REPORT NAME:	PFS-16101 Installation Instructions and Instructions for Continued Airworthiness
REPORT NUMBER:	PFS-0068-00
REVISION:	F
REPORT DATE:	June 04, 2010
AIRCRAFT APPLICABILITY:	Mooney M20B,C,D,G
PREPARED BY:	T. STROHMAYER
DISTRIBUTION:	FAA ATL ACO, END USER
STC NUMBER:	SA02549AT

REVISION CONTROL

REVISION	DATE	REMOVE PAGES	INSERT PAGES
IR	JAN/07/2002	N/A	N/A
A	JUN/05/2002	ALL	ALL
B	JAN/07/2003	7,9,13	7,9,13
C	FEB/26/2003	4-7,12,16,17	4-7,12,16,17
D	JUL/02/2004	1,4,5,7,8,9,10	1,4,5,7,8,9,10
E	MAY/21/2007	3,9,10	3,9,10
F	JUN/04/2010	ALL	ALL

Description of Changes (Rev F):
Updated format. Changed from castle nuts to lock nuts. Added reference for Hartzell 3-blade propellers. Added anti-seize minimum standard. Expanded troubleshooting table.

F. A. A.
APPROVED
ATLANTA AIRCRAFT CERTIFICATION
OFFICE CENTRAL REGION
BY:
DATE: 9-10-2010

SECTIONS 4.0(ALL) & 6.2

TABLE of CONTENTS

1.0 INTRODUCTION

- PFS is the abbreviation for Power Flow Systems, Inc.
- Please read these instructions and the instructions for continued airworthiness 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.
- The Power Flow Systems Exhaust has been designed and FAA certified to be installed in accordance with these instructions. *Any* modification to the exhaust system or its components, or any deviation from these instructions without express written permission from Power Flow Systems, Inc. invalidates the design and the FAA approval. Any such modifications or deviations will also void the exhaust system warranty.
- If your cowling has been modified at all to be different than when it was originally built, please ensure our modification will be compatible before installation or flying.
- The PFS exhaust consists of an exhaust pipe from each cylinder to the collector assembly located beneath the engine. The collector assembly is enclosed in a shroud, which captures ram air from the engine compartment baffle to be heated by passing around the collector assembly's inner tubes. This heated air is used to heat the aircraft cabin. A separate compartment of the collector assembly furnishes heated air for carburetor heat. A tailpipe from the collector assembly routes exhaust gases to a muffler through the passenger side cowl flap. The original Mooney exhaust hanger supports the muffler. For those aircraft that came equipped with spring type exhaust hangers, Power Flow Systems, Inc. supplies a new strap type hanger.
- If your aircraft is equipped with a generator, the Power Flow Systems exhaust may not fit. If this is the case, the installer has a number of options:
  - Install a shorter belt on the generator. In most cases this will allow the generator to be rotated out of the way of the collector assembly.
  - Install a smaller generator.
  - Install an STC'd alternator conversion.
  - Return the system for a full refund (less shipping and handling).

2.0 KIT CONTENTS

Quantity	***Part Description***	***Part Number***
1	Number 1 Header	11600
1	Number 2 Header	12600
1	Number 3 Header	13600
1	Number 4 Header	14600
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	41601
1	Muffler Assembly	80060 (-CER)
3	Drilled Bolt	AN3C12
3	Castle Nut	AN310C3
6	Flat Washers	AN960C10
3	Ball Joint Springs	33703
3	Cotter Pin	MS24665-153
12”	SCAT Tube	SCAT-8
1	Muffler Clamp	8031
1	Bolt	AN4C5A
1	Lock Nut	MS21045C4
2	Flat Washer	AN960C416
1	Heat Shield (Optional)	2001*
2	Adel Clamp size 6 (Optional)	MS21919WH6
2	Locknut (Optional)	MS21045C3
2	Bolt (Optional)	MS51958-63
4	Flat Washer (Optional)	AN960C10
1	Exhaust Hanger (Optional)	90060**
1	Bolt (Optional)	AN3-12A
2	Flat Washers (Optional)	AN960-10

* Aircraft without cowl supports do not require Heat Shield PN 2001 or associated hardware.

** Only aircraft equipped with spring type tailpipe supports receive the Exhaust Hanger PN 90060 and associated hardware.

Equivalent Hardware May Be Used Throughout.

3.0 PREPARATION

Verify that all contents listed on page 4 of this instruction set are included in your kit. See notes on bottom of page 4 regarding spring type exhaust hangers and cowl support rods. Read all instructions before attempting installation, to become familiar with the procedure. If you have any questions regarding the installation, please call (386) 253-8833 *before* attempting installation.

3.1 Remove engine cowling(s) in accordance with the current Aircraft Service Manual. It is normally not necessary to remove the bottom cowling, only the side panels.

