Report 97-201

Jet Boat

foundered

Fulljames Rapid, Waikato River, Taupo

20 January 1997

Abstract

On Monday, 20 January 1997, at about 1255 a jet boat carrying ten passengers plus the driver, and a substantial amount of water in the cockpit, was proceeding up the Ngaawapurua (Fulljames) Rapid, when it lost engine power, took on more water and foundered in the rapid. The 11 occupants escaped to the river bank uninjured. Causes included the driver's failure to notice the substantial amount of water in the cockpit which affected the performance of the boat, reduced the freeboard and caused the engine to stop.

A safety issue identified was the carriage of more than the approved number of passengers. Safety recommendations were made to the operator, the Waikato Regional Council and the Taupo District Council regarding the regulation of operators on the Waikato River.

1. Factual Information

1.1 History of the trip

1.1.1 By about 1215 on Monday, 20 January 1997, ten passengers had arrived at the Rapids Jet departure point on the banks of the Waikato River, some distance below the Aratiatia Dam. Seven of the passengers had made a group booking five days prior, one other booked on the day and two casuals had arrived without a booking.

1.1.2 The Taupo District Council had issued a temporary licence for the boat to carry a total of nine people (including the driver). The driver decided to accept the ten passengers.

1.1.3 The passengers chose and fitted their own life-jackets and made their way down to the river bank where the jet boat was moored to a floating jetty. The driver, who was on the boat, called for the passengers to board. The group of seven was initially told that they would all have to fit across the middle seat. This would leave two seated at the rear (one either side of the engine) and one seated next to the driver.

1.1.4 The group of seven were unable to fit across the middle seat so one extra person sat next to the driver. There was still not enough room on the middle seat so two of the smaller persons in the group had to sit forward on the edge of the seat to make room.

1.1.5 The boat departed the jetty at about 1230, half an hour after the scheduled departure time. The driver headed up river a short distance, stopped in a calm section of the river and gave the passengers a safety talk.

1.1.6 The safety talk included a description of the fire and safety equipment fitted on the boat. The passengers were told to hold on when he gave the signal, which would be just before performing a spin (Hamilton turn), or before negotiating white water (rapids). The passengers were also told to take some of their body weight on their legs when the boat was traversing rapids.

1.1.7 After the safety talk the boat proceeded further up river to the Aratiatia Dam where the driver executed a spin. The driver stopped the boat and gave a talk about the history of the area before proceeding down river, past the start point, through the first two of three rapids (The Washing Machine and The Haybarn) and down to the third rapid (Fulljames).

1.1.8 During the down-river passage the driver executed spins near points of interest which he followed with a short commentary. The passengers in the middle and back seats "were soaked" during these manoeuvres and, according to them, water was about ankle deep in the back of the boat by the time they reached Fulljames Rapid.

1.1.9 The driver stopped and turned the boat around in a pool immediately above Fulljames Rapid. He turned and looked down river to check if there were any other river users in or near the rapid. He briefed the passengers again on how to take the weight on their legs and told them "to expect a bit of water going down".

1.1.10 Seeing no other river users, the driver turned the boat and proceeded down the rapid. According to him he had both bilge pumps switched on before starting his run. The boat took on more water over the back during the descent through the rapid.

1.1.11 The driver turned the boat in the large pool below the rapid, gave a short commentary and then asked if the passengers wanted to come back down the rapid. They all did, so he pointed out to the passengers the location of the photographer on the river bank who would take their photograph as the boat climbed the rapid, and started back up the rapid.

1.1.12 According to the driver he checked the back of the boat and noted "a certain amount" of water before starting back up the rapid. The passengers did not recall the driver asking them to move so that he could see into the back of the boat.

1.1.13 The boat climbed the rapid, reached the same turning point used on the previous run and descended the rapid again, taking on more water on each run. At the bottom of the rapid the driver turned the boat and approached the rapid again. According to him the bilge pumps were still switched on and he had again checked the bottom of the boat for water, again noting "a certain amount of water".

