



**Civil Aviation Advisory
Publication**

Revised September 2010

This publication is only advisory. It provides information relevant to ditching an aeroplane.

Contents

1. Acronyms	2
2. Ditching	2
3. General technique	2
4. Behaviour of the aeroplane on impact	4
5. Escape from the aeroplane	5
6. Survival aspects of ditching	6
7. Checklist	6
8. Ongoing survival considerations	7
9. Rescue	10
10. Conclusion	11

Ditching

The relevant regulations and other references

- Civil Aviation Regulation 1988 (CAR) 253 (3); and
- Aeronautical Information Package – En Route Supplement Australia (AIP ERSA).

This CAAP will be of interest to

This Civil Aviation Advisory Publication (CAAP) applies to all pilots who operate over water.

Why this publication was written

This publication has been written to provide advice to operators of issues relevant to ditching an aeroplane and came about as a result of Australian Transport Safety Bureau (ATSB) Safety Recommendation 2000258 which recommended that the Civil Aviation Safety Authority (CASA) educate the industry on the procedures and techniques that may maximise the chances of survival in a ditching event.

Status of this CAAP

This CAAP is intended to assist pilots and operators to plan for and execute a ditching. It also provides advice on the subsequent issues associated with survival while waiting for rescue.

For further information

For application and policy advice, contact CASA's Operational and Flight Crew Licensing Standards Branch, (Telephone 131 757).

1. Acronyms

CAAP	Civil Aviation Advisory Publication
CASA	Civil Aviation Safety Authority
ERSA	En Route Supplement Australia

2. Ditching

2.1 The majority of aeroplanes are not designed for ditching!

2.2 However, the statistical chances of surviving a ditching are high. It is estimated from United Kingdom and United States of America data that 88% of controlled ditchings result in few injuries to pilots or passengers.

2.3 You are more likely to die after ditching by drowning, usually hastened by hypothermia and exhaustion. By wearing a life jacket in the aeroplane your survival prospects are greatly improved. However in cold water, at temperatures of 15 degrees Celsius or less, your life expectancy is only about one hour.

3. General technique

3.1 If one has to ditch what are the issues?

3.2 In general terms it is always preferable to impact the water as slowly as possible, under full control; don't stall the aeroplane in. Keep the wings parallel with the surface of the water on impact, i.e. wings level in calm conditions. One wing tip striking the water first will cause a violent uncontrollable slewing action.

3.3 In ideal conditions you should always ditch into wind because it provides the lowest speed over the water and therefore causes the lowest impact damage. This process is effective provided the surface of the water is flat or if the water is smooth with a very long swell inside which the aeroplane will come to rest.

3.4 If the swell is more severe, including breaking waves, it is more advisable to ditch along the swell, accepting the cross wind and higher speed over the water, because this is preferable to ditching into the face of a wave and nosing in. Ditching into the face of a wave is very likely to cause extreme damage to the aeroplane and violent deceleration with severe implications for passengers and crew. The final approach will result in considerable drift which must be controlled to achieve the required tracking over the water. You must be careful to maintain sufficient airspeed to ensure that any action you take in controlling the path of the aeroplane does not lead to a stall. You must retain complete control of the aeroplane.

3.5 In extremely windy conditions, greater than 20 kt for light aeroplanes with low stalling speeds or 30 kt or more for heavy aeroplanes with high stalling speeds, it may be worth ditching into wind to gain the large reduction in speed over the water. Aim to touchdown on the receding face of the swell. You may need to compromise between the beneficial effects of wind and the problems of swell. Advice on judging wind speed is provided in the table at the end of this CAAP.

