



REPORT NAME: PFS-16204 Tuned Exhaust System Installation Instructions
REPORT NUMBER: PFS-16204 -EXP
REVISION: IR
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AIRCRAFT APPLICABILITY: Glasstar or Sportsman with IO-360 or IO-390 Lycoming Angle Valve Engines
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Revision History

REVISION	DATE	REMOVE PAGES	INSERT PAGES
IR	DEC/13/2013	N/A	N/A

Revision Notes:

N/A

Approval Notes:

This is not an FAA approved kit. It is only for homebuilt/experimental aircraft and is not for installation or use on a FAA certified aircraft.



TABLE of CONTENTS

Section	Page
1.0 INTRODUCTION	3
Kit Identification.....	4
2.0 KIT CONTENTS	5
PFS-16204.....	5
3.0 PREPARATION.....	6
4.0 INSTALLATION OF PFS EXHAUST SYSTEM.....	6
4.1 Installing the Optional Pre-Heat Shroud	6
4.2 Installing Collector Box Assembly and Header Pipes	6
4.3 Installing the Tailpipe.....	7
5.0 INSPECTION AND PAPERWORK	7
5.1 Check Clearances	7
5.2 Placards.....	7
5.3 Records.....	8
6.0 INSTRUCTIONS FOR CONTINUED AIRWORTHINESS	8
6.1 BASIC OPERATION.....	8
6.2 AIRWORTHINESS LIMITATIONS	8
6.3 TROUBLESHOOTING	9
6.4 MAXIMIZING SERVICE LIFE	10
6.5 REMOVAL OF PFS EXHAUST SYSTEM	10
6.6 INSPECTION	10
INSTALLATION OVERVIEW.....	12



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 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. Any such modifications or deviations will also void the exhaust system warranty.
- 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. There is an optional pre-heat shroud that warms the air before it is routed over the collector tubes. This heated air is used to heat the aircraft cabin. A tailpipe from the collector assembly routes exhaust gases to a muffler that directs gases out of the cowling.