1.1.14 As the boat approached the rapid for the second time the driver said to the passengers that they were going to surf on the main standing wave in the rapid. According to the passengers, as the boat lifted on to the plane, the water level in the bottom of the boat was up to the ankles of those in the middle row and up to the knees of those in the back row.

1.1.15 The boat struggled to climb the wave and the driver, realising that they were not going to make it, moved the boat to the left out of the main line of standing waves and throttled off slightly. On throttling off, the engine began to falter, the left rear corner of the boat struck a rock near the river bank and the engine stopped.

1.1.16 According to the driver, the jet unit did not develop sufficient thrust to climb the rapid because a surge of aerated water in the rapid caused the jet unit to cavitate (break away) and lose thrust. He said that this occasionally happened when the river level was high and it was then his standard procedure to move left out of the standing waves. The passengers could not recall any unusual sounds coming from either the engine or jet unit during the second attempt to climb the rapid.

1.1.17 As the boat drifted down river with the current the driver, after several attempts, managed to restart the engine. He immediately manoeuvred the boat back into the main line of standing waves and tried to climb the rapid again but the engine faltered and the boat fell back off the first wave into a hole; the engine stopped, water poured over the back and the boat began to sink stern first.

1.1.18 The driver told the passengers to climb onto the bow to try and raise the stern but the boat sank before anybody could move. The 11 occupants entered the water and managed to swim to the river bank in the pool below the rapid, shaken but uninjured.

1.1.19 The boat was last seen floating down river with about 30 cm of the bow above the surface.

1.1.20 Shortly after the passengers had gathered on the river bank another jet boat happened by and ferried the group to a beach near where the photographer was standing. Meanwhile, an observer, who saw the jet boat sink, had called emergency services and by the time the group had climbed the hill from the river there were two ambulances waiting to administer any first aid required.

1.2 Boat information

1.2.1 The jet boat, constructed from aluminium, was formerly used for racing. At that time it was powered by a 454 cubic inch Chevrolet engine driving a three-stage water-jet unit and was designed for a crew of three.

1.2.2 When the operator purchased the boat in April 1996, he replaced the engine with a lighter small-block 400 cubic inch, 239 kW Ford engine driving a 10-31 single stage water-jet unit, before entering it into service as a tourist boat.

1.2.3 Although the engine was lighter, the weight of the 10-31 jet unit was about 56 kg heavier than the three-stage unit and the weight of the entrained[2] water about a further 12 kg heavier (68 kg total).

1.2.4 Over the winter of 1996 the following modifications were made to the boat:

- one of the two fuel tanks was removed reducing fuel capacity from 180 to 90 litres,
- a GRP spoiler was fitted to the back effectively increasing the freeboard across the back by about 15 cm,
- a canvas splash guard cover was fitted at the back over the engine compartment,
- twelve inflated tyre tubes were placed in the space under the foredeck for additional buoyancy.

1.2.5 The following components were renewed over the same period:

- engine fuel pump,
- jet unit impeller (reconditioned),
- battery and associated wiring,
- reverse bucket cables,
- steering cables and pulleys,
- seats (with built-in buoyancy).

1.2.6 The following safety equipment was carried on the boat:

- paddles,
- fire extinguisher,
- first aid kit,
- flotation device,
- a life-jacket for the driver and each passenger.

1.2.7 Two electric bilge pumps were located in the cockpit at the rear of the boat, one either side of the engine. Each bilge pump was rated at 1100 U.S. gallons per hour (69.4 litres per minute). Both bilge pumps were activated manually by a single push/pull switch located on the driver's instrument panel. Each pump had its own overboard discharge through the transom of the boat. The discharges were not visible from the driving position.

1.3 Driver and company information

1.3.1 The company started operation in the summer of 1994/95. The owner, who also owned several craft operating commercially on the Wanganui River, divided his time between the two locations. When he was in Wanganui the Taupo Rapids Jet operation was run by his wife, supporting ground staff and the jet boat drivers.

