gippsland Lakes could be up to 5.5 knots[3] in the direction of the tidal flow (ebb or flood), reducing in strength north of Bullock Island.

Hirer's were not required to hold a marine licence to operate these boats. The *Marine Safety Act 2010* (Vic) permitted persons who did not hold a marine licence to operate powered hire vessels that were limited to a speed of less than 10 knots (about 18 km/h).

[3] One knot is 1 nautical mile/hr (approximately 1.85 km/h)

2.2 The vessel

2.2.1 Configuration

The boat was a 5.2 m half-cabin runabout of fibreglass construction (Figure 4). It was one of nine of this type within this fleet. Two other hire-and-drive businesses at Lakes Entrance also used boats of this type.

Figure 4: A typical Victor Boat Hire vessel of similar configuration to the incident boat

Source: Chief Investigator, Transport Safety

The boat was powered by a single-cylinder, W. Olds & Sons Pty Ltd, 4-stroke, 2.6 kW inboard petrol engine driving a shaft and propeller. This gave the boat a maximum speed of about 5 knots. The covered engine was located centrally within the boat (Figure 4).

Fuel was gravity-fed to the engine carburettor from a fuel tank located forward. A float valve regulated the quantity of petrol in the carburettor and the level was indicated by a pin protruding from the top of the float bowl. Depressing this pin would allow a larger quantity of fuel into the carburettor and therefore a richer fuel-to-air mixture into the engine for starting. Cranking the engine would drive a magneto[4] which would generate a spark for ignition when the piston was on a compression stroke.

[4] An electrical generator that produces pulses of high voltage in ignition systems of petrol internal combustion engines.

2.2.2 Boat maintenance

As part of its Safety Management Plan, Victor Boat Hire was required to have a description of the procedures established for inspection, maintenance, and potential withdrawal from service of a defective craft.[5] At the time of the incident, the operator had not incorporated a description of these procedures within the Plan.

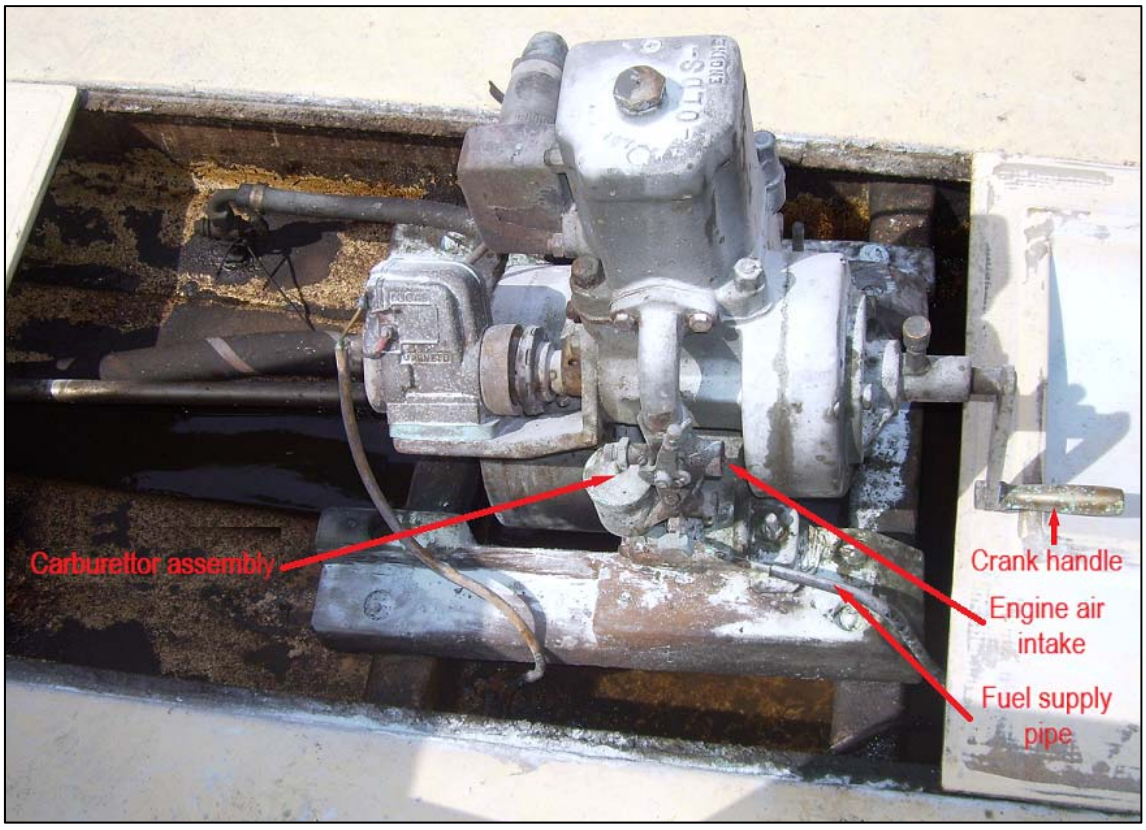
The local manager was responsible for boat maintenance and had learnt on-the-job. Larger maintenance tasks were recorded in a diary and smaller routine tasks (such as replacing a spark plug) were not recorded.

