



Installation Instructions and
Instructions for Continued Airworthiness
Kit: PFS-13706

REPORT NAME: PFS-13706 Tuned Exhaust System Installation Instructions and Instructions for Continued Airworthiness

REPORT NUMBER: PFS-13752-00

REVISION: D

REPORT DATE: September 29, 2010

AIRCRAFT APPLICABILITY: Cessna 177RG (Cardinal RG) with Lycoming IO-360
Cessna F177RG (Reims) with Lycoming IO-360

PREPARED BY: T. STROHMAYER

DISTRIBUTION: FAA ATL ACO, END USER

STC NUMBER: SA03623AT

REVISION CONTROL

REVISION	DATE	REMOVE PAGES	INSERT PAGES
IR	01/18/2008	N/A	N/A
A	05/21/2008	1,4-6,8,9,11,13-15	1,4-6,8,9,11,13-15,17,18
B	12/08/2008	1,2,4-7,10,11	1,2,4-7,10,11,18,19-21
C	05/15/2009	4-6	4-6
D	SEP/29/2010	1,2,5,7,8-10,11	1,2,5,7,8-10,11

Description of changes:

Added specific reference to anti-seize minimum standard (MIL-A-907 or equivalent).
Added paragraph 5.10 to reference Hartzell HC-C3YR-1RF/F7282 propeller requirements.

F. A. A.
APPROVED*
ATLANTA AIRCRAFT CERTIFICATION
OFFICE CENTRAL REGION
BY: 
DATE: 10-25-2010

* INSTALLATION (SECTION 4)
‡ ALL (SECTION 6-2) ONLY
September 29, 2010



TABLE of CONTENTS

Section	Page
1.0 INTRODUCTION	3
2.0 KIT CONTENTS	4
3.0 PREPARATION	5
4.0 INSTALLATION OF PFS EXHAUST SYSTEM	5
4.1 - INSTALLING COLLECTOR BOX ASSEMBLY AND HEADER PIPES	5
4.2 - INSTALLING THE INTERMEDIATE TUBE AND TAILPIPE	6
5.0 INSPECTION AND PAPERWORK	6
6.0 INSTRUCTIONS FOR CONTINUED AIRWORTHINESS	7
6.1 - BASIC OPERATION	7
6.2 - AIRWORTHINESS LIMITATIONS	7
6.3 - TROUBLESHOOTING	9
6.4 - MAXIMIZING SERVICE LIFE	10
6.5 - REMOVAL	10
6.6 - INSPECTION	11
INSTALLATION OVERVIEW	12
DETAIL A	13
DETAIL B	14
DETAIL C	15
DETAIL D	16
DETAIL E	17
DETAIL F	18
DETAIL G	19



1.0 Introduction

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

Please read these directions 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.

Please Note: 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.



2.0 Kit Contents

<i>Quantity</i>	<i>Part Description</i>	<i>Part Number</i>
1	#1 Header	11400
1	#2 Header	12400
1	#3 Header	13400
1	#4 Header	14400
1	Shrouded Collector Assembly	40400
1	Intermediate Tube	70400
1	Tailpipe	80400(-CER)
1	Intermediate Tube Clamp (3.0" ID)	8033
1	Tailpipe Clamp (3.1" ID w/ Pin)	7025
1	Header Tube Clamp (1.90" ID)	7026
1	Mixture Cable Bracket	7140
1	Plain Washer	AN960-416L
1	Lock Washer	MS35333-40
1	Bolt, Coarse Thread	MS90725-10
1	Bolt, Drilled Head, Coarse Thread ¼ Grip	MS20074-04-06
2	Bolt, Drilled Head, Coarse Thread 1/8 Grip	MS20074-04-05
1	Heat Shield	2001
2	Adel Clamps	MS21919WH12
2	Screws	MS51958-63
4	No-blow Header Gasket	77611
8	Exhaust Nut	SL-STD-1410
8	Lock Washer	MS35333-41
8	Plain Washer	AN960-516
1	Bolt	AN4C5A
2	Plain Washer	AN960C416
1	Lock Nut	MS21045C4
1	Bolt	AN3C4A
1	Bolt	AN3C5A
1	Bolt	AN3C22A
1	Spring	33703
9	Flat Washer	AN960C10
4	Lock Nut	MS21045C3
18	3.0 SCAT Hose	SCAT-12
24	2.0 SCAT Hose (2x12" Pieces)	SCAT-8

Equivalent hardware may be used throughout, some hardware may already be installed by Power Flow Systems.



3.0 PREPARATION

Verify that all contents listed on page 4 of this instruction set are included in your kit. 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 cowling and stock exhaust system (including all brackets) in accordance with the latest approved revision of the aircraft service manual. A course thread bolt (MS90725-10), plain light washer (AN960-416L), and lock washer (MS35333-40) are included to replace the hardware attaching the muffler support bracket to the number three cylinder intake port. A drilled head bolt (MS20074-04-06) with ¼” grip and plain light washer (AN960-416L) have been included to replace the hardware attaching the muffler support bracket to the front of the fuel servo (if required). Two drilled head bolts (MS20074-04-05) with 1/8” grip have been supplied to replace the longer bolts attaching the throttle cable bracket to the sump. Be sure to safety all new bolts, where applicable.
- 3.2 – Replace mixture cable attach bracket on the engine sump with the enclosed P/N 7140 using the existing hardware. See Detail B.
- 3.3 – If your aircraft has a straight manifold drain valve (often referred to as a “sniffle” valve), you may need to replace it with an angled valve for exhaust system clearance.
- 3.4 – If your aircraft has an oil drain adapter that attaches to the oil drain to route drained oil toward the nose wheel opening, it may be necessary to remove it. If you are performing an oil change in conjunction with this installation, we recommend relocating the oil drain to the passenger side of the engine sump.