1.3.2 The driver on the day of the accident had been personally trained by the owner. His training included about 125 hours on the river as an observer, followed by about 125 hours while being observed by the owner. The driver held a Local Launchman Licence issued by the Maritime Safety Authority (MSA).

---

[2] Cubic capacity of the water in the jet unit which constitutes an added weight.

1.3.3 Drivers were trained to switch on the two bilge pumps frequently during the trip in case the boat was taking on water unnoticed by the driver. While negotiating the rapids the bilge pumps were to be left switched on. This procedure meant the pumps often ran dry and required frequent replacement. The owner accepted this as "a price to pay in the interests of safety".

1.3.4 Drivers were told never to proceed up or down any rapid with a significant amount of water in the bilge, and in particular no water in the bilge when negotiating Fulljames Rapid.

1.3.5 The drivers were also instructed not to exceed the eight-passenger limit on any trip.

1.3.6 About four months after the accident, during a period when the river level was low, the boat was recovered from the riverbed. The boat had been imbedded stern-first in mud on the river bottom. The engine cover was missing and the rear spoiler was damaged but the hull, although badly corroded, was intact.

1.3.7 The engine ignition key was on but the bilge pump switch was off (pushed in).

1.3.8 The electrical system on the boat had suffered substantial damage due to the long period of being immersed in water, but when the bilge pumps were tested using an independent power source they were both found to be working.

1.4 Survey information

1.4.1 The stretch of the Waikato River above the Huka Falls came under the jurisdiction of the Department of Internal Affairs Harbourmaster for Lake Taupo. Any commercial operator was required to obtain a licence issued by the harbourmaster, and to have their craft inspected to ensure it was fit for purpose. Similarly, the stretch of the river below the Paetataramoa Stream junction came under the Rotorua District Council jurisdiction.

1.4.2 The stretch of the Waikato River between the Paetataramoa Stream junction and the Huka Falls, where Rapids Jet operated, came under the Waikato Regional and Taupo District Council's jurisdiction. It was not in the Taupo District Council Plan to regulate the stretch of water on which Rapids Jet was operating, other than for the purposes of the Resource Management Act. According to the Council, matters of safety on the water were an issue for the MSA.

1.4.3 According to the Waikato Regional Council, powers under the Harbours Act were available to them, but as it was not compulsory for them to exercise those powers, they chose not to; consequently they were not regulating commercial operators on the Waikato River such as Rapids Jet.

1.4.4 The jet boats operated by Rapids Jet were under six metres in length and were therefore not required to be surveyed under the Maritime Transport Act 1994.

1.4.5 In January 1994 the MSA produced a set of recommended guidelines for authorities to use in determining the maximum number of persons which boats less than six metres in length should be allowed to carry. The formula used cubic capacity and known weights (using an average weight of 80 kg per person).

1.4.6 Notwithstanding the number of persons so derived, the guidelines recommended that the number of persons should not exceed that for which proper seating is provided based on an allowance of 450 mm of lineal seating per person where bench seats were fitted.

1.4.7 The Taupo District Council granted Rapids Jet a temporary licence to operate pending the outcome of the application for resource management consent. Using calculations provided by Rapids Jet (which were supposed to be based on the MSA guidelines) the Council restricted the maximum allowable persons to nine (including the driver). It was necessary for the Taupo District Council to specify the maximum allowable number of persons to be carried so as to define the scope of the operation and its effects on the environment, and because it was a requirement of the consent that the operator "maintained safety standards".

1.4.8 In the absence of an appropriate authority willing to inspect the Rapids Jet boats, the owner devised his own inspection and maintenance programme and employed an adventure tourism consultant to devise an operation and safety plan for the company.

