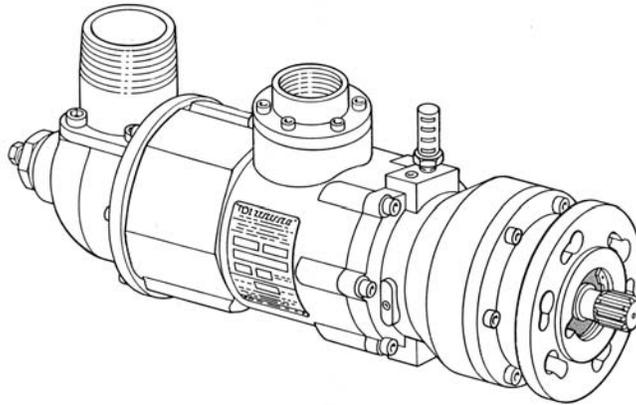


INSTALLATION AND OPERATING MANUAL



MODEL: 56K ***Gas Turbine Engine*** ***Air Starter***

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1.0 GENERAL INFORMATION

This manual provides instructions for the installation and operation of the TDI **TURBOSTART** Model 56K air starters. If there are questions not answered by this manual, please contact your TDI distributor or dealer for assistance.

The model 56K is a turbine driven air starter with a sprag-type over-running clutch. The 56K is best suited for use with industrial gas turbine engines and is designed for installation on engines which use an AND 20002 Type XII-S engine accessory drive pad. The 56K has a mounting flange and output spline shaft that mates with the accessory drive assembly starter mounting pad on Allison 501KC gas turbine engines.

The 56K air starter is suited to operate within a wide range of inlet pressures and ambient temperatures. These starters are designed for operation with either compressed air or natural gas; materials used are compatible with "sour" natural gas and marine environments.

Small amounts of foreign matter or liquid in the air stream will normally not adversely affect 56K air starters. As with all other TDI air starter models, no lubrication is required in the supply air.

The 56 K air starters are normally supplied for use within a dedicated start monitoring system. Some models may be equipped with the TDI Automatic Trip Valve (ATV) to shut off air to the starter when a predetermined cranking speed is reached. This prevents excessive cranking speeds, which could damage the starter.

Please review the rest of this manual before installing your TDI **TURBOSTART** 56 K starter.

1.1 WARNINGS, CAUTIONS, & NOTES

Throughout this manual, certain types of information will be highlighted for your attention:

WARNING - used where injury to personnel or damage to the equipment is likely.

CAUTION - used where there is the possibility of damage to the equipment.

NOTE - used to point out special interest information.

NOTE

Throughout this manual, the term "air" is used to denote the starter drive medium. Unless otherwise stated, "air" means either compressed air or natural gas.

2.0 ORIENTATION OF THE STARTER

If the factory orientation of the starter's turbine housing assembly does not fit your engine installation, this component can be re-oriented.

Determine the required orientation of the turbine housing assembly and gearbox housing assembly. The turbine housing assembly can be rotated to six different positions relative to the gearbox housing assembly to achieve the desired inlet position. See figure 1.

CAUTION

When using a shared lubrication system, the starter must be installed with the oil drain/return port located in the 4° Clock or 8° Clock position to maintain a small amount of oil in the starter when the unit is not operating. This will allow lubrication of the planetary gears during initial engine cranking.

Remove the six turbine housing assembly to gearbox housing assembly socket head cap screws.

Rotate the turbine housing assembly to the desired position. Apply loctite 242 to screw thread and reinstall the six cap screws. Torque the six screws to **150 in-lbs.**

CAUTION

Ensure that the O-ring on the gearbox housing assembly remains in position and is not cut.

3.0 INSTALLING THE STARTER

3.1 A turbine driven starter does not require lubrication in the supply air. Therefore, if a vane-type starter motor is being replaced, TDI recommends that all lubrication devices and lines be removed to minimize flow restrictions.

WARNING

If a fuel (pulse) lubricator has previously been installed in the system, disconnect and plug the line to eliminate spraying diesel fuel on the engine.