3.2 Disconnect flexible ducts from muffler assembly and exhaust pipe.

3.3 Remove EGT probe(s), if installed.

3.4 Remove nuts, bolts, and clamps attaching exhaust pipes to muffler assembly.

3.5 Loosen nuts attaching exhaust pipes to cylinders and remove muffler assembly.

3.6 Remove exhaust pipes, gaskets, muffler and tailpipe.

3.7 If your aircraft has a 2.5" cabin heat tube, cut off and debur the reducer portion of the cabin heat outlet on the PFS shroud.

4.0 INSTALLATION OF PFS EXHAUST SYSTEM

4.1 Installing Collector Box Assembly and Exhaust Pipes

4.1.1 Apply a thin layer of MIL-A-907E or equivalent anti-seize to the inside of all slip joints (the header slip joints come with anti-seize applied from the factory).

4.1.2 Slide the collector assembly behind the passenger side cowl support rod (if applicable) and maneuver the assembly in place forward of the oil sump. See installation overview, page 11.

4.1.3 Attach all flexible tubing to the appropriate inlet/outlet tube on the collector assembly. If the carb heat SCAT tube is not long enough, replace it with the supplied tube. Some aircraft will require a longer SCAT tube for the fresh air inlet (not included).

4.1.4 Each header and corresponding collector slip joint is marked with its appropriate cylinder number – make sure that each header installed matches the correct collector location. The header pipes must be installed at least 1 1/2" into the collector assembly (P/N 38002). Align each header with the factory's alignment marks to ensure correct orientation and adequate installation depth. Remove the alignment labels.

4.1.5 If the headers are not numbered and/or there are no alignment marks, use the installation overview to determine proper header orientation. The collector assembly should be angled approximately 30 degrees from crankshaft centerline.

4.1.6 Put new exhaust gaskets 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. Lift and hold the assembly into position.

4.1.7 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 final torque after proper orientation and assembly position of the exhaust system is achieved. Use the torque recommended in the latest approved revision of either the Aircraft or Engine Service Manual.

4.2 Installing the Muffler

4.2.1 If aircraft is equipped with a spring type tailpipe hanger, install the Power Flow Systems, Inc. hanger P/N 90060. See Detail "E".

4.2.2 Open Cowl Flaps (if applicable). Position the muffler so that it will be in the correct position for clamping to the exhaust hanger. Using the hardware provided, assemble the ball joint. See Detail "B". The hanger may need to be shortened to ensure proper ball joint alignment. The compressed spring height on the ball joint should be between 0.430 and 0.475" add or remove washers as necessary. With the large clamp free from the hanger, the lower end of the muffler assembly should be able to 'wobble' 1/2" to 1 1/2" from side to side. Caution: Over-tightening the ball joint assembly may cause cracking in the 4 to 1 collector and damage to the ball joint assembly.

4.2.3 Attach the muffler assembly to exhaust hanger with muffler clamp P/N 8031. See Detail "C". Position the clamp and transfer hole location(s) from the exhaust hanger. Drill as necessary. Secure the clamp to the muffler using a supplied AN4C5A bolt, washers, and lock nut. Secure the clamp tab to the exhaust hanger using the existing hardware. If a Power Flow Systems, Inc. exhaust hanger was provided, use the provided hardware.

4.2.4 Ensure that the cowl flap clears the muffler when the cowl flaps are closed. Adjust as necessary.

4.2.5 On aircraft with fixed cowl flaps, it may be necessary to scallop the flap slightly for clearance.

4.3 Installing the Heat Shield

If your aircraft does not have cowl supports, skip this step.

4.3.1 Using the Adel clamps provided, install the heat shield to the pilot side cowl support. See Detail "D." The shield is designed to protect the cowl support from the heat from the number 4 header.

5.0 INSPECTION AND PAPERWORK

5.1 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 After installing the cowling and performing run-up, inspect the tailpipe and cowling for rubbing or chafing. The motion of the tailpipe will be greatest during engine start and shutdown. Excessive motion could be an indication of worn engine Lord mounts.

5.3 If the aircraft is equipped with a Hartzell 3-blade propeller model HC-C3YR-1RF/F7282 installed via STC # SA1556GL, perform the following additional steps:

- Verify the Hartzell Flight Manual Supplement is P/N AFMS_011810 Revision IR or later.
- Install a placard between the manifold pressure gage and tachometer that reads: **"AVOID CONTINUOUS OPERATION BELOW 22 INCHES HG BETWEEN 1950 AND 2350 RPM"** (Remove the existing placard if it reads differently).
- Contact Power Flow Systems, Inc. or Hartzell Propeller for the AFMS and Placard if required.

5.4 Install the placard (enclosed) in clear view of the pilot that reads:

"The Power Flow Systems, Inc. tuned exhaust system may cause the aircraft to burn more fuel at high power settings when running a rich mixture. It is the Pilot's responsibility to determine what, if any, change in fuel flow exists and to plan accordingly."

5.5 Make appropriate entries in the logbook and on FAA Form 337. This modification is considered a major ***airframe*** change. The STC is located at the back of this instruction set for easy removal.

5.6 Typical Weight and Balance Information:

- The Power Flow Exhaust system weighs approximately 17.5lbs at station –14.5.