1.4.9 The owner had also employed a safety officer who doubled as the photographer at Fulljames Rapid. The safety officer's duties included:

- boat security off the water
- checking that drivers followed the daily maintenance plan
- checking that drivers were operating in safety
- since November 1996, checking that drivers were completing the newly introduced safety checklist at the start of each day
- reporting any safety concerns to the owner.

1.4.10 At the time of the accident a draft "Code of Practice for the safety of Commercial Jet Boats Operating on Rivers" had been drafted by the MSA in consultation with the New Zealand Jet Boat Association. The code will come into effect in January 1998 to coincide with the implementation of the New Zealand Ship Safety Management Code.

1.4.11 Under the code all commercial jet boat operators will be required to operate in accordance with safe ship management guidelines, including boats less than six metres in length.

1.4.12 Under the code two similar criteria for calculating the maximum allowable number of persons will be used; they will be:

1.4.12.1 The boat, when in still water and loaded with fuel and weights representing a total number of persons carried (taken as 75 kg per person), must have a freeboard, measured down from the lowest point of the upper edge of the hull at which water can enter the boat, of not less than 300 mm (400 mm if the boat is to perform spins).

1.4.12.2 For the purpose of determining the freeboard, the total number of persons carried is to be taken as the driver plus the number of passengers for which there is seating. Bench seats are to be assumed to provide seating for the number of passengers obtained by dividing the lineal seat length in millimetres by 400, and rounding this to the nearest whole number.

1.4.13 Initially the boat was not available for measurement but calculations using data from the builder's file, and taking into account subsequent modifications, show that if the volume versus weight method of calculation had been used the boat would have been licensed to carry seven persons only. Dimensions used in the above calculations were similar to those measured when the boat was recovered.

1.4.14 The total weight of the 11 occupants of the boat on the accident trip was about 640 kg (the equivalent of eight persons at 80 kg each), one more than would have been allowed using the old MSA recommended guidelines.

2. Analysis

2.1 The driver of the jet boat was responsible for the safe loading and operation of the boat. He was aware that the boat was restricted to carrying eight passengers at any one time. In spite of this he exceeded the maximum number by two for that trip.

2.2 The driver did not know why the allowable number of passengers was restricted to eight. Assuming it was due to a weight factor, and noting that some of the passengers were small, he decided to carry the surplus passengers on that trip.

2.3 The driver, seeing that the passengers could not be seated comfortably and safely, should not have proceeded on the trip. On past occasions where overbooking for trips had occurred, excess passengers had been offered a reduced rate and had been carried on a subsequent trip. The driver knew that this option was available to him.

2.4 According to the driver, he was checking the amount of water in the cockpit of the boat after each manoeuvre. His assessment that there was "a certain amount of water" in the cockpit each time was imprecise and unhelpful. As the passengers were packed in tight, and the passengers were not asked to move, it is unlikely that the driver checked the level of water in the back of the cockpit at any stage.

2.5 As the bilge pump overboard discharges were not visible to the driver from his driving position, and there was no indicator to show the driver if the bilge pumps were working, a visual inspection of the back of the cockpit was the only sure way for the driver to know how much water he had in the boat.

2.6 The passengers' account of the accident indicates that there was a large amount of water in the cockpit before the jet boat ascended Fulljames Rapid for the first time. The driver maintained that the bilge pumps were working continuously. When the boat was recovered the bilge switch was found in the off position. It is possible that the switch may have been inadvertently pushed in (off) when the driver entered the water; however, the amount of water accumulated in the cockpit suggests otherwise.

2.7 The engine appeared to be operating normally during the first attempt to climb the rapid. It is likely that the jet unit was unable to drive the boat up the aerated water in the standing waves due to the additional weight of the water in the cockpit.

2.8 When the driver moved across into the smoother section of the rapid, and the engine stopped, the boat should have simply floated down into the relatively calm pool below the rapid. Given the knee-deep water at the back of the cockpit around the engine, it probably faltered and stopped due to water immersion of a key electrical component. If the engine had ingested water through the intakes it is unlikely that the driver would have succeeded in restarting it.

