



Figure 1: Wreckage

EXAMINATION

The initial examination revealed a disconnect of the compressor rotor from the N1 drive train. A complete engine teardown followed.

Removal of the compressor module revealed significant damage to the Compressor / Compressor- Turbine (CT) Shaft coupling area. The aft end of the compressor, the Spur Adapter Gearshaft and the Splined Adapter were all found extensively damaged. The resultant damage had disconnected the compressor from the N1 drive train, which would have rendered the engine inoperable.

The rear compressor diffuser shims at teardown were found to not match the shims that should have been in place according to the last compressor overhaul records. According to the overhaul records, two of the shims recorded at teardown were each off by 0.02 inch. Based on these findings the investigation concluded that the engine was operating in a misaligned condition that was not permitted by the overhaul manual.

Removal of the compressor also revealed an unusual number of shims present on the compressor to- accessor gearbox mounts. Per the Rolls-Royce Maintenance Manual, a maximum of 0.020" of shimming is permissible on any single mount. One mount was found to have 0.036" shim, while another mount had 0.022" shim. There was no record of shimming in the engine's log book. A standard "shim card" is included in all Rolls-Royce M250 engine log books. It is standard practice to record the compressor's shimming during module installation.

Additionally, the compressor shim thickness on the pads that mate together the gearbox and compressor noted during the engine teardown was found non-conforming. Per the OMM alignment build procedures, the total thickness of shims at any one location must not exceed 0.020 inch. Shimming of the compressor assembly provides correct alignment of the compressor rotor and the gas producer turbine rotor. As the height of the mounting pads varies, the angle of the compressor relative to the gearbox also changes; this change in angle changes the alignment of the engine. The alignment build procedures in the OMM must be followed to prevent misalignment conditions.

