



REPORT NAME: PFS-17101 Tuned Exhaust System Installation Instructions and
Instructions for Continued Airworthiness.

REPORT NUMBER: PFS-17160-00

REVISION: C

REPORT DATE: February 1, 2011

AIRCRAFT APPLICABILITY: Robinson R22 Series Equipped with O-320-B2C Engines

PREPARED BY: T. Strohmayer 

DISTRIBUTION: FAA-ATL-ACO, End User

STC NUMBER: SR03863AT

Revision History

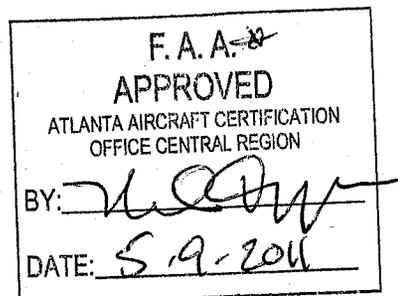
REVISION	DATE	REMOVE PAGES	INSERT PAGES
IR	OCT/28/2009	N/A	N/A
A	JAN/26/2010	1-4,6	1-4,6-15
B	JUL/23/2010	ALL	ALL
C	FEB/01/2011	4-7,9,10,12	4-7,9,10,12

Revision Summary (Rev C):

- Changed Intermediate Tube P/N.
- Added W&B info for carb heat only shroud.

Approval Notes:

* The Installation Instructions and Airworthiness Limitations Sections of this document are FAA Approved.



*Sections 40 & 62



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1.0 Introduction

Note: PFS is the abbreviation for Power Flow Systems, Inc.

Please read these directions completely before starting installation.
Please call us at 386-253-8833 during normal business hours if you have any questions regarding the installation of this kit.

1.1 Description

This modification is a new type of (tuned) exhaust system on Robinson R22 Alpha, Beta, Mariner rotorcraft. The tuned exhaust is made from stainless steel and is installed in lieu of the standard R22 exhaust. The muffler (tailpipe) is supported by a bracket attached to the fan cowling/scroll.

The installation of this tuned exhaust system will allow an R22 equipped with a Lycoming O-320-B2C engine and Robinson's P/N C649-1 or P/N A649-2 Large Oil Cooler to operate to Beta II (or Mariner II, as appropriate) manifold pressure limitations. Additional benefits include fuel savings and the ability to meet Beta II (or Mariner II, as appropriate) IGE and OGE performance.

Please Note: The Power Flow Systems Exhaust has been designed and FAA approved to be installed and maintained in accordance with these instructions. *Any* modification to the exhaust system or its components, or any deviation from these instructions invalidates the design and the FAA approval. Any such modifications or deviations will also void the exhaust system warranty.

1.2 Update Procedure

It is the responsibility of the aircraft owner/technician to ensure that the most recent revision of these instructions is followed. The most recent revision of this report can be obtained by calling Power Flow Systems, Inc. at (386) 253-8833 or online at www.powerflowsystems.com



2.0 Kit Contents

Qty	Part Description	Part Number
1	#1 Header	11600
1	#2 Header	12600-1
1	#3 Header	13600
1	#4 Header	14600-1
4	No-blow Header Gasket	77611
8	Exhaust Nut	SL-STD-1410
8	Lock Washer	MS35333-41
8	Plain Washer	AN960-516
1	Shrouded Collector Assembly	40710 / 40711
	-Combination Shroud (Cabin Heat and Carb Heat)	50710 (shroud P/N)
	-Carb Heat Shroud (Carb Heat Only)	50711 (shroud P/N)
1	Exhaust Extension Assembly	78105
1	Tailpipe Assembly	80070(-CER)
1	Exhaust Clamp (2" with pin)	7022
1	Support Bracket	7101
1	Muffler Clamp (3-1/2" without pin)	8030(-CER)
1	Male Balljoint Flange	510
2	Neoprene Strap Hangers	212
3	Balljoint Springs	33703
1	Bolt	AN3C5A
3	Bolt	AN3C12A
1	Bolt	AN4C5A
1	Bolt	AN4C6A
7	Washers	AN960C10
3	Washers	AN960C416
1	Washer	AN970-3
1	Washer	AN970-4
4	Locknut	MS21045C3
2	Locknut	MS21045C4
4	Pal Nut	MS27151-7
2	Pal Nut	MS27151-13
1	Manifold Pressure Gage	A600-5*
1	Decal – Flight Limitations	L_MAP-LIMITS (A654-90*)
1	Decal – DANGER Hot Exhaust	L_DANGER
1	Decal – Operate to Beta II Limits	L_BETA

*Robinson Part Numbers, Approved Equivalents may be used.

3.0 Preparation

- 3.1 Verify that Robinson A649-2 or C649-1 Oil Cooler is installed. Remove original exhaust in accordance with the Robinson R22 Maintenance Manual. If the rotorcraft is not equipped with cabin heat or if the cabin heat is not frequently used, make sure that the shrouded collector assembly is wrapped in the Carb Heat Shroud (50711), not the Combination Shroud (50710) shown in Detail E.
- 3.2 Replace the existing manifold pressure gage with Robinson manifold pressure gage P/N A600-5 (or approved equivalent). An alternative method is to remark the existing manifold pressure gage with a yellow arc from 19.6 to 24.1 and a red line at 24.1 (as specified for the Beta II in the limitations section of the RFM).

4.0 Installation of PFS Exhaust System

4.1 Installing Collector Assembly and Header Pipes

NOTE: Each header and collector tube is marked with its appropriate cylinder number and alignment marks when shipped from the factory. Use the Installation Overview on page 11, and additional views on pages 12 and 13.