3.2 Liberally grease the starter's splined shaft with chassis lube and then mount the 56K starter on the engine. Tighten all mounting hardware as appropriate to secure starter to engine.

Remove the plug from the oil supply port (1/4" NPT) on the sprag clutch housing and connect the oil supply line from the engine lube oil system. See figure 2.

CAUTION

The oil supply can be connected to the power turbine/compressor lube oil system to ensure the pre-lubrication system will supply oil to the 56K air starter before engine cranking.

A pressure gauge can be installed in the oil supply line to ensure oil pressure is approximately 25 psig.

Remove the starter oil drain plug (1" NPT) and connect the oil drain/return line. This line from the starter is connected to the oil sump.

3.3 Natural Gas Operation

Proper control of natural gas is a major consideration when used in the starter system.

3.3.1 The turbine exhaust must be piped away from the starter area and vented to atmosphere. 3" NPT and 4" NPT exhaust fittings are available from TDI.

CAUTION

When an exhaust adapter and piping is used, the exhaust line must be supported to prevent load transfer back to the starter and engine mounting pad.

3.3.2 The turbine housing natural gas vent port is plugged for compressed air use. When using natural gas, remove the 3/8" NPT plug and install a line to carry gas away from the starter area and vent to atmosphere.

CAUTION

Do not connect the turbine housing vent line to the turbine exhaust line; exhaust line gas can pressurize the turbine housing.

3.4 Turbine starters such as the 56K are sensitive to flow restrictions therefore care must be taken to use uniform hose or tubing and fittings for connection of the supply air line.

Tees, elbows, and line length must be kept to a minimum. TDI recommends hose or flex couplings be installed to eliminate possible leakage caused by strain on the supply line.

3.5 Normally an air strainer is not required. In dirty environments, use of a #40 mesh Y-strainer is recommended.

4.0 OIL LEVEL/FLOW VERIFICATION PROCEDURE

4.1 With starter installed on engine and drain/return line disconnected from starter, install a short (12") stainless steel flex hose approximately 1" diameter to the starter oil return/drain port.

4.2 Temporarily remove the plug from the oil fill port (port 1) on the starter gearbox housing and fill the starter with oil until oil is observed flowing freely from the flex hose connected to the oil return/drain port. A pan or bucket can be used to contain the oil flowing from the oil return port.

- 4.3 Re-install the plug into the oil fill port.
- 4.4 At this point initiate a manual start with **no ignition or fuel** for 20-30 seconds until oil is observed flowing from the flex hose connected to starter oil return port.
- 4.5 After oil flow is confirmed, stop manually cranking the engine.
- 4.6 Remove the flex hose from starter return port and reconnect the oil return line to engine oil sump.
- 4.7 Initiate a normal engine start.

5.0 STARTER OPERATION

The maximum operating pressure limit is the inlet pressure when measured at the starter inlet pressure check port and reflects all supply air pipe and valving losses. In order to check the starter inlet pressure, a 1/4" NPT pipe tap connection is provided in the inlet housing to attach a pressure gauge; See figure 1.

WARNING

Do not operate the TDI Turbostart 56K air starter with air pressure greater than the pressure rating on the nameplate. This pressure is to be measured at the starter inlet while the starter is running.

The static supply pressure will always be higher than the operating pressure. As a guideline, the maximum pressure limit (proof pressure) that the 56K air starter may be subjected to is 600 psig. System pressure that exceeds the maximum operating limit must use a pressure reducer device to ensure that the operating pressure limit to the 56K is maintained.

System pressure that exceeds the 600 psig limit must, in addition to a pressure reducer device, incorporate a pressure relief valve, set below 600 psig, in the supply air line.

All appropriate local pressure codes and pressure limitations on other system components must be adhered to and would supersede the guidelines given in this manual.

5.1 Follow the engine manufacturer's instructions for starting the engine.

5.2 If a start is aborted before a successful engine start, a restart may be attempted after the starter and engine have come to a full stop. Refer to the Engine Operator's Manual if the system continues to shut down before a successful start.

