

Party Submission

Technical Analysis of ASG-29 Accident near Ely, Nevada on July 11, 2020

September 18, 2022

Andy Kanigowski



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SECTION 1: PROPOSED FINDINGS FROM DOCUMENTED EVIDENCE

SECTION 1: DEBRIS FIELD

The debris field, stretching over 150 feet, is rather large for a glider accident. The debris field curves strongly to the left indicating that the glider was in a left spiral turn (as opposed to straight flight - which would have seen the debris distributed in a straight line).

The size of the debris field indicates a high-speed (high-energy) flight and impact. This type of debris field rules out a stall or spin which would result in a small, more contained, debris field.

There is no doubt that the first point of impact was the glider's left wing hitting the ground.



IMG_5531: Crash site and debris field.

SECTION 1: LEFT WING – EXTENSIVE DAMAGE FROM INTERNAL WATER BALLAST

There is no doubt that the left wing was full of water ballast at time of impact.



Image_1985: Reconstructed fragments of lower and upper parts of left inner wing.

The re-assembled fragments of the left wing clearly demonstrate damage consistent with the outward expulsion of water contained in the wing inside the integrated water tanks.

This inner wing section houses the internal water tanks along its entire 5m span, in the forward first half of the wing chord (see appendix Figure 2.4-1). Observations show this section of the wing was broken into fragments along the entire 5m span, precisely along the forward half of the wing chord where the water tanks are located.

The damage observed indicates that the left wing was full of water ballast. Upon impact, the mass of the water inside the wing was propelled forward and exploded the wing into fragments from the inside-out.

The water ballast had a downward and a forward component vector force, severely damaging the lower surface and upper surfaces of the wing. The forward component of the force of the water split open the leading edge of the wing, separating the wing into top and bottom wing surfaces along the entire leading edge of the inner wing section.

The top of the wing sustained damage from the forward force of the water as the water burst forward along the front half of the wing cord, tearing the top surface in a diagonal pattern consistent with its fiberglass construction.

The bottom of the wing received extensive damage as most of the water burst downward through the bottom of the wing, breaking the bottom wing surface it into small fragments.

This photo shows the top surface of the wing laid on top of a metal rack, while the bottom wing is shown on the floor, dark interior turned up (as would be the correct orientation for bottom of the wing).



Image_1995: Left Wing (Top and Bottom)



Image_1983: Top of Left Inner Wing



Image_1982: Top of Left Inner Wing



Image_1994: Front View of Left Inner Wing



Image_1989: Side View of Left Inner Wing



Image_1992: Side View of Left Inner Wing



Image_1997: Left Wing Extension

This image above shows the detached 1.5m left wing extension. The left wing extension was first part of the glider to impact the ground. The wing extension broke away from the inner wing section upon impact and sustained minor damage. This fiberglass wing section (without internal water) sustained little damage, even though it impacted the ground first.

This is consistent with the observation that the damage on the inner section of the wing was caused by the water contained inside the wing, rather than impact with the ground.

SECTION 1: RIGHT WING – MINOR DAMAGE – NO WATER BALLAST

There is no doubt that the right wing was empty of water ballast at time of impact.

The right wing shows only minor signs of damage (in striking contrast to the water born damage sustained on the left wing). The right wing structure, including top and bottom surfaces, is completely intact and is not broken apart like the left wing. Lack of damage on the right wing indicates that the right wing was empty of internal water ballast. Lack of water ballast makes the wing significantly lighter and prevented any substantial damage.

If the right wing contained water ballast inside the integrated wing tank, there would be extensive damage to the wing (as observed on the left wing). The right wing was traveling at the same speed as the left wing and if it contained water, the sudden deacceleration and momentum of the water would cause substantial damage (as was observed on the left wing). Lack of this type of damage is evidence that the right wing was empty of water ballast.

The photo below shows the right inner wing section in good condition (considering the high energy of the crash). The top surface is damaged slightly at the outer end (upper left corner), where a single piece of the upper surface has come loose (most likely when the outer wing section detached from it).

The entire leading edge of the right wing and both upper and lower surfaces from the (orange) airbrake to the wing root show very little damage.



Image_1980: Right Inner Wing

SECTION 1: FAULTY WATER RELEASE CABLE TERMINATION

Evidence suggests that there was catastrophic malfunction of the water ballast release system.



Image_2829: L/H rocker view from outside.



Image_2832: L/H rocker view from inside.