- 4.1.1 Apply generous amounts of high-temperature anti-seize to the slip joints on the collector box (new kits will have anti-seize applied from the factory).
- 4.1.2 Put new exhaust gaskets P/N 77611 into position on each cylinder. It is suggested that you keep them in place temporarily with either a loop of safety wire or a large cotter pin. Insert the headers into the collector assembly using the alignment marks as a guide. Insert the pipes between 1.5 and 1.75 inches.
- 4.1.3 Rotate each header so that the collector box will be positioned approximately 30 degrees to the engine centerline. If installing a new kit, use the factory alignment marks.
- 4.1.4 Loosely install a washer, a lock washer and a nut on each stud (there are 8 sets of these). If utilized, remove the loops of safety wire or cotter pins. See Detail A. Torque the exhaust nuts to 90 in-lbs **after** proper orientation and assembly position of the exhaust system is achieved.
- 4.1.5 Attach SCAT hoses to shroud sub assembly (50710 or 50711). The carb heat flange is the 90-deg mitered tube. If the cabin heat system is not installed or not regularly used, ensure that P/N 50711 carb heat shroud is installed, rather than the 50710 combination shroud; failure to do so may cause the collector tubes to overheat and shorten the lifespan of the exhaust system. See Detail E.

4.2 Installing the Intermediate Tube and Tailpipe

- 4.2.1 Slide the balljoint flange (P/N 510) over the intermediate tube (78105).
- 4.2.2 Slide the intermediate tube (78105) over the outlet on the collector assembly. The tube should be pushed all the way on (until it will not go any further inboard).
- 4.2.3 Remove the fasteners from the port side of the cooling scroll flange joint. Locate the bracket (7101) ensuring the end flange of the bracket is hard up against the scroll flange. Drill the bracket to match screw holes. Deburr the holes and install the bracket to the scroll using the existing hardware. Install the neoprene strap (212) to the bracket. See Detail D.



- 4.2.4 Assemble the balljoint to connect the tailpipe assembly to the intermediate tube. Do not tighten down balljoint nuts at this time (see step 4.2.6). See Detail C.
- 4.2.5 Locate the end of the tailpipe directly below the bracket. Attach the tailpipe to the bracket strap using clamp P/N 8030(-CER). The pipe will be pointed slightly outboard. See Detail D.
- 4.2.6 Drill a ¼” hole through the pilot hole in the intermediate tube (78105) and install clamp P/N 7022, then tighten balljoint nuts to a spring height of 0.430 to 0.475”. See Detail B.

5.0 Inspection and Paperwork

5.1 Clearances

- 5.1.1 Be sure that the final installation allows a minimum of 2” clearance between unshielded exhaust tubes and fuel and oil lines or battery cables. Verify that fuel, oil, and electrical lines are properly supported. Nylon, plastic, or rubber ties can melt and cause fuel, oil, or electrical lines to fall onto exhaust system components.

5.2 Placards

- 5.2.1 Replace the limitations decal with the new decal Robinson P/N A654-90, or approved equivalent. An alternative method is to fabricate a placard with the MAP Limits specified for the Beta II in the limitations section of the RFM. Install the included placard on the instrument panel near the new manifold gage P/N A600-5 that states: “Power Flow Tuned Exhaust System Installed, Operate to Beta II (Or Mariner II, as appropriate) Manifold Pressure Limits”.

MARINER ONLY: If this is a Mariner installation, DO NOT use the Never Exceed Speed half of the P/N A654-90 limitations decal. Remove it and use the existing decals for Never Exceed Speed Limitations. Use only the MAP limits table from A654-90. If fabricating a placard, use the original Mariner Never Exceed Speed Limitations.

- 5.2.2 Install the included DANGER HOT EXHAUST label on the port side of the cooling scroll, opposite the existing DANGER label.

5.3 Records

- 5.3.1 Make appropriate entries in the logbook and on FAA Form 337. This modification is considered a major airframe alteration. The STC is located at the back of this instruction set.
- 5.3.2 Typical Weight and Balance Information:
 - With Cabin Heat (Combination) Shroud - 21.9 lbs 115.0 inches aft of datum
 - With Carb Heat Only Shroud – 19.9 lbs 115.5 inches aft of datum

6.0 Continued Airworthiness Instructions

6.1 Basic Operation

The helicopter is to be operated to R22 Beta II (or Mariner II, as appropriate) Manifold Pressure limits.

6.2 Airworthiness Limitations

The Airworthiness Limitations section is FAA approved and specifies maintenance required under §§43.16 and 91.403 of the Federal Aviation Regulations unless an alternative program has been FAA approved.

6.2.1 Mandatory Replacement Time – On Condition

6.2.2 Any collector assembly that is damaged, cracked, burned or worn and/or fails the pressure test described below must be repaired, rebuilt by the manufacturer, or replaced.

- Any tailpipe baffle that is damaged, cracked, or deformed must be replaced.
- Any exhaust tube that is damaged, burned, cracked, or worn more than 25% through the material thickness (tubes are nominally 0.049 thick) must be rebuilt by the manufacturer, or replaced.
- Any damage, cracks, or wear leaving less than 0.020 thickness remaining on the carb heat portion of the heat shroud must be rebuilt by the manufacturer or replaced.

6.2.3 Structural Inspection Interval – The exhaust system must be inspected in accordance with this document at 100 hour or Annual intervals (depending on the service regime of the rotorcraft).

WARNING: Carbon Monoxide (CO) gas present in exhaust gases can lead to pilot incapacitation and/or death. A damaged exhaust system has the potential to allow Carbon Monoxide into the aircraft cabin. To prevent such an occurrence, it is imperative that the exhaust system is inspected using the intervals and procedures described in this report. Any measured CO concentrations of greater than 50ppm will require immediate rebuild by the manufacturer or replacement of the damaged component.