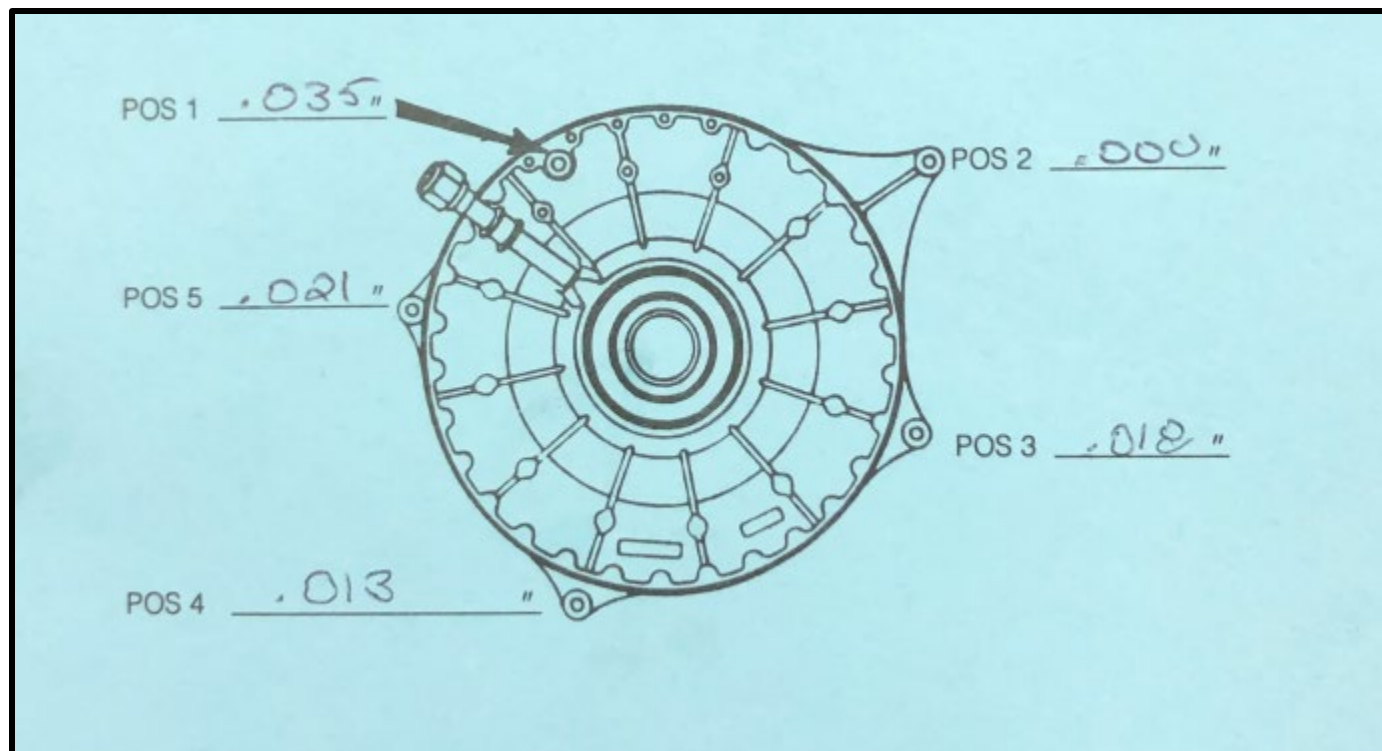


Figure 2: Shims as Measured at Examination

The Rolls Royce Materials Laboratory determined that Compressor Splined Adapter, P/N 23076559-1A (S/N 312392) was the primary failed item. There are multiple fatigue cracks on the Compressor Splined Adapter originating from the radius aft of the external splines. The stub shaft pilot inner diameter (ID) of the Impeller installed on engine AE-405061 during the event was measured and found consistent with it having been machined to fit a -3 Compressor Splined Adapter with a larger pilot outer diameter.

COMPRESSOR SPLINED ADAPTER INFORMATION

There are three dash size Compressor Splined Adapters available. For part number 23076559, -1, -2 and -3 each have progressively larger pilot diameters. The ID of the Impeller must be machined to achieve the proper fit. This machining results in a progressively larger ID, necessitating a Compressor Splined Adapter with a larger OD for a proper fit. If a -1 adapter is removed, a -2 adapter must be installed. If a -3 adapter is removed, a new Impeller is required. The Operation and Maintenance Manual (OMM) and C20 Series Commercial Engine Bulletin (CEB) A-1392 have the proper procedures for installing Compressor Splined Adapters of the correct size to prevent fractures that could lead to a power loss event.

According to the engine logbooks, in 2009 the compressor had the Impeller installed with Compressor Splined Adapter part number 23076559-3 s/n 316112 in order to comply with CEB A-1392; there is no mention of the Compressor Splined Adapter being removed/replaced in the engine logbooks. However, the Compressor Splined Adapter found installed during the event is P/N 23076559-1 S/N 312392. This is not allowed per the Rolls-Royce OMM or CEB A-1392 procedures. A new impeller should have been installed in order to use a -1 Compressor Splined Adapter.

Inspection - Maintenance - Overhaul Record Compressor Assembly			
Compressor Serial Number		Engine Model	
CAC- 17660		250-C2	
Date	Compressor Time		Remarks
	Since OH	Total	
3-11-18	1414.0	2797.4	INSPECTED COMPRESSOR FOR POSSIBLE HANDLANDING DAMAGE. INSPECTED COMPRESSOR ROTOR. CHECKED ROTOR WHEELS BLADES FOR DAMAGE. NONE FOUND. INSTALLED GO NO GO GAUGES ON BLADES, ALL CHECK GOOD. INSTALLED SERVICEABLE COMP. CASE VALVES SET S/N 40571. INSTALLED NEW COMPRESSOR FRONT SUPPORT. DYE PEN COUPLING SHAFTS, RE-ASSY COMPRESSOR. ALL WORK FAW ROLLS ROYCE INSTRUCTIONS END
2784C (12/98)			

Figure 3: Compressor Maintenance

4-09-2019	THIS ENGINE NO LONGER INSTALLED ON HELICOPTER OH-58A+ N288NS. THIS ENGINE S/N 70-15200 CAE-405061 WITH 3180.5 T.C. 2270 REMOVED FOR TROUBLE SHOOTING LOW POWER. T.C. 2270
-----------	--

