

AIR FORCE QUALIFICATION TRAINING PACKAGE (AFQTP)



FOR
ELECTRICAL POWER PRODUCTION
(3E0X2)

MODULE 23
INTAKE AND EXHAUST SYSTEMS

TABLE OF CONTENTS

MODULE 21

INTAKE AND EXHAUST SYSTEMS

AFQTP GUIDANCE

INTRODUCTION23-3

AFQTP UNIT 2

TROUBLESHOOT (23.2.)23-4

REVIEW ANSWER KEYKEY-1

CORRECTIONS/IMPROVEMENT LETTER.....APPENDIX A

Career Field Education and Training Plan (CFETP) references from 1 Aug 02 version.

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Supersedes AFQTP 3E0X2-21, 1 Oct 99

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Pages: 13/Distribution F

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(3E0X2)**

INTRODUCTION

Before starting this AFQTP, refer to and read the "[AFQTP Trainer/Trainee Guide](#)."

AFQTPs are mandatory and must be completed to fulfill task knowledge requirements on core and diamond tasks for upgrade training. **It is important for the trainer and trainee to understand** that an AFQTP **does not** replace hands-on training, nor will completion of an AFQTP meet the requirement for core task certification. AFQTPs will be used in conjunction with applicable technical references and hands-on training.

AFQTPs and Certification and Testing (CerTest) must be used as minimum upgrade requirements for Diamond tasks.

MANDATORY minimum upgrade requirements:

Core task:

AFQTP completion
Hands-on certification

Diamond task:

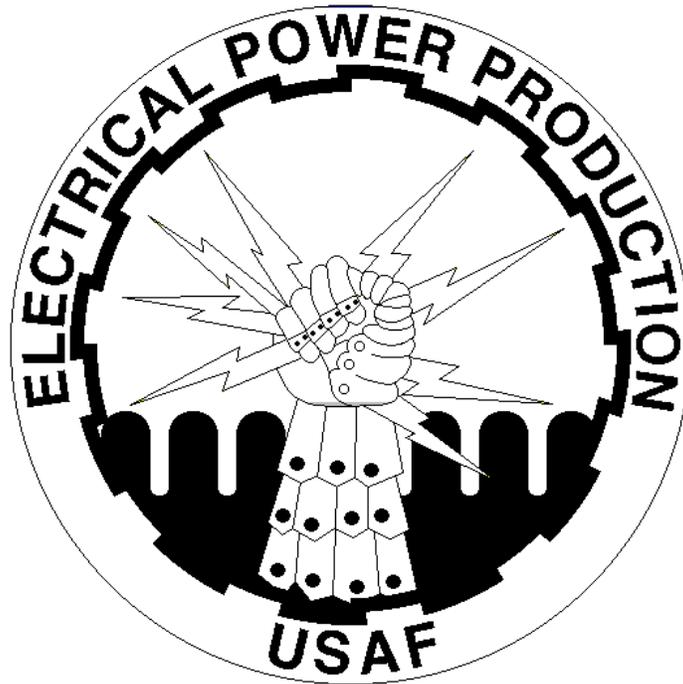
AFQTP completion
CerTest completion (80% minimum to pass)

Note: Trainees will receive hands-on certification training for Diamond Tasks when equipment becomes available either at home station or at a TDY location.

Put this package to use. Subject matter experts under the direction and guidance of HQ AFCESA/CEOF revised this AFQTP. If you have any recommendations for improving this document, please contact the Career Field Manager at the address below.

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INTAKE AND EXHAUST SYSTEMS

MODULE 23

AFQTP UNIT 2

TROUBLESHOOT (23.2.)