6.2.4 Structural Inspection Procedure – See Section 6.6 below.

6.2.5 All slip joints must be disassembled and lubricated with a high-temperature anti-seize compound meeting or exceeding MIL-A-907E at 500hr or Annual intervals (whichever comes first). While disassembled, inspect for wear or galling. This must be performed more frequently if headers seize between inspections.



6.2.6 Verify the following:

- Robinson P/N C649-1 or Robinson A649-2 Large Oil cooler is installed.
- The manifold pressure gage marked in accordance with the limitations prescribed for the Beta II in the Limitations Section of the Rotorcraft Flight Manual.
- The limitations decal is Robinson P/N A654-90 or equivalent (shown below).
- A placard is installed on the instrument panel near the manifold pressure gage that states: “Power Flow Tuned Exhaust System Installed, Operate to Beta II (Or Mariner II, as appropriate) Manifold Pressure Limits”.

NOTE: If this is a Mariner installation, only the MAP limits table from A654-90 should be used, not the Never Exceed Speed table.

LIMIT MANIFOLD PRESSURE - IN. HG								NEVER EXCEED SPEED - KIAS									
MAXIMUM CONTINUOUS POWER								OAT - °C									
PRESS	OAT - °C							PRESS	OAT - °C								
ALT-FT	-20	-10	0	10	20	30	40	ALT-FT	-20	-10	0	10	20	30	40		
SL	21.5	21.8	22.1	22.3	22.6	22.9	23.2	2000	102							99	96
2000	21.1	21.4	21.6	21.9	22.2	22.5	22.8	4000				98	94	91	87		
4000	20.7	21.0	21.2	21.5	21.8	22.0	22.3	6000			98	94	90	87	82	77	
6000	20.3	20.6	20.8	21.1	21.3	21.6	21.9	8000	94	90	86	80	75	69	64		
8000	19.9	20.2	20.4	20.7	20.9	FULL THROTTLE		10000	86	80	74	68	62	57			
FOR MAX TAKEOFF POWER (5 MIN), ADD 0.9 IN. HG								12000	74	67	61					NO FLIGHT	
								14000	61								

6.3 Troubleshooting

Problem	Possible Cause	Solution
Exhaust smell or carbon monoxide in cockpit	Exhaust Leak, opening in firewall or fuselage	Immediately inspect exhaust system and airframe for leaks, do not return to service until problem is resolved.
Excessive vibration	Balljoint too loose.	Tighten Balljoint
	Collector not centered on header pipes	Reposition collector -- ensure minimum of 1 1/2" penetration per header into central collector system
	Broken Exhaust Hanger	Replace Exhaust Hanger
	Cooling Fan not properly balanced	Have cooling fan dynamically balanced.
	Worn Engine Mounts	Inspect Engine mounts and replace if necessary.
Excessive noise	Muffler insert damaged or missing	Contact PFS, Inc. for new muffler insert kit, PN PFS-8018.
Staining at or near slip joints.	Exhaust Leak or Anti-Seize stain.	Anti-Seize will creep from slip joints and appear as a stain, this is not a problem. Exhaust leaks from slip joints are extremely rare, but if stains are determined to be from exhaust, the slip joints should be reworked for better fit for better fit by carefully expanding the inside tube until it fits tightly within the outer tube.

6.4 Maximizing Service Life

To get the maximum possible service life from your Power Flow Systems Tuned Exhaust, follow these steps:

- 6.4.1 Dynamically balance your cooling fan to below 0.15 ips (inches per second) every year or 500 hours (whichever occurs first).
- 6.4.2 Dynamically balance your cooling fan to below 0.15 ips after removing and refitting of cooling fan.
- 6.4.3 Keep slip joints lubricated with a high temperature anti-seize (MIL-A-907E or equivalent).
- 6.4.4 Maintain even engine compressions above 70/80 psi.
- 6.4.5 Keep magnetos in good working order and ensure that mag drops are even and less than the maximum recommended by the aircraft manufacturer.
- 6.4.6 Make sure that the Carb Heat Only shroud (P/N 50711) is installed if the rotorcraft cabin heating system is either not installed or infrequently used.

PLEASE NOTE THAT FAILURE TO COMPLY WITH ONE OR MORE OF THESE STEPS MAY IMPACT THE PRODUCT WARRANTY. PLEASE CONSULT YOUR WARRANTY DOCUMENTATION FOR FURTHER DETAILS.