2.9 Once the engine stopped, its residual heat probably dried out the component enough for the driver to restart the engine. The driver offered no explanation as to why he attempted to climb the fast flowing rapid after he restarted the engine without first checking what had caused the initial stoppage.

2.10 On restarting the engine the driver could have beached the boat at the edge of the pool, removed the water from the cockpit and checked the engine. His decision to attempt the climb back up the rapid immediately, with a substantial amount of water already in the cockpit, and an engine that had already stopped once, was unwise and created an unnecessary risk to the passengers.

2.11 The driver had received comprehensive training on the Waikato River and had since successfully completed many trips through the Fulljames Rapid. He had from time to time encountered difficulties with the boat climbing Fulljames Rapid when the river was flowing fast, due to the ingestion of aerated water into the jet unit causing cavitation and resultant loss of thrust. On each of those occasions he had moved left, off the standing wave, into smoother water and continued up the rapid.

2.12 Much of the information and instruction to the Rapids Jet drivers and staff was given verbally. The Taupo District Council did not require the Rapids Jet boats to be inspected, or for them to have operational safety plans and written instructions in the form of company manuals for the staff to follow.

2.13 In the absence of these requirements the operator had implemented an inspection and maintenance plan of his own; however much of the day to day and standing instruction was given verbally. This created the potential for staff to forget the instructions, or ignore them.

2.14 When the New Zealand Ship Safety Management Code becomes mandatory it will encompass operators such as the Rapids Jet, who currently are not regulated for safety by the local authority.

3. Findings

3.1 There was no requirement for Rapids Jet to have their boats surveyed under the Maritime Transport Act 1994, nor to have them inspected under the Taupo District Council Plan.

3.2 If the MSA Guidelines For Launches and Boats had been applied correctly, the operator's temporary licence should have specified the boat carry a maximum of seven persons only, instead of nine.

3.3 In carrying 10 passengers on the accident trip, Rapids Jet were not complying with the terms of the temporary licence issued by the Taupo District Council.

3.4 The driver on the accident trip knowingly exceeded the nine-person limit for the jet boat despite the verbal instruction he had received not to exceed eight passengers on any one trip.

3.5 The driver did not appreciate the amount of water that the boat had taken onboard during the trip because the crowded cockpit made it difficult for him to check the water level in the cockpit near the stern visually.

3.6 The substantial amount of water which the boat accumulated in the cockpit during the various manoeuvres performed on the trip reduced the freeboard to an unsafe level.

3.7 The reduction in performance caused by the extra weight of water in the cockpit contributed to the boat being unable to ascend Fulljames Rapid on the second attempt.

3.8 The engine probably stopped due to water immersion of a key electrical component.

3.9 The driver's decision to re-enter the rapid without checking the cockpit for water, and with an engine that had already stopped once, was ill considered.

4. Safety Recommendations

4.1 It was recommended to the owner of Rapids Jet that:

4.1.1 As a matter of urgency, he register Rapids Jet with an approved organisation to comply with the Code of Practice for the safety of Commercial Jet Boats Operating on Rivers under the New Zealand Ship Safety Management Code. (046/97)

Such action will become mandatory in January 1998.

4.2 It was recommended to the Taupo District Council that they liaise with the Waikato Regional Council to:

4.2.1 Ensure all operators of commercial vessels in areas under their jurisdiction who are not currently monitored for safety by another organisation, be made to comply with the New Zealand Ship Safety Management Code as a matter of urgency, (047/97); and

4.2.2 Monitor and regulate the number and type of commercial operators on the stretch of the Waikato River between the Huka Falls and the Paetataramoa Stream to ensure that such operations do not pose a safety hazard to each other and their clients. (051/97)

4.3 Taupo District Council responded as follows:

4.3.1 Regarding the recommendation for Taupo District Council to liaise with Environment Waikato on the matter of commercial vessels Code Compliance, this is accepted and we will take this up immediately. The matter has been an ongoing concern with the practical issues of monitoring and regulating requiring resolution.