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TROUBLESHOOT INTAKE AND EXHAUST SYSTEMS

Task Training Guide

STS Reference Number/Title	23.2., Troubleshoot Intake and Exhaust Systems.
Training References:	<ol style="list-style-type: none"> 1. Career Development Course (CDC) Electrical Power Production Journeyman 3E052B, Vol. 1, Unit 2-2: Intake and Exhaust System. 2. 35C2 series Technical Orders (TOs). 3. Air Force Occupational Safety and Health Standard (AFOSHSTD) 91-45, Hazardous Energy Control and Mishap Prevention Signs and Tags. 4. Manufacturer's Manual. 5. Local Procedures.
Prerequisites	<ol style="list-style-type: none"> 1. Possess as a minimum a, 3E052 AFSC. 2. Review the following references: <ol style="list-style-type: none"> 2.1. CDC 3E052B, Vol. 1, Unit 2-2. 2.2. Applicable TOs and Manufacturer's Manual. 2.3. AFOSHSTD 91-45 for lockout/tag out procedures.
Equipment/Tools Required:	<ol style="list-style-type: none"> 1. General Tool Kit. 2. Personal Safety Equipment. 3. Applicable Technical References. 4. Generator to perform troubleshooting task on.
Learning Objective:	<ol style="list-style-type: none"> 1. Know system components of air intake and exhaust system. 2. To be able to troubleshoot air intake and exhaust systems.
Samples of Behavior:	Trainee should be able to successfully and safely service the intake and exhaust systems on a diesel/gas engine.
Notes:	
<ol style="list-style-type: none"> 1. Prior to performing any maintenance, technician MUST isolate the starting system, and apply lockout and tag-out procedures. 2. Trainer must develop an exercise scenario to validate ability of trainee to meet learning objective and samples of behavior. 3. Any safety violation is an automatic failure. 	

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TROUBLESHOOT INTAKE AND EXHAUST SYSTEM

1. Background: When troubleshooting a system, you must be familiar with the system in order to troubleshoot effectively. The primary function of the air intake system is to supply the air needed for combustion; however, the system also cleans the air and reduces the noise created as it enters the engine. The efficiency in which it accomplishes this depends on engine design, smoothness of the internal air passages, degree, and number of bends in the air passages, and size of the ports. Valve timing can also affect the breathing efficiency. If the valves on a four-cycle engine close too soon, exhaust gases can be pushed out through the intake port during the valve over-lap period, which can dilute or restrict the flow of clean incoming air.

1.1. It is important to mention that the intake and exhaust systems work together and some components may serve purposes for each system. The intake system brings fresh air into the engine and the exhaust system gets rid of the burnt gases.

1.2. The basic components of the air intake system include; air filter, intake manifold, related piping, and intercooler. If a turbocharger is used, the compressor side of the turbocharger is considered part of the intake system.

1.2.1. Air filter: The air filter removes airborne particles such as soot, dust, dirt and moisture before air enters the engine. Particles that enter the air supply can cause premature wear of moving parts and if dirt build up is allowed in the air cleaner passages, it can restrict the air supply resulting in heavy carbon deposits on the valves and pistons due to incomplete combustion. Two basic types of air filters are the oil bath type and dry type.

1.2.2. Intake manifold: Passageway that carries air to the cylinders. On four cycle engines external manifolds are made of cast iron or die cast, attached to the block for conducting intake air to the cylinders. On two cycle engines, the passage that conducts intake air to the cylinders is called an air box. The air box surrounds the cylinders and is built into the block.

1.2.3. Intercooler: The intercooler cools the air after it leaves the turbocharger and before it enters the air intake manifold. Its purpose is to increase the density of the intake air and increase engine efficiency; resulting in more power, quieter combustion, and reduced emissions.

1.3. The exhaust system is just as important for effective combustion as the intake system. The exhaust system collects combustion gases from the diesel engine and carries them away. It also removes engine heat, muffles exhaust noise, limits spark, and removes solid material from exhaust gases. The basic components of the exhaust system include; exhaust manifold, exhaust muffler, exhaust piping and turbocharger.

