Document Title	Landing Gear Collapse Under Tow
Document Number	SB06-0012
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Subject: Un-Commanded Gear Unlock During Towing Operations

Affected Aircraft: All Lancair Evolution Aircraft

Status: Service Advisory

Importance: Compliance Recommended

Background: As stated in the newsletter, "There have been two incidents of nose gear collapse during towing due to the actuator becoming "unlocked". There is also anecdotal suggestion of at least one main gear "sag" during movement during construction. Lancair engineering has completed an intensive in depth study of the gear actuation system, safeguards and possible failure modes."

Results: The landing gear is commanded either up or down using the landing gear switch on the Instrument panel. The gear is driven via solenoids. As long as power to the aircraft is applied, if the gear should deviate from the commanded position the gear will be driven back into place. When power is removed from the aircraft, both sides of the gear actuators are ported to return pressure through these solenoids and the actuator lock mechanism holds the gear in place. The counterbalance valve does provide some load reacting force when power is removed but this force will diminish over time due to seal leakage.

The hydraulic system is designed to reliably operate in the absence of contamination. The UP/DOWN solenoids require particulates to be less than ~15 microns to operate properly with only abrasive wear. Larger particulates may cause malfunction. A particulate blocking the orifice of one of these valves could result in pressure transients in the hydraulic lines to the actuators during towing. Under this condition the transient may be large enough to unlock the actuator.

As previously stated in the newsletter:

> "Regarding safeguards to preclude an un-commanded unlock during towing, we suggest two.
>
> • Momentarily or continually power up the system during the towing operation.
>
> or...

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• Open the emergency gear “dump” valve and leave it open during manually moving the aircraft.”

The first safeguard works because the counterbalance valve will provide load holding if powered momentarily and the gear will be driven back into place if continually powered. The second safeguard works because it “mimics” the normal down and locked function of the system but precludes the pressure imbalance because orifice sizes through the dump valve are much larger than the UP/DOWN solenoid orifices.

Improvements and built in safeguards were considered by engineering. Each option increased the complexity of the landing gear design and increased the number of components to implement the design. This in turn increases the number of possible failure modes. All possible improvements would only function in the absence of contaminants in the system.

Action: The landing gear as designed will function reliably if the hydraulic fluid is free from contaminates larger than 10 microns. When building the aircraft and installing hydraulic components it is essential to prevent contamination by keeping any exposed ports or lines capped or covered with a lint free material until they are connected into the system. The human eye can easily detect a 100 micron particulate size but visual inspection for smaller debris is not possible. After completion of aircraft build, the hydraulic system should be flushed to ensure the quality/cleanliness of the hydraulic fluid. There is a 10 micron filter in the hydraulic system to maintain the cleanliness of the fluid to the hydraulic components once initial cleanliness is established. It is recommended that the hydraulic system be maintained by performing periodic flushing of the system.

The flushing procedure and maintenance recommendation has been added to the build manual, Section 11.2.P, and is provided below for reference. Refer to the latest revision of the build manual for any revisions to this procedure.

If at any time the state of your hydraulic system cleanliness is in question, employing the two aforementioned safeguards will prevent a “collapse” incident.

11.2.P System Flush

Before initial system activation and at every annual inspection, flush the hydraulic system using the following procedures.

11.2.O.1 Piping

Steps….

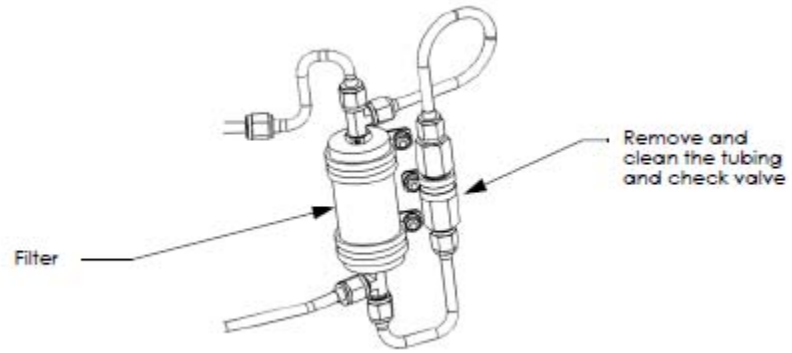
1. Raise the aircraft so the landing gear is clear of the ground and can move freely. Secure the tail with a tail stand to lift the nose gear off the ground. Make sure the airplane is stable before retracting the gear.

