REPORT IN-023/2008

DATA SUMMARY

LOCATION

Date and time	**Monday, 23 June 2008; 13:20 h[1]**
Site	**4.5 km west of the Madrid-Cuatro Vientos Airport**

AIRCRAFT

Registration	**EC-GCX**
Type and model	**CESSNA 177 RG "Cardinal"**
Operator	**Private**

Engines

Type and model	**LYCOMING IO-360-A1B6D**
Number	**1**

CREW

Pilot in command

Age	**60 years old**
Licence	**PPL(A)**
Total flight hours	**500 h, approximately**
Flight hours on the type	**440 h, approximately**
Flight hours in last 24 h	**None**

INJURIES	Fatal	Serious	Minor/None
Crew			**1**
Passengers			
Third persons			

DAMAGE

Aircraft	**Significant, especially to the engine and propeller**
Third parties	**Minor**

FLIGHT DATA

Operation	**General – Check flight**
Phase of flight	**En route**

REPORT

Date of approval	**9 June 2011**

[1] All times in this report are local unless otherwise specified.

1. FACTUAL INFORMATION

1.1. History of the flight

On 23 June 2008, a CESSNA 177RG "Cardinal" aircraft, registration EC-GCX, was on a check flight after having undergone an annual inspection at an authorized maintenance center located in the Madrid-Cuatro Vientos Airport. The check flight was part of the process necessary for the renewal of its Airworthiness Certificate.

A local flight plan had been filed for this purpose. The flight, to be conducted under visual flight rules, was scheduled to last one hour and would be made by the owner and usual pilot of the aircraft as the pilot in command and its sole occupant. The weather conditions were suitable for the flight.

The aircraft took off at 13:10 from runway 10, entered the circuit with the runway to the right, and departed it via point W, which is located above Villaviciosa de Odon. The pilot then headed toward Aldea del Fresno to carry out the scheduled tests. At 13:14, with the airplane 3 NM west of Villaviciosa de Odon and flying at an altitude of 4,000 ft, the pilot notified the control tower at Madrid-Cuatro Vientos that he was experiencing engine problems and requested to return directly to the airport. After being cleared to proceed directly to runway 10 he initiated the trip back at 13:15. The controller in the tower asked the pilot if he was declaring an emergency, to which the latter replied no. He then asked the pilot if he had a suitable landing site in sight. This time the pilot replied in the affirmative and that he was already landing. It was about 13:20.

Figure 1 shows the aircraft's path overlaid on a map of the area as determined by the radar data recorded by ATC stations.

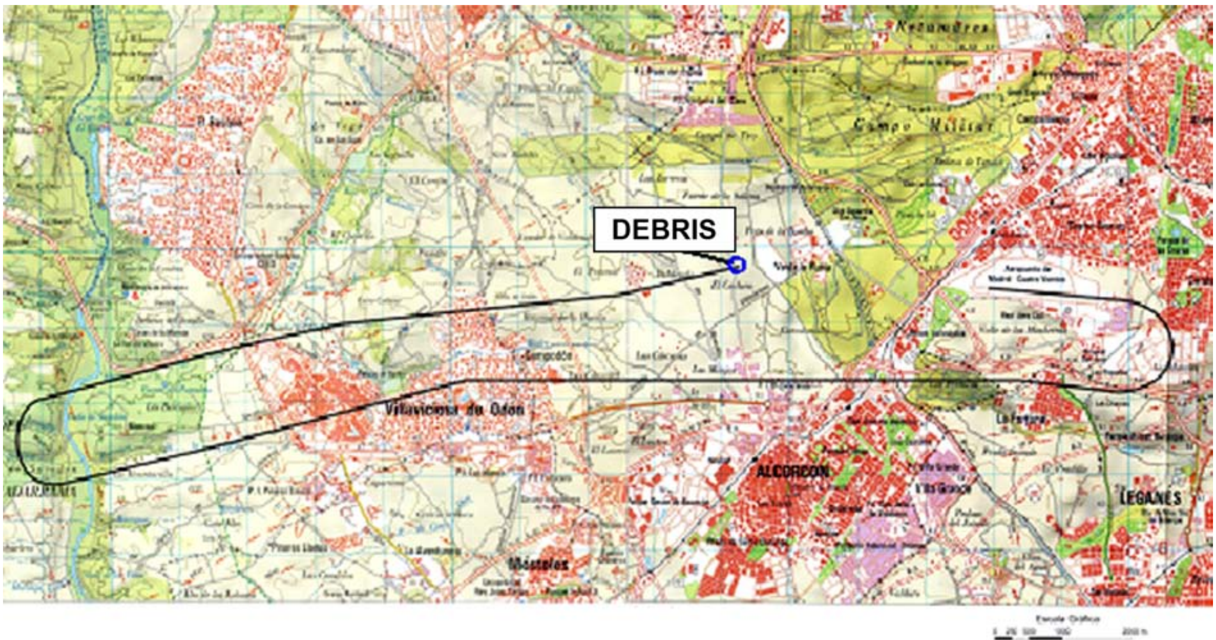

Figure 1. Estimated trajectory

The aircraft landed in a wheat field, parallel to the plow furrows, which faced in the same direction as the airport runway. The pilot was uninjured and left the aircraft under his own power. After ascertaining his situation, he returned to the airplane and reported his position. Ten minutes later, a Traffic Authority helicopter landed at the site to render assistance.

1.2. Damage to aircraft

The emergency landing was conducted with the landing gear retracted. The aircraft contacted the ground gently, after which it made about a 70-meter landing run that ended with a 60° turn to the right. Figure 2 shows an aerial view of the aircraft in its final position.

Figure 2. Aircraft after landing

The aircraft did not exhibit any significant damage apart from those in the inferior part of the fuselage, produced during the landing run on the ground.

The lower part of the fuselage was also saturated with engine oil.

Figure 3. Aircraft on the ground

As for the power plant, the forward crankshaft retainer on the engine was out of its housing and shifted forward. There was also a hole in the top part of the crankcase near the no. 4 cylinder. The propeller showed signs of having impacted the ground with no applied power. The blade tips were bent backward and there were noticeable scratch marks parallel to the width of the blades.

1.3. Aircraft information

1.3.1. *Airframe*

Registration:	EC-GCX
Manufacturer:	CESSNA AIRCRAFT CO.

Model:	177 RG “Cardinal”
Serial number:	177 RG 0567
Year of manufacture:	1974
MTOW:	1,270 kg

1.3.2. *Engine*

Manufacturer:	LYCOMING
Model:	IO-360-A1B6D
Serial number:	L-12337-51A
Power:	200 HP

1.3.3. *Propeller*

Manufacturer:	McCAULEY
Model:	B3D36C428
Type:	Three blade, constant speed
Serial number:	010335
Governor:	McCauley DC290D1 F/T3, S/N 010521

1.3.4. *Airworthiness certificate*

Number:	3823
Category:	Normal airplane category
Issued:	17-11-2004
Expiration:	26-03-2008

1.3.5. *Maintenance*

The aircraft’s approved maintenance program listed the following inspections:

A. Line Inspection, to be done every 50 h, no calendar limit.
B. Basic Inspection, to be done every 100 h, no calendar limit.
C. Periodic Inspection, to be done every 200 h, no calendar limit.

It also included the following notes:

Note 1. An inspection must be done every calendar year, consisting of performing the 50-, 100- and 200-hour inspections, if not already completed as required by the hour limit.
Note 2. The periodic engine inspections will coincide with the airplane's, as per the approved maintenance manual, except for the engine overhaul, which must be completed as per the current appendix to I.C. 35-03b, dated 15-03-1988, or a subsequent revision[2].
Note 3. The special airframe inspection items, as well as their calendar items, will be taken into account as per the airplane's approved maintenance manual.
Note 4. The propeller must be overhauled every 1500 hours or 5 years[3].

On the date of the incident, the aircraft had 2,864 total flight hours. On 15-02-2007, with 2,830:10 flight hours, its annual inspection was done. A year later, a new annual inspection was completed, over the course of which the propeller and governor had been removed from the aircraft, overhauled as required by the calendar limits, and then re-installed.

Once the scheduled maintenance tasks were complete, and so as to renew the Airworthiness Certificate, a check flight had to be completed. The permit to flight had been requested and granted, on 17-06-2008. It was valid for ten days and subject to the following conditions: no passengers, no payload, minimum crew and VMC. It was this permit that was used to conduct the flight on which the incident took place.

1.3.6. *Technical maintenance documentation*

According to the requirements of the aircraft's approved maintenance program, it must be maintained as per the latest Cessna 177 RG Maintenance Manual and Parts Catalog, and the engine as per the Avco Lycoming IO-360 Maintenance Manual.

The Maintenance Manual applicable to the aircraft was Cessna reference document D991-3-13, titled "Cardinal RG Series 1971 thru 1975 Service Manual", dated 01-09-1972, Revision 3, dated 01-09-1974. On the date of the incident, there were six temporary revisions to this manual issued by the manufacturer, of which only the first was included in the manual. The rest had been distributed separately, and were: 2, dated 03-10-1994; 3, dated 07-01-2000; 4, dated 07-10-2002; 5, dated 11-07-2005; and 6, dated 15-01-2008.