6.5 Removal

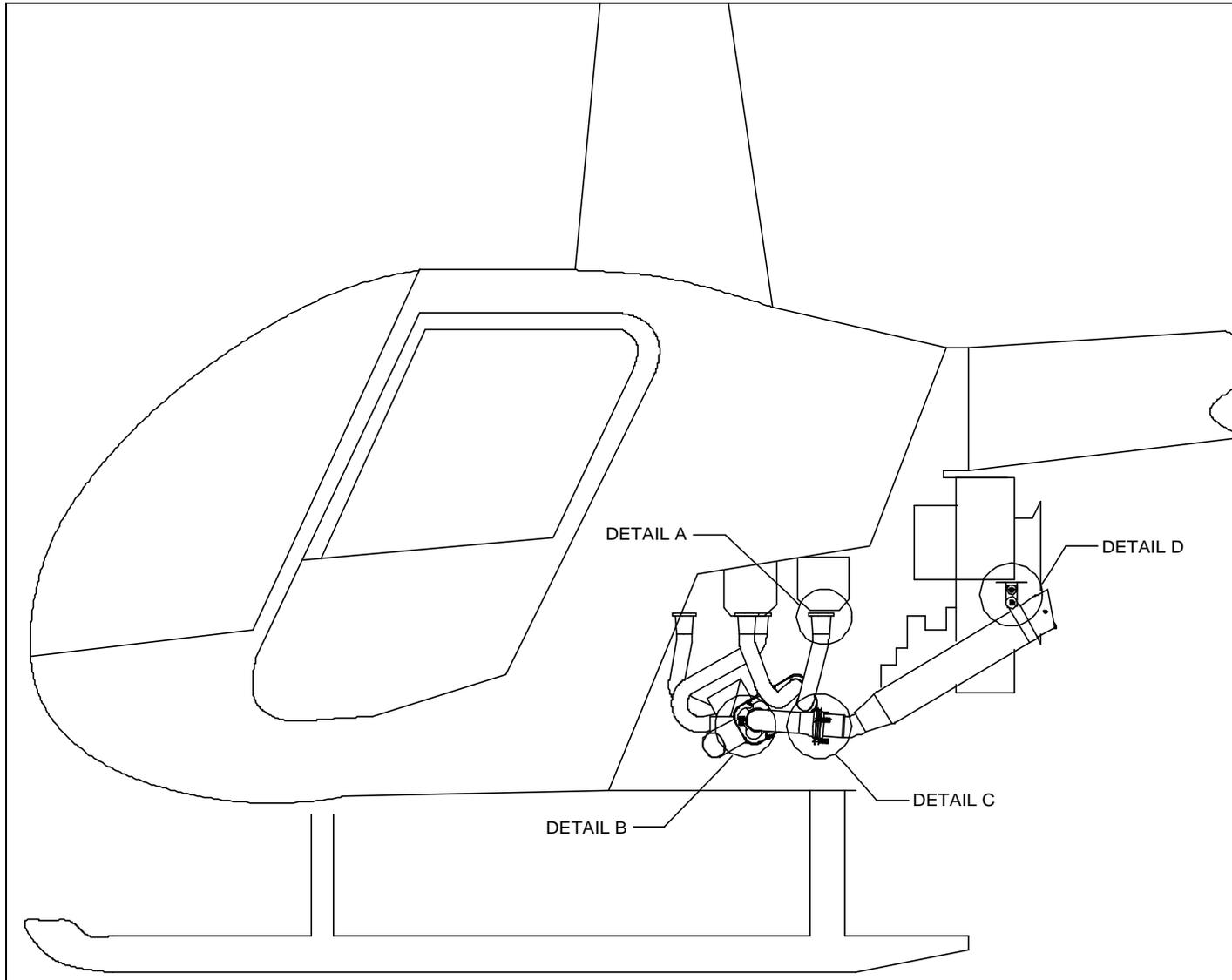
- 6.5.1 Remove the tailpipe by disconnecting the strap hanger and balljoint.
- 6.5.2 Disconnect SCAT hose(s).
- 6.5.3 Mark each of the header pipes with their respective cylinder number with a felt tipped pen or marker. Also mark the insertion depth and rotation angle of the header slip joints. **DO NOT MARK EXHAUST PIPES WITH A PENCIL OR ANY OTHER GRAPHITE OR CARBON BASED MARKING DEVICE.**
- 6.5.4 Remove EGT probes (if installed)
- 6.5.5 Loosen nuts and washers attaching header pipes to the exhaust studs.
- 6.5.6 Remove the remainder of the assembly as one complete unit.

6.6 Inspection

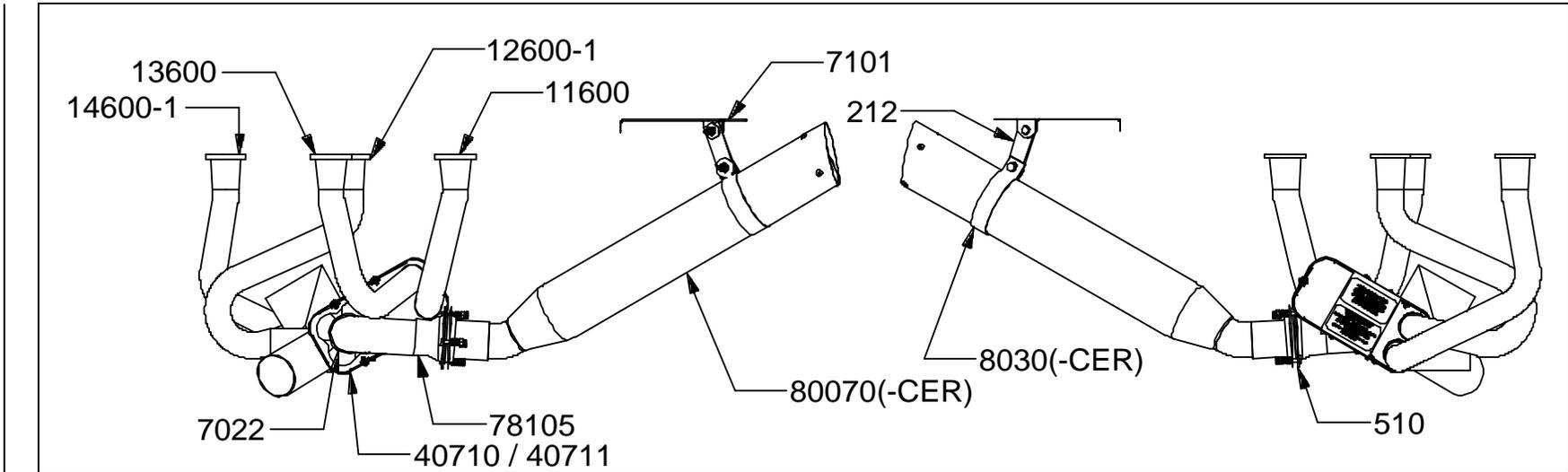
The exhaust system must be thoroughly inspected, especially within the heat exchanger section(s). A detailed visual inspection of the exhaust system must be performed in accordance with this document at either 100 hour or annual intervals (depending on the service regime of the rotorcraft). Parts that fail inspection must be rebuilt by the manufacturer or replaced.