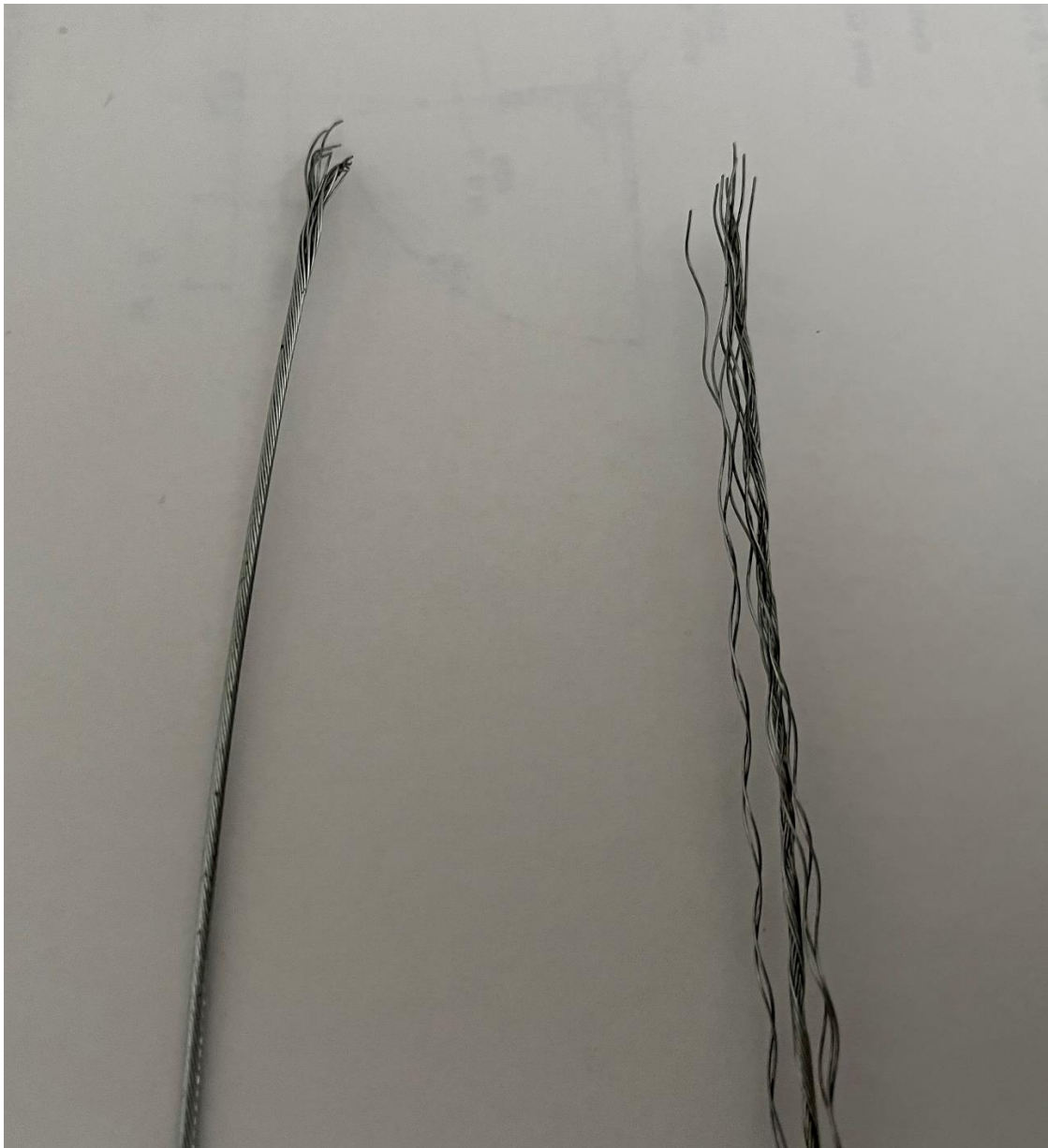
Image_2833: L/H rocker close-up view showing side profile of crimp on brass tube.



Image_2836: Crimp on brass tube measures 0.25 inches (6mm) in size.



Image_6094: L/H Bowden cable pulled out from the brass tube.



Image_2837: Difference observed between Left Cable and Right Cable showing tensile forces.

The water release Bowden cables are a multi-stranded steel cable (1.5mm in diameter) that feed directly into a female brass tube mounted to the rocker assembly that is located on the inside of the fuselage at the root wing rib.

The Bowden cables leading to both the right and left wing water tanks were inspected for signs of damage related to high tensile tension, especially at the termination end of the cable (by the rocker housing).

Observations show that cable to the right wing is broken in a manner which shows signs of tensile stress. The ends of the cable are frayed due to tensile force pulling on the cable during impact. This indicates that the cable termination was secure during flight and broke

under significant load during impact. This evidence suggests that the right valve was operational during flight, allowing the water from the right wing to be jettisoned.

Observations show that the cable to the left wing does NOT show signs of stress or breaking under tensile force. The evidence suggests that the cable termination failed prematurely (during flight).

The Bowden cable termination represents a critical "weak link" in the water ballast release mechanism.

The design of the cable termination is problematic in that the cable is secured in the brass female tube using only a crimp to hold it in place. This termination method lacks ANY safety feature or fail safe to prevent the cable from coming loose or detaching from the female housing. The crimp-style termination is not suitable for a critical aircraft assembly. This design is susceptible to manufacturing defects and fatigue. The cable termination should be made safer using a full-loop attachment to ensure that the cable cannot pull free with repeated use.