[2] In this case, the time interval between engine overhauls was 2,000 h.
[3] Since the propeller was of the variable pitch type, this note applies equally to the governor.

The installation of the propeller governor is described in Section 13, Sub-section 13.1 of said manual, which was modified by Temporary Revision 5 to the manual. Appendix A to this report includes the pages from the Maintenance Manual relevant to the governor and the text of Temporary Revision no. 5 to the Manual.

As regards the installation, Section 13-11 of the Manual, "INSTALLATION", Item c, states:

> "c. Install a new mounting gasket on the mounting studs. Install gasket with raised surface of the gasket screen toward the governor."

In Temporary Revision no. 5, the text in this section is modified to read:

> "c. Install new Lycoming part number 72053 Gasket on the mounting studs. Install a Lycoming LW-12347 Plate over the 72053 Gasket and a MS9144-01 Gasket over the LW-12347 Plate. Install gasket with raised surface toward the governor. Refer to Lycoming Service Instruction 1438 or latest revision."

Appendix B to this report is the Lycoming Service Instruction (SI) no. 1438A, dated 09-12-2005, which details the installation of the propeller governor on the engine using two gaskets and a plate between them. This installation is required on certain propeller governors to eliminate the possibility of oil leakage between the governor and the engine accessory housing.

Appendix C to this report is the Federal Aviation Administration's (FAA) Special Airworthiness Information Bulletin (SAIB) NE-06-08, dated 09-11-2005 and amended on 14-11-2005, which lists the known engine models, and the airplanes on which they are installed, affected by Lycoming Service Instruction no. 1438A. The list includes the Lycoming IO-360-A1B6D engine installed on Cessna 177 RG Cardinal airplanes.

1.4. Inspection of airplane after incident

The airplane was taken to the hangar at Cuatro Vientos airport, where the structural damage was verified to have been limited to that noted during the field inspection and confirmed to be, in general, minor.

The external inspection of the power plant confirmed the presence of an oil leak where the governor is coupled to the engine. Additionally, the engine could not be turned and the forward crankshaft retainer had shifted from its housing. A 4-cm hole was also found in the main engine crankcase, located between the no. 4 cylinder lifters, and due to which the camshaft was visible. The hole was apparently made by the impact from an unidentified engine component. As a result of the above, it was decided to inspect each component separately.

1.4.1. *Propeller inspection*

The assembly was removed from the group without any difficulty once the blades, whose tips were scratched and bent backwards (see Fig. 3) were confirmed to be in the lower pitch position. The damage to the blades showed that the aircraft had contacted the ground without thrust and at low rpm's.

The blades and hub components were then removed. No appreciable damage was found in any of these parts.

1.4.2. *Propeller pitch control (governor) and findings from inspection*

On the engine type installed on the aircraft, the propeller governor is installed in the fitting at the lower left of the engine accessory housing.

The governor is a device that varies the pitch of the propeller blades so as to maintain the rotation speed selected by the pilot. The variation is achieved by applying the pressure generated by the governor's own pump to the pitch actuator, which is located in the propeller hub. The pump is supplied by engine oil, which it takes directly from the crankcase before it flows through the filter. On the type of propeller installed on the aircraft, the pitch increases to minimum rpm's by increasing the pitch actuator pressure when the pilot moves the control to higher positions, and decreases to maximum rpm's by the effect of the centrifugal force of the blades when the pilot reduces the pressure by moving the control downward.

The inspection of the governor confirmed the visual indications of the leak mentioned earlier. There was no damage to either the mechanical linkage from the cockpit control to the governor nor to the line that carries oil from the governor to the pitch actuator in the propeller hub. This line was found to contain only a few drops of a dense, gray-colored oil. The small amount of oil in the line indicated that the oil flow had been cut off prior to the stoppage of the propeller.

The governor was removed from its vent in the engine accessory housing without any problems. It was confirmed that there was only one MS 9144-01 type gasket in the engine coupling, as required by the aircraft's Service Manual. There was a large amount of metal shavings in the gasket screen.

The exact cause of the oil leak at the engine coupling could not be determined. The likely possibilities include a defect in the gasket, either pre-existing or caused during the installation, improper tightening of the bolts that attach the governor to the engine, either due to the wrong applied torque or, because of a faulty installation, the grooved end of the governor was in contact with the depth of the engine drive gear such that the governor body could not be tightened against the engine. The leak could also have been caused by a combination of these factors.

The governor itself was inspected at the workshop of the specialized company that had done the overhaul before the flight and using the same test bench. The resistance to rotation found at the start of the inspection disappeared when the metallic particles, both magnetic and non-magnetic, that had collected at the oil inlet and outlet ports were removed. Functional tests were then performed on the test bench and resulted in stable operation within tolerances. The governor was removed and its internal components found to be in good overall conditions. There was only some localized wear on the non-moving parts caused by friction with rotating parts.

In light of the results of the inspection, it was concluded that even though the oil leak had affected its operation, the governor had not malfunctioned.

1.4.3. *Engine inspection*

When the engine was disassembled, a large amount of metallic, both magnetic and non-magnetic, shavings were found in the lower crankcase (Fig. 4) and greasing ports, and especially in the filter mesh at the suction to the engine oil pump. When the inside of this pump was inspected, its components were found to be in good condition, with only minor wear caused by friction between the gear teeth and the housing. The pump did not show any signs of having been run without oil.

Figure 4. Metal particles and shavings in the crankcase

The cylinders were then disassembled from the main crankcase. The connecting rods on the nos. 2, 3 and 4 cylinders had detached from the crankshaft and showed signs of severe overheating, as evidenced by the flow of material in a longitudinal direction, especially in the no. 2 cylinder (Fig. 5). Some of the crankshaft bearings had also fractured and exited the race, causing scorching of the journal (Fig. 6). The damage to the main components increased with their distance from the oil pump. The no. 1 cylinder connecting rod remained attached to the crankshaft and its bearings; though they also showed signs of a lack of grease, they were not scorched.

Figure 5. No. 2, cylinder, partly disassembled, showing broken connecting rod

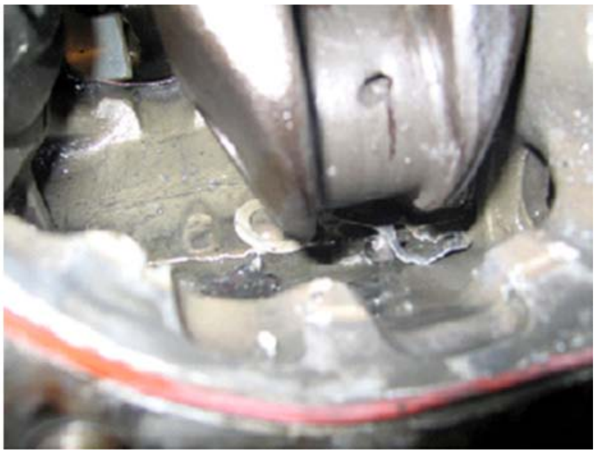

Figure 6. Scorched crankshaft journal and loose metallic debris

The engine did not show any of the typical signs of seizing, such as static fractures of connecting rods and cylinders without any apparent deformations. In this case, considerable plastic deformation was found, caused by pulling in excess of the material's creep load at high temperature over a period of time, typically resulting from operating the engine at high rpm's, even above the maximum allowed (overspeed) with increasingly insufficient lubrication.

In general, the engine mount bearings were in good condition and had traces of lubricating oil. There was much less oil found inside the engine than should have been present under normal conditions.

In summary, the damage found was consistent with an engine operated at high rpm's, possibly above the overspeed limit, in combination with a loss of oil that impeded its proper lubrication and resulted in excessive heating of the engine's moving parts.

The disassembly of the engine's remaining components and accessories did not reveal the presence of other damage or provide additional information.

1.5. Pilot's statement

During the investigation into the incident, the pilot provided a report that details, among other things, the history of the flight, a description of the flight and some personal conclusions.

As described in this report, the airplane took off at approximately 13:30 (local time) from runway 10 at Madrid-Cuatro Vientos Airport. The magneto, regulator, flight controls and other typical tests had been performed satisfactorily. Following the takeoff circuit, the pilot reduced engine speed and adjusted the altitude to 3,000 ft, departing the CTR circuit via point W.

He then climbed to 4,000 ft and, after just five minutes of flight, at a distance of 4.5 km west of Villaviciosa de Odon, detected a loss of thrust and increased engine rpm's above 2,800, in excess of the maximum allowed. When he attempted to lower the rpm's, the pilot noted that the propeller pitch control was not responding, after which he proceeded to turn toward the field while decreasing power to idle in an effort to limit engine damage. He also reported his position and status to ATC. The pilot then attempted to glide back to the airport, but upon noticing that the success of this operation was not guaranteed, he applied moderate thrust to obtain more power from the engine. Doing this caused the engine rpm's to climb above 2,800 once again, resulting in strong vibrations that caused the cover on the control panel to fall and smoke that smelled of oil to enter the cockpit.