6.0 INSTRUCTIONS FOR CONTINUED AIRWORTHINESS

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 obtained by calling Power Flow Systems, Inc. at (386) 253-8833 or online at www.powerflowsystems.com

6.1 Basic Operation

Basic operation of the airplane remains the same.

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 – None. Any collector assembly that is damaged and/or fails the pressure test described below must be rebuilt or replaced with new.

6.2.2 Structural Inspection Interval – At 100 hour or Annual intervals, depending on the service regime of the aircraft.

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

6.2.4 Structural Inspection Procedure – See Section 6.6 Below.

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	Tailpipe contacting cowling	Check for wear marks on the engine cowling, reposition tailpipe or trim opening as necessary.
	Collector not centered on header pipes	Reposition collector -- ensure minimum of 1 1/2" penetration per header into central collector system
	Broken Clamp	Replace Broken Clamp
	Propeller not properly balanced	Have propeller dynamically balanced to at or below 0.2 ips.
	Worn Engine Mounts	Inspect Engine mounts and replace if necessary. Verify that mounts are shimmed in accordance with the Mooney Service Manual.
Excessive noise	Muffler insert damaged or missing	Contact PFS, Inc. for new muffler insert kit, PN PFS-8016.
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.

6.4 Maximizing Service Life

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

6.4.1 Dynamically balance your propeller to below 0.2 ips (inches per second) every 4 years or 1000 hours (whichever occurs first).

6.4.2 Dynamically balance your propeller to below 0.2 ips after modifying, overhauling, dressing, or replacing any rotating component on the engine or propeller.

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 manufacture.

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 Cowl Side Panels.

6.5.2 Disconnect muffler clamp P/N 8031 from the exhaust hanger. Remove clamp.

6.5.3 Disconnect the ball joint assembly.

6.5.4 Remove EGT probes if installed.

6.5.5 Remove heat shield from pilot side cowl support (if installed).

6.5.6 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.

6.5.7 Remove EGT probes if installed.

6.5.8 Remove headers.

6.5.9 Disconnect flexible ducts from the collector assembly.

6.5.10 Remove the collector assembly by pulling out from the 1 & 3 cylinder side, behind the cowl support rod (if applicable).

6.6 Inspection

The exhaust system must be thoroughly inspected, especially within the heat exchanger section. A detailed inspection of the exhaust system must be performed in accordance with the latest revision of the Aircraft Service Manual and this document at either 100 hour or Annual intervals.

All components displaying cracking or general deterioration must be replaced with new parts or repaired in accordance with the latest approved revision of AC 43.13.

6.6.1 Check for holes, cracks, and burned spots. Especially check areas adjacent to welds. Look for exhaust gas deposits in surrounding areas. This may indicate an exhaust leak.

6.6.2 Inspect screen covering carb heat outlet. Screen must be secure with no risk of material falling off.

6.6.3 Inspect packing material in the muffler (tailpipe) body. If the packing is missing,

collapsing, or deteriorated, it will require replacement. New packing inserts are available from Power Flow Systems, Inc.

6.6.4 Ensure Placard is visible to the pilot that states "The Power Flow Systems, Inc tuned exhaust system installed on this aircraft may cause the aircraft to burn more fuel at certain power settings. It is the Pilot's responsibility to determine what, if any, change in fuel flow exists and to plan accordingly."

6.6.5 If a Hartzell HC-C3YR-1RF/F7282 propeller is installed verify the limitations placard between the manifold pressure gage and the tachometer reads: **"AVOID CONTINUOUS OPERATION BELOW 22 INCHES HG BETWEEN 1950 AND 2350 RPM"** and verify the installation of Hartzell flight manual supplement P/N AFMS_011810 Revision IR or later.

6.6.6 All slip joints must be disassembled and lubricated with a high-temperature anti-seize compound. (Only necessary at 500hr or annual intervals, whichever comes first). This should be performed more frequently if headers seize between inspections. While disassembled, inspect for wear or galling.

6.6.7 Inspect for ball joint freedom of movement by disconnecting the exhaust hanger. The tailpipe should be free to move by applying minimal force.

6.6.8 Open heat shroud to the extent necessary to inspect within the collector assembly.

If any defects (cracks, burns, etc.) 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:

6.6.9 Remove shroud.

6.6.10 Seal openings with rubber expansion plugs.

6.6.11 Submerge the collector assembly in water.

6.6.12 Using a manometer or pressure gauge, apply 3.0 to 3.5 PSI (approximately 7" Hg) of air pressure.

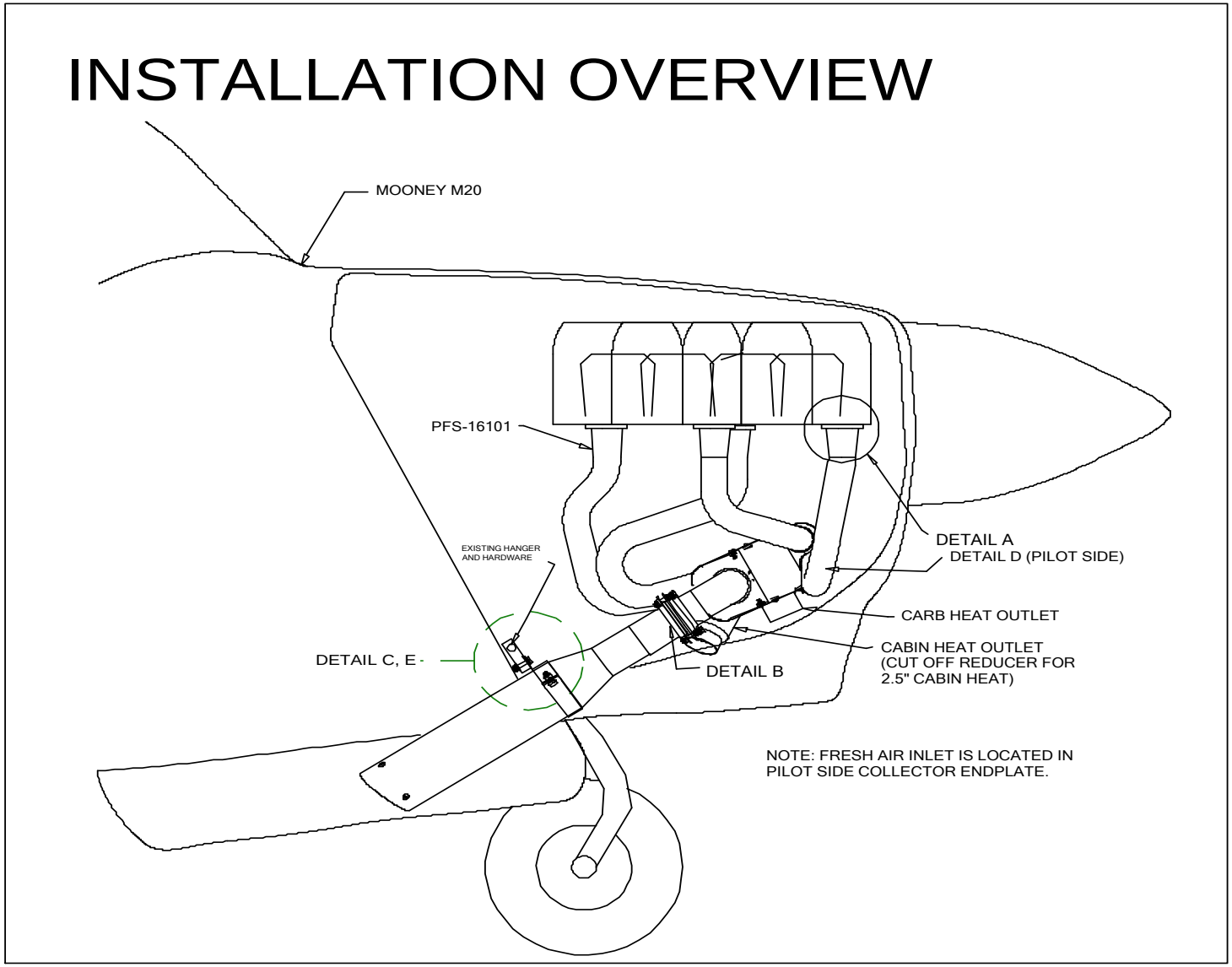
6.6.13 Let the unit sit pressurized for 10 to 30 seconds. The leak rate should be zero.

6.6.14 If a leak is found in the collector assembly, replace or repair before further flight.

6.6.15 If no leaks are found, dry components and install on airplane.

All components displaying cracking or general deterioration must be replaced with new parts or repaired in accordance with the latest approved revision of AC 43.13.