These elements provide the best evidence that the faulty cable termination on the left side disengaged prematurely during flight (making it impossible to open the left release valve and jettison the water in the left wing). In theory, when the pilot activates the water release lever inside the cockpit, it is designed to release water from both wings simultaneously - assuming that both cables and valves are working properly.

There is no doubt that the root cause of this accident was caused from the failure of one of the two independent water release valves to open.

Evidence suggests that the left cable disengaged from the female brass tube, not under the stress of impact, but when the crimp termination failed. This failure occurred in-flight causing the left wing water release valve to remain closed (the valve is spring loaded and normally closed). The left valve remained closed and prevented the jettison of water from the left wing, meanwhile the right valve was opened, releasing all the water from the right wing.

There is no doubt that failure of the water release system led to a severe asymmetrical weight imbalance which caused the glider to enter a left spiral dive that was unrecoverable, directly precipitating the accident.

The ASG-29, when configured for 15m wingspan, lacks sufficient aileron force to recover from such a flight attitude under asymmetrical water ballast load.



IMG_1988: Width of aileron on 15m wing tip extension ("mini-aileron")

SECTION 2: PROPOSED PROBABLE CAUSE

The proposed probable cause of this glider accident is a severe weight imbalance caused by failure of water ballast release cable of the left wing coupled with insufficient aileron force of 1.5m wing extension which does not allow controlled flight with such weight imbalance.

Factor 1: The “root cause” is the faulty joint of the water release Bowden cable which pulled out from its sleeve and prevented the water in the left wing from being released (while the water in the right wing was released). The failure of this critical component in one of two independent valves caused an asymmetrical loading of water ballast. The maximum imbalance of water (one wing full, the other empty) caused the aircraft’s left wing to be 85kg (190lbs) heavier than the right wing. This represents a severe weight imbalance, especially in the shorter wingspan 15-meter configuration.

Factor 2: Lack of a warning system to notify the pilot when water is not being released from one of the wings may be considered as a contributing factor.

Factor 3: In the 15-meter wingspan configuration, the aileron design at the outer tip of the aileron is only 1.5in. wide (chord-wise). The 15m aileron is half the length compared to the 18-meter aileron. This could be called “mini” aileron. It lacks sufficient force to lift an excessively heavy wing from a banked turn to return to level flight. In this attitude, the aircraft will quickly accelerate into a high-speed spiral dive (within seconds) resulting in uncontrollable aircraft.

SECTION 3: PROPOSED SAFETY RECOMMENDATIONS

The following safety recommendations are proposed to ensure pilot safety and to prevent possible accidents in the future:

SECTION 3: SERVICE BULLETIN AND DESIGN CHANGE

1. Change the crimp-style termination of Bowden cable to a fail-safe design which ensures the cable cannot pull free from the housing. The existing crimp-style termination, without additional safety feature, presents a potentially life-threatening hazard and should be rectified.
2. Provide indicator to verify when water release valve fails to open.

SECTION 3: OPERATING LIMITS

1. Decrease permissible water ballast in 15-meter wing configuration of ASG-29.

The size of ailerons on 1.5m wing extension is evidently too small to provide sufficient aileron force to lift a heavy wing in a full asymmetrical weight imbalance.

The amount of permissible water ballast should be limited to an amount such that sustained, controlled flight can continue with a maximum weight imbalance which may potentially occur if one wing does not release water.

If a partial water ballast limit is not feasible or practical, consider full ban on flying with water ballast in 15-meter configuration.

SECTION 3: MANDATORY INSPECTION

1. ASG type glider (or similar) equipped with independent water ballast release valves and crimp style cable termination should undergo mandatory inspection to verify that the termination of Bowden cable in the female brass tube of the housing assembly is adequately secure.

The inspection should include:

- a. test by applying rigorous hand-force to the water ballast release lever (r/h side of cockpit), forcefully pushing it to the full-forward position, and back again, repeatably (as the flight manual suggests in the event of uneven water release).
- b. inspect for any weakness of the crimp-style termination of Bowden cable which is the weakest link of the water ballast release system.

SECTION 3: PILOT ADVISORY

Following this investigation, I interviewed a couple pilot-owners of this glider type. I was alarmed to find that the pilots had a cavalier attitude about the safety of this glider.

The fine reputation of these sailplanes may contribute to a **false sense of security** and a belief among some pilots that nothing mechanical in these gliders can go wrong. This is a dangerous attitude.

The flying community needs to be better informed about what occurred in this fatal accident and the potential risks associated with flying with water ballast in the 15m wingspan configuration, even in these “high performance” gliders.

Manufacturers are not impervious from mistakes, design flaws, or manufacturing defects.