4.0 INSTALLATION OF PFS EXHAUST SYSTEM

NOTE: If you are installing EGT probes, we recommend locating and drilling the holes for the probes in the headers in accordance with the latest approved revision of the Aircraft Service Manual (typically 2 to 4 inches from the exhaust port).

4.1 - Installing Collector Box Assembly and Header Pipes

NOTE: Each header and collector is marked with its appropriate cylinder number – make sure that each header installed matches the correct collector location. If you are installing used headers, be sure to correctly identify them before proceeding. Use the Installation Overview on page 12.

- 4.1.1 – Apply generous amounts of high-temperature anti-seize (MIL-A-907E or equivalent) to the slip joints on the collector box.
- 4.1.2 – 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.
- 4.1.3 – Insert the number two and four headers into the collector box, using the numbering and alignment marks provided. If marks are not visible, insert the pipes approximately 1.75 inches.
- 4.1.4 – Loosely install the number two and four headers over their respective studs.
- 4.1.5 – Install the one and three headers into the collector box and onto their respective studs.
- 4.1.6 – Rotate or reposition the collector box as necessary to line up all of the factory alignment marks. If the alignment marks are not visible, position the collector box parallel to the engine centerline.



- 4.1.7 – 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 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. Verify position of alignment marks and then remove alignment labels.
- 4.1.8 – Attach SCAT hoses as shown in Detail C.

4.2 – Installing the Intermediate Tube and Tailpipe

- 4.2.1 – Slide the intermediate tube over the oval outlet on the collector assembly (skip to 4.2.4 if the intermediate tube is already installed). Leave about ¼” between the end of the flare and the collector box endplate.
- 4.2.2 – Install the long AN3C22A bolt, (1) AN960C10 washer, and the 33703 spring through the tab in the intermediate tube, into the nutplate on the collector assembly. Tighten the bolt until the last of the threads disappear into the collector box. This bolt serves as a safety mechanism to prevent the joint from disconnecting in flight. See Detail G.
- 4.2.3 – Install the 8032 clamp and the 7026 clamp as shown in Detail D (twist tab on 8032 clamp as required).
- 4.2.4 – Slide the tailpipe over the round end of the intermediate tube. The tailpipe should be installed as far up on the intermediate tube as possible (maximum overlap).
- 4.2.5 – Point the tailpipe straight aft and drill a 0.25” hole through the existing pilot hole.
- 4.2.6 – Remove the tailpipe and install the cowling in accordance with the latest approved revision of the aircraft service manual.
- 4.2.7 – Install the tailpipe and pinned clamp (P/N 7025) through the hole drilled in step 4.2.5. Install using AN4C5A Bolt, two AN960C416 washers, and one MS21045C4 locknut. See Detail E.

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 – Check for a minimum of 0.5” of clearance between exhaust system components and any part of the nose gear assembly (including the nose gear door). Make sure that there is enough clearance to allow the nose wheel to retract and the door to open and close freely. The top of the nose gear door may need to be trimmed up to 0.25” to obtain sufficient clearance. If there is any doubt as to the clearance to landing gear components, the aircraft should be put on jacks and the gear cycled in accordance with the proper maintenance manual.
- 5.3 – Install heat shield between intermediate tube and engine mount tube at the point of closest approach. See Detail F.
- 5.4 – The bracket that attaches the pilot side cowl flap cable to the tubular engine mount may need to be adjusted to obtain clearance to the number four header pipe.



Installation Instructions and
Instructions for Continued Airworthiness
Kit: PFS-13706

- 5.5 – Verify proper range of motion and rigging of the mixture cable, and cowl flap cable (if adjusted). Also verify throttle cable to heat shroud clearance throughout the full range of throttle motion.
- 5.6 – After installing the cowling and performing run-up, inspect the tailpipe and cowling for rubbing or chafing. The hole that the tailpipe passes through may need to be enlarged based on the amount of motion caused by engine start and shutdown. The motion of the tailpipe will be greatest during engine start and shutdown. Excessive motion could be an indication of worn engine Lord mounts. A minimum of 3/8” static clearance should exist on all sides of the tailpipe, although more clearance may be required if chafing is evident.
- 5.7 – 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.”
- 5.8 – 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.
- 5.9 – Typical Weight and Balance Information: The PFS System weighs 24 lbs at station 40.3. Refer to the aircraft equipment list for the weight and station of the original exhaust. An example from a 1971 177RG lists the original exhaust as 22 lbs at station 45.7.
- 5.10 – 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_011210 Revision B 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**” (Replace the existing placard if it reads differently).
 - Contact Power Flow Systems, Inc. or Hartzell Propeller for the AFMS and Placard if required.

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 be 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.”



*Installation Instructions and
Instructions for Continued Airworthiness
Kit: PFS-13706*

- 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. **WARNING: Carbon Monoxide 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. It is recommended that in-cabin carbon monoxide levels be measured periodically. Concentrations of greater than 50ppm will require immediate exhaust system repair, rebuild, or replacement.**
- 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 shall 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 Clamps	Replace Broken Clamps
	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 Cessna Cardinal RG Service Manual.
Excessive noise	Muffler insert damaged or missing	Contact PFS, Inc. for new muffler insert kit, PN PFS-8011.
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 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 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-907 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.