3.6 In many cases, especially for modern or the more complex aeroplanes, the aircraft flight manual (or pilot's operating handbook) will provide detailed handling information for the execution of a ditching. For example, one light aircraft manufacturer recommends that their aircraft not be flared for landing due to the difficulty in judging the height of an aircraft above the water surface and the potentially serious consequences of a stall. However, in the absence of such information you should consider the following:

- Don a life jacket if time permits;
- Reduce the aeroplane's weight to a minimum if you have time and if practicable. This will reduce the stalling speed and therefore your planned impact speed;
- Ensure landing gear is up and the associated circuit breaker is pulled;
- Dispose of, or restrain, any loose articles in the cabin which could create a hazard during impact;
- Consider possible airframe distortion on impact and arrange to have an escape door or hatch open before impact so that you can vacate the aeroplane;
- Make every effort to precisely control airspeed and rate of descent; both should be as low as possible, consistent with maintaining full control of the aeroplane. If you are conducting a glide approach you must consider approaching at a higher speed which will provide the lift energy necessary for the larger than usual flare required to achieve an appropriate rate of descent at impact;
- Ditch into wind if possible otherwise ditch along the swell (see above); a compromise may be necessary in extreme cases;
- Use flaps set to a medium position to ensure the slowest speed on impact—flaps also usually induce a lower angle of incidence and therefore smaller aeroplane body angle when approaching stalling speed thus providing for a better aeroplane attitude on impact;

- If possible make the approach using power. If the ditching has to occur because of impending fuel exhaustion, make the approach before all the fuel is expended. A powered approach provides for the greatest potential to execute a successful flare and hold off enabling the aeroplane to have almost no descent rate at impact;
- Be prepared for a violent impact. There will probably be two or more impacts—the tail end of the aeroplane followed by the entire fuselage.

3.7 At night the use of lights could be critical. You should set the cockpit lights as low as possible to optimise your night vision and carefully consider the use of landing lights or possibly taxi lights. The directional nature of landing lights could cause confusion for the pilot, whereas the more general light provided by taxi lights may prove more satisfactory. If the air is misty (a serious probability if there is blowing spray), the glare of external lights could upset your night vision and prove more of a hindrance than a help.

3.8 One of the most difficult things to get right in a ditching is judging the height for the flare and hold-off (see the comment regarding not flaring the aircraft at paragraph 3.6 above).

3.9 Judging height over water can be extremely difficult particularly when the water is calm or on a very dark night. An aneroid altimeter will be of little use unless you have an accurate QNH. The best device to use is a radio/radar altimeter if you have one. If all else fails set up a low rate of descent (less than 200 feet per minute) and wait. This is another good reason for conducting a powered approach if power is available.

4. Behaviour of the aeroplane on impact

4.1 The overall design of an aeroplane has a significant influence on how it will behave during the ditching impact. As a general rule, aeroplanes with an almost straight fuselage under surface will behave in a more benign manner than those with a swept up rear fuselage. Because of the angle of attack of the wings near the stall, all aeroplanes have a nose high, tail low attitude near the stall and therefore, if flown correctly, will have such an attitude as they impact the water. Thus the rear fuselage will impact the water first, except for fixed undercarriage aeroplanes. If the rear fuselage is markedly upswept it is not unusual immediately after impact for the aeroplane to violently pitch up to an almost vertical attitude before violently crashing down onto the surface and probably nosing under the water. Aeroplanes with straight under surfaces are less likely to suffer such a violent pitch up and subsequent violent pitch down.

4.2 The use of a moderate flap setting also has an effect as mentioned above, both reducing touch down speed and aircraft body angle.

4.3 Ditching into the face of the swell or into waves should be avoided because the aeroplane will behave in a similar manner to one impacting a cliff face.

4.4 Aeroplanes with fixed undercarriages strike the water wheels first. This is most likely to cause violent nose down pitch with the aeroplane ending up in a near vertical position with the nose buried under the water. Individual aeroplane design may have a significant effect on this outcome with aeroplanes with a significant amount of their structure ahead of the main wheels performing in a less violent manner; however, a misjudged flare may exacerbate the consequences of a ditching.

4.5 After the aeroplane has come to rest, high wing aeroplanes may quickly assume an attitude where most of their fuselage, and therefore you, is under water. Low wing aeroplanes are more likely to keep the fuselage above water. How long either type stays in that position before sinking is related to many issues. It is best to assume that you will have little time, so evacuate the aeroplane quickly but in an orderly and organised manner. This is best achieved if all the passengers and crew have been comprehensively briefed during the descent phase prior to impact so that everyone knows what actions to take and what their responsibilities are.