The evidence in this case is indisputable: the mechanical failure of a release cable precipitated this accident. NTSB should make sure that this flaw is recognized, publicized, and rectified to prevent similar incident in the future.

APPENDIX

ASG-29 GENERAL DESCRIPTION OF SAILPLANE

The ASG-29 derives from the ASW-27. The type certification is carried from the ASW 27. For some authorities, the designation needs to reference the type certificate, therefore, in the manuals, the denomination used to refer to this glider is ASW 27-18.

The ASW 27-18 is a high performance, single-seat, flapped sailplane with exchangeable wingtips for 15m and 18m wingspan. This makes it possible to fly within FAI 15m Class or 18m Class. The ASW 27-18 is suitable for record breaking and competition flying.

The ASW 27-18 is a shoulder wing glider with T-tail (fixed stabilizer plus elevator) and retractable landing gear with hydraulic disc brake. Detachable 0.5m high winglets are installed at the wing tips.

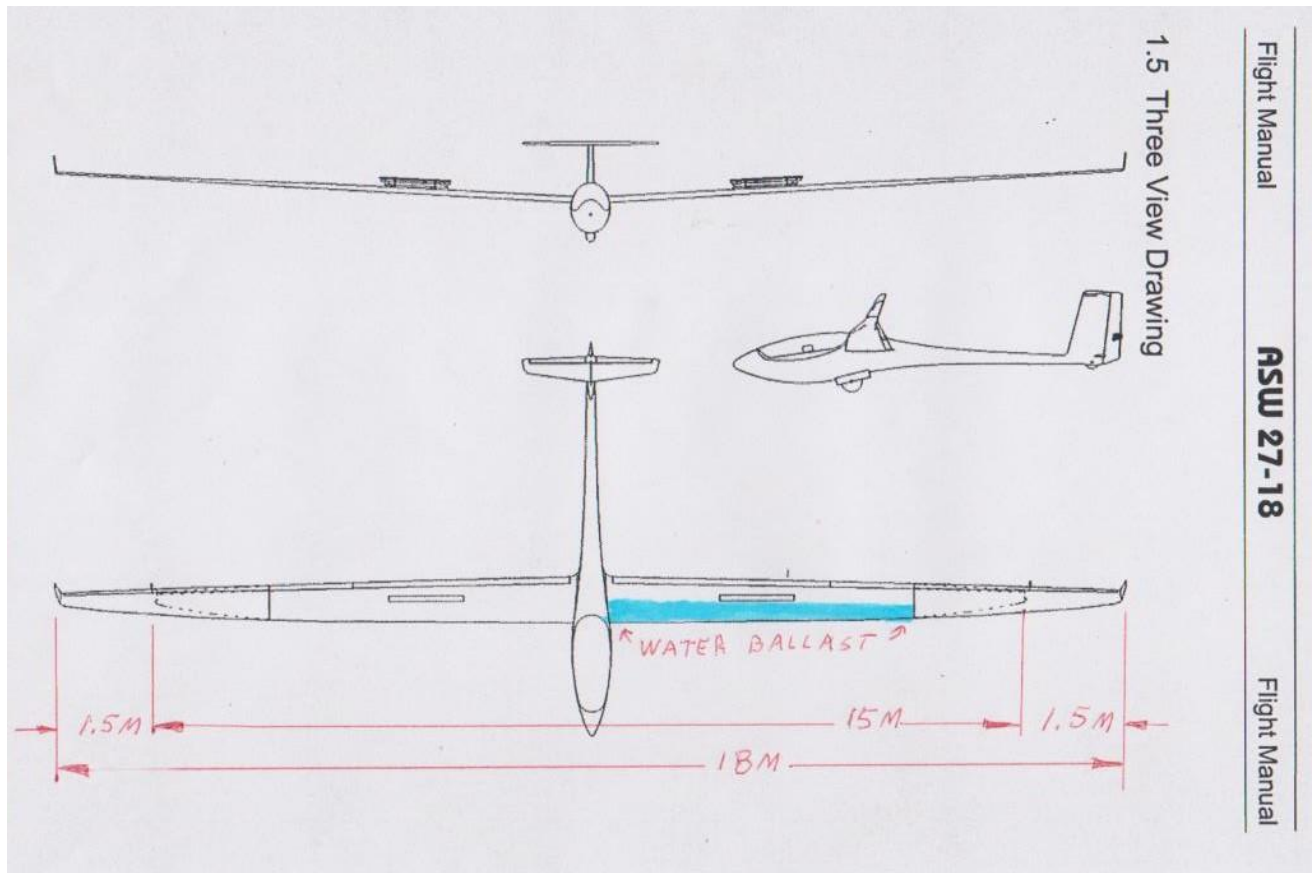


Figure 1.5: Three View Drawing showing water ballast and difference in wing extensions.

There is a difference in the aileron size between the 15m and 18m wing extensions. Each aileron on the 15m tip is 1.5m shorter (50%) at their outer most location, where the leverage is most effective. This has significant impact during asymmetrical wing ballast loading, decreasing the aileron force.

