BULLETIN RE-ISSUED

A report on this event was originally published in the August 2008 issue of the AAIB Bulletin. Since publication, additional information has came to light, and the investigation was re-opened, in accordance with Section 15 of *The Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996*, and the report is herewith re-issued.

INCIDENT

Aircraft Type and Registration:	Cessna 208 Caravan I amphibious floatplane, G-MDJE
No & Type of Engines:	1 Pratt & Whitney Canada PT6A-114A turboprop engine
Year of Manufacture:	2001
Date & Time (UTC):	24 May 2008 at 1930 hrs
Location:	Overhead Partick, Glasgow
Type of Flight:	Commercial Air Transport (Non-Revenue)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Water rudder detached in flight
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	34 years
Commander's Flying Experience:	4,615 hours (of which 6.5 were on type) Last 90 days - 32 hours Last 28 days - 6.5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and AAIB examination

Synopsis

Whilst flying at 1,200 ft over Glasgow, the left float water rudder fell from the aircraft due to a failure of the rudder attachment post. The damage to the attachment post was consistent with the aircraft 'reversing' into a submerged object during manoeuvring with the water rudders deployed.

History of the flight

The aircraft had taken off from the River Clyde on a positioning flight to Loch Lomond. Shortly after reaching its cruising altitude of 1,200 ft, a vibration was felt through the aircraft which lasted for approximately 10 seconds. The pilot carried out a visual inspection of the airframe from the cockpit and observed that the left water rudder was missing. The aircraft diverted to Glasgow Airport where an uneventful landing was made. The water rudder was later recovered in a garden in the Partick area of Glasgow. No one on the ground was injured.

Description of the aircraft

The aircraft was a Cessna 208 Caravan 1 fitted with a pair of Wipaire Inc Wipline model 8000 amphibious floats. These are fitted with a retractable wheeled landing gear to allow the use of conventional runways in addition to waterborne operation. Each float is fitted with a retractable water rudder on its rear bulkhead, connected to the aircraft's rudder system via a series of

cables and bellcranks. The rudders are retracted when taking off and landing on water, and are deployed to when manoeuvring on water at slow speed. With the rudders retracted for takeoff and landing, it is highly unlikely that the rudders could be damaged by any floating or semi-submerged objects. The rudders are designed to pivot upwards in the event that they do hit an object passing forward to aft, thereby minimising any potential damage.

Rudder system examination

It was reported that there were no entries in the aircraft's technical log relating to the water rudder system. Initial examination by the operator and their maintenance organisation revealed that the water rudder attachment post at the rear of the left float had been distorted and that the welds on the rudder pivot tube had failed, allowing the rudder to separate from the float. Prior to the removal of the rudder post, the water rudder steering cable tension was checked and found to be 8 lb.

A photograph of the post, Figure 1, showed that it had been liberally coated with grease as a corrosion prevention measure. After removal, it was dispatched to the AAIB for detailed examination. Damage was also found on the rear float bulkhead, Figure 1, which indicated that the rudder had, at some time, rotated sufficiently to allow the pivot bolt to make contact with the bulkhead.

Maintenance history

The approved inspection program for the Wipline model 8000 floats details two periodic inspections of the water rudder system. One should be conducted at 25 flying hour intervals involving inspection of the rudder blades and posts for damage, security and corrosion. The other should take place every 100 flying hours, inspecting the rudder steering and retraction system for damage as well as ensuring correct rigging. Both checks are also carried out during the aircraft's annual inspection.