Given the situation, the pilot decided to execute an emergency landing with the landing gear up, since he could not ascertain the topography of the wheat field on which he had decided to land. Prior to the landing, which was controlled, he shut off the fuel, contact and battery. As already noted, the aircraft traveled some 70 m over the terrain and stopped after turning some 60° with respect to the landing roll.

The pilot left the aircraft in the event a fire broke out. He returned later after the situation was under control to inform ATC of his position. A helicopter from the Traffic Authority reported to the site within ten minutes.

1.6. Additional information

1.6.1. *Similar incidents in the NTSB database*

A check of the United States National Transportation Safety Board (NTSB) database revealed two similar events, references LAX96LA270 and SEA07LA172, which took place on 13-07-1996 and 18-06-2006, respectively, and involved CESSNA 177 RG aircraft, registrations N52185 and N2144Q. Both flights had taken place immediately after installing the propeller governor. In the first case the governor had been removed to repair a malfunction, and in the second, for an overhaul. The flights lasted 1:40 and 1:10 h, respectively.

The investigation into these events, which did not result in any injuries to persons, revealed that in both cases, the governor had been coupled to the engine using a single MS9144-01 gasket and that oil had leaked through this coupling. In both cases the leak caused a loss of oil pressure in the propeller governor, with the ensuing positioning of the blades in the fine pitch position and a loss of thrust, along with a lack of lubrication in the engine, which led to the overheating of the connecting rod sleeves and of the connecting rods themselves, especially near the crankshaft. This resulted in the plastic deformation and eventual fracture of some of these components.

As detailed in the relevant NTSB reports, the loss of oil pressure in the propeller governor and the lack of engine lubrication was caused in both cases by an oil leak at the propeller governor-engine coupling. The oil leak had resulted because only a single MS9144-01 gasket had been installed instead of a Lycoming 72053 gasket, a Lycoming LW12347 plate and then a MS9144-01 gasket on top.

1.6.2. *Installation of the propeller governor on this aircraft*

The Authorized Maintenance Center (AMC) where the airplane's propeller governor had been removed and then re-installed had the applicable maintenance documentation, which it kept updated via an electronic CD-ROM subscription (Avantext TechPubs CD).

As part of the investigation, it was noted that the applicable edition of said CD-ROM (with the applicable updates from April to June 2008) included the Maintenance Manual, reference D991-3-13, titled "Cardinal RG series 1971 thru 1975 Service Manual", dated 01-09-1972, Revision 3, dated 01-09 1974, which included Temporary Revision 1, in addition to Temporary Revisions 2, dated 03-10-1994, 3, dated 07-01-2000, and 4, dated 07-10-2002

By the date of the incident, the AMC had already received the CD-ROM with the updates applicable for the next quarter, which included Temporary Revision 6, dated 15-01-2008, but did not include Revision 5 or make any reference to it.

The Maintenance Manual applicable to more modern versions of the same aircraft type, Cessna reference document D2009-4-13, titled "Cardinal RG Series 1976 thru 1978 Service Manual", dated 02-10-1995, discussed the installation of the propeller governor using the same terms as in D991-3-13, and had been modified via Temporary Revision 6, dated 01-05-1997.

When the airplane manufacturer was questioned about the applicable manuals, investigators were referenced to the on-line distribution of said manuals, which was accessed on 14-01-2009 and found to be identical to the CD-ROM edition. Specifically, it included Temporary Revisions nos. 2, 3, 4 and 6 to reference manual D991-3-13, but it did not include or make any reference to no. 5.

When the manufacturer was questioned about this, it submitted the Temporary Revision no. 5, dated 11-07-2005, included in Appendix A, which has a note stating that the revision "will be incorporated to the Manual at a later date". It was then that the existence of this temporary revision was confirmed and verified to be similar to revision no. 6 of reference manual D2009-4-13.

The current version of the Maintenance Manual, reference D991-3-13, included in the electronic CD-ROM version includes Temporary Revision no. 5 to said manual. It is not, however, included in the on-line version.

1.6.3. *Propeller and engine overspeed criteria*

As indicated in 1.5, the aircraft pilot reported that the engine rpm's climbed above 2,800, meaning that the maximum rpm rate of 2,700 specified for the engine and propeller type outfitted on the airplane was exceeded.

As regards the propeller, its manufacturer, McCauley, specifies the inspection criteria for those propellers that have been exposed to overspeed conditions in Service Letter 1998-23, dated 21-09-1998, included here as Appendix D. Specifically, for propellers installed in reciprocating engines that have not exceeded a 15% of the the maximum rated (takeoff) rpm's, only a general external visual inspection is required. No additional actions are specified.

The mechanism that changes the pitch on the propeller blades has physical stops that limit the turn rate on this propeller type to approximately 2,800 rpm. This rate is noticeably below the 2,980 rpm's that would correspond to a 15% overspeed in this case.

As regards the engine, its manufacturer, Lycoming, specifies the criteria for inspecting engines that have been exposed to overspeed conditions in its Mandatory Service Bulletin No. 369J, dated 22-11-2004, and which is also included here in appendix D. It defines the term "momentary overspeed" as "an increase of no more than 10% of rated engine RPM for a period not exceeding 3 seconds", and states that an instantaneous overspeed is allowable in fixed-wing aircraft. It also establishes inspection criteria depending on whether the overspeed was less than or equal to 5%, between 5 and 10% or in excess of 10% of rated engine rpm's. Specifically, for engines of the type outfitted on the incident airplane that do not exceed 5% of their rated rpm's, it specifies that the causes of the overspeed must be determined and corrected. In this case the overspeed was 2,835 rpm's.

2. ANALYSIS AND CONCLUSIONS

The aircraft pilot described a situation in which the engine rpm's climbed above 2,800, meaning that the maximum rated rpm's for the engine and propeller type outfitted on the airplane were exceeded. The propeller pitch did not respond to his attempts to adjust it and the rpm's only dropped when he set the throttle to idle. Then, when he opened the throttle slightly, the engine once again exceeded 2,800 rpm's, the airplane vibrated and smoke smelling of oil entered the cockpit.

The inspection of the power plant components revealed the presence of an oil leak at the governor-engine coupling. Additionally, as described in 1.4.3, the engine inspection showed damage that was consistent with a high rotation rate that may even have involved an engine overspeed condition. Concurrent with this was the oil leak that hampered the lubrication of the engine and led to the overheating of the engine's moving parts. Finally, the inspection of the propeller governor showed that even though the oil leak had affected its operation, the governor itself had not malfunctioned.

Based on the inspection criteria specified by the respective engine and propeller manufacturers for components exposed to overspeed conditions, the situation described by the pilot would have corresponded to a momentary overspeed or, at most, to an overspeed below 5% of the engine's rated rpm's. These engine and propeller overspeed conditions alone should not have produced the damage found in the engine.

In light of these considerations, it may be concluded that the damage found in the aircraft's engine resulted from an engine oil leak in the area where the propeller governor is coupled to the engine. This leak gave rise to a gradual reduction in the amount of oil in the engine, with the ensuing drop in the flow of lubricating oil. The flow received by the governor was sufficient for its continued operation since its oil is supplied directly by the engine's oil pump. Under these conditions, the engine's moving parts overheated, leading to increased load torque in these components which would have tended to reduce their rotation rate. The governor reacted to this drop in rotation rate by reducing the pitch of the blades. Since the engine rpm's did not recover, it is probable that the engine behaved in such a way that the propeller blade pitch was reduced to the minimum practically instantaneously, to the point where the blades could have reached their physical stops. This would have resulted in the sudden increase in rpm's, which aggravated the damage already being caused by the engine's moving parts.

In the case at hand, Lycoming Service Instruction (SI) no. 1438A, dated 09-12-2005, is applicable in that is specifies that certain propeller governors must be coupled to the engine using two gaskets and a plate so as to eliminate the possibility of oil leaking between the governor and the engine accessory housing. Since the installation in this case was completed using a single gasket, the result was a leak that, at least initially, must have been small and slow to develop, as determined by the amount of oil recovered during the inspection, the time elapsed between engine start-up and when the pilot detected the overspeed, the extent of the warping of the engine's internal components, and the fact that the engine oil pump and the propeller governor had sufficient oil to keep running at all times.

Since the propeller governor is considered to be an aircraft component, the Aircraft Maintenance Manual must include the instructions for its proper installation and, as noted in 1.6.2, in this case, even though the manual included the modification issued as Temporary Revision no. 5, this revision had not been made available to users who accessed the electronic version of said manual. This is considered to have been a contributing factor to the incident.

3. SAFETY RECOMMENDATIONS

Since, as noted in the last paragraph in 1.6.2, the manufacturer has yet to include Temporary Revision no. 5 to the electronic on-line version of its Maintenance Manual, reference D991-3-13, the issuance of the following safety recommendation is deemed necessary:

REC 15/2011. It is recommended that the Cessna Aircraft Co. include Temporary Revision no. 5, dated 11-07-2005, to the on-line distribution of the electronic edition of its Maintenance Manual, reference D991-3-13, titled "Cardinal RG Series 1971 thru 1975 Service Manual", dated 01-09-1972, Revision 3, dated 01-09-1974, in addition to the temporary revisions already included in said distribution.

The Manufacturer has accepted this Safety Recommendation.