5.3 If an Automatic Trip Valve (ATV) is used and the ATV happens to trip before a successful engine start, a restart may be attempted after the starter and engine come to a full stop. If the ATV continues to trip, it indicates that the supply line pressure is too high. Refer to the Operator's Trouble Shooting Guide, Section 6.0.

5.4 If the starter fails to function properly when first operated, or its performance deteriorates with use, refer to the Operator's Trouble Shooting Guide, Section 6.0. If you cannot solve the problem, or repair is necessary, contact your local TDI Turbostart distributor or dealer.

5.5 Accessories

DESCRIPTION	KIT P/N:
3" Marman inlet flange	55-119
6" Marman exhaust flange	55-120
3" NPT exhaust fitting	52-419
3" NPT exhaust elbow	52-403
4" NPT exhaust fitting	52-418

6.0 WARRANTY

TDI ENGINE STARTER STANDARD WARRANTY

Tech Development (TDI) warrants to the original user of the TDI *TURBOSTART*[™] air starters to be free from defects in material and workmanship for a period of one year (6 month for remanufactured units) from the date of installation. The warranty period shall not extend beyond two years (12 months for factory remanufactured units) from the date the unit was manufactured. (i.e.: a unit with a manufactured date of July 1999 (SN: 9907-101) will not be covered under warranty after July 2001). The conditions of this warranty are: **a)** TDI is notified within this period by return of such product to TDI or its authorized distributor/dealer, transportation prepaid by user; **b)** the starter has been installed according to TDI's specifications; **c)** the starter has not been misused, abused, or improperly maintained by user; **d)** the defect is not the result of normal wear and tear; **e)** the starter has been repaired with parts manufactured or authorized by TDI; and **f)** TDI installation and repair procedures as outlined in the appropriate manual were properly followed.

Tech Development will repair, or at its option, replace the unit during the warranty period at no charge to the customer, provided it is returned to TDI with the proper return procedure.

Tech Development makes no other warranty, and implied warranties including any warranty or merchantability or fitness for a particular purpose are hereby disclaimed.

This warranty constitutes the entire obligation of Tech Development relating to the sale and use of such product, and TDI's maximum liability is limited to the purchase price of such product at the date of purchase. In no event shall TDI be liable for incidental, indirect, consequential, or special damages of any nature arising from the sale or use of such engine starter product.