Kit Identification

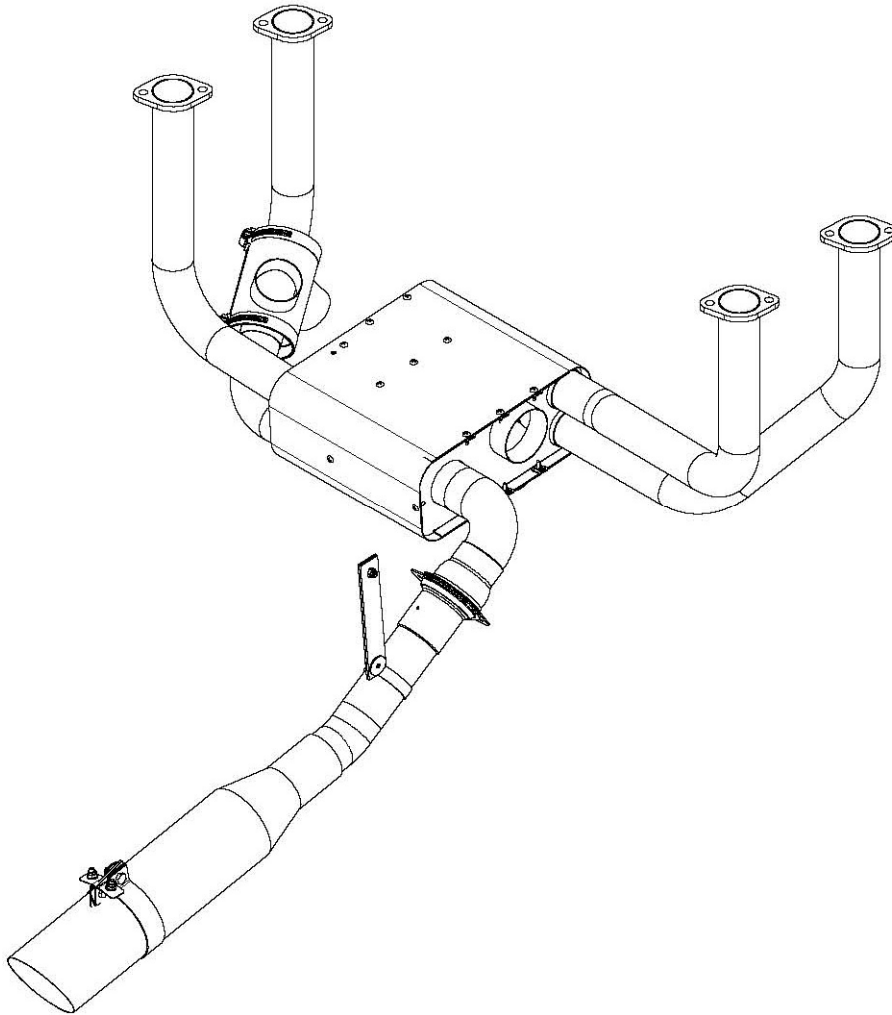


Figure 1. PFS-16204 Exhaust Assembly



2.0 KIT CONTENTS

PFS-16204

<u>Qty</u>	<u>Part Description</u>	<u>Part Number</u>
1	Number 1 Header	11310
1	Number 2 Header	12310
1	Number 3 Header	13310
1	Number 4 Header	14310
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	40670
1	Tailpipe Assembly	80670
3	3/16" Castle Nut	AN310C3
3	Ball Joint Springs	33703
6	3/16" Flat Washers	AN960C10
3	Cotter Pin	MS24665-153
1	3.5" Tailpipe Clamp	8030
1	1/4" Undrilled Clamp Bolt	AN4C6A
1	1/4" Large Area Washer	AN970-4
1	1/4" Locknut	MS21045C4
1	2.0" Tailpipe Clamp	7024
1	3/16" Undrilled Clamp Bolt	AN3C5A
1	3/16" Large Area Washer	AN970-3
1	3/16" Locknut	MS21045C3
4	Neoprene Straps	210
36"	2.5" SCAT Tube	SCAT-10
24"	2.0" SCAT Tube	SCAT-8
<u>For Aircraft with Optional Pre-Heat Assembly:</u>		
1	Cabin Pre-Heat Assembly	51310
2	Hose Clamps	QS200M32H
32"	2.0" SCAT Tube	SCAT-8

A/R Associated Hardware

Equivalent Hardware may be used throughout.



3.0 PREPARATION

Verify that all contents listed in section 2 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 existing exhaust system (if installed) in accordance with the latest revision of the aircraft service manual.

4.0 INSTALLATION OF PFS EXHAUST SYSTEM

4.1 Installing the Optional Pre-Heat Shroud

- 4.1.1 Determine which header tube will work best for the installation. We recommend installing the shroud on the number two header (P/N 12310).
- 4.1.2 Install the heat shroud flanges over the header tube with the open end of the “C” shaped profile facing the ends of the tube.
- 4.1.3 Install the shroud over the tube and flanges, locating the flanges flush with the end of the shroud.
- 4.1.4 Install the band clamps over the ends of the shroud.
- 4.1.5 Orient the shroud as necessary to maximize clearances and simplify hose routing.
- 4.1.6 The band clamps should be re-tightened within the first 25 hrs of service.

4.2 Installing Collector Box Assembly and Header Pipes

Each header and collector is marked with its appropriate cylinder number – make sure that each header installed matches the correct collector location. If the headers are not numbered and/or there are no alignment marks, use the Installation Overview and Figure 1 in section 1 to determine proper header orientation.

- 4.2.1 Apply generous amounts of high-temperature anti-seize (MIL-A-907E or equivalent) to the slip joints on the collector box. New exhaust systems have anti-seize applied at the factory.
- 4.2.2 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.
- 4.2.3 Loosely install the number two and four headers on their respective studs.
- 4.2.4 Install the collector box over the number two and four headers, using the alignment marks.
- 4.2.5 Install the one and three headers into the collector box and onto their respective studs.
- 4.2.6 Rotate or reposition the collector box as necessary to line up the alignment marks.
- 4.2.7 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. 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 current Aircraft or Engine Service Manual. Remove alignment labels.

- 4.2.8 If installing EGT probes, install them now to the headers in accordance with the manufacturer's recommendations (typically 2 to 4 inches from the exhaust port).
- 4.2.9 Attach all flexible tubing to the appropriate inlet/outlet tube on the collector assembly and Pre-Heat shroud (if installed).

4.3 Installing the Tailpipe

- 4.3.1 Position the tailpipe so that it will come out the cowling exit ramp area with suitable clearance. Using the hardware provided, assemble the ball joint. **See Installation Overview.** The compressed spring height on the ball joint should be between 0.430 and 0.475 inches, add or remove washers as necessary to obtain this height.
- 4.3.2 At this stage, the lower end of the tailpipe assembly should be able to 'wobble' ½ inch to 1 ½ inches from side to side. **Caution: Over-tightening the ball joint assembly may cause cracking in the collector and damage to the ball joint assembly.**
- 4.3.3 Attach the tailpipe assembly to the neoprene straps with the included clamps. (See **Installation Overview**). The upper 2.0 inch clamp should be attached either directly to the firewall with an AN3C4A bolt, AN970-3 Large Area Washer and appropriate nuts/washers, or to any other suitable area such as the nose gear support angle. The straps for the 3.5 inch clamp should be attached to the airframe in a suitable manner.