On the day of this incident, there were four boats in the fleet that were out of service due to the unavailability of engine parts.

2.2.3 Post-fire boat inspection

There was a mixture of water, oil, and dry chemical powder (from the discharge of a portable fire extinguisher) in the bilge of the boat, as well as a strong smell of petrol. The engine was coated with dry chemical powder (Figure 5).

Figure 5: Inboard petrol engine with cover removed, photographed after the incident



Source: Chief Investigator, Transport Safety

There were also soot deposits, consistent with a flash fire, on the under-side of the engine cover and in the air intake. The carburettor drip tray had been displaced and was found loose in the bilge.

[5] In accordance with the National Standard for Commercial Vessels Part F2 existing at the time of the vessel's survey and re-certification in 2013. Part F2 was amended in April 2017 with new requirements for the content of a safety management system.

The right-angled terminal connection between the high-tension ignition lead and spark plug was loose-fitting (Figure 6), indicating that the metal-to-metal electrical connection was probably unreliable. This terminal connection was exposed, and not enclosed with a protective boot. Other boats inspected in the fleet were fitted with a different and more electrically-secure connection than MB22M.

Figure 6: Connecting arrangement between high-tension lead and spark plug. The terminal connection could easily be lifted from the spark plug as shown

Source: Chief Investigator, Transport Safety

2.3 Regulatory oversight

2.3.1 Vessel construction and registration

The incident boat was registered with the Marine Board of Victoria (MBV)[6] in November 1982. It was one of a series of boats of this design constructed for hire and drive use. The first of the series was reportedly constructed in the mid-1970s.

At the time of the initial registration of MB22M, the applicable construction standard was the Uniform Shipping Laws (USL) Code (the Code). This standard included requirements for boat construction, stability, fitted equipment and safety equipment.

[6] Established in 1887 and replaced by Marine Safety Victoria in 2002.

First introduced in 1979[7], the Code limited the use of inboard petrol engines in commercial boats, and excluded their use in hire and drive boats (Class 1F). This requirement, that remained largely unchanged after its introduction, applied to inboard engines operating on fuel having a closed flash point[8] of less than 60°C. Contrary to this requirement, the incident boat and similar boats in this fleet and two other boat-hire fleets at Lakes Entrance, were registered by MBV and permitted to operate. Documented evidence detailing the rationale, processes and any conditions associated with these permissions was not available.

Available records[9] indicate that up to 2012, these boats were subject to annual survey by the Victorian marine regulator. The regulator was MBV to 2002, Marine Safety Victoria (MSV) from 2002 to 2010 and then Transport Safety Victoria (TSV) from 2010.

