Aircraft Type and Registration:	Yak-50, G-OJDR
No & Type of Engines:	1 Ivchenko Vedeneyev M-14P radial piston engine
Year of Manufacture:	1979
Date & Time (UTC):	30 October 2004 at 1438 hrs
Location:	Wellesbourne Mountford Airfield, Warwickshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to aircraft underside and propeller, oil cooler torn off and engine shockloaded
Commander's Licence:	Private Pilot's Licence
Commander's Age:	36 years
Commander's Flying Experience:	464 hours (of which 114 were on type) Last 90 days - 30 hours Last 28 days - 21 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

After takeoff the pilot selected the landing gear to UP but only the left main gear locked up while the right main gear remained unlocked. The pilot left the circuit and made numerous attempts to extend both main gear legs using the normal and emergency pneumatic systems. After conducting two low 'fly-bys' at the airfield to confirm the state of the landing gear, he decided to land on the grass surface alongside the paved runway. During the landing roll both main gears collapsed. Examination of the landing gear system revealed that the O-ring seals on the right main gear actuator piston were 'rolled'. The rolled seals caused a leak that prevented the actuating air pressure from fully extending both main landing gears.

Aircraft description

The Yak 50 is a low-wing, single-seat aircraft of Russian design and manufacture with a tailwheel landing gear configuration (see Figure 1). It is constructed primarily of aluminium alloy and it is

powered by a 360 HP radial piston engine which drives a variable-pitch propeller. The aircraft does not have an Airworthiness Type Certificate recognised by the UK Civil Aviation Authority (CAA) but the CAA had issued G-OJDR with a Permit to Fly, authorising its operation on the UK Register.

History of the flight

The pilot was intending to carry out a local flight of approximately 15 minutes duration to practice landings and then he was going to refuel the aircraft and repeat the exercise. He carried out a normal pre-flight inspection of the aircraft and checked that the landing gear uplocks operated freely and checked that the pneumatic system water drain valve was closed. Before engine start the pneumatic system contained 30 kg/cm^2 (427 psi) of air pressure which recharged to 45 kg/cm^2 (640 psi) after the engine had been started and warmed. After carrying out taxi and power checks the pilot performed a normal takeoff. When he selected the gear lever to UP he heard a noise which sounded like air venting from behind the gear selector lever. The gear indication lights showed that only the left gear had locked up and that the right gear was unlocked. The pneumatic gauge showed very little remaining air pressure so the pilot selected the gear lever to NEUTRAL which stopped the venting noise.

The pilot departed the airfield circuit to the south and climbed to 2,000 feet to try and diagnose the problem. After approximately eight minutes the engine-driven compressor had recharged the pneumatic system to 45 kg/cm^2. He selected the gear lever to DOWN at which point the same venting noise was heard. The left gear indicated down and locked while the right gear remained unlocked. Once again the pilot selected the gear lever to NEUTRAL to preserve the air pressure, and then repeated the exercise once the pneumatic system had recharged. Again this was unsuccessful so he tried various aircraft manoeuvres involving pitching, yawing and pulling 'g' but still the right gear would not lock down. With the gear lever in the NEUTRAL position the pilot opened the emergency air valve to allow the emergency air supply to extend the gear. Despite unwinding the valve quickly (the recommended procedure) the pressure rapidly reduced to zero and the right gear remained unlocked.

With only approximately 10 minutes of fuel remaining the pilot decided to return to Wellesbourne so he contacted Wellesbourne Radio to advise them of his predicament and to request a low fly-by. Witnesses to the fly-by observed that one gear leg appeared to be down while the other leg appeared to be semi-retracted. The pilot rejoined the circuit and attempted to recycle the gear one last time using both the normal and emergency air systems sequentially but these actions were unsuccessful. The pilot requested a further fly-by and again one gear appeared to be down while the other was semi-retracted, but this time it was reported to be the other leg that was down. With only an estimated 5 minutes of fuel remaining the pilot decided to carry out a landing on the grass surface

alongside the paved Runway 36. After carrying out a go-around to establish in the pilot's words "the correct descent profile", he carried out a low-level circuit followed by an approach to the grass surface.

At between 15 and 20 feet agl the pilot switched off the magnetos. The aircraft touched down tailwheel first and rolled on all three wheels for approximately 20 metres before both main gears collapsed almost simultaneously. As the aircraft dropped, the windmilling propeller struck the ground breaking its tips. When the aircraft's underside hit the ground the oil cooler housing and oil cooler on the aircraft's belly were torn off. The aircraft finally came to rest after travelling approximately 100 metres on its belly. The pilot switched off all the electrical systems and was able to vacate the aircraft unassisted in the normal manner. The airfield's fire service arrived on the scene soon afterwards but there was no fire.

Description of the landing gear system

The aircraft has retractable main landing gear and a non-retractable tailwheel. The main landing gear legs are unconventional in that they retract aft into the wing rather than sideways. Half of each wheel retracts into the wing leaving the other half and the landing gear leg exposed to the airstream (see Figure 2). The design makes wheels-up landings (on hard surface runways) practicable while minimising damage to the aircraft's underside. The left and right main gear actuators are pneumatically powered. When the gear is selected DOWN pneumatic pressure causes each actuator arm to pull on the top of the respective main gear leg, rotating the leg forwards into the air stream. The leg needs to rotate approximately 10 degrees forward of the vertical before it will lock down. Two spring loaded hooks on the main gear leg engage a fixed stop within the wing as the leg is forced forwards against it until the hooks lock the gear in place. The hooks also press against a microswitch which triggers the 'green' down and locked light in the cockpit. If not properly rigged it is possible for the 'green' down and locked light to illuminate before the gear has fully locked into position.