ASG-29 DESCRIPTION OF WATER BALLAST SYSTEM

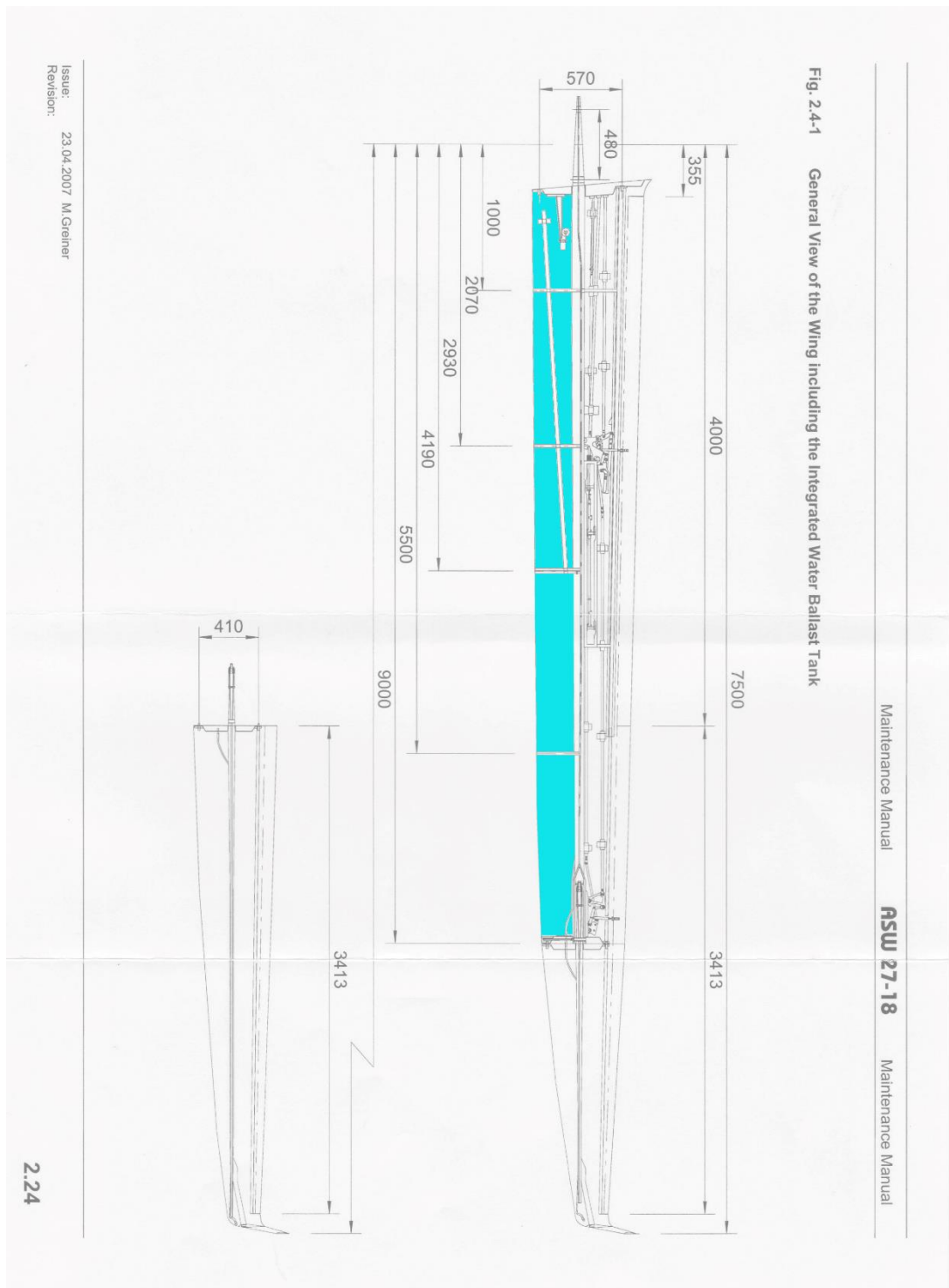


Figure 2.4-1: General View of the Wing including the integrated Water Ballast Tank.

The leading edge section of the wing is directly used as water ballast tank (integrated tanks) that extend over the entire span of the inner wing (excluding the wing extensions).

Each wing can hold approximately 85 liters (22.4 US gallons) or 85 kilograms (187lbs).

The water ballast is dumped from an opening in the bottom of each wing controlled by independent water release valves, designed to function in unison.

Figure 2.4-2 shows detail of the water release mechanisms inside each wing, located in the chamber closest to the wing root. The water release valve is spring loaded and kept closed by the force of the spring. A pushrod works against the force of the spring to open the valve. The pushrod is actuated by a rocker located inside the fuselage.