- 6.6.1 Check for holes, cracks, and burned spots. Especially check areas adjacent to welds. Look for exhaust gas deposits in surrounding areas. Look for unusual tube discoloration. This may indicate an exhaust leak.
- 6.6.2 Inspect the muffler (tailpipe) insert. If the insert is missing or deteriorated, it will require replacement. New inserts are available from Power Flow Systems, Inc. as part number PFS-8018.
- 6.6.3 All slip joints must be disassembled and lubricated with anti-seize meeting or exceeding MIL-A-907E at 500hr or Annual intervals, whichever comes first. While disassembled, inspect for wear or galling. This must be performed more frequently if headers seize between inspections.
- 6.6.4 Be sure to open heat shroud(s) and shields to inspect within the collector assembly. If any defects on the collector assembly (other than on the shroud) are noted during the visual inspection, then the collector needs to be pressure tested using the procedure below:
 - Remove shrouds.
 - Seal four of the openings (tubes) with rubber expansion plugs.
 - Submerge the collector assembly in water.
 - Using a manometer or calibrated pressure gauge, apply 3.0 to 3.5 PSI (approximately 7" Hg) of air pressure to the fifth opening.
 - Let the unit sit pressurized for 10 to 30 seconds. The leak rate should be zero.
 - If a leak is found in the collector assembly, replace before further flight.