5.0 INSPECTION AND PAPERWORK

5.1 Check Clearances

- 5.1.1 Using a flashlight and mirror if necessary, check for clearances between all exhaust system and airframe components. **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.
- 5.1.2 It may be necessary to fabricate one or more brackets to hold the fuel lines or fuel flow transducer away from exhaust pipes
- 5.1.3 Install the engine cowling in accordance with the latest appropriate revision of the aircraft service manual.
- 5.1.4 After installing, perform a 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.

5.2 Placards

Install a Placard in clear view of the pilot that reads:

"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."

If the aircraft is equipped with a Hartzell Model HC-C3YR-1RF/F7282 propeller, change



the limitations placard located between the manifold pressure gage and the tachometer to read: “**AVOID CONTINUOUS OPERATION BELOW 22 INCHES HG BETWEEN 1950 AND 2350 RPM**” and replace the Hartzell flight manual supplement with AFMS_011810 Rev IR or later.

5.3 Records

5.3.1 Make appropriate entries in the logbook. This installation is a major *airframe* alteration.

5.3.2 Weight and Balance:

- The 16204 Power Flow Exhaust system weighs approximately 20 pounds.

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

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.

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 inspection and repair or replacement as necessary.**

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	Broken or Worn Engine Mounts	Replace or repair engine mounts.
	Tailpipe contacting firewall or cowling	Check for wear marks on the lower firewall and engine cowling, reposition tailpipe as necessary.
	Collector not centered on header pipes	Reposition collector -- ensure minimum of 1 1/2" penetration per header into central collector system
	Ball Joint too Loose	Tighten Ball Joint
	Broken Exhaust Hanger	Replace Exhaust Hanger
	Propeller not properly balanced	Have propeller dynamically balanced to at or below 0.2 ips.
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 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 OF PFS EXHAUST SYSTEM

- 6.5.1 Disconnect muffler clamps from the exhaust hangers. Remove clamps.
- 6.5.2 Disconnect the ball joint assembly and remove tailpipe.
- 6.5.3 Remove EGT probes if installed.
- 6.5.4 Disconnect flexible ducts from the collector assembly.
- 6.5.5 Identify each header with its cylinder number for later installation.
- 6.5.6 Mark each slip joint so that the depth and rotation of each joint can be replicated when the exhaust is reinstalled. **DO NOT USE PENCIL** or other graphite or carbon based marking device on any exhaust system component.
- 6.5.7 Remove nuts and washers attaching headers to exhaust ports.
- 6.5.8 Remove the collector assembly.

6.6 INSPECTION

The exhaust system must be thoroughly inspected, especially within the heat exchanger section. A detailed visual inspection of the exhaust system must be performed in accordance with the latest revision of the Aircraft Service Manual and this document at 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 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 AFMS_011810 Rev IR or later.
- 6.6.2 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.

- 6.6.3 Inspect the inside of the tailpipe body. If the interior is missing, collapsing, or deteriorated, it will require replacement. New tailpipe inserts are available from Power Flow Systems, Inc.
- 6.6.4 Inspect Strap Hangers for tearing or wear. Any worn hangers should be replaced.
- 6.6.5 Inspect for ball joint freedom of movement by disconnecting the exhaust hangers. The tailpipe should be free to move in all directions by applying minimal force. If the tailpipe isn't free to move:
- Disassemble the ball joints and inspect for surface abnormalities such as galling or wear marks.
 - Rework the ball joints as required to correct noted discrepancies.
 - Reassemble the ball joints. Do not over tighten the clamp as this may distort ball surfaces.
- 6.6.6 All slip joints must be disassembled and lubricated with a high-temperature anti-seize compound (MIL-A-907E or equivalent). While disassembled, inspect for wear or galling. (Only necessary at 500hr or annual intervals, whichever comes first) This should be performed more frequently if headers seize between inspections.
- 6.6.7 Be sure to remove heat shroud from collector box to inspect beneath it.
- 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:
- 6.6.8 Remove shroud.
- 6.6.9 Seal four of the openings (tubes) with rubber expansion plugs.
- 6.6.10 Using a manometer or pressure gauge, apply 3.0 to 3.5 PSI (approximately 7" Hg) of air pressure to the fifth opening.
- 6.6.11 Submerge the collector assembly in water.
- 6.6.12 Let the unit sit pressurized for 10 to 30 seconds. The leak rate should be zero.
- 6.6.13 If a leak is found in the collector assembly, replace before further flight.
- 6.6.14 If no leaks are found, dry components and install on airplane.



Installation
Kit: PFS-16204

INSTALLATION OVERVIEW

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