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 pinned clamp just inside the cowling.
- 6.5.2 – Remove the cowling in accordance with the aircraft service manual.
- 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 number one and three header pipes.
- 6.5.7 – 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 and the latest revision of the Aircraft Service Manual at either 100 hour or Annual intervals.

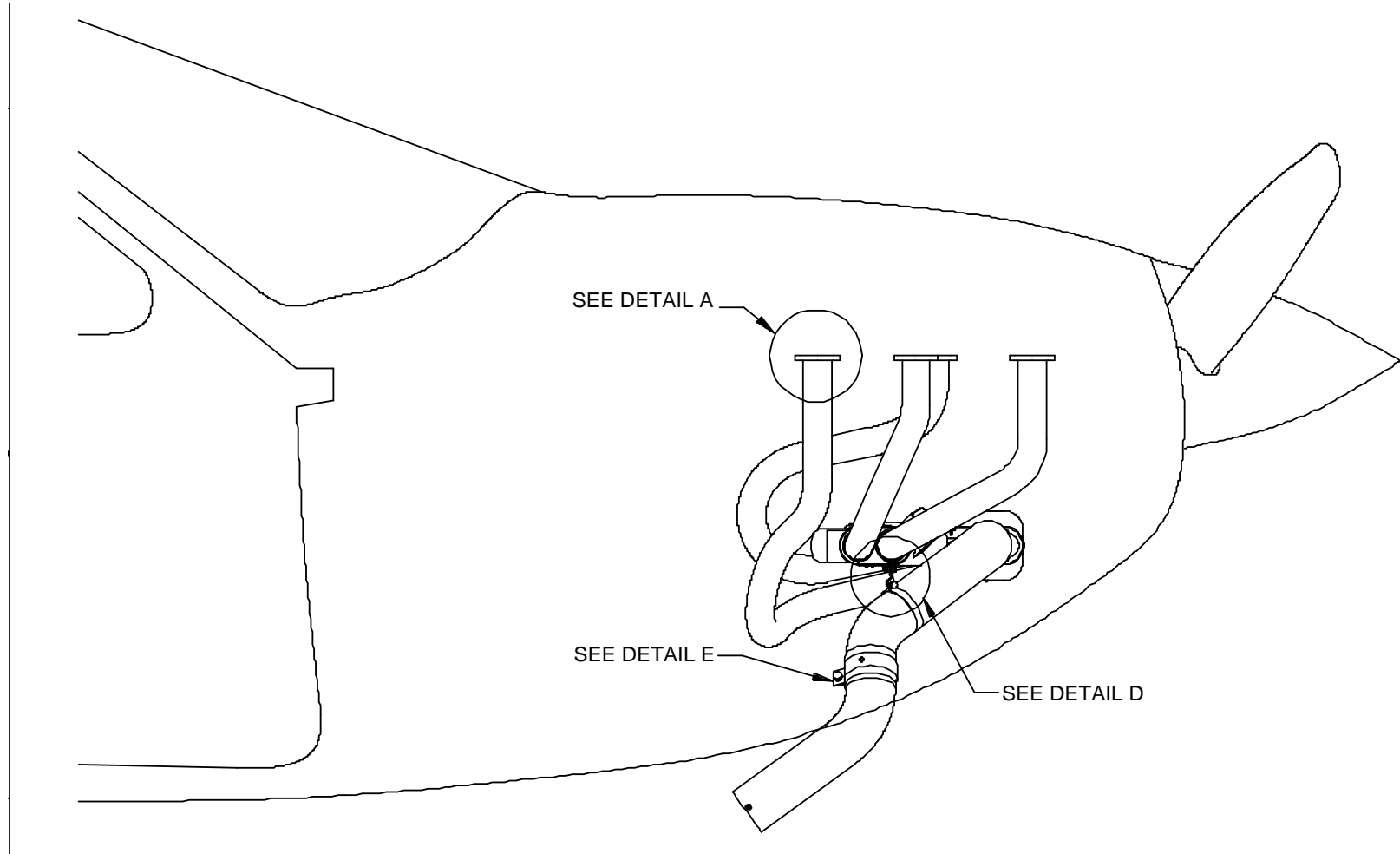
All components displaying cracking or general deterioration must be replaced with new parts or repaired in accordance with the latest approved revision of AC 43.13.

- 6.6.1 - Check for holes, cracks, and burned spots. Especially check areas adjacent to welds. Look for exhaust gas deposits in surrounding areas. 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.
- 6.6.3 - 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.
- 6.6.4 - Be sure to open heat shroud(s) and shields to inspect within the collector assembly.