Installation Overview

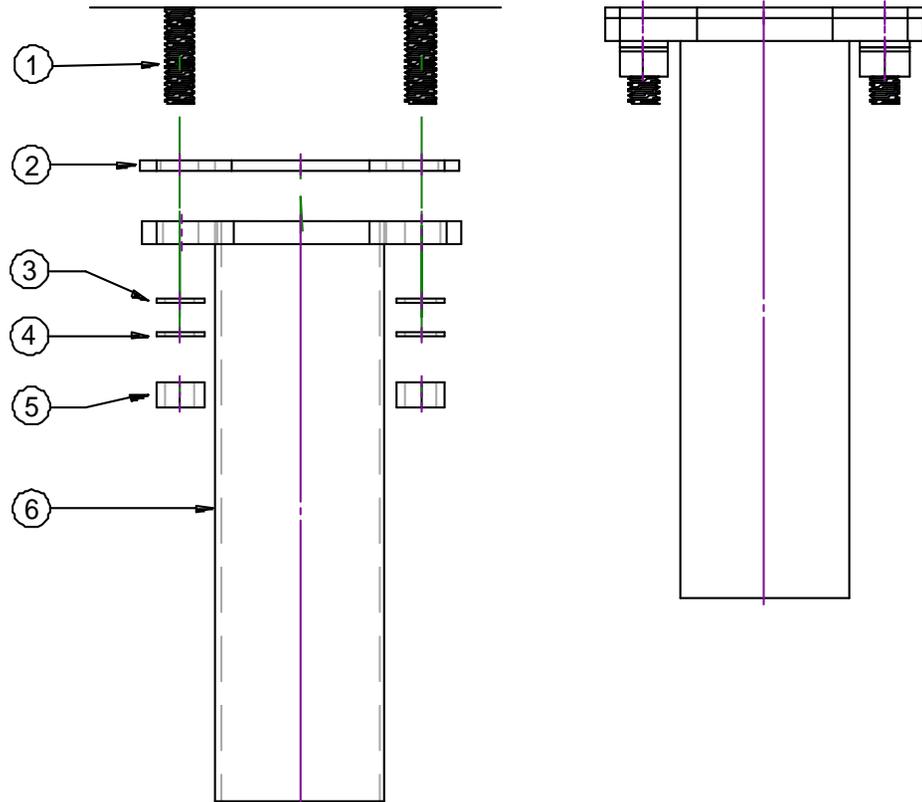


Side Views

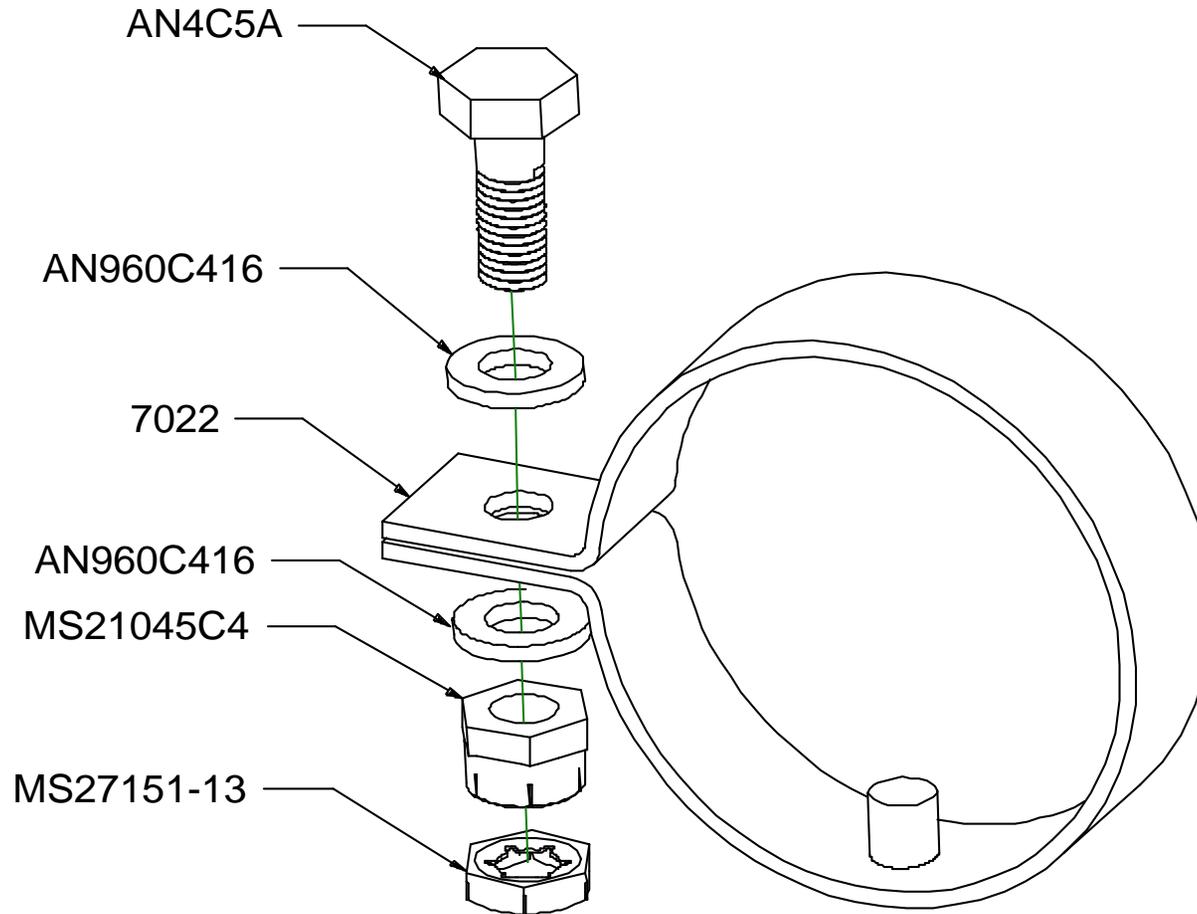


DETAIL A – Header Tube Installation

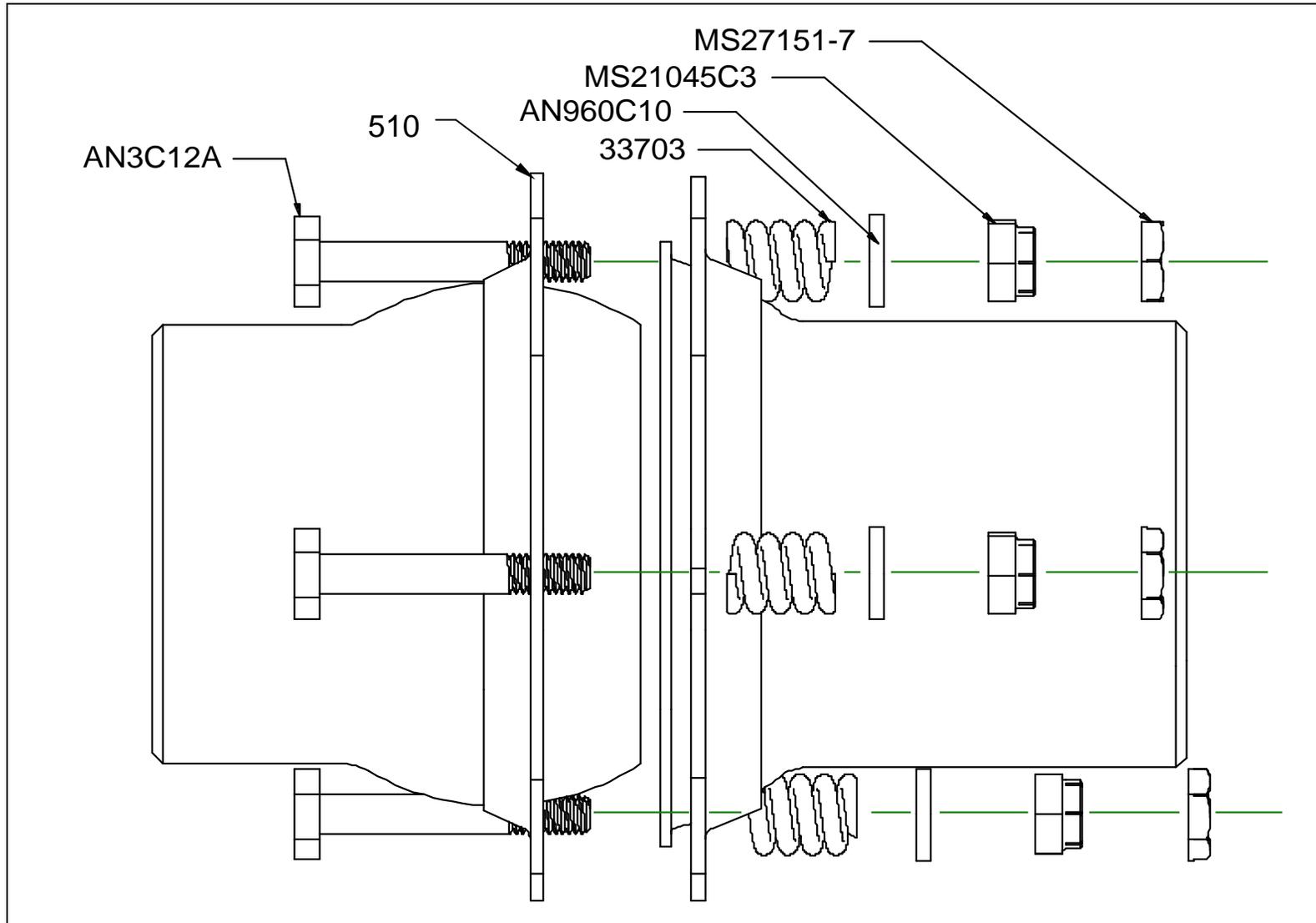
- | | |
|--------------------|-----------------|
| 1 - EXHAUST STUD | LYCOMING ENGINE |
| 2 - NO-BLOW GASKET | 77611 |
| 3 - FLAT WASHER | AN960-516 |
| 4 - LOCK WASHER | MS35333-41 |
| 5 - NUT | SL-STD-1410 |
| 6 - HEADER | VARIOUS |