The rocker is actuated by a Bowden cable terminated inside a female brass tube mounted in the rocker housing inside the fuselage at the root rib of each wing. The release cable is controlled from a pilot lever on the right side of the cockpit (see Figure 2.4-6 on the next page).

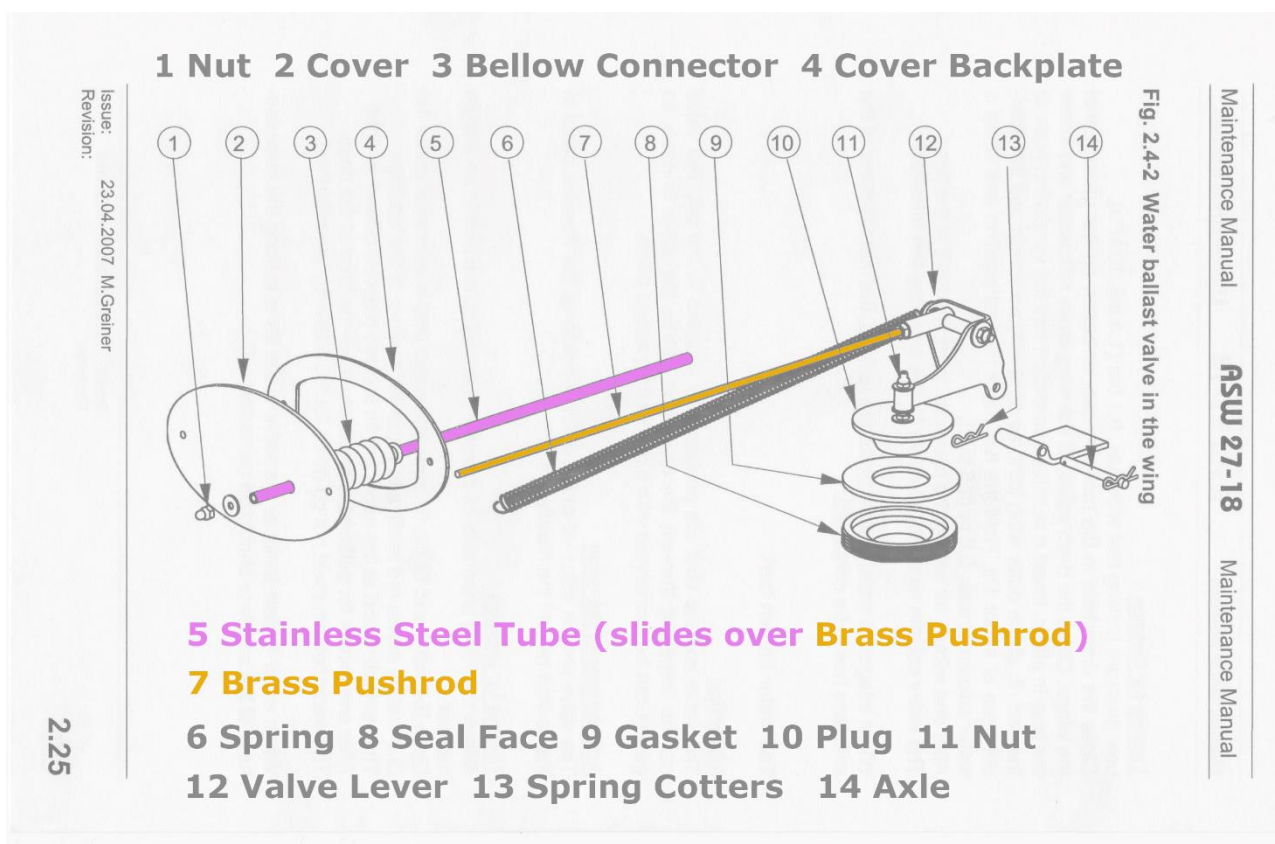


Figure 2.4-2: Water ballast valve release mechanism inside the wing

Fig. 2.4-6 Handles for water ballast

In case an optional fuselage water ballast tank is installed, its dumping valve is operated with an own handle:

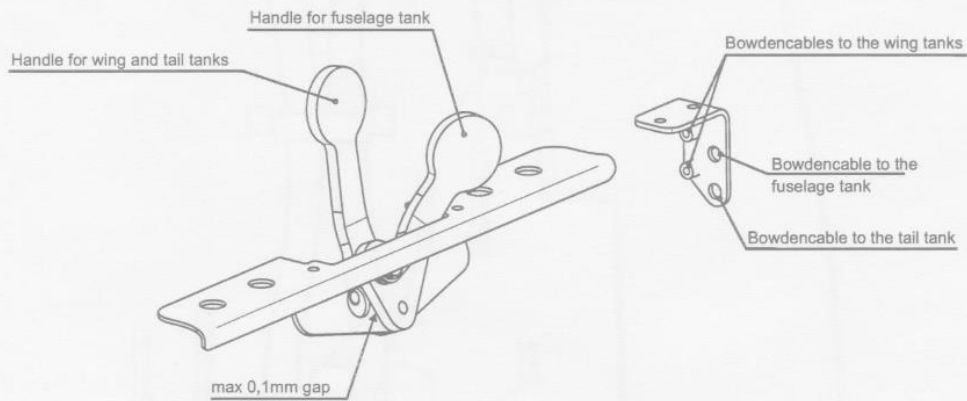


Figure 2.4-6: Cockpit (on the right-hand side) are the handles for water ballast release.