WARNING: Do not perform any work on the hydraulic system without supporting the aircraft off the ground. Severe damage to the aircraft or injury to personnel can result if the aircraft is not properly supported.

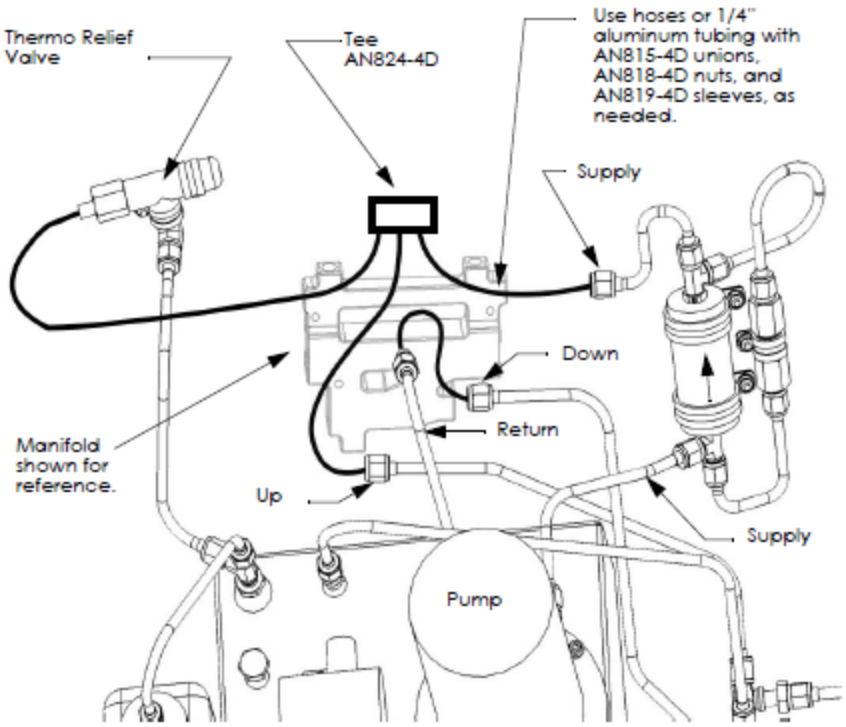
2. Shut off power to the aircraft.
3. Pull the hydraulic system circuit breaker.
4. Dump the system pressure by opening the emergency by-pass valve.
5. Release all pressure from the accumulator using the integral shraeder valve.
6. Remove the accumulator from the system.
7. Drain then disassemble and clean the accumulator using alcohol or acetone. This step is not required at initial system startup.

Note: DO NOT get acetone on the rubber seals because they will then have to be replaced.

8. Remove the filter from the filter housing.
9. Remove the check valve and attaching tubing that acts as a bypass for the hydraulic filter.
10. Clean the filter, valve and tubing using alcohol or an ultrasonic cleaner with a cleaning solution of mild soapy water. If an ultrasonic cleaner is used, after cleaning rinse everything thoroughly with alcohol. Ensure the components are completely dry by air drying of by using shop air.



11. Re-install the filter into the filter housing.
12. Re-install the check valve and tubing.
13. Disconnect the electrical connections then remove the aft hydraulic manifold.
14. Shunt the disconnected manifold tubing as shown below and cap any other disconnected lines.



15. Remove all hydraulic system components from the aft hydraulic manifold. Steps 15 through 17 are not required at initial system startup.
16. Clean the manifold and components using alcohol or an ultrasonic cleaner with a cleaning solution of mild soapy water. Soak the manifold, fittings, and one way valve if necessary. Do not soak the pressure gauge or the solenoids. Use a nylon or brass wire brush to ensure all parts are clean. If an ultrasonic cleaner is used, after cleaning rinse the tubing and valve thoroughly with alcohol. Ensure the components are completely dry by air drying of by using shop air. Carefully clean the inlet of the pressure gauge.

Note: Take care and gently clean the rubber seals. Do not use a wire brush on the rubber seals. The backing on the seals is easy to displace.

17. Re-install all hydraulic system components to the aft hydraulic manifold.
18. Disconnect the supply and return tubing from the pump.
19. Remove the pump from the reservoir. Steps 19 through 21 are not required for initial system startup
20. Empty all the hydraulic fluid from the reservoir. Examine the fluid for signs of sediment and contamination.
21. Clean the reservoir using alcohol or acetone. Ensure all sediment or contaminants are removed.