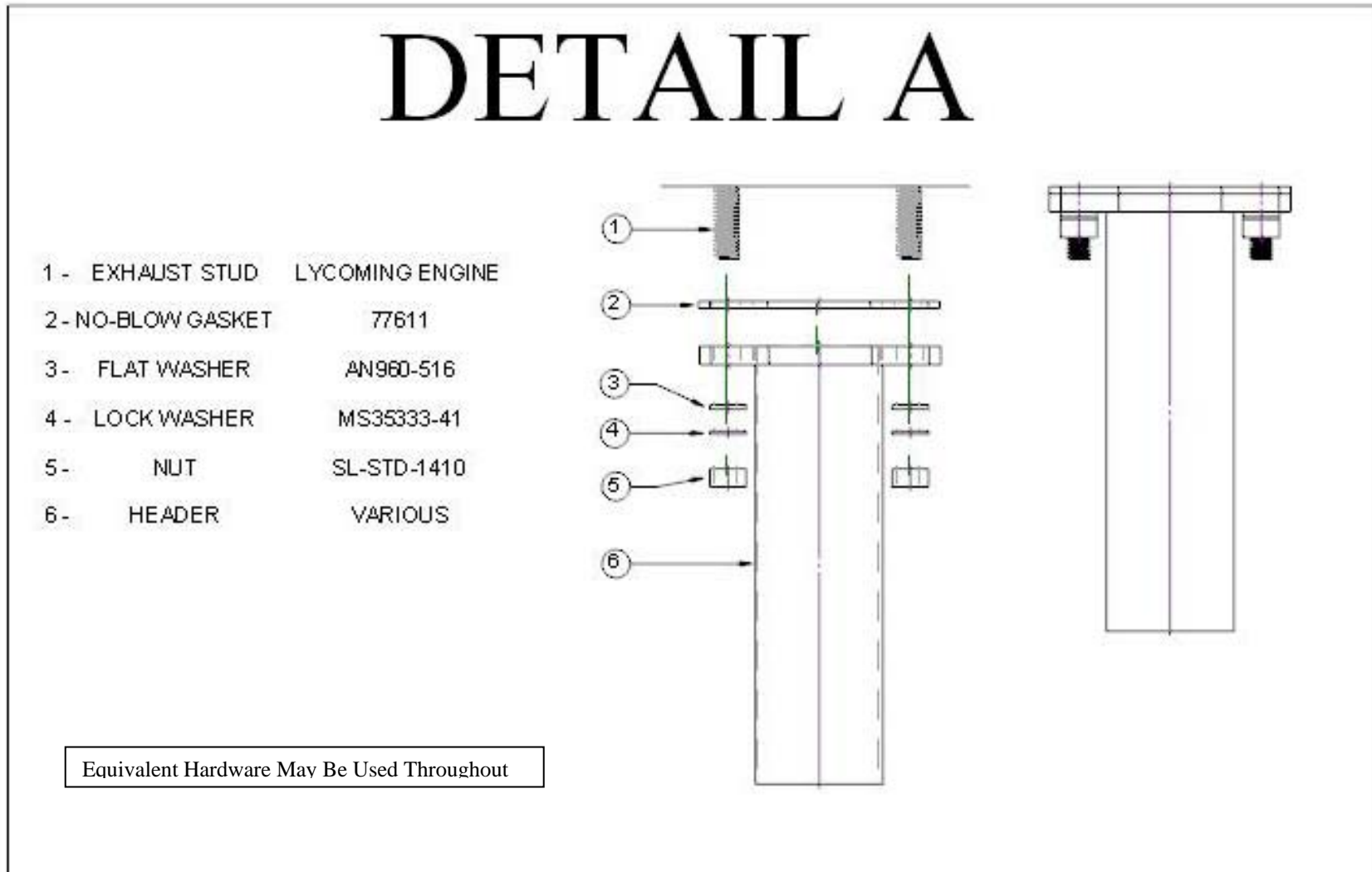
If any defects on the collector assembly (other than on the shroud) are noted during the visual inspection, then the collector needs to be pressure tested using the procedure below:

- Remove shrouds.
- Seal four of the openings (tubes) with rubber expansion plugs.
- Submerge the collector assembly in water.
- Using a manometer or 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.