2.3.2 Introduction of Marine Safety Act 2010 and Regulations

On 1 July 2012, the *Marine Safety Act 2010* (Vic) and the *Marine Safety Regulations 2012* came into force. Under this Act, a vessel was required to hold a Safe Construction Certificate (SCC) and a Safe Operations Certificate (SOC). The SCC was valid for five years and transportable to all jurisdictions. The SOC was valid only for the declared area-of-operation of the vessel. The Regulations also referenced the National Standards for Commercial Vessels (NSCV) and the National Standards for the Administration of Marine Safety (NSAMS) that specified survey-level categories based on risk[10].

In February 2013, the Victor Boat Hire vessels were surveyed by TSV under these new legislative and administrative arrangements that had been introduced in 2012. The boats were surveyed as Class 1F (Hire and Drive) and a Safe Construction Certificate was issued, valid until February 2018. TSV advised that consistent with their application of NSAMS, the boats were not required to undergo annual survey by the regulator during this period of certification. Consistent with the new Act and Regulations, the fleet was also issued with a Safe Operations Certificate based on its previously-held Certificate of Survey.

2.3.3 National Law

On 1 July 2013, the *Marine Safety (Domestic Commercial Vessels) National Law Act 2012* (National Law Act) and associated Regulations were introduced. Under this Act, the Australian Maritime Safety Authority (AMSA) became the national maritime regulator. Persons within TSV were appointed as delegates of AMSA and administered the national legislation in Victoria.[11]

Within the National Law, provision was made for vessels with existing certification and survey regimes to continue. The Regulations (as amended) specified that domestic commercial vessels operating under a State-issued Certificate of Survey (CoS) or its equivalent[12] must have that certificate replaced with a National Law CoS by 30 June 2016. AMSA advised that this process was not completed for this vessel. The vessel owner was unaware of this requirement.

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[7] The USL Code was introduced by the Australian Transport Council in 1979 to provide consistent standards for the design, construction and operation of domestic commercial vessels in Australian waters. The Code has since been superseded by the National Standards for Commercial Vessels (NSCV).

[8] The temperature at which a fuel vaporizes into a flammable gas when tested using the closed-vessel method.

[9] Not all records of early survey policies were available.

[10] The Act also introduced vessel owner's safety duties and responsibilities to balance this risk-based approach.

[11] A transitional arrangement that is scheduled to cease on 1 July 2018 when AMSA takes over most service delivery.

[12] From July 2012, the equivalent certificates issued in Victoria were termed Safe Construction Certificates (SCC).

3. SAFETY ANALYSIS

3.1 The incident

The fire was a result of a spark in the presence of a fuel vapour-and-air mixture around the engine and enclosed by the engine cover.

3.2 Fuel source

It is probable that the source of the fuel was an overflow from the carburettor. It is possible that either the sticking of the float valve (that regulated the quantity of petrol in the carburettor) or the accumulation of dirt on the fuel inlet valve seat in the carburettor resulted in petrol overflowing from the carburettor and out of the air intake into the engine space. It is also possible that there was a leak at the fuel line connection to the carburettor. The engine cover had no vents apart from an aperture to accommodate the crank handle shank.[13] As a result, vaporised fuel could accumulate in this space.

3.3 Ignition source

The probable ignition source was a spark at the loose-fitting terminal connection between the high-tension ignition lead and the spark plug during hand cranking. It is probable that the ignition lead terminal connector had loosened over time, reducing the effectiveness of the electrical connection and possibly also contributing to the difficulty in starting the engine. In addition, the spark plug connector was not protected by a rubber boot.

3.4 Maintenance plan

Victor Boat Hire did not have a documented plan that described procedures for the inspection and maintenance of their fleet, including the potential withdrawal from service of a defective boat. Such a plan that highlighted safety-critical maintenance may have reduced the risk associated with this fleet.