5. Escape from the aeroplane

5.1 You have survived the impact now to leave the aeroplane before it sinks.

5.2 First, it is worth considering how best to protect yourself from the worst effects of the ditching impact. Obviously you should be well strapped in, if possible using upper body restraint. Even in this situation your head and legs are not well restrained and are prone to damage with obvious results. Consideration should be given to protecting the head and legs by adopting the crash position. Restraining head and leg movement during impact should be considered. The issue of body protection during severe impact situations is a large and complex subject which will only be covered in this CAAP at a superficial level.

5.3 Now to leave the aeroplane. As has already been mentioned, it is best to have a door or hatch wedged open before impact because airframe distortion may make it difficult if not impossible to open the door after impact. However, ingress of water during the impact should also be considered but normally have at least one door or hatch open.

5.4 If you have not been wearing your life jacket make sure you collect it before you exit the aeroplane and put it on as soon as possible. Do not inflate it inside the aeroplane—it will almost certainly seriously impede your exit. Collect and deploy life rafts if you have them. Collect all signalling equipment and survival gear you have; ideally it should all be combined in one or more convenient packs or included in your life jacket or life raft.

5.5 At night it is advisable to have the cabin lights on.

6. Survival aspects of ditching

6.1 If you have any influence on where you are going to ditch consider making ease of rescue an issue. Thus if possible ditch near a benign shoreline if you can't land on solid earth. Ditching near a treacherous shoreline on the other hand should be avoided. Seek out shipping if any are within range and try to ensure that they see you. Ditch in the front hemisphere of the ship though not directly in line with its track!

6.2 Strap in tightly, protect head and legs to the best of your ability. Use pillows, blanket rolls or soft baggage as devices to restrain excessive and violent movement of your extremities. If you intend to use a life raft it is advisable to consider your footwear. Soft shoes and ones with rubber or other soft soles and heels should be satisfactory but high heel shoes and ones with hard and angular soles and heels should be discarded. If you are likely to have to swim, discard your shoes.

6.3 The overall issues related to survival in order of importance are:

- protection;
- location;
- water; and
- food.

6.4 If this does not mean much to you start learning about survival after you have finished reading this document. The Survival section in ERSA would be a good starting point.

7. Checklist

7.1 Before long over-water flights review your plans for ditching and subsequent survival, and establish what rescue services are available and how you can optimise their usefulness.

7.2 The following suggested coverall check list is provided for your consideration. It is not designed for your aeroplane or your operation—you must make your own check list considering the issues raised above and the information provided in this check list:

- Plan to ditch using power if you have a choice;

- Look for likely rescue sources—ships, shorelines;
- Make Mayday calls, for the correct format—see ERSA, set transponder code to 7700;
- Study the wind and sea surface then make a plan of action for the direction of the ditching manoeuvre;
- Burn off or jettison fuel if possible to ensure the aeroplane is as light as practicable;
- Jettison any freight and other unnecessary heavy objects;
- Brief all crew and passengers, covering their actions and responsibilities before and after the ditching event including the use of a life jacket;
- Ensure all survival equipment is readily accessible, including your personal locator beacon;
- Ensure there are no loose objects anywhere in the cockpit or cabin;
- Conduct pre-landing checks, leave undercarriage up unless it is advised to do otherwise;
- Select an intermediate amount of flap to optimise lift but not providing high drag, unless advised otherwise;
- Wedge open some doors or hatches;
- Make a final decision on the direction of ditching;
- Set up the final approach not below 500 ft above the surface;
- Unless the aircraft manufacturer recommends to the contrary, if you can accurately judge the height of the aeroplane above the water, round out at the usual flare height and hold off until impact, ensure rate of descent is less than 200 ft per minute and wings parallel with the sea surface (level for a calm surface);
- After the aeroplane stops, vacate, taking all necessary gear; and
- Only inflate your life jacket when outside the aeroplane.

8. Ongoing survival considerations

8.1 It is no good surviving for a time if you cannot be found or no one is looking for you, so ensure that you have a good personal locator beacon, preferably one that communicates via a satellite, and that someone will miss you when you don't arrive. Consider activating a locator beacon before impacting the water.

8.2 Survival is a complex issue. Statistics tell us that only 50% of those that survive the ditching survive to be rescued. You are advised to seek out specialised training appropriate to your operation and the climatic conditions in which you operate. What follows are some general guidelines which in no way can substitute for proper training.