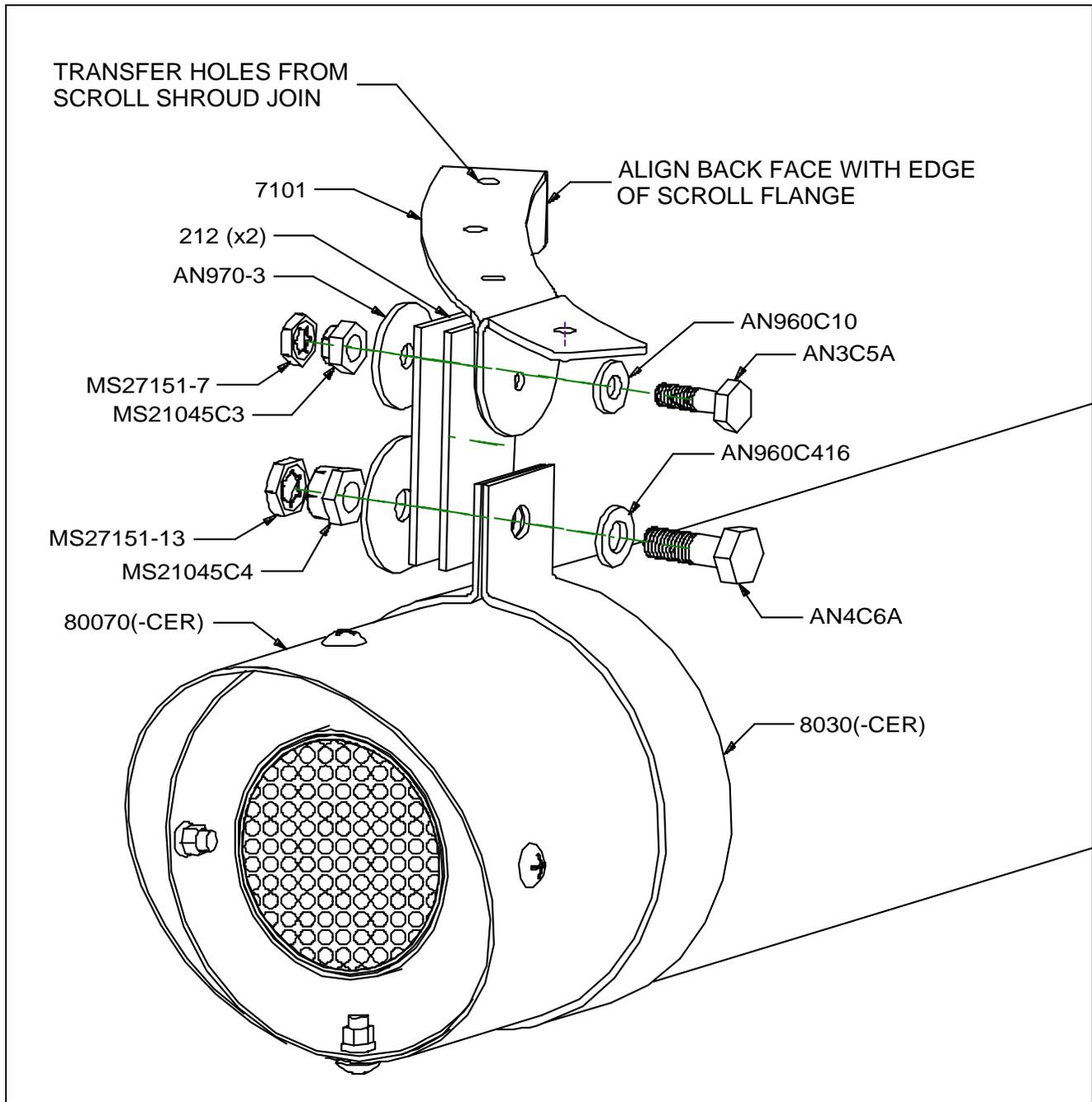
DETAIL B – Clamp Installation



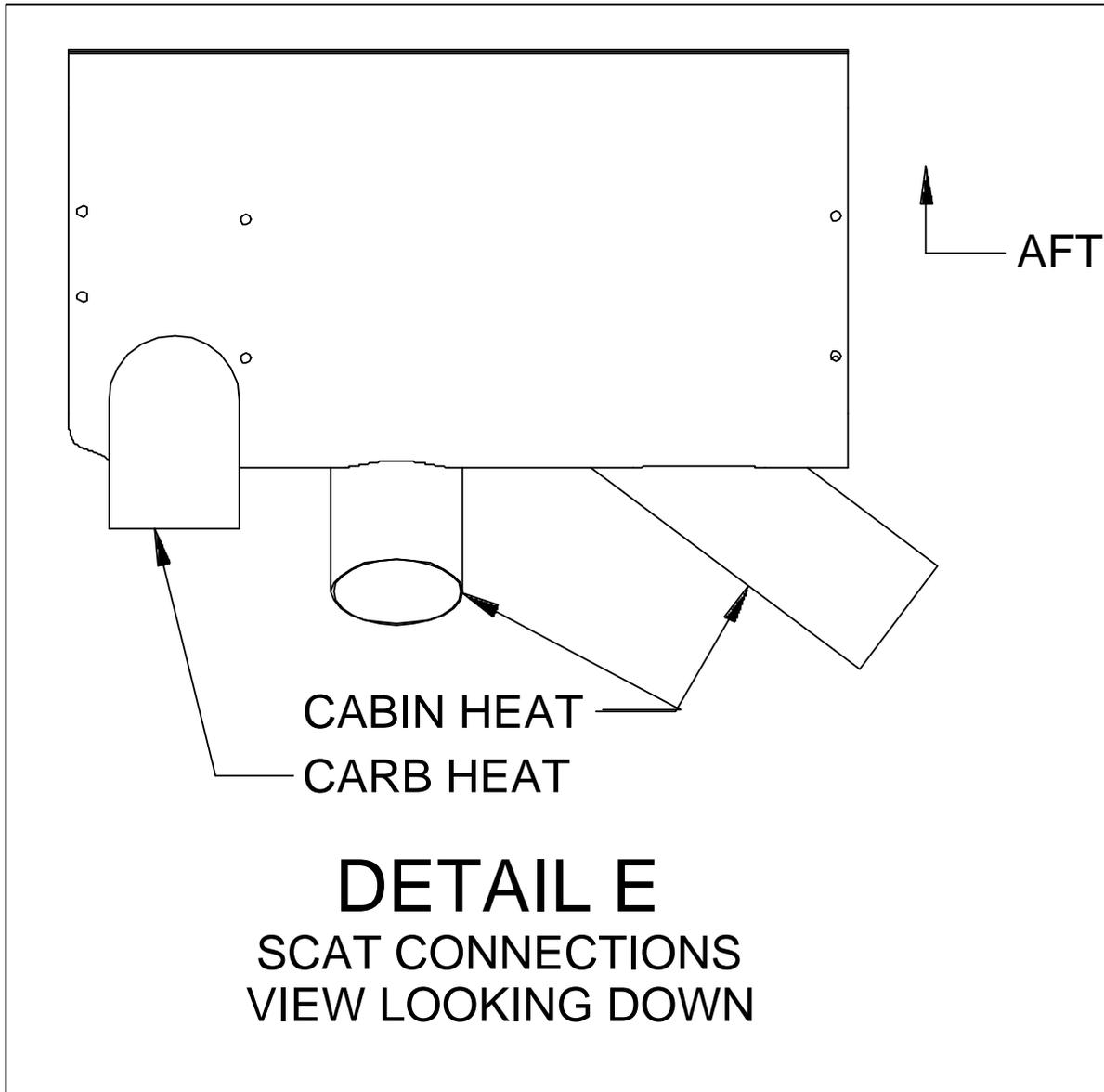
DETAIL C – Balljoint Installation



DETAIL D – Hanger Installation



DETAIL E – SCAT Tube Connections



Combination shroud (50710) shown. When cabin heat is not installed or not regularly used, the Carb Heat Only Shroud (51711) must be installed. The Carb Heat Only shroud can be identified by the large cutout exposing the collector tubes and lack of cabin heat flanges.

STC

United States of America
Department of Transportation -- Federal Aviation Administration

Supplemental Type Certificate

Number SR03863AT

NOT VALID WITHOUT LETTER
OF AUTHORIZATION FROM
POWER FLOW SYSTEMS, INC.

This certificate issued to

Power Flow Systems, Inc.
1585 Aviation Center Parkway
Hangar 804
Daytona Beach, FL 32114

certifies that the change in the type design for the following product with the limitations and conditions therefor as specified herein meets the airworthiness requirements of Part 27 of the Federal Aviation Regulations.

Original Product-Type Certificate Number: H10WE
Make: Robinson
Model: R22; R22 Alpha; R22 Beta; R22 Mariner

Description of Type Design Change: Installation of Power Flow Systems, Inc. (PFS) tuned exhaust system drawing PFS-17101, rev A, dated 11/2/2009 or later FAA approved revisions. Installed per Power Flow Systems, Inc. drawing 117101, rev A, dated 11/2/2009 or later FAA approved revisions and Tuned Exhaust System Installation Instructions and Instructions for Continued Airworthiness, PFS-17160, rev A, dated 1/26/2010 or later FAA approved revisions.

Limitations and Conditions: Applicable to Robinson R22 Series aircraft equipped with O-320-B2C engines only. Instructions for Continued Airworthiness contained in Tuned Exhaust System Installation Instructions and Instructions for Continued Airworthiness, PFS-17160, rev A, dated 1/26/2010 or later FAA approved revisions must be made available to the operator at the time of installation.