Figure 4: Engine Removal

Inspection - Maintenance - Overhaul Record Engine Assembly			
Part IV Page No.		Rolls-Royce	
AE- 405061		Engine Model 250-C20C (T-63-A720)	
Time	Remarks	Signature and Certificate No.	Organization
3180.5 T.C. 2270	INSTALLED ENGINE ON HELICOPTER N901XV S/N 69-16273 MODEL OH58A+. ALL WORK FAW BHT AND ARROW FALCON MAINT. INSTRUCTIONS		

Figure 5: Engine Installation

Inspection - Maintenance - Overhaul Record Engine Assembly				Rolls-Royce	
				Part IV Page No. _____	
Engine Serial Number <u>SAE- 405061</u>		Engine Model <u>250- C20C (T63-A-720)</u>			
Date	Engine Time		Remarks	Signature and Certificate No.	Organization
	Since OH	Total			
6-10-20	MODULAR	3635.0	REMOVED COMPRESSOR ASSY. P/N 6890570 S/N AC-17102 WITH 3635.0 TSN AND DUE OVERHAUL. INSTALLED COMPRESSOR ASSY. P/N 6890570 S/N AC-17660 WITH 1414.0 HRS TSO AND 2797.4 TSN. ALL WORK IN ACCORDANCE WITH AND ROLLS ROYCE INSTRUCTIONS AIRCRAFT MUST BE TEST FLOWN AND POWER CHECK PERFORMED		

Figure 6: Compressor Removal

A/C Model Bell OH58A+ Aircraft S/N 69-15873 REG NO 901XV	Valley Rotor & Wing 502 W 1 St Hanger B-6 Imperial, CA 92251 760-455-3838	Date 6/10-2020 TSN: 7278.0 Hobbs: 454.5 ENGT 3635.0
ENGINE ENTRIES Removed Engine Assy due to Compressor O/H due. Removed Compressor P/N 6890570 S/N AC-17660. And Installed P/N 6890570 S/N AC-17660 work Performed By Del Rio Aviation Reinstalled Engine Assy Bleed fuel system and Performed Operational check and round runs.		
1 This Aircraft or Component Has been Repaired And/Or Inspected as Outlined above In Accordance With Current Maintenance Rules of CFR 14 It is Found Airworthy And is Approved For Return to Service.		

Figure 7: Compressor Overhaul



Rolls Royce 250 Series Compressor Assy.

ASSEMBLY RECORD

Part V
 Page: 1

P/N: 6890570
S/N: AC - 17660
Model 250-C20C / T63-A-720

Item Nomenclature	Item Part Number	Item Serial Number	INSTALLED			REMOVED			Reason
			Date	Compr. Total Time	Item TT Cycles	Date	Compr. Total Time	Item TT Cycles	
1st Stg Wheel	E23057111	TB2-0631	5-Feb-09	2208.9	0.0				
2-3 Stg Wheel	23060182	KR 64790	5-Feb-09	2208.9	TSO 0.0				
4th Stg Wheel	23057114	ER 68777	5-Feb-09	2208.9	TSO 0.0				
5th Stg Wheel	23057115	C 22001	5-Feb-09	2208.9	TSO 0.0				
6th Stg Wheel	23060416	C 21602	5-Feb-09	2208.9	TSO 0.0				
Impeller	23058147	KR 864058	5-Feb-09	2208.9	2104.9				
					N/A				
Tie Bolt	E6871259	PJ1-065	5-Feb-09	2208.9	0.0				
Case Halves	23057142	208992	5-Feb-09	2208.9	TSO 1090.9				
Coupling	23076559-3	316112	5-Feb-09	2208.9	0.0				
Gearshaft	E23031922	SG19-1044	5-Feb-09	2208.9	0.0				