The aircraft records showed that the last 100 hour inspection had been completed on 1 May 2008 and the 25 hour inspection on 21 May 2008, four days prior to the incident. There was no documented evidence to suggest that any problems had been identified during these inspections. A manufacturer's installation drawing for the water rudder and its cable systems, provided by the operator, indicated that both the steering and rudder retraction cables should have a tension of 30 lb, plus or minus 5 lb, whereas the service manual states *'CABLES SHOULD BE TENSIONED TO 10 POUNDS +/- 5'*

Figure 1

Damaged rudder hinge post

Detailed examination

The rudder mounting post consists of a square-section steel tube with hinge points and a rudder 'steering input bar' secured to its forward face. A tube is welded into a 'cut out' in the lower aft portion of the post which provides the attachment and retraction pivot point for the rudder blade, Figure 2. A mechanical stop is fitted to the bottom of the rudder post to prevent the rudder swinging too far forward when deployed. Examination showed that the steering input bar had been bent to the left, and the mounting post distorted rearwards, where the pivot tube had been welded to the post, Figure 3. The tube had separated from the post. The rudder post was distorted on its aft face, and there was 'tearing' of both tube sidewalls where the pivot tube had been secured.

Damaged water rudder hinge post

Microscopic examination revealed that the upper and lower failure surfaces, together with the 'tears' in the post sidewall, exhibited characteristics of a failure due to overload. The circumferential welds securing the pivot tube to the rudder post had not completely penetrated the post sidewall, and had also failed in overload, Figure 4. Both of the rudder post sidewalls in the region of the circumferential welds had been distorted by the application of a torsional load in a clockwise sense (viewed from the rear). There was no evidence of corrosion or crack progression by a fatigue mechanism on any of the fracture faces. When operating from water, the water rudder pivot is below the waterline which together with the presence of a liberal