7.0 OPERATOR'S TROUBLESHOOTING GUIDE

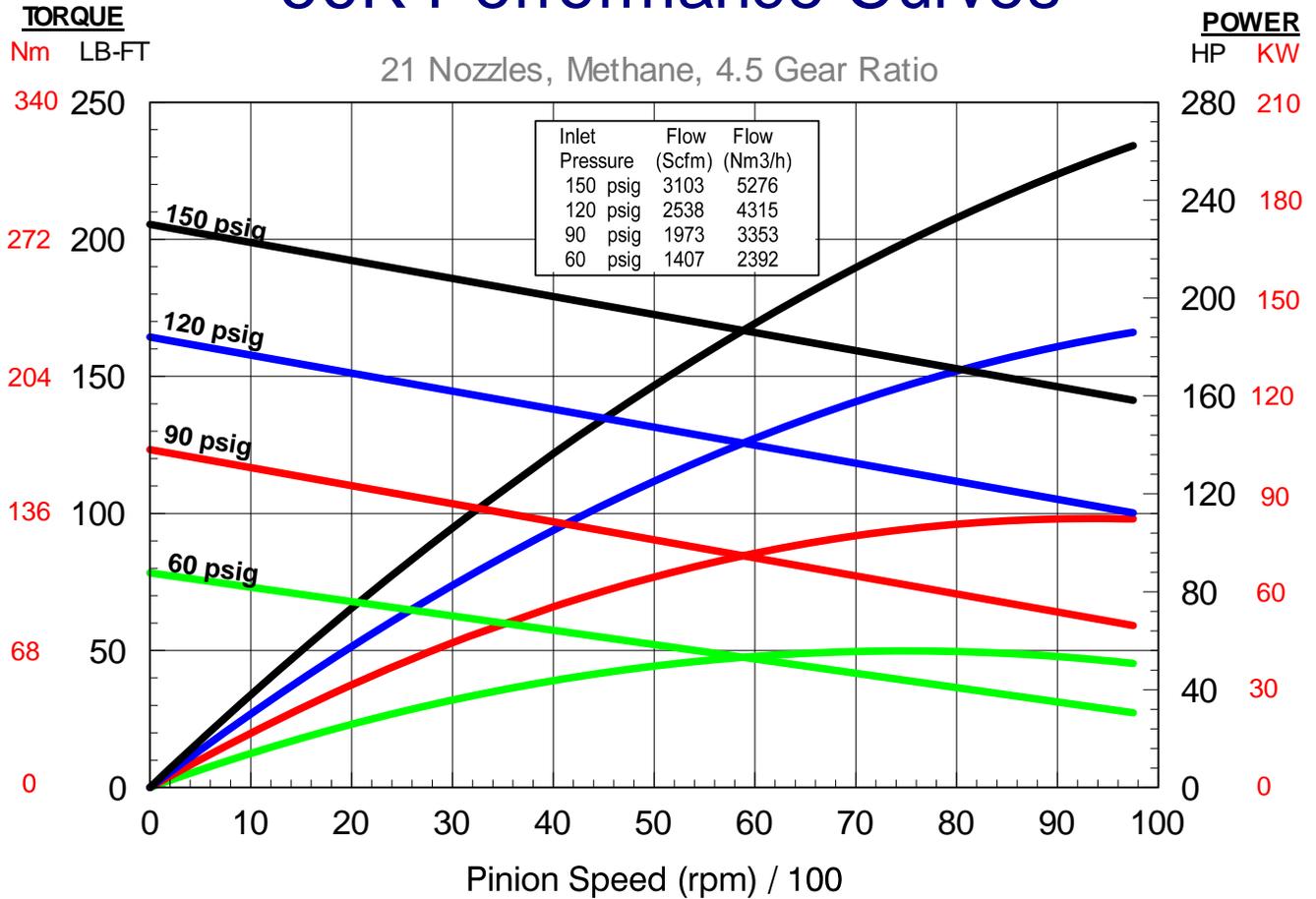
TROUBLE	PROBABLE CAUSE	SOLUTION
1. Starter speed / torque insufficient to start gas turbine engine.	A. Low gas supply pressure.	A. Increase gas supply pressure.
	B. Restricted inlet.	B. Re-pipe supply line or increase supply pressure.
	C. Restricted exhaust piping.	C. Increase gas supply pressure.
	D. Damaged turbine rotor.	D. Replace turbine rotor.
	E. Icing of exhaust.	E. Remove ice. Increase exhaust diameter.
2. Starter does not run; normal gas flow from exhaust.	A. Broken turbine rotor.	A. Replace all damaged parts. NOTE: If the turbine rotor fails due to overspeed, the reason for the overspeed must be determined. Examine complete system.
	B. Reduction gear train or sprag clutch worn or damaged	B. Replace or repair.
3. Starter continues to run after completing a normal starting operation.	A. Supply gas shut-off valve not fully closed.	A. Replace valve.
4. Oil leakage from natural gas vent hole.	A. Damaged oil seals.	A. Replace oil seals.
	B. High back-pressure.	B. Re-pipe; max 20 PSIG is recommended.
5. Starter operates with excessive noise.	A. Low oil level.	A. Replenish lubricating oil.
	B. Bearing failure.	B. Replace bearing.
6. Starter runs, but gas turbine does not turn.	A. Sprag clutch worn.	A. Replace sprag clutch.
	B. Sprag clutch installed incorrectly.	B. Disassemble sprag clutch housing and reverse sprag clutch. Reassemble.
	C. Damaged reduction gear train.	C. Replace or repair reduction gear train.
	D. Damaged output shaft.	D. Replace output shaft.
«WARNING» Release all starter system gas pressure before attempting to work on starter system components		