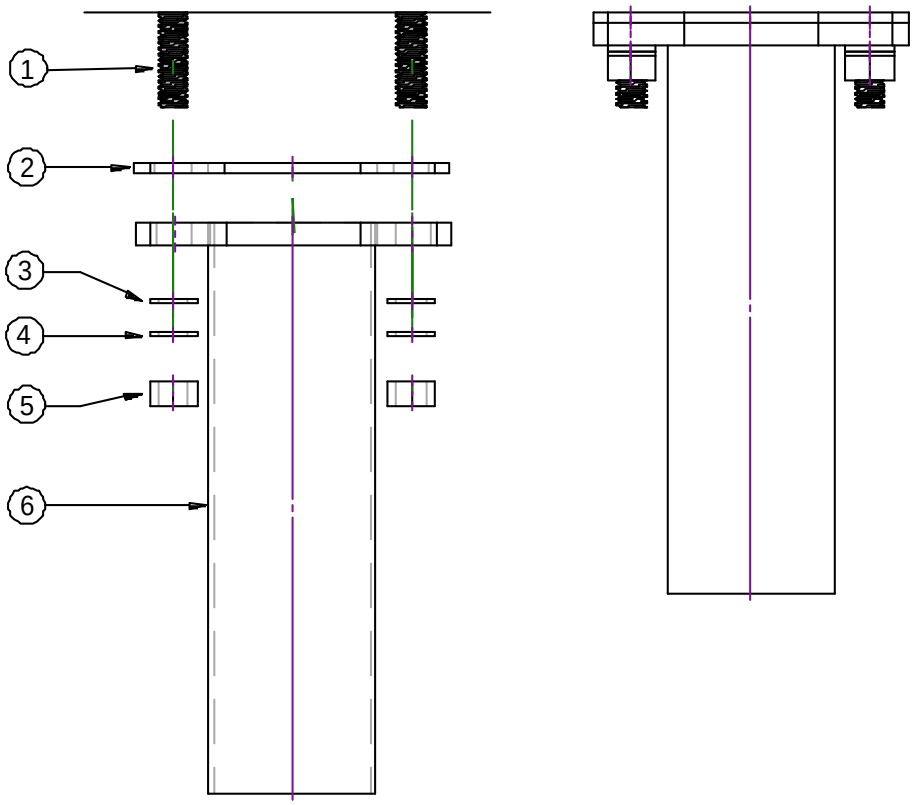
INSTALLATION OVERVIEW



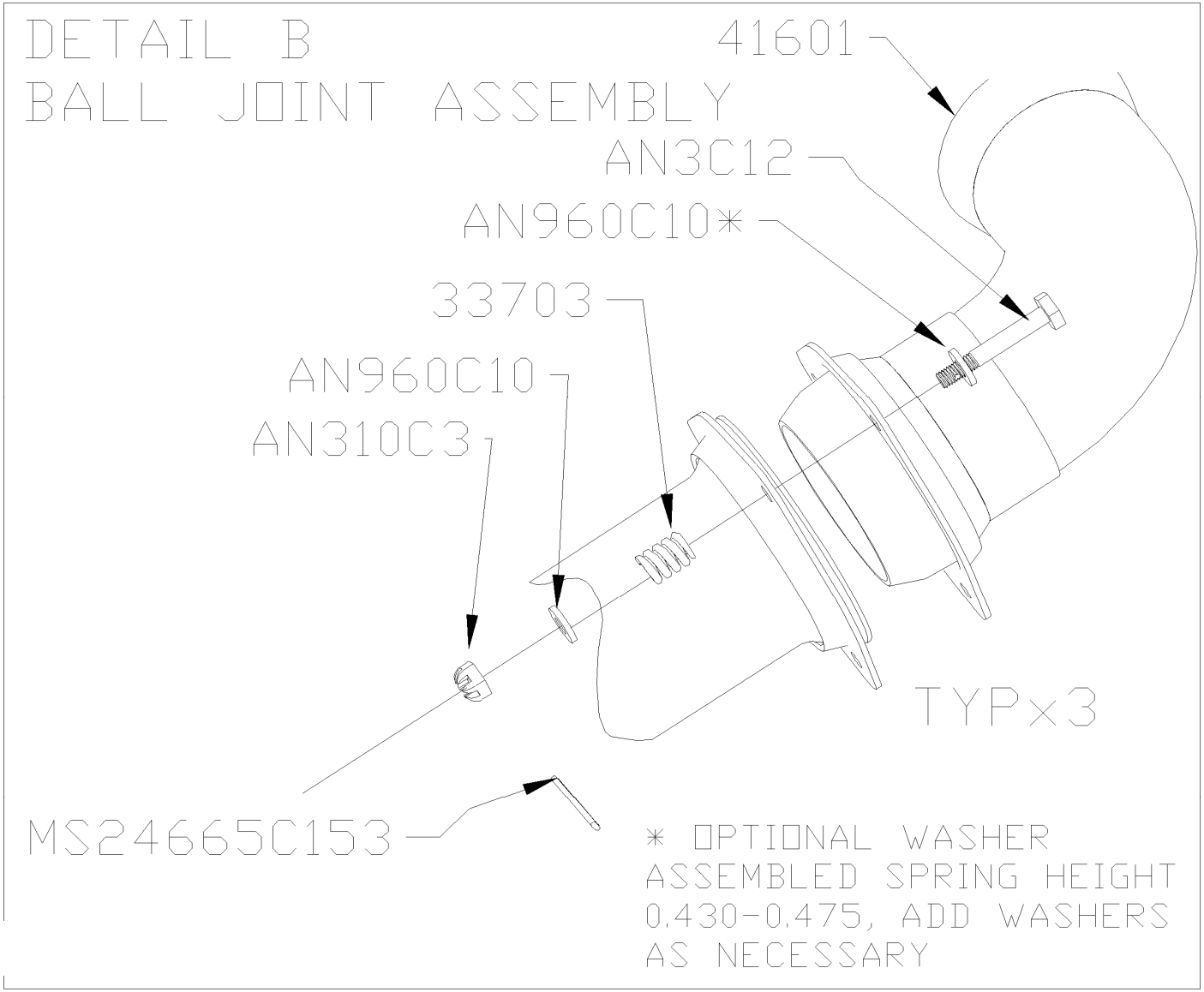
DETAIL A