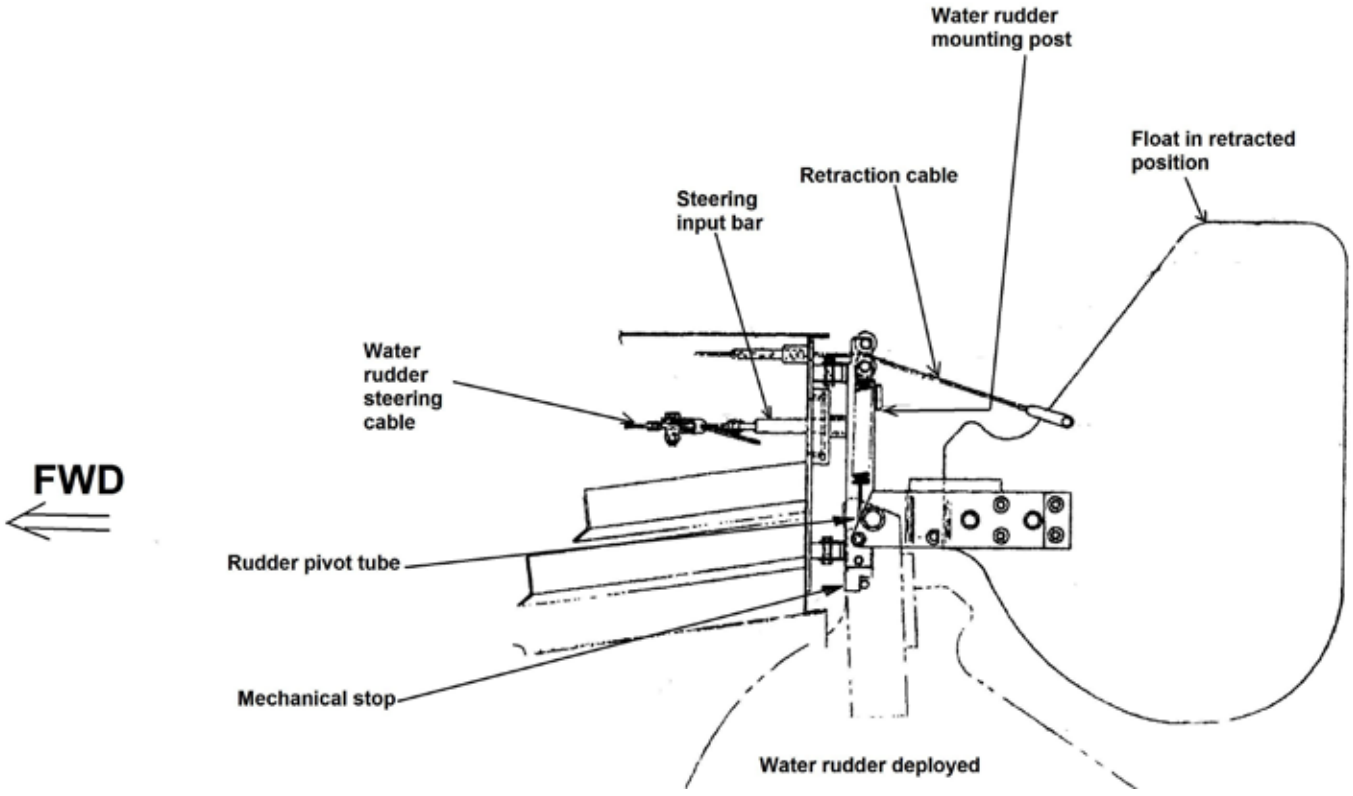

Figure 2

Water rudder installation diagram

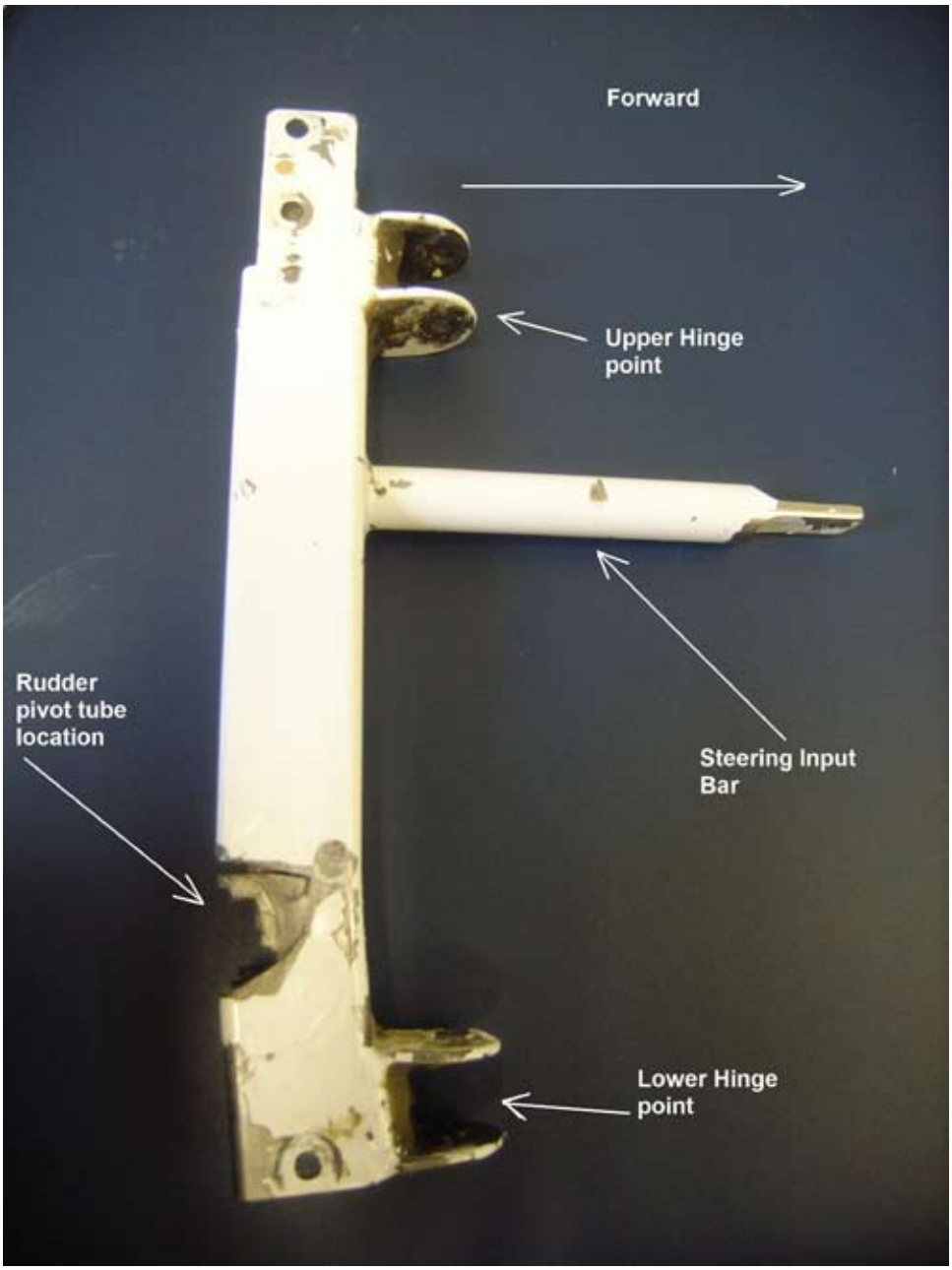

Figure 3

Damaged water rudder hinge post

coating of protective grease, may have prevented the damage to the post being observed during a pre-flight inspection on the water.

Analysis

The operator has highlighted to the manufacturer the disparity between the cable tension requirements detailed in the float installation drawing and the manufacturer's service manual. The manufacturuer is reviewing the situation and has undertaken to issue clarification of the cable tension requirements.