APPENDIX A
Cardinal RG Series 1971 thru 1975 Service Manual:
– 13-7 a 13. Propeller Governor
– Temporary Revision Number 5

13-4. TROUBLE SHOOTING (Cont).

TROUBLE	PROBABLE CAUSE	REMEDY
ENGINE SPEED WILL NOT STABILIZE (Cont).	Defective governor.	Install new governor. Refer to paragraph 13-9.
OIL LEAKAGE AT MOUNTING FLANGE.	Damaged O-ring between engine and propeller.	Install new O-ring.
	Foreign material between engine and propeller mating surfaces or mounting nuts not tight.	Remove propeller, clean mating surfaces, install propeller and torque mounting nuts.
OIL LEAKAGE AT ANY OTHER PLACE.	Defective seals, gaskets, threads, etc., or incorrect assembly.	Propeller repair or replacement is required.

13-5. REMOVAL. (See figure 13-1.)

a. Remove spinner dome (1).

b. Remove safety wire and loosen bolts, attaching propeller to engine crankshaft, about 1/4-inch and pull propeller forward.

NOTE

Bolts will have to be backed out evenly so that propeller may be pulled forward (approximately 1/4-inch at a time) until all bolts are disengaged from the engine crankshaft flange. As the propeller is separated from the engine crankshaft, oil will drain from the propeller and engine crankshaft cavities.

c. Pull propeller from engine crankshaft.

d. If necessary to remove the aft spinner bulkhead, remove bolts, washers and nuts attaching bulkheads. to the starter ring gear support. Retain shims.

NOTE

After removal of the propeller, the starter ring gear support assembly may be removed from the engine crankshaft to allow easier access of the aft spinner bulkhead attaching bolts. Loosen alternator adjusting arm and disengage alternator drive pulley belt from pulley on aft face of starter ring gear support assembly.

13-6. INSTALLATION. (Refer to figure 13-1.)

a. If aft spinner bulkhead was removed, reinstall on ring gear support, using bolts, nuts and shims as shown in figure 13-1.

b. If starter ring gear support and aft spinner bulkhead were removed, clean mating surfaces of support assembly and engine crankshaft flange.

c. Place alternator drive belt in the pulley groove of the starter ring gear support. Fit starter ring gear over propeller flange bushings on crankshaft.

NOTE

Make sure the bushing hole in the ring gear support, that bears the identification "O", is assembled at the "O" identified crankshaft flange bushing. This bushing is marked "O" by an etching on the crankshaft flange next to the bushing. The starter ring gear must be located correctly to assure proper alignment of the timing marks on the ring gear.

d. Clean propeller hub cavity and mating surfaces of propeller hub and ring gear support.

e. Lightly lubricate a new O-ring and the crankshaft pilot with clean engine oil and install O-ring in the propeller hub.

f. Align propeller mounting bolts with proper holes in engine crankshaft flange and slide propeller carefully over crankshaft pilot until bolts can be started in crankshaft flange bushing. Position propeller blades to extend by aft spinner bulkhead with ample clearance.

g. Tighten bolts evenly and work propeller aft on crankshaft flange. Tighten bolts to the torque value shown in figure 13-1.

h. Install safety wire through roll pins saftying bolts in pairs.

i. Adjust alternator drive belt tension as outlined in Section 16.

j. Install spinner dome.

13-7. PROPELLER GOVERNOR.

13-8. DESCRIPTION. The base mounted, engine-driven, centrifugal, single-acting governor is mounted on the lower right side of the engine accessory drive housing. The term single-acting refers to the manner in which engine oil is directed to the propeller to effect changes in propeller blade pitch. This governor produces oil pressure to increase blade pitch. Decreased blade pitch is produced by centrifugal twisting moment of the rotating propeller blades and the force of an internal spring in the propeller, when governor oil pressure is relieved. Oil relieved by the governor is permitted to return from the propeller to the engine. Basically the governor consists of an engine-driven gear pump with a pressure relief valve, a pair of rotating flyweights pivoted on a flyweight head, a spring-loaded pilot valve operated by the flyweights under the influence of centrifugal force and a control lever which varies the spring load on the pilot valve.

NOTE

Outward physical appearance of specific governors is the same, but internal parts determine whether it uses oil pressure to increase or decrease propeller blade pitch. Always be sure the correct governor is used with the propeller.

13-9. TROUBLE SHOOTING. Since governor action is directly related to the propeller pitch changing mechanism, there are very few governor troubles that can be isolated with the governor installed and operating. Failure of the propeller to change pitch correctly might be caused either by the governor or propeller. Except for locating obvious troubles, it is best to install a governor known to be in good condition to check whether the propeller or the governor is at fault when trouble occurs in the propeller pitch-changing mechanism. If the trouble disappears, the governor was at fault; if the trouble persists, the propeller may be at fault. Removal and installation, rigging of control, high-speed stop adjustment, desludging, and installation of the governor mounting gasket are not major repairs and may be accomplished in the field. Repairs to propeller governors are classed as propeller major repairs in Federal Aviation Regulations, which also define who may accomplish such repairs.

13-10. REMOVAL.

a. Remove engine cowling as required for access.
b. Disconnect heater ducts and oil cooler duct as required for access to governor.
c. Disconnect control from arm on governor and disconnect control from bracket.
d. Remove nuts and washers securing governor to adapter on engine accessory housing and work governor from mounting studs.
e. Remove mounting gasket.
f. Remove control bracket from governor.

13-11. INSTALLATION.

a. Install control bracket on governor, safety attaching screws.
b. Wipe governor and adapter mounting pad clean.
c. Install a new mounting gasket on the mounting studs. Install gasket with raised surface of the gasket screen toward the governor.
d. Position governor on mounting studs, aligning governor drive splines with drive splines in the engine, and install mounting washers and nuts. Do not force spline engagement. Rotate engine crankshaft slightly and splines will engage smoothly when properly aligned.
e. Tighten mounting nuts to 100-150 pound-inches.
f. Connect control to bracket and control arm on the governor. Rig control as required for full travel. Refer to paragraph 13-13.
g. Install all parts removed for access.

13-12. HIGH RPM STOP ADJUSTMENT.

a. Remove engine cowling as required for access.
b. Loosen the high-speed stop screw lock nut.
c. Turn the stop screw IN to decrease maximum rpm and OUT to increase maximum rpm. One full revolution of the stop screw causes a change of approximately 25 rpm. Refer to paragraph 11-3 for maximum rpm.
d. Tighten stop screw lock nut and make control linkage adjustment as necessary to maintain full travel of the control so that governor arm contacts stop screw.
e. Install cowling and test operate propeller and governor combination.

NOTE

It is possible for either the propeller low pitch (high rpm) stop or the governor high rpm stop to be the high rpm limiting factor. It is desirable for the governor stop to limit the high rpm at the maximum rated rpm for a particular aircraft. Due to climatic conditions, field elevation, low pitch propeller blade angle and other considerations, an engine may not reach rated rpm on the ground. It may be necessary to readjust the governor stop after test flying to obtain maximum rated rpm when airborne.

13-13. RIGGING.

NOTE

The result of rigging of the governor control is full travel of the governor control arm (bottomed out against both high and low pitch stops) with some "cushion" at both ends of the control travel.

a. Disconnect control from governor arm.
b. Place control in the cabin full forward then pull control knob back approximately 1/8-inch and lock in this position. This will allow "cushion" to assure full contact with governor high rpm stop screw.
c. Place governor control arm against high rpm stop screw.
d. Loosen jam nuts and adjust control rod end until attaching holes align while governor control arm is a against high rpm stop screw. Be sure to maintain sufficient thread engagement of the control and rod end. If necessary, shift control in its clamps to achieve this.
e. Attach control rod end to governor control arm, tighten control rod end jam nuts and install all safties.
f. Operate the propeller control to see that the governor arm attains full travel in both directions.

NOTE

Refer to the inspection chart in Section 2 for inspection and/or replacement interval for the propeller control.

Change 1 13-5/(13-6 blank)

Cessna
A Textron Company

TEMPORARY REVISION NUMBER 5

DATED 11 July, 2005

MANUAL TITLE Cardinal RG Series 1971 Thru 1975 Service Manual

MANUAL NUMBER - PAPER COPY D991-3-13

MANUAL NUMBER - AEROFICHE D991-3-13AF

TEMPORARY REVISION NUMBER D991-3TR5

MANUAL DATE 1 September 1972 **REVISION NUMBER** 3 **DATE** 1 September 1974

This Temporary Revision consists of the following pages, which affect and replace existing pages in the paper copy manual and supersede aerofiche information.

SECTION	PAGE	AEROFICHE FICHE/FRAME	SECTION	PAGE	AEROFICHE FICHE/FRAME
13	13-5	1/L01			
13	13-6	Added			

REASON FOR TEMPORARY REVISION

1. To add additional information to install gaskets and plate between the propeller governor and the engine accessory case.

FILING INSTRUCTIONS FOR THIS TEMPORARY REVISION

1. For Paper Publications, file this cover sheet behind the publication's title page to identify the inclusion of the Temporary Revision into the manual. Insert the new pages into the publication at the appropriate locations and remove and discard the superseded pages.