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8.0 56K PERFORMANCE CURVE

56K Performance Curves



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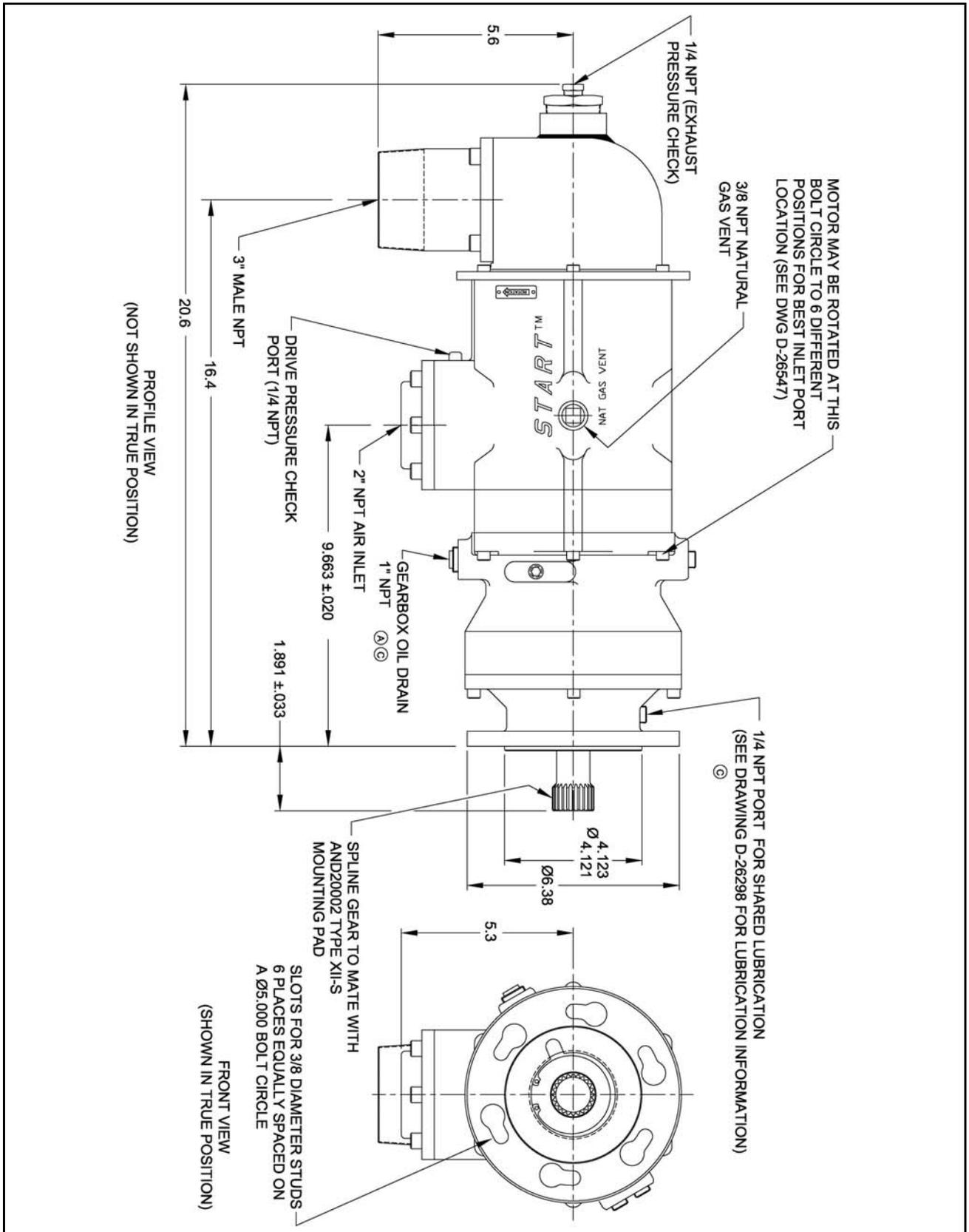