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

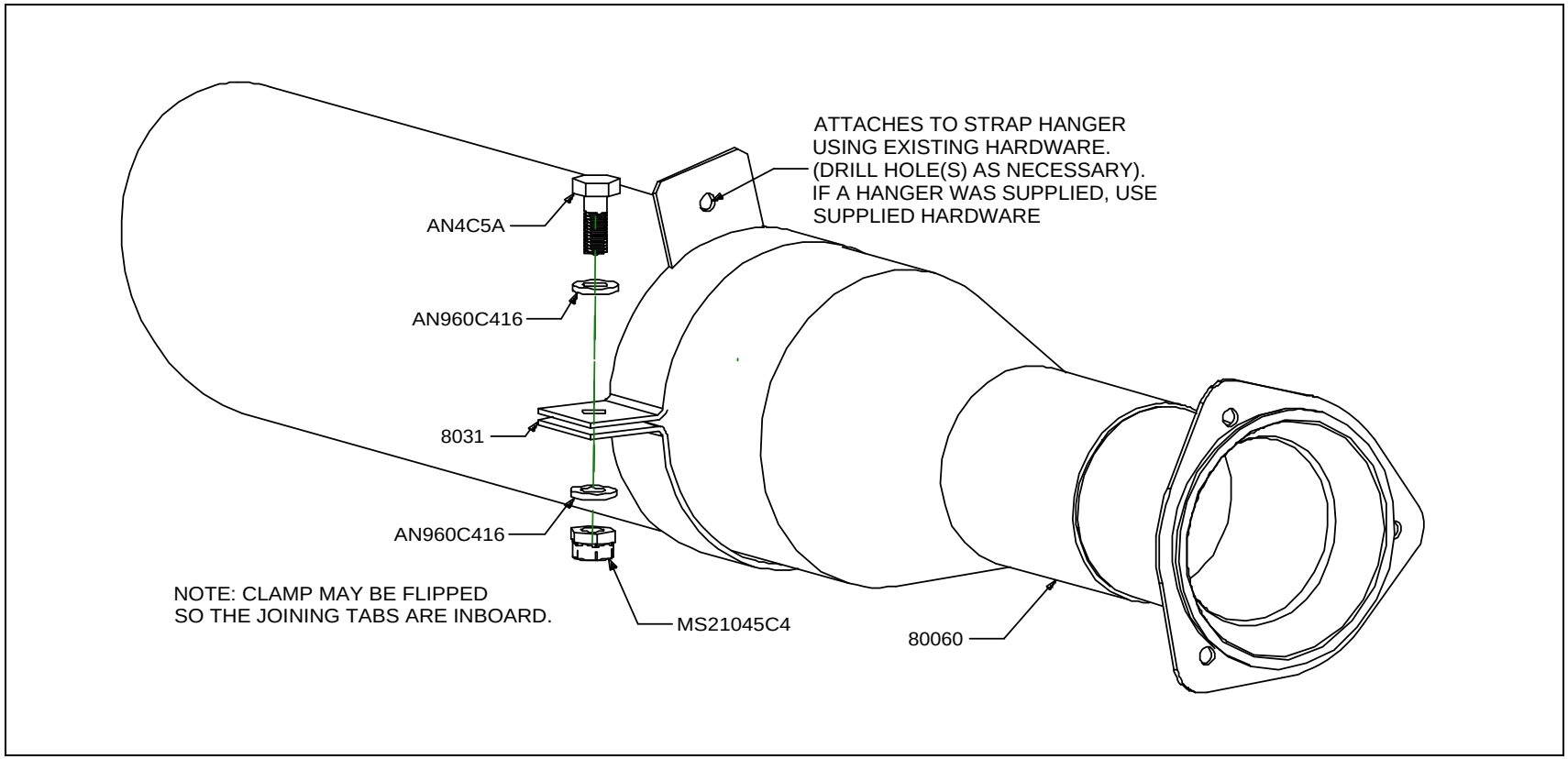
Equivalent Hardware May Be Supplied.