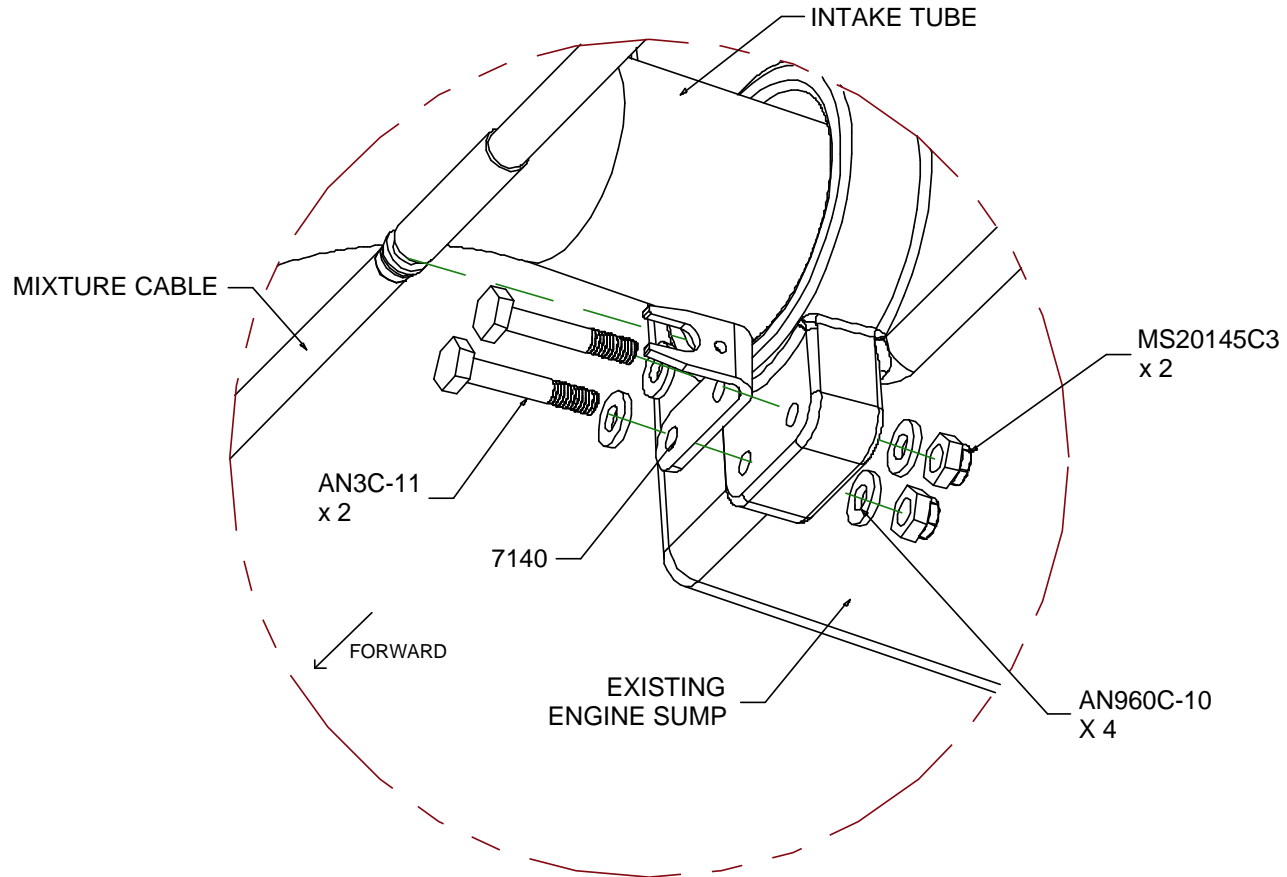
INSTALLATION OVERVIEW



DETAIL A

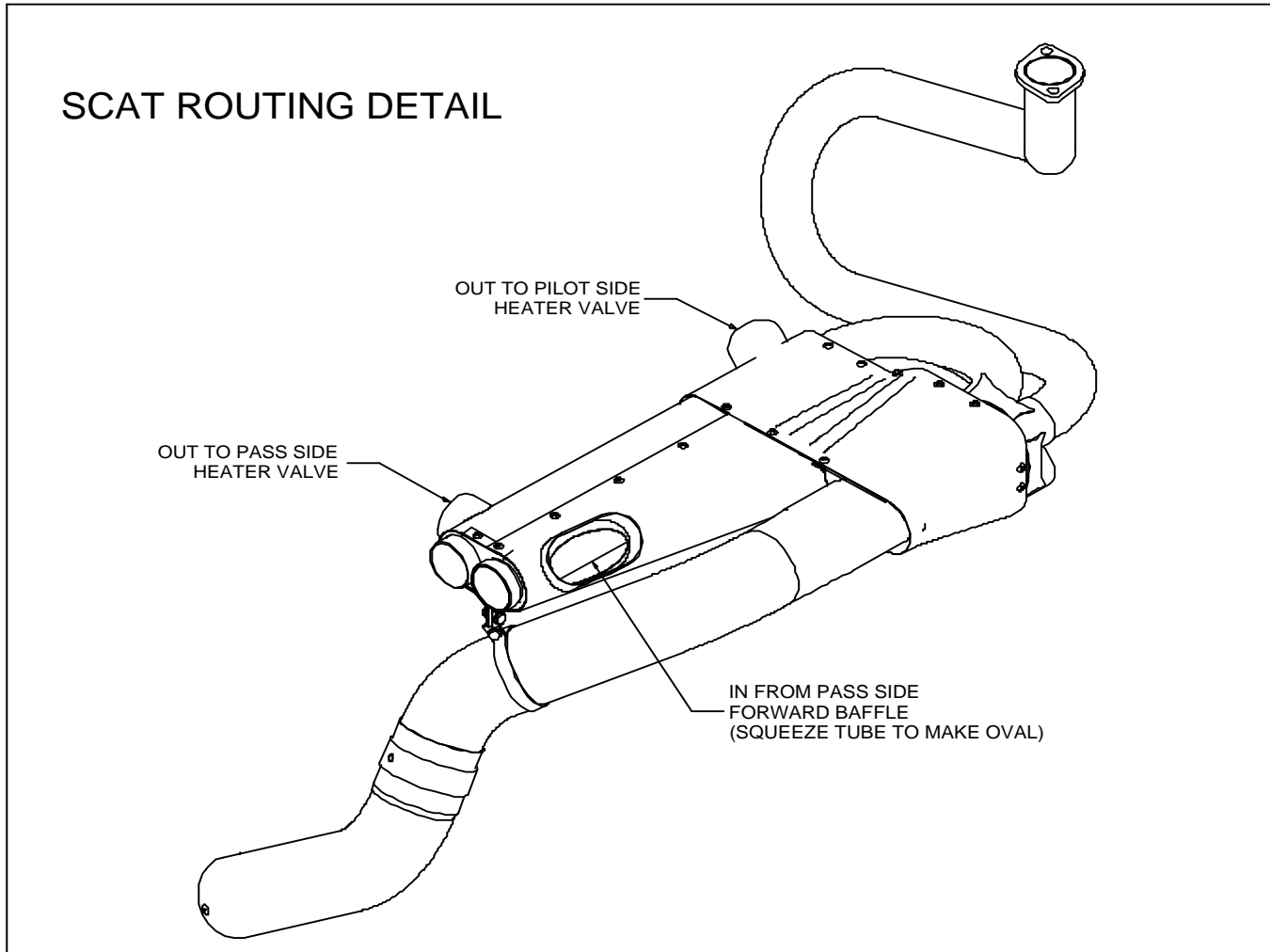


DETAIL B

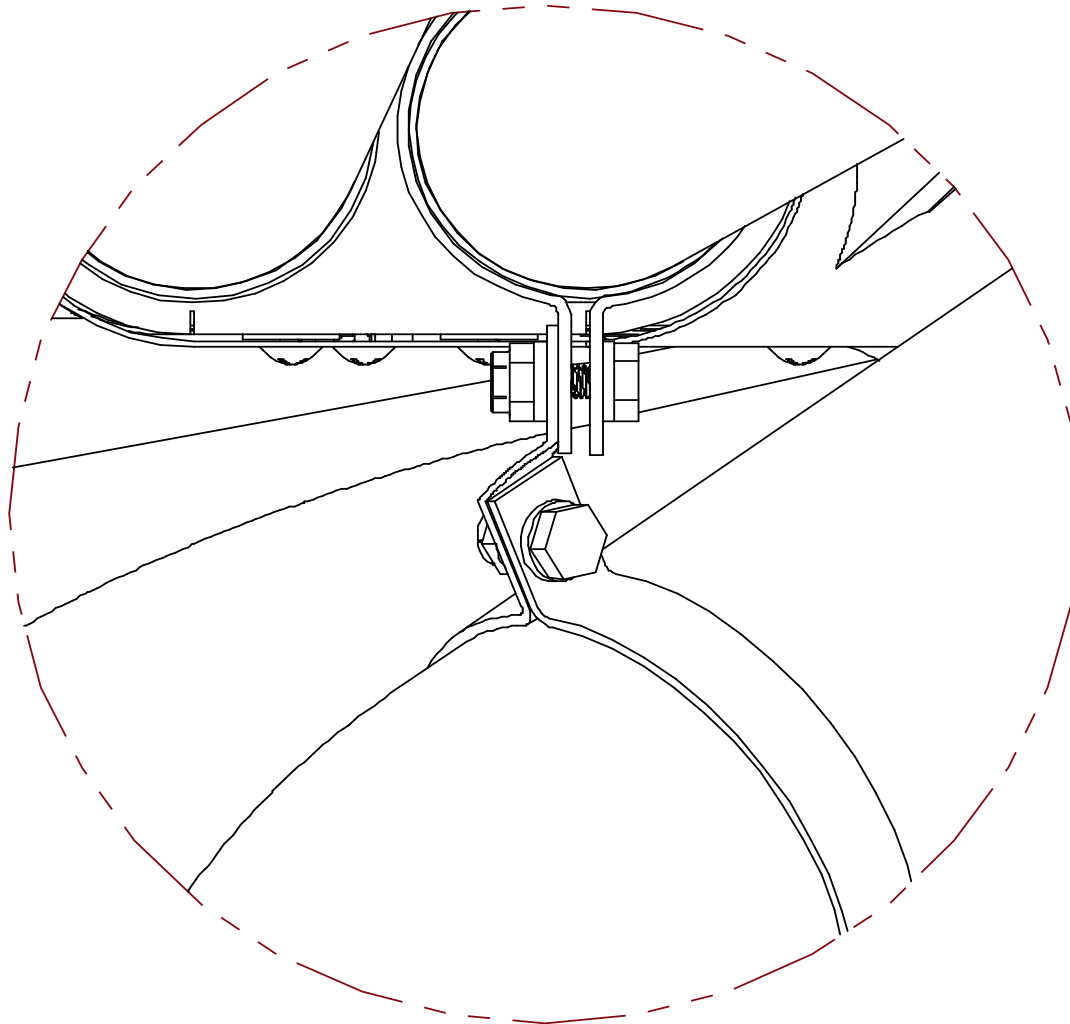


MIXTURE CABLE BRACKET INSTALLATION
EQUIVALENT HARDWARE MAY BE USED THROUGHOUT
MIXTURE CABLE IS TO BE SECURED WITH SAFETY WIRE (NOT SHOWN)