2. For Aerofiche Publications, draw a line with permanent red ink marker, through any aerofiche frame (page) affected by the Temporary Revision. This will be a visual identifier that the information on the frame (page) is no longer valid and the Temporary Revision should be referenced. For "added" pages in a Temporary Revision, draw a vertical line between the applicable frames. Line should be wide enough to show on the edges of the pages. Temporary Revisions should be collected and maintained in a notebook or binder near the aerofiche library for quick reference.

3. For CD publications, mark the temporary revision part number on the CD label with permanent red marker. This will be a visual identifier that the temporary revision must be referenced when the content of the CD is being used. Temporary revisions should be collected and maintained in a notebook or binder near the CD library for quick reference.

and the force of an internal spring in the propeller, when governor oil pressure is relieved. Oil relieved by the governor is permitted to return from the propeller to the engine. Basically the governor consists of an engine-driven gear pump with a pressure relief valve, a pair of rotating flyweights pivoted on a flyweight head, a spring-loaded pilot valve operated by the flyweights under the influence of centrifugal force and a control lever which varies the spring load on the pilot valve.

NOTE: Outward physical appearance of specific governors is the same, but internal parts determine whether it uses oil pressure to increase or decrease propeller blade pitch. Always be sure the correct governor is used with the propeller.

13-9. TROUBLE SHOOTING.

Since governor action is directly related to the propeller pitch changing mechanism, there are very few governor troubles that can be isolated with the governor installed and operating. Failure of the propeller to change pitch correctly might be caused either by the governor or propeller. Except for locating obvious troubles, it is best to install a governor known to be in good condition to check whether the propeller or the governor is at fault when trouble occurs in the propeller pitch-changing mechanism. If the trouble disappears, the governor was at fault; if the trouble persists, the propeller may be at fault. Removal and installation, rigging of control, high-speed stop adjustment, desludging, and installation of the governor mounting gasket are not major repairs and may be accomplished in the field. Repairs to propeller governors are classed as propeller major repairs in Part 43 of the Code of Federal Regulations, which also defines who may accomplish such repairs.

13-10. REMOVAL.

a. Remove engine cowling as required for access.
b. Disconnect heater ducts and oil cooler ducts as required for access to governor.
c. Disconnect control from arm on governor and disconnect control from bracket.
d. Remove nuts and washers securing governor to adapter on engine accessory housing and work governor from mounting studs.
e. Remove mounting gasket, and if installed, the Lycoming LW-12347 Plate and the MS9144-01 Gasket.
f. Remove control bracket from governor.

13-11. INSTALLATION.

a. Install control bracket on governor and safety attaching screws.
b. Wipe governor and adapter mounting pad clean.
c. Install new Lycoming part number 72053 Gasket on the mounting studs. Install a Lycoming LW-12347 Plate over the 72053 Gasket and a MS9144-01 Gasket over the LW-12347 Plate. Install gasket with raised surface toward the governor. Refer to Lycoming Service Instruction 1438 or latest revision.
d. Position governor on mounting studs, aligning governor drive splines with drive splines in the engine, and install mounting washers and nuts. Do not force spline engagement. Rotate engine crankshaft slightly and splines will engage smoothly when properly aligned.
e. Tighten mounting nuts to 100-150 pound-inches.
f. Connect control to bracket and control arm on the governor. Rig control as required for full travel. Refer to paragraph 13-13.
g. Install all parts removed for access.

13-12. HIGH RPM STOP ADJUSTMENT.
a. Remove engine cowling as required for access.
b. Loosen the high-speed stop screw lock nut.

c. Turn the stop screw IN to decrease maximum rpm and OUT to increase maximum rpm. One full revolution of the stop screw causes a change of approximately 25 rpm. Refer to paragraph 11-3 for maximum rpm.
d. Tighten stop screw lock nut and make control linkage adjustment as necessary to maintain full travel of the control so that governor arm contacts stop screw.
e. Install cowling and test operate propeller and governor combination.

NOTE: It is possible for either the propeller low pitch (high rpm) stop or the governor high rpm stop to be the high rpm limiting factor. It is desirable for the governor stop to limit the high rpm at the maximum rated rpm for a particular aircraft. Due to climatic conditions, field elevation, low pitch propeller blade angle and other considerations, an engine may not reach rated rpm on the ground. It may be necessary to readjust the governor stop after test flying to obtain maximum rated rpm when airborne.

13-13. RIGGING.

NOTE: The result of rigging of the governor control is full travel of the governor control arm (bottomed out against both high and low pitch stops) with some "cushion" at both ends of the control travel.

a. Disconnect control from governor arm.
b. Place control in the cabin full forward then pull control knob back approximately l/8-inch and lock in this position. This will allow "cushion" to assure full contact with governor high rpm stop screw.
c. Place governor control arm against high rpm stop screw.
d. Loosen jam nuts and adjust control rod end until attaching holes align while governor control arm is against high rpm stop screw. Be sure to maintain sufficient thread engagement of the control and rod end. If necessary, shift control in its clamps to achieve this.
e. Attach control rod end to governor control arm, tighten control rod end jam nuts and install all safeties.
f. Operate the propeller control to see that the governor arm attains full travel in both directions.

NOTE: Refer to the inspection chart in Section 2 for inspection and/or replacement interval for the propeller control.

APPENDIX B
Lycoming Service Instruction (SI) No. 14381,

LYCOMING
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SERVICE INSTRUCTION

DATE: December 9, 2005

Service Instruction No. 1438A
(Supersedes Service Instruction No. 1438)

SUBJECT: Propeller Governor Pad Plate P/N LW-12347

MODELS AFFECTED: All four and six cylinder, dual magneto engines with rear mounted propeller governor drives.

TIME OF COMPLIANCE: Anytime the propeller governor is installed.

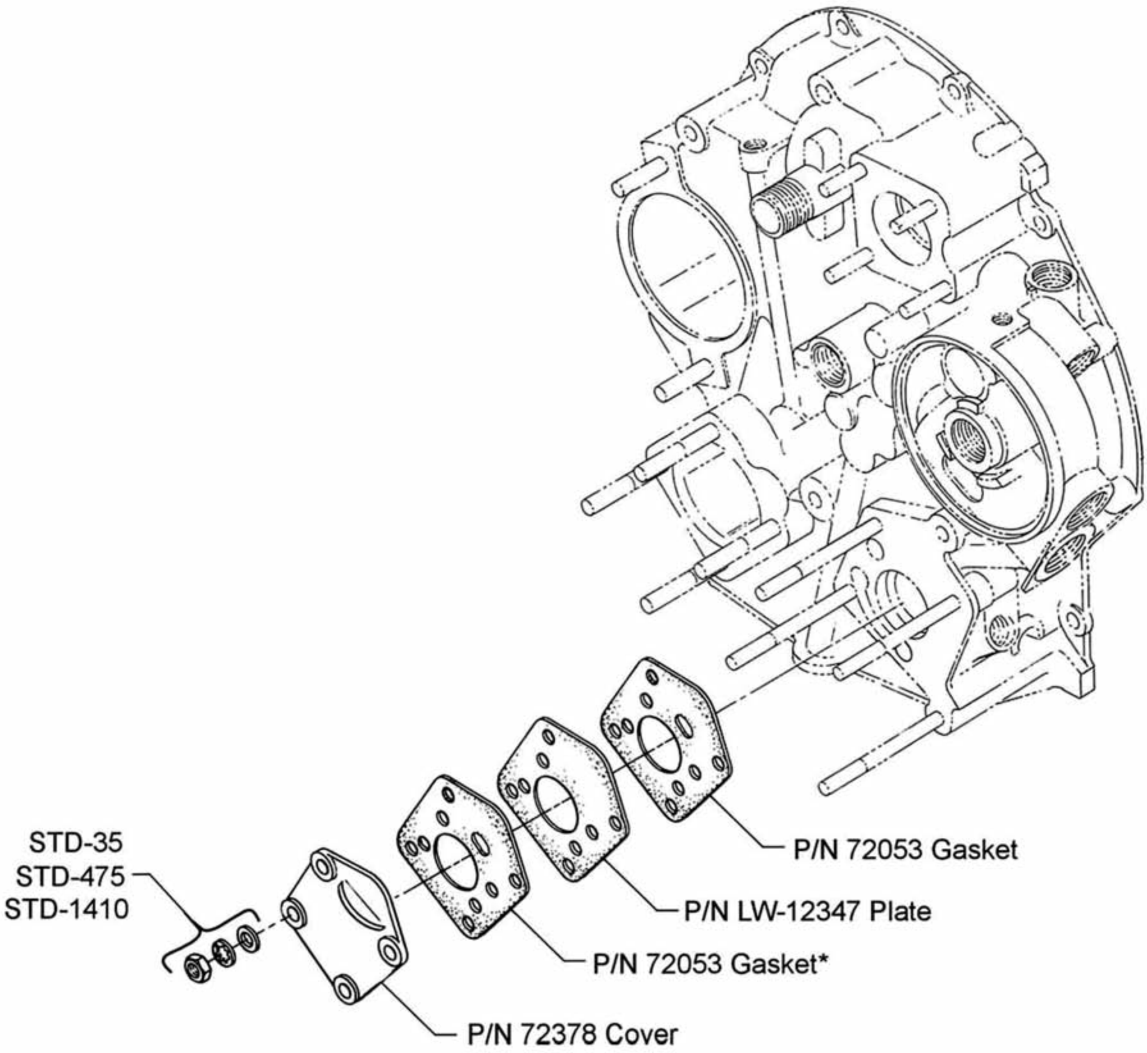
The use of a P/N LW-12347 propeller governor pad plate and two P/N 72053 gaskets on dual magneto engines with rear mounted propeller governor drives is necessary with some propeller governors to eliminate the possibility of oil leakage between the propeller governor and the accessory housing.