3.5 Regulatory oversight

3.5.1 Inboard petrol engines

When the USL Code came into force, there was also provision for jurisdictions to exempt a vessel from parts of the Code. For the boat-hire fleets at Lakes Entrance, the Marine Board of Victoria (the Victorian marine regulator at that time) permitted the use of inboard petrol engines. The rationale for this decision, processes, and any associated conditions, could not be determined due to the absence of documentary evidence.

Transport Safety Victoria did not identify any records of previous instances of fire on this type of hire and drive boat at Lakes Entrance.

3.5.2 Changes to survey regime

TSV's application of new legislative, regulatory and administrative arrangements introduced on 1 July 2012 resulted in the Victor Boat Hire fleet no longer being scheduled for a regulator's annual survey. MB22M was last surveyed in January 2013 by TSV.

[13] There was also a small opening to access the throttle, but this was normally closed with a swivel cover.

The subsequent introduction in the National Law in 2013 and its application did not result in any change to the status of, or survey regime for, the Lakes Entrance hire and drive fleets.

Boats powered by inboard petrol engines present additional hazards due to the relatively low flash point of petrol and the potential for petrol vapour to accumulate. Removal of annual regulatory survey reduced oversight of this higher-risk engine type and arrangement.

4. FINDINGS

The following findings are made with respect to the engine fire aboard the hire boat MB22M at Lakes Entrance on 3 October 2017. These findings should not be read as apportioning blame or liability to any organisation or individual.

Findings are expressed as safety factors. A *safety factor* is an event or condition that increases safety risk, and if it occurred in the future would increase the likelihood of an occurrence and/or the severity of the adverse consequences associated with an occurrence. Safety factors include occurrence events, individual actions such as errors and violations, local conditions, risk controls, and organisational influences.

4.1 Contributing factors

A *contributing factor* is a safety factor that, had it not occurred or existed at the time of an event, then the event would probably not have occurred and/or its adverse consequences would probably not have occurred or would have been less.

For this event, the identified contributing safety factors were:

- There was a build-up of petrol vapour under the engine cover, probably because of overflow from the engine carburettor, or from a fuel leak
- The terminal connection between the high-tension ignition lead and spark plug was loose and lacked a protective cover
- During hand-cranking, an exposed spark ignited the fuel vapour. The spark was probably at the connection between the high-tension lead and spark plug
- MB22M was fitted with an inboard petrol engine that was contrary to construction standards for this type of commercial application. This was first permitted by the Marine Board of Victoria at the time of the boat's registration in 1982.

4.2 Other factors that increased risk

Other factors that increased risk are safety factors that existed, but did not meet the test for directly contributing to this event. These other factors are considered important to communicate in an investigation report in the interests of improved transport safety.

The identified other factors that increased risk were:

- Victor Boat Hire did not have a documented maintenance plan. Such a plan may have assisted in identifying safety-critical defects on MB22M
- The reduced frequency of regulatory survey of the Lakes Entrance hire and drive fleets lessened the opportunity for the marine regulator to identify safety-critical defects on these boats.

5. SAFETY ACTIONS

5.1 The marine regulator

The operation of the Lakes Entrance hire and drive boats using inboard petrol engines was halted by Transport Safety Victoria issuing prohibition notices under National Law, utilising delegations from the Australian Maritime Safety Authority.

AMSA has advised that all vessels of this type (grandfathered vessels with petrol inboard engines that are required to hold a Certificate of Survey) will be required to move into a 2-in-5 year survey regime from 1 July 2018. Having a petrol inboard will now be a vessel 'modifier' that will result in a vessel being in a higher level of survey frequency than it would otherwise be.

5.2 Victor Boat Hire

Victor Boat Hire and the two other boat hire fleets at Lakes Entrance with inboard petrol engines have replaced engines on their hire boats with outboard engines.

Victor Boat Hire has developed a Safety Management Plan that includes maintenance procedures.