DETAIL C

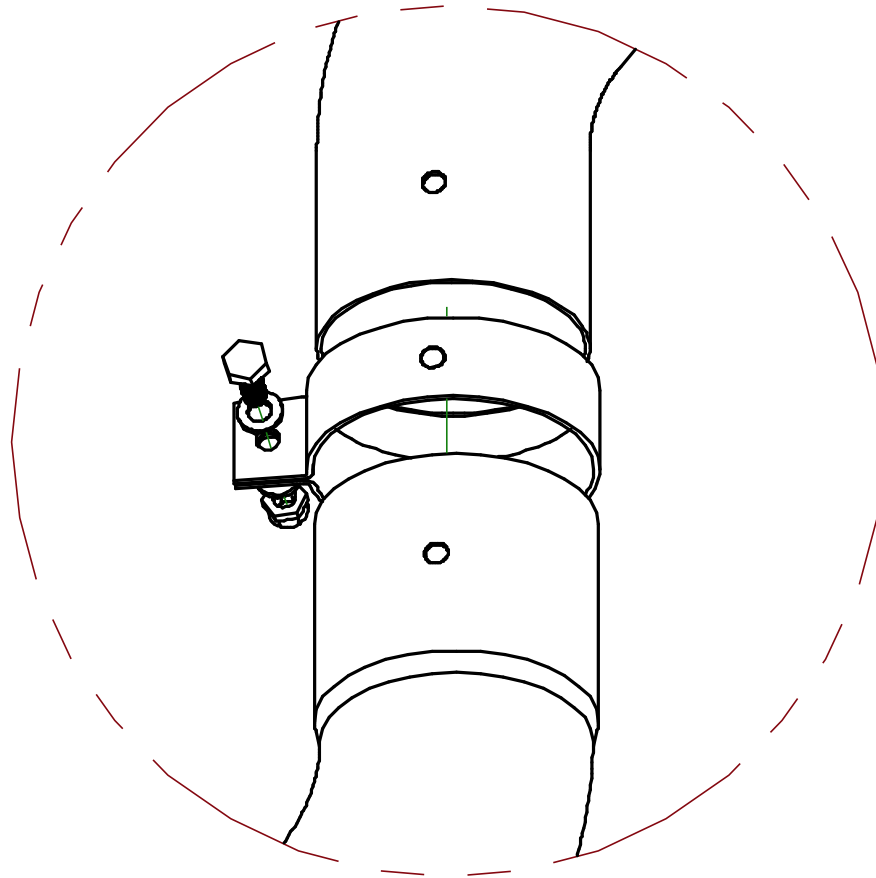


DETAIL D

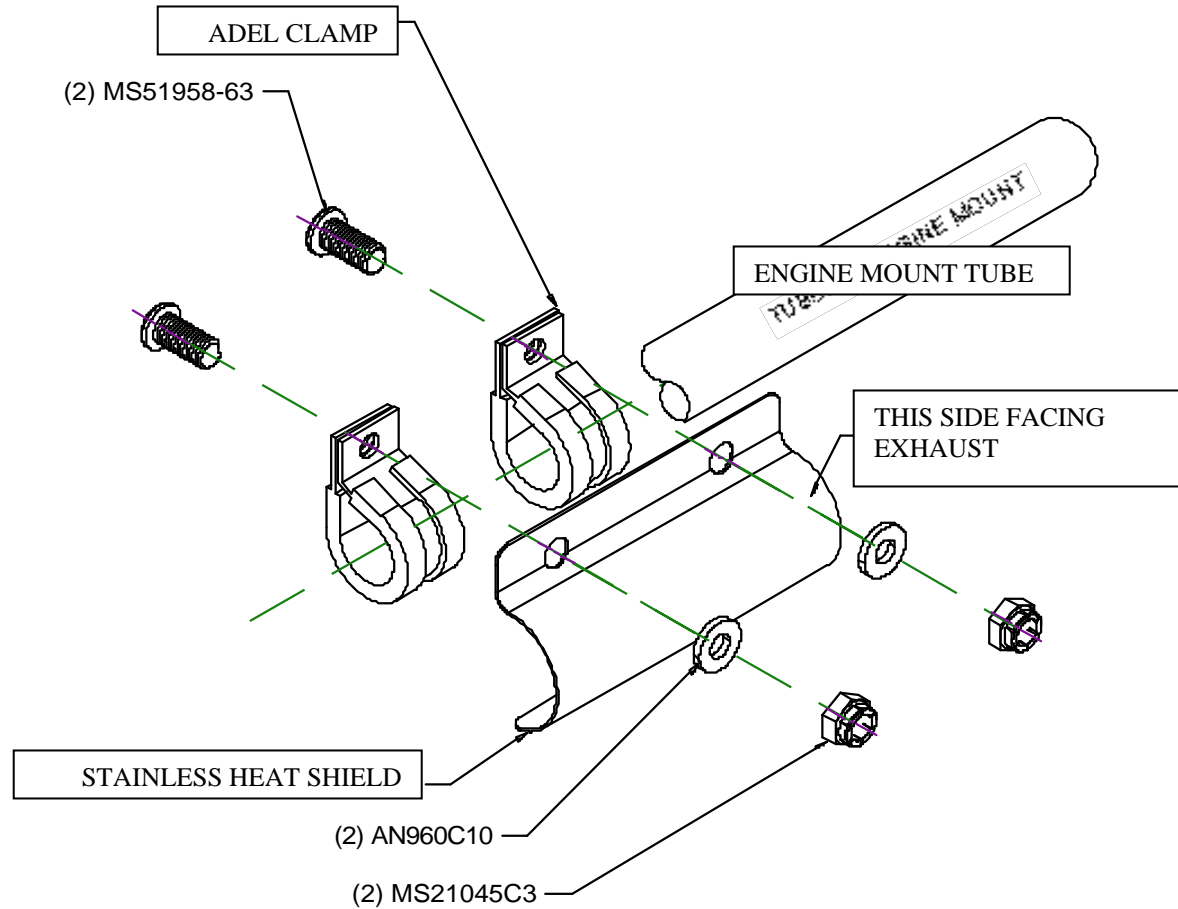


DETAIL E

TAILPIPE DETAIL



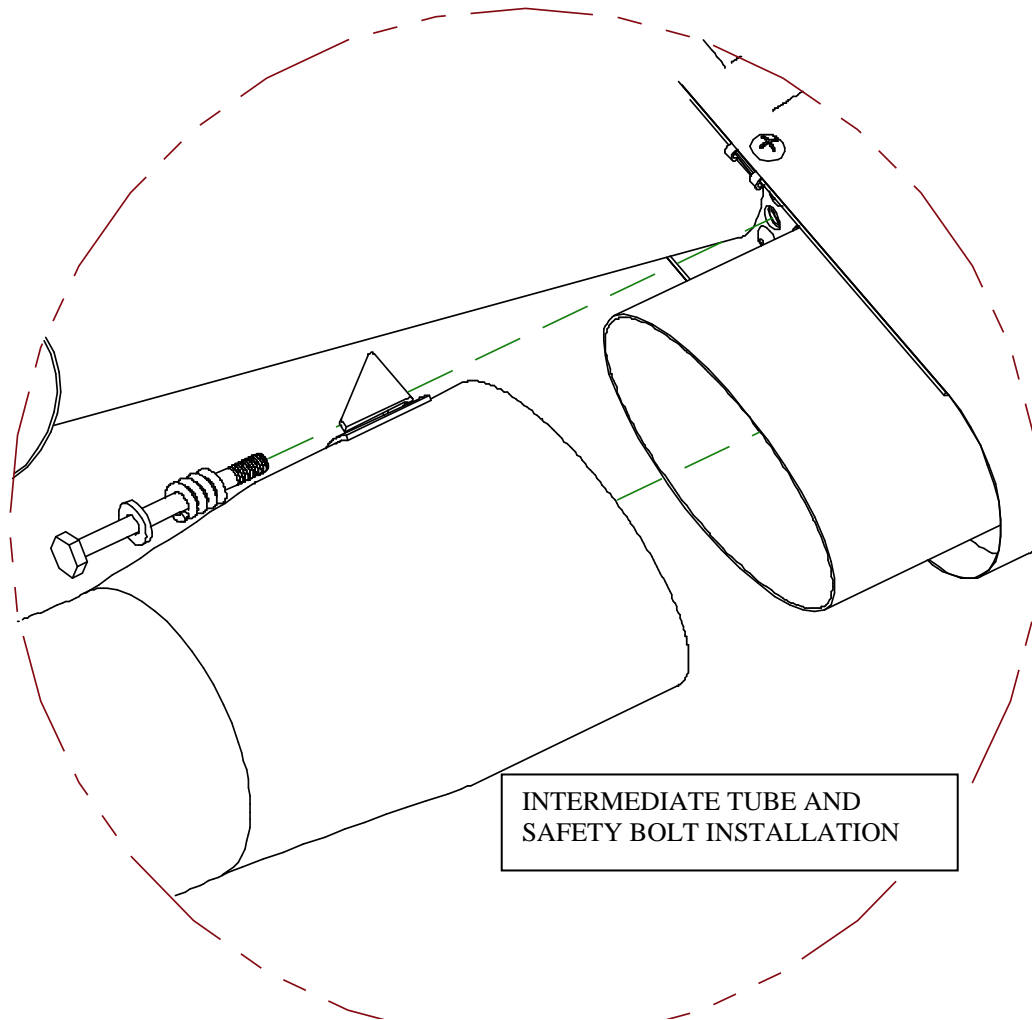
DETAIL F



HEAT SHIELD INSTALLATION

*EQUIVALENT HARDWARE MAY BE USED

DETAIL G



Department of Transportation -- Federal Aviation Administration

Supplemental Type Certificate

Number SA03623AT

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

**NOT VALID WITHOUT
PERMISSION LETTER**

certifies that the change in the type design for the following product with the limitations and conditions therefor as specified hereon meets the airworthiness requirements of Part 23 of the Federal Aviation Regulations.

Original Product - Type Certificate Number : A20CE / A26EU

Make : Cessna

Model : 177 RG; F177 RG

Description of Type Design Change:

Installation of Power Flow, Inc. (PFS) "improved performance" exhaust system per PFS-13706 Tuned Exhaust System Installation Instructions and Instructions for Continued Airworthiness, Report No. PFS-13752-00 Rev. A, dated 05/21/2008 or later FAA approved revisions.

Limitations and Conditions: Instructions for Continued Airworthiness contained in Section 6.0 of Report No. PFS-13752-00, Rev. A, dated 05/21/2008 or later FAA accepted revision must be made available to the operator at the time of installation. "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

(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 : January 23, 2008

Date reissued :

Date of issuance : October 01, 2008

Date amended :



By direction of the Administrator

Melvin D. Taylor
(Signature)

Melvin D. Taylor
Manager
Small Aircraft Certification Office

(Title)

United States of America
Department of Transportation - Federal Aviation Administration
Supplemental Type Certificate
(Continuation Sheet)

Number SA03623AT
Date of Issuance: October 01, 2008

Limitations and Conditions (Continued):

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: Part 23 of the Federal Aviation Regulations effective February 1, 1965 as amended by 23-1 through 23-6.

Regulations Addressed: At latest amendment 23-14 through 23.51

23.177, 23.201, 23.203, 23.207, 23.151, 23.831, 23.993, 23.1017, 23.1041, 23.1043, 23.1047, 23.1121, 23.1123, 23.1125, 23.1183, 23.1529 and G35.301 (b) as amended by 36-28.

END