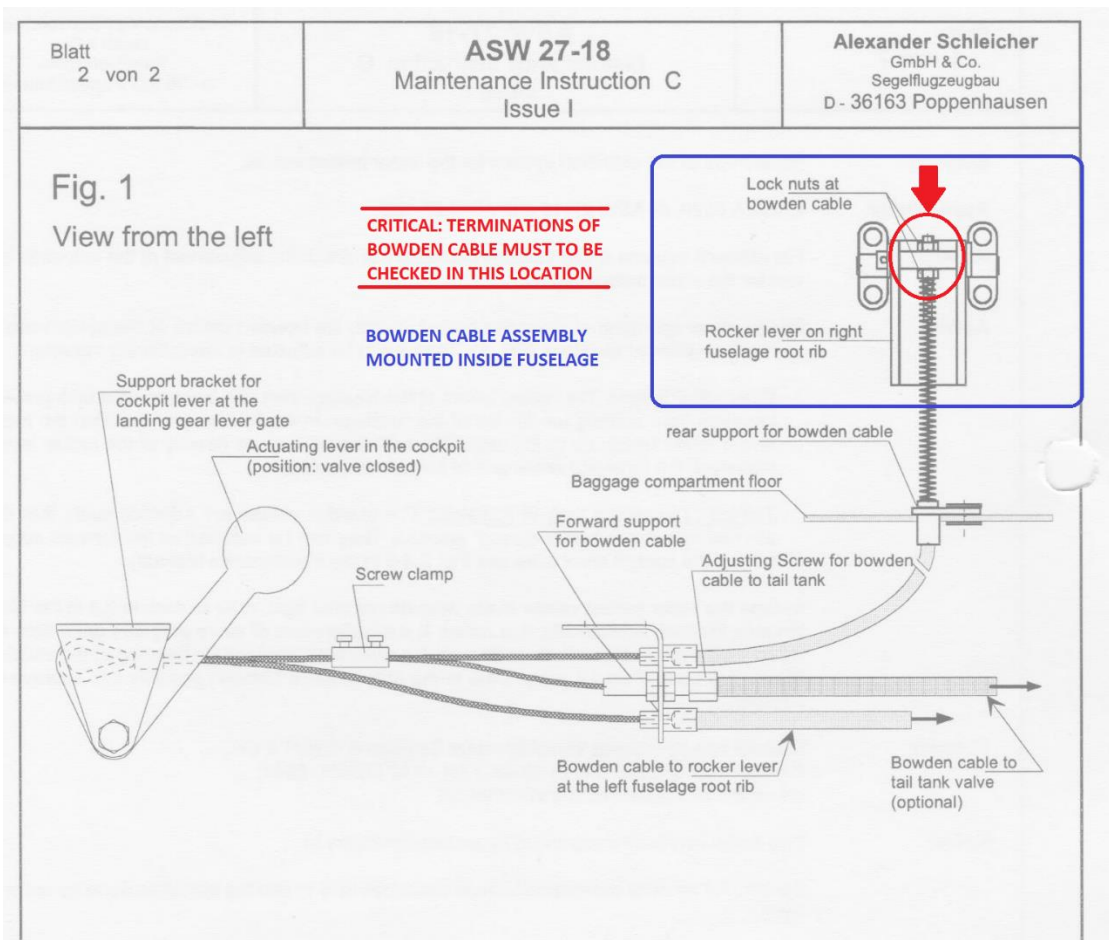


Figure 1: Wing Tank Bowden Cable Housing Assembly (outlined inside blue box)

Jettisoning of Water Ballast

To jettison water ballast, the operating lever at the right hand cockpit arm rest (in the landing gear gate) is pushed forward (valve open).

With a fuselage water ballast tank installed, two levers are present. The left lever operates the fuselage tank and the right one operates the wing and tail tank.

Draining the complete wing water ballast takes 4 minutes. The dump system does not synchronise the water flow from wing and tail tank. The tail tank must unload in less than half the time for safety reasons. Therefore it is not possible to maintain the c.g., when the water load is only partially disposed.

Every time any water is jettisoned, it is most important to check that the water is draining at an equal rate from both valves! Asymmetric control deflections may also indicate unequal loading.

Should the wing ballast fail to drain as intended, the valves should be closed immediately (pull the operation lever backwards); try again to achieve even drainage by operating the valves again or, if icing is suspected, try again after descending into warmer air to achieve a symmetric jettison.