Figure 1. 56K Envelope Drawing

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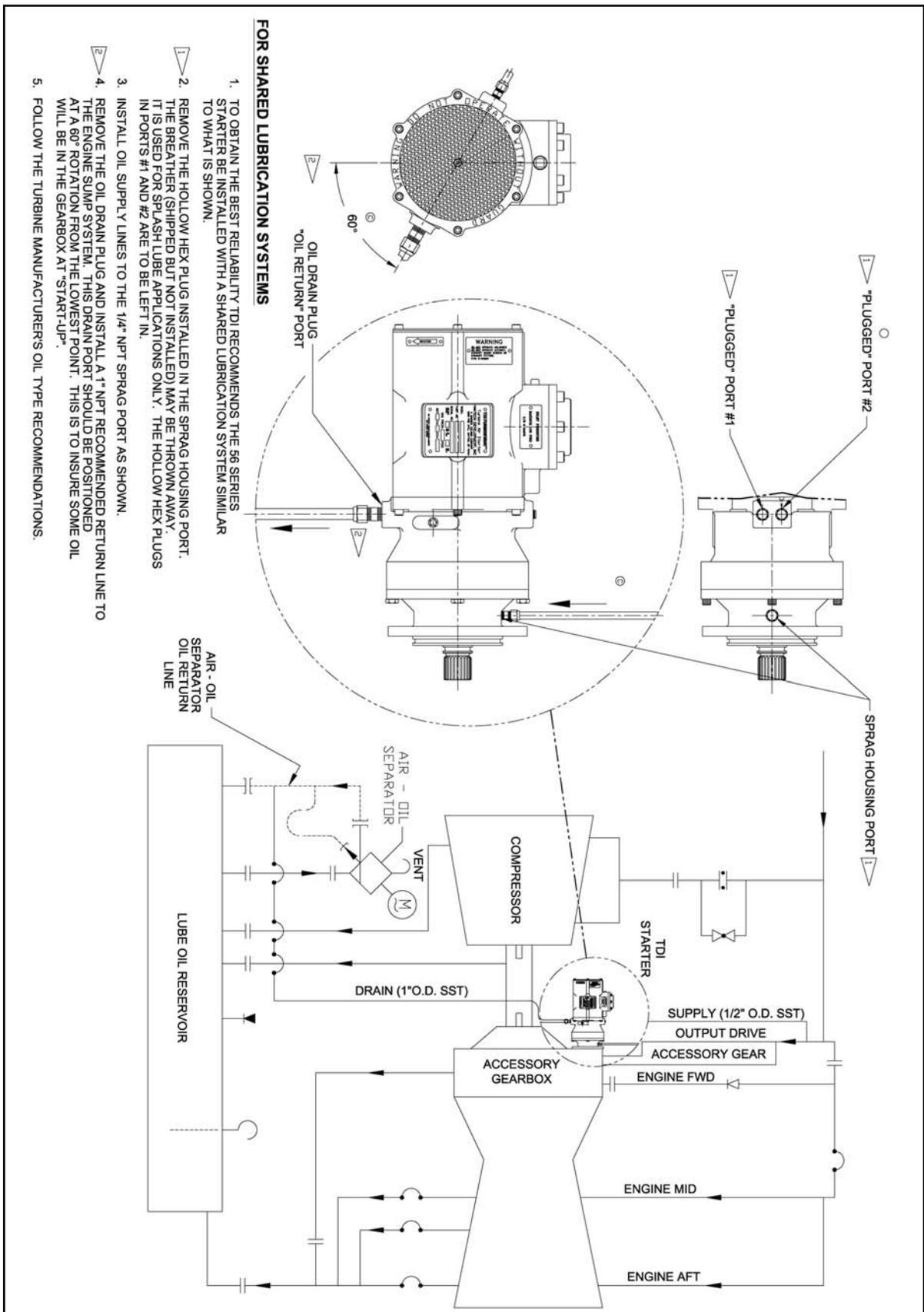
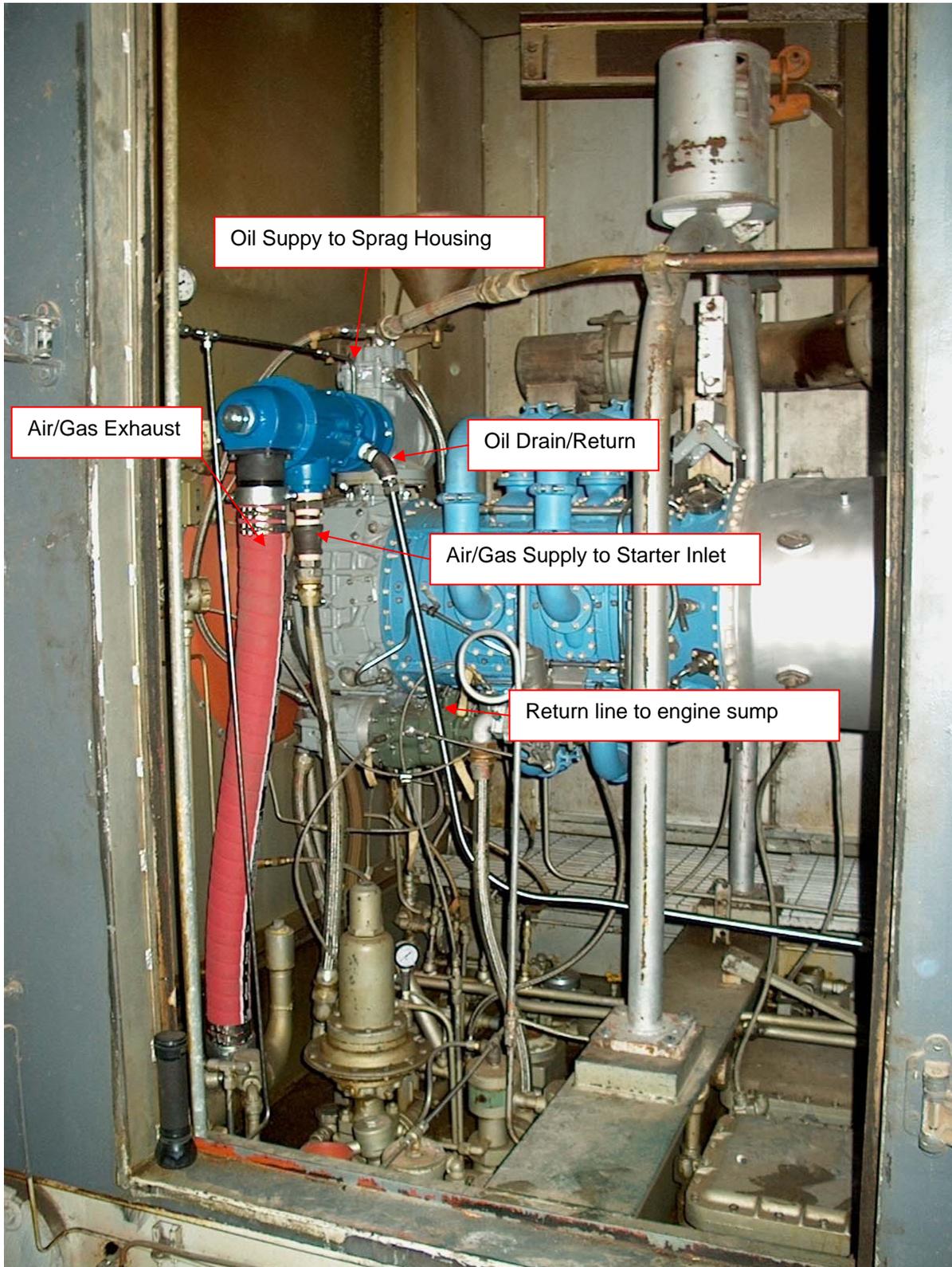


Figure 2. 56 Series Shared Lubrication Drawing

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56K installed on Allison 501KC