As a product improvement, to insure against oil leakage, the propeller governor pad plate and gaskets are being incorporated and will not effect operation with any propeller governor drive installed on the engines. See illustration.

CAUTION

WHEN INSTALLING THE PROPELLER GOVERNOR, THE P/N 72053 GASKET BETWEEN THE PROPELLER GOVERNOR PLATE AND THE COVER IS REPLACED BY A GASKET SPECIFIED BY THE AIRFRAME OR PROPELLER GOVERNOR MANUFACTURER. (REFER TO AIRFRAME IPC.) LYCOMING DOES NOT SUPPLY THIS GASKET; HOWEVER, IT MAY BE PURCHASED THROUGH THE AIRFRAME OR PROPELLER GOVERNOR MANUFACTURER.

Service Instruction No. 1438A



* Replaced by gasket specified by airframe or propeller governor manufacturer when propeller governor installed.

Propeller Governor Pad Plate and Gaskets

Page 2 of 2

APPENDIX C
Special Airworthiness Information Bulletin (SAIB) NE-06-08 United States Federal Aviation Administration (FAA)

SPECIAL AIRWORTHINESS INFORMATION BULLETIN

Aircraft Certification Service
Washington, DC

U.S. Department of Transportation
Federal Aviation Administration

NE-06-08
November 9, 2005

http://www.faa.gov/aircraft/safety/alerts/SAIB

This is information only. Recommendations aren't mandatory.

CORRECTION: Today, November 14, 2005, we corrected 2 typos in Table 1, under make and model.

Introduction

This Special Airworthiness Information Bulletin (SAIB) alerts you, owners, operators, and certificated repair facilities of **Lycoming four and six cylinder, dual magneto engines with rear mounted propeller governor drives**, of a potential assembly problem that could result in loss of engine oil leading to engine failure. The oil loss results from the omission of a plate, Lycoming part number (P/N) LW-12347, which is required between the propeller governor drive pad and the propeller governor. This plate is only 0.040 inches thick and could be mistaken for a used gasket and discarded when you removed the propeller governor or shipping cover.

Background

Some aircraft manufacturers order Lycoming engines with a propeller governor drive pad located on the rear accessory case and then install the propeller governor when they install the engine at the aircraft factory. Lycoming ships these engines with two gaskets, a plate, and a shipping cover over the propeller governor drive pad. Table 1 lists known engines delivered to aircraft manufacturers with the two gaskets, plate, and shipping cover installed.

> *NOTE: There are other Lycoming four and six cylinder, dual magneto, engine and aircraft combinations with a rear mounted propeller governor that are still in service but out of production.*

TABLE 1 – KNOWN ENGINES IN PRODUCTION

Lycoming Engine Model	Aircraft Make & Model
IO-360-A1B6D	Cessna 177RG Cardinal
IO-360-A1B6D	Siai-Marchetti (S-205)
IO-360-A3B6D	Mooney M20J-201
LO-360-A1G6D	Beech Aircraft. Duchess.
O-360-A1AD	S.O.C.A.T.A. Tabago TB-10
O-360-A3AD	Robin. Aiglon (R-1180T)
O-360-A3AD	S.O.C.A.T.A. TB-10
O-360-A1F6D	Cessna 177B Cardinal
O-360-A1F6D	Teal III. TSC (1A3)
O-360-A1G6D	Beech Duchess 76
TIO-540-AA2AD	Aerofab Inc. Turbo Renegade (270)
TIO-540-AB1BD	Schweizer SA2-37A, -37B

These engines also require the plate, P/N LW-12347, between the propeller governor drive pad and the propeller governor.

Lycoming's Overhaul Manual, Illustrated Parts Catalog, and Service Instruction (SI) No. 1438A illustrate the proper sequence of the parts installed on the propeller governor drive pad of the engine's rear accessory case when Lycoming ships the engine. They show two gaskets, P/N 72053, separated by a plate, P/N LW-12347, and a shipping cover, P/N 72378. SI No. 1438A also illustrates which of the two gaskets, P/N 72053, is replaced by the aircraft manufacturer's gasket when the propeller governor replaces the shipping cover.

If the plate, P/N LW-12347, is omitted from the assembly, a massive oil leak might occur resulting in an engine failure and a forced landing. The following website, http://www.cardinalflyers.com/pub/info/govplate.htm, documents at least one engine failure occurrence. This web site has photographs showing the edge of the plate with the propeller governor installed.

> *NOTE: We are referencing this website for information only. With the exception of the photographs showing the location of the plate, we don't endorse any other website content.*

The plate is actually a spacer to position the propeller governor away from the propeller governor drive pad. Without this plate, the propeller governor shaft might make contact with the bottom of the gear assembly inside the rear accessory case and prevent the propeller governor drive pad and the propeller governor flange from being drawn together to compress the gaskets. If the gaskets aren't compressed, they will not form a sufficient seal, which could cause an oil leak. The leak could be massive.

Recommendation

Accurate propeller governor installation instructions should be in the aircraft manuals. Lycoming SI No. 1438A shows the proper location of the gaskets and plate, and references the aircraft manufacturer's installation instructions for the proper replacement of one of the two gaskets, P/N 72053.

When installing a propeller governor on a Lycoming four or six cylinder engine with a dual magneto and a rear mounted propeller governor drive, refer to (1) Lycoming SI No. 1438A, (2) the aircraft manufacturers Propeller Governor Installation Instructions, and (3) the aircraft manufacturers Illustrated Parts Catalog.

You may need all three documents because some aircraft manuals don't have complete instructions. Refer to Lycoming SI No. 1438A for the sequencing of the gaskets, plate, and propeller governor, and to this SAIB for the plate inspection instructions.

We recommend the following:

- If you replace the propeller governor, the plate may be cleaned and reused with new gaskets.
- After installation, always verify that the plate has been installed and inspect for an oil leak by running the engine after propeller governor installation.
- If you receive an engine from someone other than Lycoming, none of the required items may be with the engine and it might be necessary to order a new plate and gaskets from Lycoming as well as a new gasket from the aircraft manufacturer.
- Be sure to run an overhauled engine in accordance with the RECOMMENDED RUN-IN SCHEDULE in the Lycoming Overhaul Manual (approximately 2 hours).
- Inspect engine for leaks after the Lycoming "RUN-IN".

For Service Bulletin Copies, Contact

Lycoming at 652 Oliver St, Williamsport, PA 17701: phone: (570) 323-6181; fax: (570) 327-7101; or go to their web site at: http://www.lycoming.textron.com/support/publications/maintenancePublications/serviceInstructions.html and open SI-1438A.

For Further Information Contact

Norm Perenson, Aerospace Engineer, FAA NYACO, ANE-171, 1600 Stewart Avenue, Suite 410, Westbury, NY 11590; phone: (516) 228-7337; fax: (516) 794-5531; email: norman.perenson@faa.gov

APPENDIX D
Propeller and engine overspeed criteria:
– McCauley Service Letter 1998-23
– Lycoming Mandatory Service Bulletin No. 369J

SERVICE LETTER 1998-23

September 21, 1998

TO: FAA-Approved Propeller Repair Stations, Owners, Operators, and Aircraft Maintenance Personnel

SUBJECT: Overspeeding of Propellers

MODEL AFFECTED: All McCauley Propellers except C1101, C1102, C1103, and C1104

SERVICE MANUALS AFFECTED: 720415, 710930, 701115, 780630, 761001, 810915, 790901, 730720, 860201, 810301, 880415, 890119, MPC1101-1, CMM1100-1, MPC-11, MPC-12, MPC-13, MPC-14, and MPC-15

This service information is to be added to the appropriate McCauley Service Manual until the next manual revision is issued.

Following are inspection criteria for McCauley propellers involved in overspeed conditions. Specific instructions for C1101, C1102, C1103, and C1104 model propellers are in manuals MPC1101-1 and CMM1100-1.

Inspection: Follow the inspection requirements per the following categories for overspeeding of rated take-off RPM. Disregard length of time at overspeed.

Models	Percentage Overspeed	Action to be Taken
All Propellers on Reciprocating Engines	Up to, but not including 15%	General external visual inspection. No further action required.
	15% or Higher	Contact McCauley Product Support for disposition.
All Propellers on Turbine Engines except C1101, C1102, C1103, & C1104	Up to, but not including 10%	General external visual inspection. No further action required.
	10% or Higher	Contact McCauley Product Support for disposition.

APPROVAL: FAA approval has been obtained on technical data in this publication that affects product type design.