If the valves are to be closed again to retain water in the tanks (partial reduction of wing loading), also check that both valves really close. Otherwise jettison all water.

If you do not achieve a symmetric situation after several attempts the situation should be regarded as an emergency, and instructions in Section 3.9 (Other Emergencies) should be followed.

COMPONENTS SENT TO NTSB FOR EVALUTATION

ID	Component Name or Description	Comments
001	Right Rocker and Housing Assembly	Very Important – Inspect Brass Female Housing & Cable Termination
002	Left Rocker and Housing Assembly	Very Important – Inspect Brass Female Housing & Cable Termination
003	Cockpit Water Release Lever and Bowden Cables to Wind Tanks	Very Important – Inspect Cable Ends (pay particular attention to differentiate cable to right wing tank and cable to left wing tank)
004	5-Stainless Tube/Pushrod, 1-Nut, 3-Cover Backplate, 4-Bellow Connector (see Fig 2.4-2)	Not Contributing Factor
005	12-Water Release Lever, 10-Plug, 14-Axle (see Fig 2.4-2)	Not Contributing Factor
006	6-Spring (see Fig 2.4-2)	Not Contributing Factor



001: Right Rocker and Housing Assembly (inside view)



001: Right Rocker and Housing Assembly (outside view)



002: Left Wing Rocker and Housing Assembly (outside view)



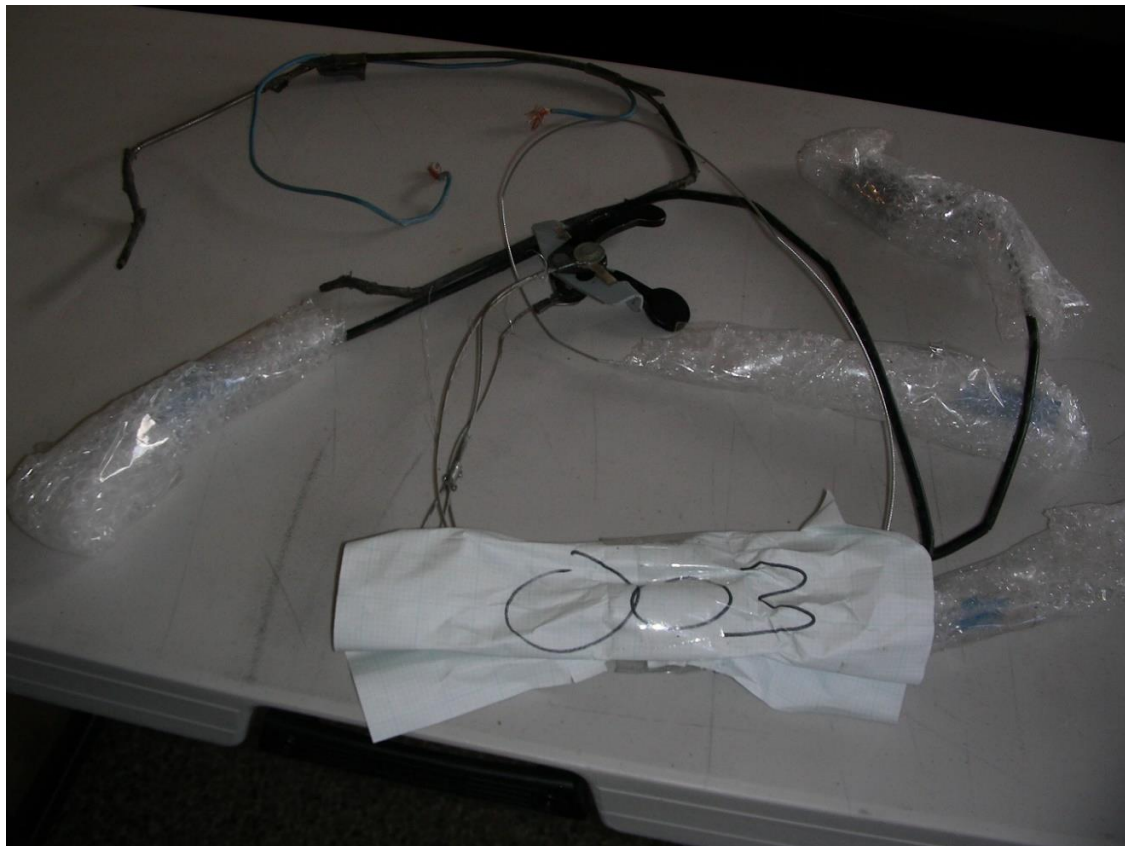
The left side brass female housing and cable termination is suspected of failure.

This is the "root cause" of the accident.

The faulty termination allowed the cable to pull free in flight.

Check for LACK of evidence of cable break from impact forces (unlike the right side)

002: Left Wing Rocker and Housing Assembly (inside view)



003: Cockpit water ballast release lever with attached Bowden cables for water tanks.