The landing gear selector has three positions, UP, NEUTRAL and DOWN. For emergency operation of the landing gear, the selector must be set to NEUTRAL and the emergency valve on the right side of the cockpit opened rapidly to allow the emergency air supply to extend the gear. The maintenance organisation stated that the reason for opening the valve rapidly is to overcome any minor leaks within the system and to ensure there is sufficient pressure to close the spring-loaded bleed-off valve.

Description of the pneumatic system

The aircraft's pneumatic system is provided for engine starting and for operating the wheelbrakes and retractable main landing gear. The nominal operating pressure of the system is 50 kg/cm^2 (711 psi). The main air pressure reservoir, located on the left side of the firewall has a 6.4 litre capacity and an emergency reservoir, located on the right side of the firewall has a 3.2 litre capacity. Both reservoirs are recharged by an engine-driven compressor. A pneumatic system water drain, located on the forward lower side of the firewall, should be operated before and after flight to drain any water in the system. If the drain is left open the air system will not charge.

Aircraft examination

When the aircraft was raised during the recovery operation both main landing gear were extended by hand and they both locked into place. The aircraft was then transported, with the gear retracted and the wings removed, to a maintenance organisation that specialised in maintaining Yak aircraft. At the maintenance facility a stand-alone compressed air tank was attached to the aircraft's pneumatic system. Although this tank was not full, it had sufficient pressure to extend both main landing gear and lock them into place. However, it is important to note that on the ground, the actuators did not need to overcome the drag force on the landing gear that was encountered in flight. The maintenance organisation carried out a detailed examination of the landing gear system and discovered a problem with the seals in the right main landing gear actuator.

The two O-ring seals on the piston of the right main landing gear actuator are shown in Figure 3. The seal on the left (used for extension) had a rolled lip and the seal on the right (used for retraction) had a side that was severely rolled. The condition of both seals would have resulted in air leakage during both retraction and extension.

No anomalies with the operation of the main gear downlock mechanism were found.

Discussion

The maintenance organisation reported that a pressure of at least 30 kg/cm^2 was required to lock the gear in the DOWN position at the maximum gear extension speed of 200 km/hr (108 kt). According to the pilot the pneumatic system pressure was depleting at approximately 10 kg/cm^2 each second when the gear was selected down. Since gear extension takes at least four seconds there was never sufficient pressure in the system to lock down both gear legs in flight. The cause of the leak was attributed to the rolled seals in the right main gear actuator. The plumbing of the pneumatics is such that as air leaked past the piston to the other side of the actuator, it would have vented at the valve behind the gear selector lever. This explains the venting noise heard by the pilot.

Both main gear actuators had been installed on 13 January 2004 following an overhaul which involved replacing the seals. According to the maintenance organisation the grooves in the actuator piston make it easy to install the seals correctly. However, it is possible that inadequate or improper lubrication could have contributed to the rolled state of the seal.

Because the air leak was within the actuator, the effectiveness of the emergency reservoir would also have been reduced. The pilot reported that on a previous occasion in 2003 he had suffered a partial pressure loss due to the water drain valve working loose in flight. On that occasion he had been able to persuade the gear to lock down by yawing and pitching the aircraft without recourse to the emergency system. The Yak-50 Pilot's Operating Handbook only mentions the use of the emergency valve in the event of a gear extension problem. The maintenance organisation stated that it was important to open the emergency valve rapidly, in the event of a problem with the gear locking down.

It appeared to the pilot that one of the main gear legs was locking down each time he attempted to extend the gear, and yet both main gear legs collapsed on landing. It is probable that neither main gear leg was locked down prior to the landing. The design of the down lock microswitch and locking mechanism makes it possible to obtain a 'green' down and locked indication when the downlock hook is not fully engaged.

Conclusions

Both main gears collapsed on landing because they were not locked down. The gear did not lock down because there was insufficient pneumatic pressure to extend fully the main gear actuators in flight. The loss of pneumatic pressure was attributed to a leak in the right main gear actuator which was caused by a rolled O-ring seal on the actuator piston.

Figure 1 Accident aircraft

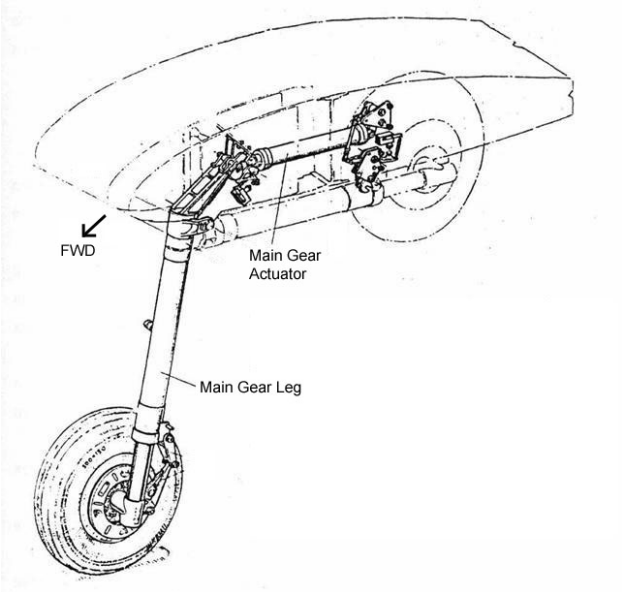

Figure 2 Yak-50 main landing gear

Figure 3 Rolled O-ring seals found on right main gear actuator piston