TO OBTAIN SATISFACTORY RESULTS, PROCEDURES SPECIFIED IN THIS SERVICE INFORMATION MUST BE ACCOMPLISHED IN ACCORDANCE WITH ACCEPTED METHODS AND PREVAILING GOVERNMENT REGULATIONS. MCCAULEY PROPELLER SYSTEMS CANNOT BE RESPONSIBLE FOR THE QUALITY OF WORK PERFORMED IN ACCOMPLISHING THIS SERVICE INFORMATION.

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MANDATORY SERVICE BULLETIN

DATE: November 22, 2004

Service Bulletin No. 369J
(Supersedes Service Bulletin No. 369I)

SUBJECT: Engine Inspection after Overspeed or Overboost

MODELS AFFECTED: All Lycoming piston engines.

TIME OF COMPLIANCE: As required by the subject bulletin.

PART I – OVERSPEED

As shown in Chart I, every Lycoming piston engine is rated at a specified RPM value above which it may not be operated safely. Operating above the rated engine speed can accelerate wear of stressed parts, possibly resulting in their damage or failure. Momentary overspeed can occur during a landing attempt, when the prop governor lags as the throttle is suddenly opened for a go-around.

For fixed wing aircraft, momentary overspeed is defined as an increase of no more than 10% of rated engine RPM for a period not exceeding 3 seconds. For rotary wing aircraft, overspeed is defined as operating at any speed above rated engine RPM for any period of time. **No momentary overspeed is allowed for rotary wing aircraft.**

CAUTION

ENGINES MAY NOT BE CONTINUOUSLY OPERATED ABOVE SPECIFIED MAXIMUM CONTINUOUS RPM; TO DO SO WILL RESULT IN ABNORMAL WEAR ON BEARINGS, COUNTERWEIGHT ROLLERS AND OTHER ENGINE PARTS, CONCLUDING IN EVENTUAL ENGINE FAILURE.

Because inadvertent overspeed does occur, the information in this Service Bulletin is provided as an inspection procedure for an engine subjected to overspeed. Record any instance of overspeed in the engine log, along with the corrective action taken. Also note that the engine was inspected per this Service Bulletin.

NOTE

A few models have a five (5) minute take-off rating in addition to the continuous rating. On these engines, if overspeed does not exceed the take-off rating for longer than five minutes it may be disregarded. Also, for these engines the take-off rating may be considered to be the maximum rated speed when considering any momentary event of overspeed. Some engines, even though possessing parts of the same structural integrity, have different HP and RPM ratings. In these cases, when computing overspeed, the greater RPM may be used. (Reference Chart I.)

After locating the rated speed in Chart I, find the column for it in Chart II; then determine the percentage of overspeed from the values shown in the applicable column. For example, if the rated speed of the engine was found to be 2800 RPM and the overspeed was 2900 RPM, then from the 2800 column it can be determined that percentage of overspeed is less than 5%. In the lower portion of the chart, across from "2800" and down from 5% or less, locate the number "1" indicating that the instructions in Note 1 should be followed before the engine is returned to service.

CAUTION

IF OVERSPEED EXCEEDS 10% OF THE RPM VALUES IN THE COMPUTING-OVERSPEED COLUMN IN CHART I, IT IS RECOMMENDED THAT THE PROPELLER MANUFACTURER BE CONTACTED FOR POSSIBLE PROPELLER INSPECTION PROCEDURES.

NOTES

1. Determine the cause for overspeed and correct it.
2. Drain the lubricating system.
   a. Remove oil screens and filters and inspect for metal contamination.
   b. Perform a differential pressure check on all cylinders to determine the sealing quality of the rings and valves. See latest revision to Service Instruction No. 1191 for procedure.
   c. Using a borescope or equivalent instrument, examine the walls of each cylinder for scoring, which could be caused by stuck or broken piston rings.
   d. Disassemble magnetos and inspect all components for damage; recondition or replace parts as required. Reassemble and test in accordance with the applicable magneto overhaul instruction manual. Also inspect condition of the magneto drive gears on the engine for looseness, which would indicate the supporting idler shafts are loose due to failure of safety attachments. If applicable, inspect condition of magneto bearing recess in crankcase for excessive wear. Repair as necessary in accordance with the latest revision of Service Instruction No. 1140 or Service Instruction No. 1197.

   CAUTION

   EARLIER SLICK MAGNETOS ARE NON-REPAIRABLE. CONSULT SLICK PUBLICATION.
3. On mechanically supercharged engines, remove the supercharger drain cover and look for presence of engine lubricating oil which, if found, is indicative of a damaged supercharger seal. To determine the extent of damage, permit the oil to drain from the supercharger for a period of 8 hours; if the quantity of oil accumulated is more than a teaspoonful, the supercharger seal should be replaced.
4. Disconnect both the inlet and outlet attaching hardware from the turbocharger and examine the compressor and turbine wheels for possible damage. Check the shaft-wheel assembly for free turning and for vertical and lateral motion, which is indicative of damaged center housing bearings. Damage in these areas must be corrected before the engine is returned to service.
5. Either repeated moments or short periods of operation in the overspeed region accelerate the rate of wear in the parts that comprise the valve train and consequently reduce the reliability of the engine. In addition to the checks normally performed on the engine during a 100-hour periodic maintenance inspection, also accomplish the following steps on page 4 and 5 before the aircraft is returned to service.

Service Bulletin No. 369J

Chart I – Specified Rated Engine RPM			
ENGINE MODELS	SPECIFIED ENGINE SPEED		
	Continuous Rated RPM	5 Minute Take-Off Rating	RPM For Computing Overspeed
O-235-C1, -C1B, -C2A, -C2B, -E, -F, -G, -J; -K2A, -L2A, -M, -N, -P	2800		2800
O-235-C1C, -H2C, -L2C, -K2C	2800	2800	2800
O-290-D, -D2	2600	2800	2800
O-320-A, -B, -C, -D, -E, -H; IO-320; LIO-320-B, -C; *AIO-320-A, -B, -C; *AEIO-320-E	2700		2700
O-320-E2A; -E2C, -E2F; *AEIO-320-E2A (rated at 140 hp)	2450		2700
O-340-A, -B	2700		2700
O-360-A, -B, -C (except –C2D), -D, -E, -F, -G, -J; IO/LIO-360, LO-360-A, -E; *AIO-360; VO/IVO-360; HO-360-A1A, -C1A; HIO-360-G1A; *AEIO-360-A, -B, -H	2700		2700
O-360-C2D	2700	2900	2900
HO-360-B; HIO-360-A, -B, -C, -E	2900		2900
HIO-360-D1A	3200		3200
HIO-360-F1AD	3050		3050
TO-360-A, -C, -E, -F; LTO-360-A, -E; TIO-360-A, -C	2575		2575
O-435-A, -C	2550		2550
GO-435-C2	3100	3400	3400
VO-435-A	3200	3400	3400
VO-435-B; TVO-435	3200		3200
GO-480-B	3000	3400	3400
GO-480-C, -D, -F, -G, -H; IGO-480	3100	3400	3400
GSO-480; IGSO-480	3200	3400	3400
O-540-A, -B, -D; IO-540-C, -J	2575		2700
IO-540-A, -B, -E, -G, -P; HIO-540-A; TIO/LTIO-540 (except -S, -V)	2575		2575
O-540-J, -L; IO-540-W, -AB1A5	2400		2400
IO-540-AA1A5 (Alt. Rating)	2425		2425
O-540-E, -G, -H; IO-540-AA1B5, -AC1A5, -D, -K, -L, -M, -N, -R, -S, -T, -V; TIO-540-S; AEIO-540-D, -L	2700		2700
**O-540-F1B5, **IO-540-AE1A5	2800		2800
TIO-540-AK1A	2400		2400
TIO-540-AE2A, -AH1A, -AJ1A	2500		2500
TIO-540-AG1A, -AF1B	2575		2575
TIO/LTIO-540-V, TIO-540-W	2600		2600
VO-540-A	3200	3300	3300
VO-540-B; IVO-540; TIVO-540; VO-540-C	3200		3200
IGO-540	3000	3400	3400
IGSO-540	3200	3400	3400
TIO-541-A1A	2575		2575
TIO-541-E	2900		2900
TIGO-541	3200		3200
IO-720 (400 hp)	2650		2650
IO-720-D1BD, -D1CD (375 hp)	2400		2650

* - Aerobatic engines that are engaged in flight maneuvers which cause engine overspeed are subject to abnormal wear and possible overstress of rotating parts, which will shorten the service life of the engine. The damage accumulated due to the amount of overspeed, along with the extent of repeated operation at alternating high and low power applications, must be evaluated by the operator to determine the inspection procedures required.

** - Helicopter engines.

Page 3 of 7

Service Bulletin No. 369J

Chart II – Inspection Requirements in Event of Overspeed

Engine Overspeed in Excess of Max. Rated RPM	ENGINE RPM													
	2400	2425	2500	2550	2575	2600	2650	2700	2800	2900	3050	3200	3300	3400
* 5%	2520	2456	2625	2675	2705	2730	2780	2835	2940	3045	3202	3360	3465	3570
*10%	2640	2668	2750	2800	2830	2860	2915	2970	3080	3190	3355	3520	3630	3740

* - Except as defined as "Momentary Overspeed" in 2nd paragraph of Service Bulletin.