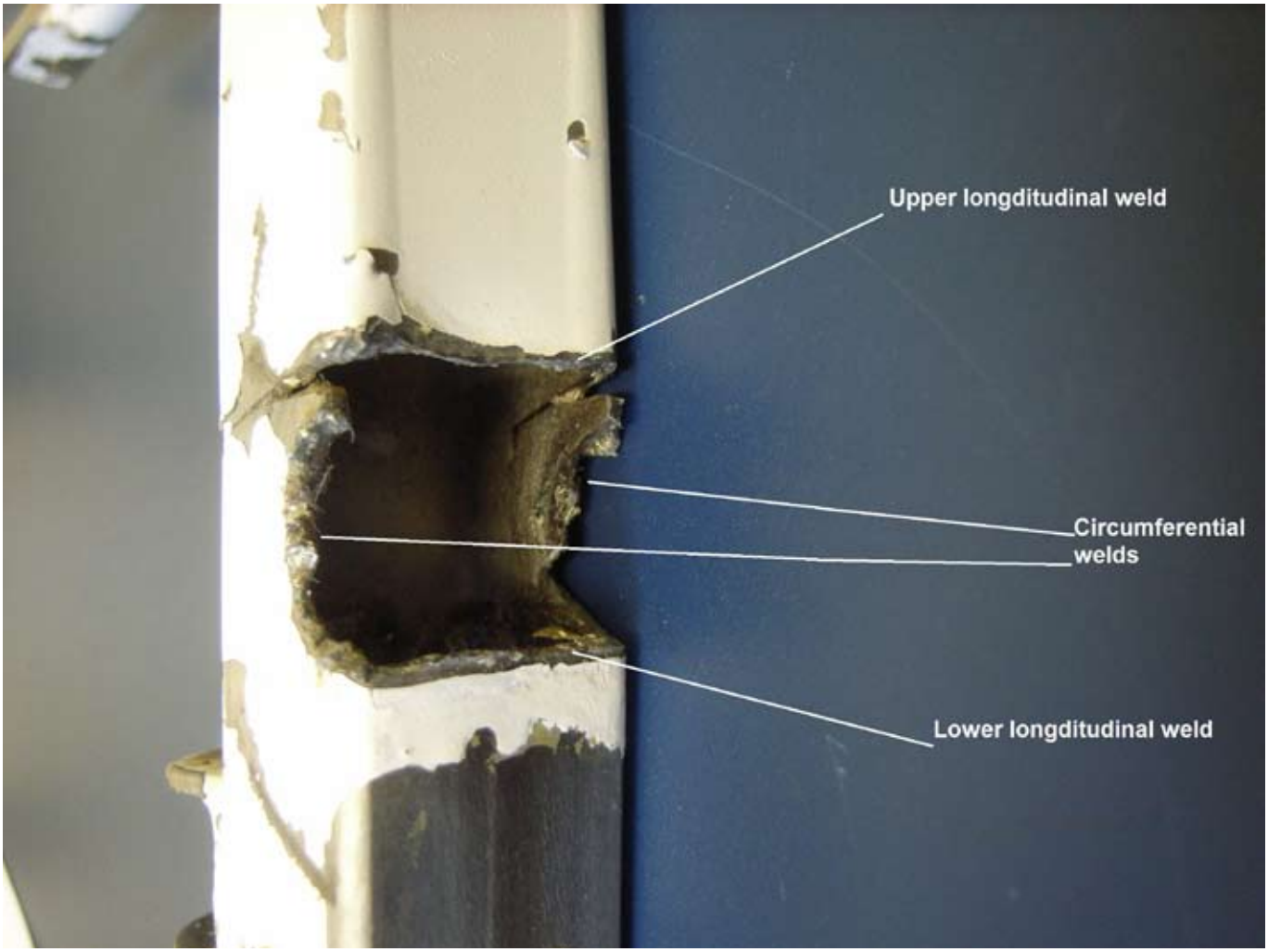

Figure 4

Rudder post weld details

The deformation of the rudder mounting post indicated that the rudder pivot tube had been pulled aft, causing the aft wall of the rudder post to fail where the pivot tube was attached. The 'tears' in the post sidewalls illustrate that, despite the welds securing the pivot tube having only partial material penetration, they were able to transmit sufficient load to damage the rudder post sidewalls without failing. The damage observed was consistent with a force being applied to the lower portion of the rudder from the rear whilst deployed. This caused the rudder to 'pivot' about the lower mechanical stop, producing the rearward bending of the post where the pivot tube was attached. The force was of sufficient magnitude to cause the failure in overload of the two longitudinal welds securing the pivot tube. The distortion of the post sidewalls close to the circumferential welds showed that a torsional load had been applied through the pivot tube, in a clockwise sense (aft looking forward), after the failure of the upper and lower longitudinal welds which resulted in the failure of the sidewalls. The subsequent failure of the remaining circumferential welds allowed the rudder to separate from the aircraft. It could not be determined when the damage to the

rudder post had occurred. The bending of the steering input bar indicated that, either the rudder had been restrained against a right rudder input from the cockpit or, more probably, given the use of cables in the water rudder system, an external force being applied to the rudder, forcing it to the left. The damage to the rear bulkhead of the float was indicative of 'overtravel' of the water rudder. It is considered possible that this could be caused by the water rudder cables being incorrectly rigged. However, the aircraft records made available during the investigation showed no evidence of this prior to the incident. The damage to the rudder mounting post was inconsistent with it being damaged as a result of hitting the rear bulkhead of the float.

Conclusions

Given that the rudder became detached from the aircraft in-flight, the force applied to the rudder, although sufficient to cause significant damage to the mounting post, did not result in the immediate separation of the rudder. Whilst the point at which the rudder became damaged was not identified, the lack of evidence of crack progression through fatigue suggests that the damage had not been present on the aircraft for a prolonged period. Given the rudder's location, the damage to the post should have been visible during an 'out of water' pre-flight inspection but unlikely to have been seen during an inspection whilst water-borne.

All the damage observed on the rudder mounting post was consistent with the rudder being struck from behind, with some force, whilst deployed. It is considered that this was more likely to have occurred whilst the aircraft was being manoeuvred on the water, when it may have 'reversed' into a submerged object, rather than being struck from behind by a moving object.