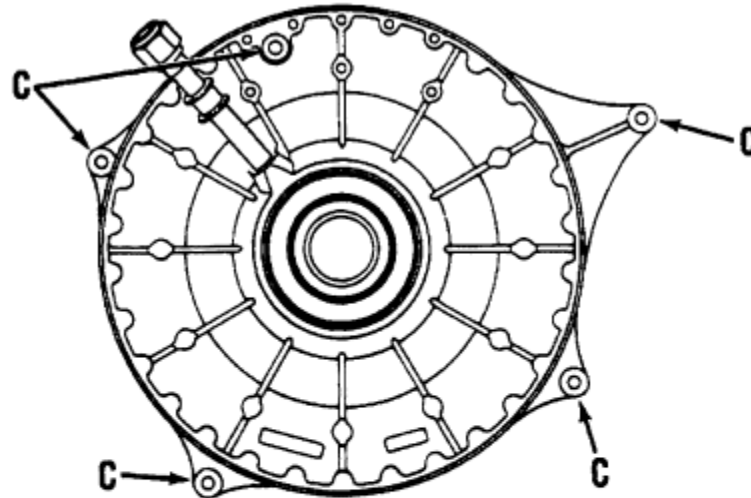
627 Ruberta Ave. Glendale, CA 91201 USA Tel (818)265-9730 Fax (818)265-9731 E-Mail: info@herosinc.com

Figure 8: Compressor Card

SHIM INSTRUCTIONS

- D. Determining Compressor Mounting Shim Thickness Requirements.
- (1) Place the compressor assembly in a vertical position (on blocks) with the impeller end up.

NOTE: Be sure the spur adapter gearshaft is match marked to the adapter coupling and the adapter coupling is match marked to the impeller hub prior to removal.
 - (2) Before removing the spur adapter gearshaft from the compressor assembly, match mark the spur adapter gearshaft to the adapter coupling and the adapter coupling to the impeller hub.
 - (3) Remove the internal retaining ring and remove the spur adapter gearshaft from the compressor.
 - (4) Using 6795588 wrench to hold the rotor and a six-point socket on the nut, remove the nut and washer securing the adapter coupling in the impeller hub. Using 6872832 puller, remove the coupling from the impeller hub.
 - (5) Install the plate of 6873066 fixture on the aft side of the rear diffuser.
 - (6) Attach the indicator and bracket on the impeller hub.
 - (7) Level the plate using the three leveling screws and the bracket mounted indicator.
 - (8) Position the dial indicator on the plate to contact the five mounting pads (C, figure 205). Record the reading at the five positions.
 - (9) Zero the indicator at the highest of the five positions. Measure and record the minus reading at each of the other four positions.
 - (10) Compute the total thickness of shims required to build the four (low) bolt holes up to the zero indicated hole as required to obtain an installed compressor squareness of 0.002 in. (0.05 mm) FIR. The total thickness of shims at any one location shall not exceed 0.020 in. (0.51mm). Electro-chemical etch the total shim thickness adjacent to the applicable bolt hole and cover the etched surfaces with Metcoseal AMS 3135 transparent silicone resin. Mark the zero indicated hole with a 0 (zero). (See figure 205.) Shims are available in three sizes; 0.002, 0.004, and 0.008 in. (0.05, 0.10, 0.20 mm).
 - (11) Remove the 6873066 fixture from the compressor.
 - (12) Align the match marks and install the adapter coupling into the splines of the impeller hub. Retain the coupling with a washer and nut. Hold the coupling with 6795588 wrench and Torque the nut to 50–55 lb in. (5.6–6.2 N·m) above locknut drag using a six-point socket.
 - (13) Align the match marks and install the spur adapter gearshaft into the splines of the adapter coupling. Retain the gearshaft in the coupling with the internal retaining ring.



MEASURE SQUARENESS OF DIFFUSER PADS MARKED **C** WITH RELATION TO ROTOR AXIS. ELECTROCHEMICAL ETCH (AS478-7A1) THE THICKNESS OF SHIMS REQUIRED AT EACH BOLT HOLE FOR COMPRESSOR INSTALLATION AND COAT ETCHED AREA WITH METCOSEAL.

NOTE: THE TOTAL THICKNESS OF SHIMS AT ANY ONE LOCATION SHALL NOT EXCEED 0.020 IN.(0.51 mm).