Note: It is recommended that the pump and reservoir be removed from the aircraft for cleaning.

22. Disconnect the nose gear up, nose gear down, main gear up, and main gear down hoses from their respective ports on the actuators.
23. Drain as much of the old hydraulic fluid from the system as possible. Use the disconnected actuator hoses to provide the lowest point in the system.

24. After draining, shunt the up and down hoses for each landing gear. Use AN815-4D unions to tie the hoses together. This will ensure the hoses are flushed during the process.
25. After cleaning the reservoir, re-install it and the pump to the aircraft. This step is not required for initial system startup.
26. Fill the reservoir with approximately 3 quarts (96 oz.) of fresh Mil-H-5606-RED or Shell Fluid 4, Code 60421 hydraulic fluid.
27. Ensure that all lines are either capped or shunted as required for a sealed hydraulic circuit.
28. Reconnect the electrical connections to the reassembled aft manifold.

Note: The pump will not run until all electrical connections are made to the aft manifold.

29. Replace the hydraulic circuit breaker then start the pump. The fluid level in the reservoir will go down as the hydraulic system is purged of air.
30. After the air has been purged, run the hydraulic pump for 2 minutes then let it cool for two minutes. Repeat this process 3 times so that fluid runs through the filter for a total of 6 minutes.
31. Turn off the pump then remove the filter cartridge from the filter housing.
32. Clean the filter cartridge. The filter cartridge is bronze and may be cleaned using alcohol and a nylon brush or by using an ultrasonic cleaner with a cleaning solution of mild soapy water. If an ultrasonic cleaner is used, after cleaning rinse everything thoroughly with alcohol. Ensure the components are completely dry by air drying of by using shop air. Use of an ultrasonic cleaner is recommended.
33. Re-install the filter cartridge into the filter housing.
34. Start the pump then run it for 2 minutes then let it cool for two minutes. Repeat this process 3 times so that fluid runs through the filter for a total of 6 minutes.
35. Repeat the flushing process until the filter cartridge remains clean.
36. Pull the hydraulic system circuit breaker.
37. Empty the reservoir then drain as much of the hydraulic fluid from the piping as possible
38. Remove the piping shunts.
39. Reinstall the aft manifold into the aircraft.
40. Reconnect the supply and return piping to the pump.
41. Flush each actuator using the procedures that follow.

11.2.0.2 Actuators

The actuators do not require flushing at initial startup but should be flushed annually.

1. Use the following steps to flush each of the three landing gear actuators.
2. Disconnect the actuators from the landing gear. Refer to Chapter 8 *Main Landing Gear* and Chapter 21 *Nose Gear*. This step is not required for initial system startup.

Note: Leave the hydraulic lines attached to the actuators until there is no pressure in the system.

3. Attach a hose to both the “UP” and “DOWN” ports of the actuator then direct the hoses into two separate buckets.
4. Place a supply of fresh Mil-H-5606-RED or Shell Fluid 4, Code 60421 hydraulic fluid into the bucket reserved for the supply tubing.
5. Unlock the actuator by applying shop air to the “UP” port.
6. Extend the actuator piston as far as possible without locking it.

7. Submerge the end of the hose attached to the “UP” port into a container of clean hydraulic fluid. Ensure there is enough fluid available to fill the actuator. The container holding the clean fluid is the “supply” container.
8. Place the end of the hose attached to the “DOWN” port into an empty container. This container is the “return” container.
9. Fully retract the actuator piston.
10. Place the “DOWN” hose into the supply container and the “UP” hose into the return container.
11. Extend the actuator piston as far as possible without locking it.
12. Repeat steps 7 through 11 until the hydraulic fluid going into the “return” container is no longer discolored and is free of contaminants.

Note: Strain the fluid going into the “return” bucket through a fine mesh cheese cloth to check for contaminants. If there are easily visible metal particles the actuator may need to be rebuilt.

13. Reconnect the actuators to the landing gear. Refer to Chapter 8 *Main Landing Gear* and Chapter 21 *Nose Gear*.
14. Reconnect the nose gear up, nose gear down, main gear up, and main gear down hoses to the landing gear actuators.
15. Place the system back into service by following the procedures in Section 11.2.O *Hydraulic Startup and Test Procedures*.