4.4 It was recommended to the Waikato Regional Council that they seek the necessary powers under the Harbours Act and in liaison with the Taupo District Council or other relevant authorities to:

4.4.1 Ensure all operators of commercial vessels in areas under their jurisdiction who are not currently monitored for safety by another organisation, be made to comply with the New Zealand Ship Safety Management Code as a matter of urgency, (060/97); and

4.4.2 Monitor and regulate the number and type of commercial operators on the stretch of the Waikato River between the Huka Falls and the Paetataramoa Stream to ensure that such operations do not pose a safety hazard to each other and their clients. (061/97)

4.5 It was recommended to the Director of Maritime Safety that he:

4.5.1 In consultation with the commercial jet boat industry, expand the section on **Bilge Pumping** in the **Code of Practice for the safety of Commercial Jet Boats Operating on Rivers** to reflect the following:

Where practicable, bilge pumps should be activated automatically and the driver should be provided with an indicator which shows when each pump is operating; and

Where practicable, the overboard discharge(s) should be located in a position where the driver can observe the discharge. (057/97)

4.6 The Director of Maritime Safety Responded as follows:

4.6.1 Maritime Safety Authority will be including the Code of Practice for Jet Boats in Part 80 of the Maritime Rules....The requirement relating to the provision of bilge pumps stipulates that "it is recommended that one bilge pump be self activating with automatic visual means of indicating to the driver that it has been activated." No reference has been made to the position of the discharge as the visual indicator is considered sufficient and there are practical problems in locating the discharge where it can be seen by the driver. The rule is to be released for industry and public comment shortly.

18 August 1997

Hon. W P Jeffries
Chief Commissioner

Glossary of marine abbreviations and terms

AC	alternating current
aft	rear of the vessel
beam	width of a vessel
bilge	space for the collection of surplus liquid
bridge	structure from where a vessel is navigated and directed
bulkhead	nautical term for wall
bus	an arrangement of copper conductors (Bus bars) within a switchboard, from which the circuits are supplied
cable	0.1 of a nautical mile
chart datum	zero height referred to on a marine chart
command	take over-all responsibility for the vessel
conduct	in control of the vessel
conning	another term for "has conduct" or "in control"
DC	direct current
deckhead	nautical term for roof
dog	cleat or device for securing water-tight openings
draught	depth of the vessel in the water
EPIRB	Emergency Position Indicating Radio Beacon
even keel	draught forward equals the draught aft
freeboard	distance from the waterline to the deck edge
free surface	effect where liquids are free to flow within its compartment
freshet	term used to describe an increase of water level in the river due to rain in the mountains
focsle	forecastle (raised structure on the bow of a vessel)
GM	metacentric height (measure of a vessel's statical stability)
GoM	fluid metacentric height (taking account the effect of free surface)
GPS	Global Positioning System
GS	general service
heel	angle of tilt caused by external forces
hove-to	when a vessel is slowed or stopped and lying at an angle to the sea which affords the safest and most comfortable ride
Hz	Hertz (cycles)
IMO	International Maritime Organisation
ISO	International Standards Organisation
kW	kilowatt
list	angle of tilt caused by internal distribution of weights
m	metres
MSA	Maritime Safety Authority
NRCC	National Rescue Co-ordination Centre

point	measure of direction (one point = 11¼ degrees of arc)
press	force a tank to overflow by using a pump
SAR	Search and Rescue
SOLAS	Safety Of Life At Sea convention
sounding	measure of the depth of a liquid
SSB	single-side-band radio
statical stability	measure of a vessel's stability in still water
supernumerary	non-fare-paying passenger
telegraph	device used to relay engine commands from bridge to engine room
ullage	distance from the top of a tank to the surface of the liquid in the tank
V	volts
VHF	very high frequency
windlass	winch used to raise a vessels anchor