8.3 After leaving the aeroplane, survival is the only issue to consider until rescue arrives. But to give you the best chance of rejoining civilization you should have already made a number of important decisions.

8.4 ***Plan for the Worst.*** The first decision is to accept that ‘it could happen to me’. This means you should be prepared, taking into account reasonably foreseeable outcomes.

8.5 Single engine aeroplanes are more likely to ditch than twin engine aeroplanes. Approved single engine aeroplanes are most unlikely to ditch. However, any aeroplane can find itself in a situation where the only option is to ditch.

8.6 Another variable to consider is the time factor; how long are you flying over water? Crossing a river is usually going to represent less risk than crossing the Pacific Ocean, all things being equal.

8.7 How should you prepare? First ensure that air traffic services know you exist and carry your search and rescue details, and take at least one personal locator beacon on your flight.

8.8 Ensure that you have enough appropriate life jackets for everyone and possibly a spare or two. Notice the word ‘appropriate’. A life jacket not designed for use in an aeroplane is not appropriate. An airline life jacket will also not be appropriate in many aerial work or private operations where the jacket should be worn regularly. If you are in doubt about which sort of life jacket to use discuss the matter with an aviation safety equipment supplier or servicing agent. Your life jacket should be equipped with at least a whistle and a light. Calling out is much more difficult than blowing a whistle when you are trying to attract someone’s attention, and a light or strobe is invaluable at night.

8.9 Civil Aviation Order (CAO) 20.11 provides the minimum legislative requirements acceptable to CASA for the carriage of life jackets and life rafts. You might consider that your life deserves more stringent compliance.

8.10 If the water is cold or you are flying far away from rescue services you would be advised to carry sufficient life rafts to cater for everybody onboard. You may also consider using enhanced body protection such as immersion suits in extreme conditions of cold. Out of the water, woollen clothes retain 50% of their insulating qualities when wet as opposed to cotton, which retains 10%. In the water only specialised clothing is likely to provide significant protection. You lose a great amount of heat from your exposed head. In or out of the water, any form of hat or head covering should be used—even a plastic bag will help keep your head warm. Consider first aid too:

- start the breathing;
- stop the bleeding;
- protect the wound;
- immobilise the fracture; and

- treat for shock.

8.11 If this means little to you consider getting some first aid training.

8.12 **Survive.** You have lived through the ditching now you have to survive until you are rescued.

8.13 If possible always wear your life jacket in the aeroplane, it will prove very difficult to put on in the confined space after you have suffered an emergency. If wearing the jacket is not practical be sure you know where it is and how to get it without delay. **Do not inflate the life jacket inside the aeroplane.** Collect any other survival and signalling equipment you have provided for yourself and leave the aeroplane. Once outside inflate the life jacket as soon as possible.

8.14 If you do not have a life raft enter the water and move away from the aeroplane, attempt to keep close to other people and assist them as best as you can. Make every effort to keep together including connecting each other together by a line if you have one. Aeroplane tie down ropes would be most useful in such circumstances. Ensure you attach your survival and signalling equipment to yourself.

8.15 If you have a life raft attach it to the aeroplane by a line and deploy it. In high winds and rough water it will be very easy to lose your life raft as it deploys and literally blows away. Enter the raft ensuring that your footwear and other items of apparel do not represent a risk to the delicate fabric of the life raft. Take all your survival equipment with you and any other articles which could be of use (e.g. blankets, warm clothes, rope), but also consider the weight of this equipment and the buoyancy of your life raft.

8.16 Once everyone is on board the life raft with your selected equipment, detach the life raft from the aeroplane and move clear. Obviously, at any time, if the aeroplane starts to sink, immediately detach the life raft. Ensure the raft's sea anchor is deployed as soon as practical, inflate the floor and erect the canopy to provide added protection. Attach at least one person to the raft just in case it overturns—it will make reboarding easier. Bail out the water and use the sponge provided to dry the inside of the raft. Ensure the buoyancy chambers are fully inflated, a hand pump is provided for the purpose. The chambers should be firm but not rigid; do not over inflate.