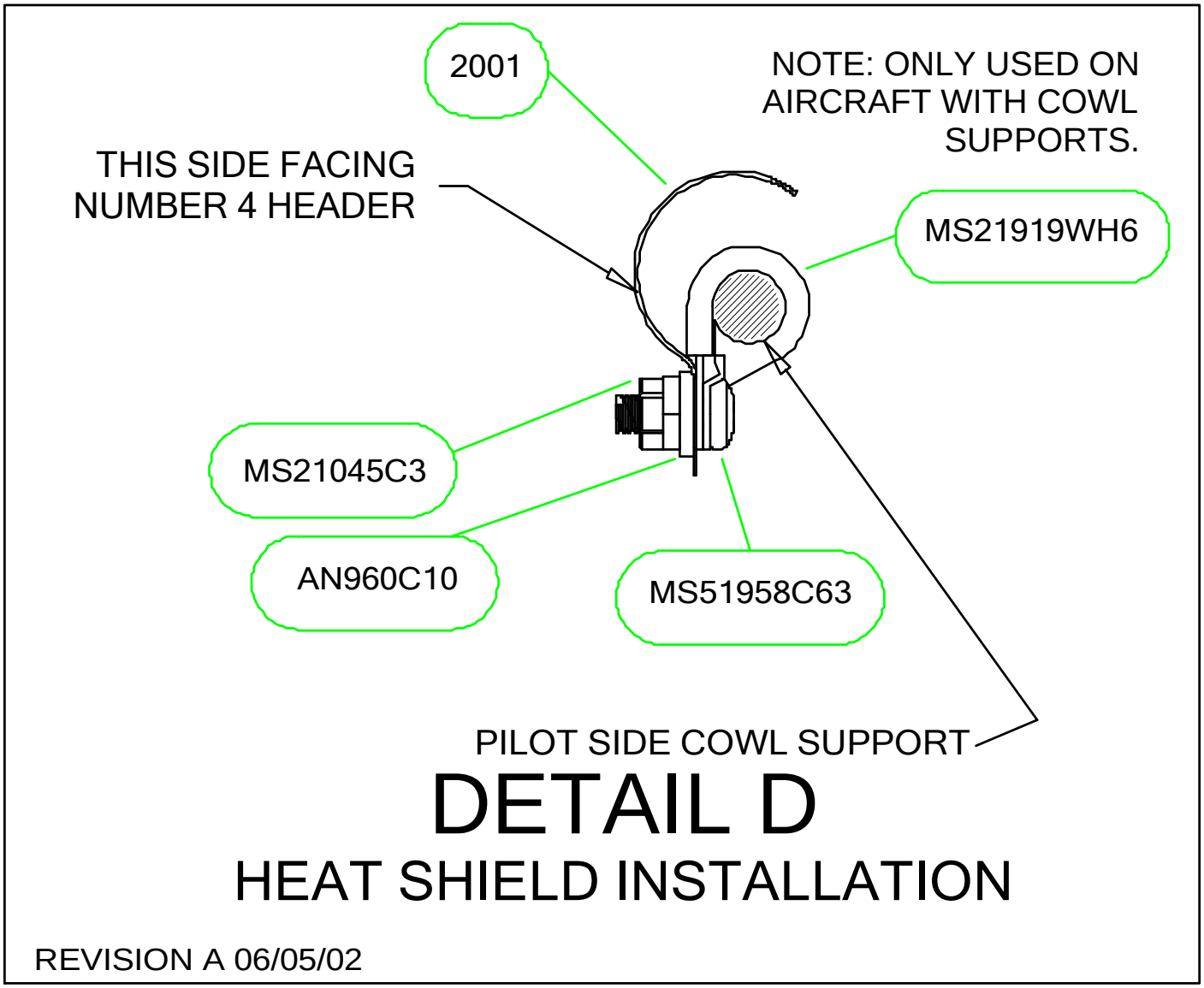
DETAIL B


DETAIL B
BALL JOINT ASSEMBLY
41601
AN3C12
AN960C10*
33703
AN960C10
AN310C3
TYP×3
MS24665C153
* OPTIONAL WASHER
ASSEMBLED SPRING HEIGHT
0.430-0.475, ADD WASHERS
AS NECESSARY