Category of Engine Types and Inspection Requirements
(Numbers Refer to Notes in Body of Text)

Specified Engine Speed	FIXED WING INSTALLATIONS									ROTARY WING INSTALLATIONS		
	DIRECT DRIVE (Normally Aspirated)			DIRECT DRIVE (Turbocharged)			GEARED DRIVE					
	5% or less	between 5-10%	over 10%	5% or less	between 5-10%	over 10%	5% or less	between 5-10%	over 10%	5% or less	between 5-10%	over 10%
2400	1	1,2,5	1,6	1	1,2,4,5	6						
2425	1	1,2,5	1,6									
2500				1	1,2,4,5	6						
2550	1	1,2,5	1,6									
2575	1	1,2,5	1,6	1	1,2,4,5	6				1	1,2,5	6
2600				1	1,2,4,5	6						
2650	1	1,2,5	1,6									
2700	1	1,2,5	1,6							1	1,2,5	6
2800	1	1,2,5	1,6							1,2	1,2,5	6
2900				1	1,2,4,5	6				1,2	1,2,5	6
3050										1,2	1,2,5	6
3200							1,3	1,3,4,5	6	1,2	1,2,5	6
3300										1,2	1,2,5	6
3400							1,3	1,3,4,5	6			

NOTES (CONT.)

a. Inspect all screens and filters in the lubrication system for metal contamination; if any unexplainable accumulation is discovered, the cause must be determined and corrected before the engine is returned to service.

b. By means of a borescope or equivalent illuminated magnifying optical device, determine the condition of the intake and exhaust valve faces and seat faces. Evidence of excessive wear, pounding, or grooving is reason for the valve and seat replacement.

c. Inspect external condition of valve keys, rockers, and exhaust valve guides for damage; particularly check valve springs for coil strikes or severe bottoming of the coils. If damage to springs is evident, remove them and check compression load as specified in Table of Limits; replace any that are not within limits.

d. Rotate the crankshaft by hand to determine if valve lift is uniform or equal for all cylinders; also note if valve rockers are free when the valves are closed. Unequal valve lift is an indication of bent push rods; and tight rockers, when valves are closed, indicate a tuliped valve or a damaged valve lifter. Repair any suspected damage before the engine is returned to service.

NOTES (CONT.)

e. Comply with the latest revision of Service Bulletin No. 388 to determine exhaust valve stem to valve guide clearance condition.

6. Remove the engine from the aircraft; disassemble it and inspect the parts in accordance with the applicable overhaul manual. Replace any parts that are damaged or not within the service limits as shown in the Table of Limits. In engines equipped with dynamic counterweights, the bushings must be replaced in both counterweight and crankshaft.

PART II – OVERBOOST

The maximum manifold pressure of turbocharged engines is controlled by various means:

1. Throttle controlled by the pilot. Here maximum rated manifold pressure is red-line and is normally reached somewhere before full-open throttle, depending upon density altitude.

2. Preset density controller. This controller senses compressor discharge density and varies the manifold pressure to ensure the engine develops rated power, up to critical altitude, regardless of the density altitude. Here take-off is at full throttle. However, the red line on the manifold pressure gage is the maximum permissible for a hot day at high field elevation. See the airframe or engine operator's manual for standard day manifold pressure, realizing that full rated power will require a lower manifold pressure on a below standard temperature day and higher on an above standard day. This further indicates that should the density controller be improperly adjusted or malfunction, it is possible to have an overboost without exceeding red-line manifold pressure.

3. Preset absolute variable pressure controller. This controller is normally used on engines incorporating a turbo compressor air bleed to pressurize the aircraft cabin. The controller is preset at the factory resulting in red-line manifold pressure at full throttle regardless of density altitude.

4. Preset slope controller. This controller is normally used on engines that do not incorporate a turbo compressor air bleed to pressurize the aircraft cabin. The controller is preset at the factory resulting in red-line manifold pressure at full throttle regardless of density altitude.

Overboost of Lycoming supercharged or turbocharged engines is not permitted beyond the limiting manifold pressure which appears on the Sea Level and Altitude Curves of the applicable Lycoming Operator's Manual. Any operation of an engine beyond this limit raises the possibility of serious engine damage. Because of this, any overboost, whether malfunction or inadvertent, which exceeds the allowable manifold pressure specified for the corresponding ambient pressure and temperature should be considered as shown in the following chart. It is the responsibility of the operator to monitor pressure to ensure limits are not exceeded. The continued use of an engine after momentary overboost has occurred is at the discretion and the responsibility of the operator.

NOTE

During take-off with low oil temperature, advancing the throttle too quickly may result in manifold pressure "overshoot". What happens is that manifold pressure advances momentarily above maximum rated by 1 or 2 inches Hg. and then returns immediately to the maximum rated. In this instance, the throttle is slightly ahead of the controller's capacity to function normally. If overshoot does not exceed 2 inches and 3 seconds duration, it may be disregarded. However, overshoot can be prevented by interrupting the throttle advance momentarily several inches below rated manifold pressure.

Chart III - Overboost Recommendations (No Manifold Pressure Relief Valve)	
IN ALL CONDITIONS LISTED BELOW, INVESTIGATE REASON FOR OVERBOOST AND CORRECT BEFORE NEXT FLIGHT	
Overboost Conditions	Recommendations
Momentary overboost not exceeding 3 inches Hg. for 5 seconds.	Enter in logbook. Include maximum manifold pressure reached, duration of overboost, cylinder head temperature, ambient air temperature, pressure altitude.
Not exceeding 5 inches Hg. or 10 seconds.	Normal 50-hour inspection plus particular attention to items 1, 2 and 3 in the following list.
Not exceeding 10 inches Hg.	Remove engine from aircraft; completely disassemble and inspect. Replace all parts that do not come within maximum service limits as shown in latest revision of Lycoming Service Table of Limits.
Over 10 inches Hg.	Complete engine overhaul required, plus replacement of crankshaft.

1. Inspect cylinder assemblies for signs of cracked heads, particularly around the lower spark plug holes; and for cracks around the hold-down flange of cylinder barrels. Also check barrels for burned paint and for oil leaks around cylinder base flanges.

2. Remove oil screens and inspect for metal particles using care to insure the particles are metal and not hard carbon.

3. Remove all spark plugs and inspect them closely for physical and structural defects. Spark plugs removed may be reused providing that each plug checks out satisfactorily in a spark plug test unit and exhibits none of the following defects:

   a. Fine wire plugs with loose center or ground electrodes.

   b. Electrodes show signs of metal or impact damage.

   c. Massive electrode plugs with copper run-out of center electrode.

   d. Ceramic core nose with a cracked or crazed surface.

PART III – ENGINES EQUIPPED WITH ABSOLUTE PRESSURE RELIEF VALVE

Some Lycoming turbocharged engines are equipped with an absolute pressure relief valve (often referred to as a "pop-off" valve). This valve is installed between the compressor outlet and the fuel injector/carburetor to protect the engine from surges of excessive manifold pressure. Even though manifold pressure may continue to rise above its normal rated value, power output will not increase appreciably. In fact, as the valve lifts off its seat, at approximately 2 inches above normal-rated, power may decrease even if manifold pressure continues to rise above normal-rated pressure.

Action required with manifold pressure overboost:

1. Determine the cause for overboost and correct it.

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2. Remove the absolute pressure relief valve (pop-off valve).

3. Place the valve assembly, mounting flange down, on a calibrated scale. The valve head should protrude approximately 0.2 inch below the mounting flange. Ensuring that the mounting flange remains parallel to the scale surface, apply pressure to the top of the valve housing. If the valve head depresses flush with the mounting flange surface, without exceeding the maximum pounds of force listed below, the valve is functioning.

In the following chart, pressure relief valves are divided into three categories, according to manifold pressure requirements.

Categories – Manifold Pressure Required to Develop Rated Power	Maximum Pounds to Depress Valve
30.00 to 40.00 inches Hg.	*43 lbs.
40.00 to 50.00 inches Hg.	*58 lbs.
50.25 to 60.00 inches Hg.	*72 lbs.
* - Any lesser pressure is acceptable as long as the valve, when in service, does not lift off its seat prior to attaining manifold pressure.	

NOTE

After complying with items 1 thru 3 and making appropriate logbook entry, return engine to service. Should the relief valve fail to lift off its seat within prescribed limits, the valve has malfunctioned. If so, refer to and comply with the Chart III overboost recommendations. Also, either reset or replace the pressure-relief valve.

CAUTION

ON ENGINES WHERE MANIFOLD PRESSURE IS THROTTLE-CONTROLLED BY THE PILOT, IN NO CASE ADVANCE THE THROTTLE BOOSTING MANIFOLD PRESSURE BEYOND RED-LINE TO DETERMINE IF THE ABSOLUTE PRESSURE RELIEF CONTROLLER IS FUNCTIONING. THIS IS AN EMERGENCY CONTROLLER. DELIBERATE MANIFOLD PRESSURE OVERBOOST MUST BE AVOIDED.

NOTE: Revision "J" revises Chart I and Chart II.