8.17 Activate any emergency locator equipment (one personal locator beacon at a time unless you become separated) and make yourselves as comfortable as possible. Consider how long you expect to wait until search and rescue services arrive and plan accordingly. With a group of people it is advisable to instigate a shift system to keep a lookout for searching aircraft and shipping. There should be somebody performing this essential task at all times.

8.18 Sort out your signalling equipment to ensure that it is readily available if a search aircraft or passing ship arrives in your area. You should educate yourself on how to use the equipment and in the case of devices such as heliographs practise using them. Remember that in the wide expanse of the ocean an individual or even a life raft is extremely difficult to find. There can be few more depressing feelings than being missed by a searching aircraft, so help the searcher all you can.

8.19 Make every effort not to become seasick—vomiting will advance the adverse effects of dehydration. Seasickness tablets may be a useful item for your survival pack. Keeping your body adequately hydrated is always an important physiological aspect of survival.

8.20 If you do not have a life raft and find yourself alone in a vast expanse of water, **do not give up hope. Your will to survive is the most powerful force to prolong your life.**

8.21 In cold water your largest threat is losing body heat. As quickly as possible perform any manual tasks before your hands become too cold to function properly. Ensure your personal locator beacon is activated and if possible attach it to your life jacket, with the aerial as vertical as possible. Keep as warm as you can by adopting the Heat Escaping Lessening Position (HELP). Hold the inner sides of your arms against the sides of your chest and fold your arms in front of you to keep the cold water from freely circulating all around your arms. Hold your thighs together and raise them slightly to protect the groin, again with the objective of reducing water circulation around critical parts of the body.

8.22 If you are with others huddle together in small groups of three or four with the sides of your chests and lower bodies pressed close together. Place children in the middle of the huddle. In all cases do not swim to retain body heat—such exercise and associated blood flow will only accelerate the heat loss process. If you are a strong swimmer you may consider swimming to a shore but only for distances of up to 1.5 km. Otherwise wait for rescue unless none will be coming because no one knows about you or your predicament.

8.23 Even if you do not have a life jacket, do not give up hope. Cushions, plastic bottles, boxes, polystyrene pieces, even plastic bags inflated like a balloon can help.

9. Rescue

9.1 If survival equipment is dropped to you, use it. It will often consist of two or more attached packs. Climb on board the life raft and investigate what equipment has been provided for you and use it as instructed.

9.2 When rescue services arrive do not stop signalling until you are certain they have you in contact. Then stop signalling. Then:

- remain seated, do not stand up;
- wait for them to initiate the rescue—do not do anything on your own initiative;
- if a helicopter is making a winching rescue, do nothing until instructed by the winch person. Do not reach out for the cable; and
- do as you are instructed—they are the experts.

10. Conclusion

10.1 Most accidents are preventable with forethought and competent operation. All accidents are made more survivable with forethought and competent action.

10.2 Make sure you plan your flight carefully and recheck your calculations; better still get someone else to recheck your rechecked calculations. Ensure your aeroplane is fully maintained and that you trust the person doing that maintenance. Always plan for the worst case and add a buffer particularly in the quantity of fuel you plan to uplift. Fuel in the tanker will do you no good! CAAP 234-1 provides good guidance about the minimum fuel you should carry, but remember that the variable fuel requirement only caters for 10% to 15% error in wind effect on your flight. Are you prepared to bet your life on a met forecast?

10.3 If you have to ditch, use your pre-planned checklist and do what it says.

10.4 Employ the survival advice you have gained from previous training.

10.5 Plan and prepare for the worst, you are worth it!

Wind Versus Sea State

Wind Speed	Appearance of Sea	Effect on Ditching
0-6 kt	Glassy calm to small ripples.	Height very difficult to judge above glassy surface. Ditch parallel to swell.
7-10 kt	Small waves; few if any white caps.	Ditch parallel to swell.
11-21 kt	Larger waves with many white caps.	Use headwind component but still ditch along general line of swell.
22-33 kt	Medium to large waves, some foam crests, numerous white caps.	Ditch into wind on crest or downslope of swell.
34 kt and above	Large waves, streaks of foam, wave crests forming spindrift.	Ditch into wind on crest or downslope of swell. Avoid at all costs ditching into face of rising swell.

Note: The effects on ditching mentioned in the table are appropriate for light aeroplanes only.