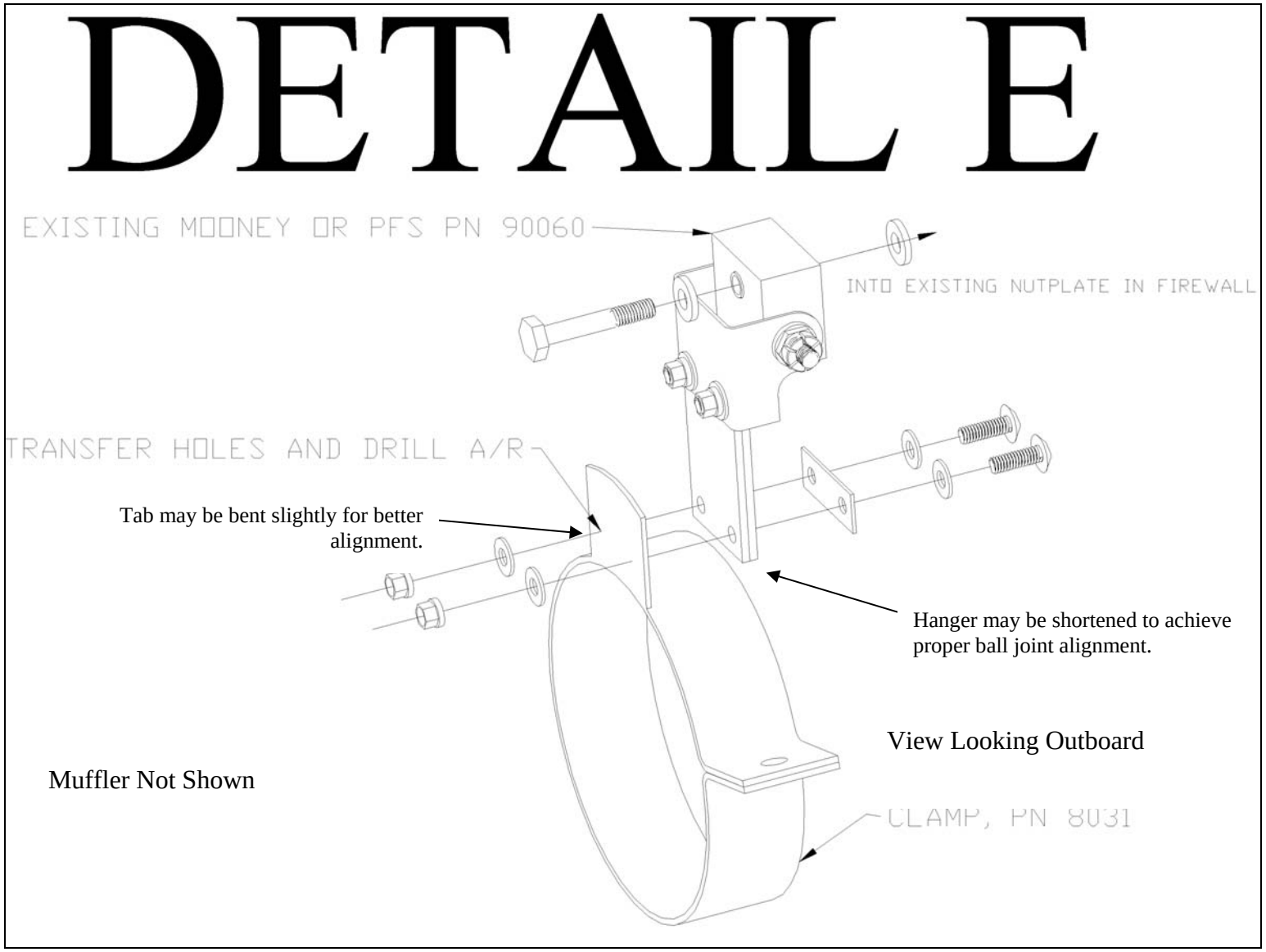
DETAIL C


ATTACHES TO STRAP HANGER
USING EXISTING HARDWARE.
(DRILL HOLE(S) AS NECESSARY).
IF A HANGER WAS SUPPLIED, USE
SUPPLIED HARDWARE
AN4C5A
AN960C416
8031
AN960C416
NOTE: CLAMP MAY BE FLIPPED
SO THE JOINING TABS ARE INBOARD.
MS21045C4
80060

DETAIL D


2001
NOTE: ONLY USED ON AIRCRAFT WITH COWL SUPPORTS.
THIS SIDE FACING NUMBER 4 HEADER
MS21919WH6
MS21045C3
AN960C10
MS51958C63
PILOT SIDE COWL SUPPORT
DETAIL D
HEAT SHIELD INSTALLATION
REVISION A 06/05/02

DETAIL E


DETAIL E
EXISTING MOONEY OR PFS PN 90060
INTO EXISTING NUTPLATE IN FIREWALL
TRANSFER HOLES AND DRILL A/R
Tab may be bent slightly for better alignment.
Hanger may be shortened to achieve proper ball joint alignment.
View Looking Outboard
Muffler Not Shown
CLAMP, PN 8031

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

Supplemental Type Certificate

Number SA02549AT

This STC is not valid without a letter of authorization for a specific aircraft registration number 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 thereto as specified hereon meets the airworthiness requirements of Part 3 of the Civil Air Regulations.

Original Product Type Certificate Number: 2A3

Make: Mooney
Model: M20B, C, D, G

Description of Type Design Change:
For M20C or G Models: Modification of engine exhaust system for improved engine performance by installation of a Power Flow Systems, Inc., tuned exhaust system per Installation Instructions, PFS-0068-00, Revision IR, dated: 01/07/02 and Master Drawing List, PFS-0069-00, Revision A, dated: 02/11/02 or later FAA approved revisions.

For M20B,C, D or G Models: Modification of engine exhaust system for improved engine performance by installation of a Power Flow Systems, Inc., tuned exhaust system per Installation Instructions, PFS-0068-00, Revision B, dated: 01/07/03 and Master Drawing List, PFS-0069-00, Revision B, dated: 06/05/02 or later FAA approved revisions.

Limitations and Conditions:
Airplane Flight Supplemen: Manual is not part of this STC. "This approval should not be extended to other aircraft of this model on which other previously approved modifications are incorporated, unless it is determine 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."

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: January 07, 2002

Date of issuance: July 19, 2002

Date reissued:

Date amended: January 09, 2003

By direction of the Administrator

(Signature)

for Melvin D. Taylor, Manager
Atlanta Aircraft Certification Office

(Title)