(See continuation sheet 3 of 3)

This certificate and the supporting data which is the basis for approval shall remain in effect until surrendered, suspended, revoked or a termination date is otherwise established by the Administrator of the Federal Aviation Administration.

Date of application August 31, 2009

Date reissued:

Date of issuance July 16, 2010

Date amended:



By direction of the Administrator
(Signature)
Melvin Taylor, Manager
Atlanta Aircraft Certification Office
(Title)

United States of America
Department of Transportation - Federal Aviation Administration

Supplemental Type Certificate
(Continuation Sheet)

Number SR03863AT

Date of Issuance: July 16, 2010

Limitations and Conditions (Continued):

The engine performance effects of this STC were evaluated and were found to be within the limitations of the aircraft and engine Type Certificates. Any additional modifications that contribute to HP increases could adversely affect the aircraft or engine airworthiness. This approval should not be extended to other aircraft of this model on which other previously approved modifications are incorporated, unless it is determined by the installer that the interrelationship between this change and any other previously approved modifications will produce no adverse effect upon the airworthiness of that airplane. If the holder agrees to permit another person to use this certificate to alter the product, the holder shall give the other person written evidence of that permission.

Certification Basis:

Based on 14CFR §§ 21.115 and 21.101, this STC modification to the type design is considered not to be a major or significant change.

Original Certification Basis: 14 CFR Part 27 dated February 1, 1965, including Amendments 27-1 through 27-10. § 27.1559 of Amendment 27-21 is an option for all S/Ns.

National Environmental Act of 1969

Noise Control Act of 1972

Equivalent Safety Finding:

Number TD10352LA-R/S-1

14 CFR Part 27.1401(d), Anticollision Light System

END