1.3.1. Exhaust manifold: The exhaust manifold collects the exhaust gases from the cylinder ports and carries them to an exhaust pipe. It consists of a pipe that has exhaust ports or openings from each cylinder of the engine feeding into it. Exhaust manifolds are made of cast aluminum or cast iron. Cast iron manifolds are of two or more pieces with slip joints that allow for heat expansion.

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1.3.2. Muffler/Silencer: The exhaust muffler removes noise from the exhaust gases without obstructing flow to the outlet pipe.

1.3.3. Turbocharger: Turbochargers utilizes energy from the exhaust, to drive a turbine-powered centrifugal air compressor that converts velocity into air pressure to increase the flow of air to the engine cylinders. A turbocharger improves combustion; decreases exhaust emissions, smoke, and noise.

1.4. Little maintenance is required on intake and exhaust systems, provided periodic maintenance is performed. Always use the appropriate technical order or manufacturers manual when performing maintenance or replacing components.

1.5. Since troubleshooting is a step-by-step procedure, the effectiveness depends on how much you know about the equipment and how much you think while working. The ability to troubleshoot depends on your capability to think and apply knowledge. To troubleshoot effectively, you must follow a systematic procedure. First, study the symptoms of the trouble thoroughly and ask yourself these questions:

1.5.1. What were the warning signs preceding the trouble?

1.5.2. What recent repair has been done?

1.5.3. Has a similar trouble occurred before?

1.6. Next, follow the basic troubleshooting procedures:

1.6.1. The first step is to **perform an operational check** to determine if an actual problem really exists. Follow step-by-step procedures in the technical manual for your particular item of equipment. Perform a visual inspection of the electrical components, check wiring harness for breaks, and check relays for loose connections, evidence of over heating, cracks, or any signs of damage.

1.6.2. The second step in troubleshooting is to **analyze the malfunction**. Detect the trouble by sight, sound, smell, or feel. Once you are aware of a malfunction, consult the proper technical manual for normal operation. This gives one a clearer understanding of how things should be working. One can also use the troubleshooting chart located in the proper technical manual.

1.6.2.1. It is in this step that one determines the type of trouble in order to determine the type of test equipment to use.

1.6.3. The third step is **locating the malfunction**; this is the most difficult task. In this step, one will need to stay focused on the problem and not allow frustration to set in. This can cause one to resort back to the remove and replace technique. Perform the previous steps; determine type of test equipment needed to check the performance. Understanding the operation and knowing the “how, what, when and where” is the key to locating the malfunction.

1.6.4. The fourth step is to **perform corrective action**, once you have located the problem; a neat and permanent repair is a necessity. If possible, use original replacement parts to make repairs.

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1.6.5. The last step is to **perform an operational check**; this is the most rewarding step in the troubleshooting process. If you do not prove your work, you will not know if the problem is solved. Remember, one malfunction can produce more than one problem.

NOTE:

Trainer/Certifier must provide equipment and scenario for troubleshooting intake/exhaust systems in order to complete task. Use troubleshooting chart on the next page for guidelines if needed.

2. To perform this task, follow these steps:

Step 1: Trainee is provided equipment and scenario in which to perform task.

Step 2: Use five-step process in troubleshooting:

- 2.1. Perform an operational check.
- 2.2. Analyze the malfunction.
- 2.3. Locate the malfunction.
- 2.4. Perform corrective action.
- 2.5. Perform an operational check.

Step 3: Document maintenance on AF Form 719.

INTAKE/EXHAUST TROUBLESHOOTING CHART	
<i>BLACK OR GRAY EXHAUST SMOKE (ENGINE RUNS SMOOTH)</i>	
CAUSE	REMEDY
Intake air system restriction.	Checked for blocked air intake system.
<i>EXCESSIVE FUEL CONSUMPTION</i>	
CAUSE	REMEDY
Air intake system restriction.	Inspect ductwork for damage and/or excessive turns and bends. Check for Damaged rain cap or cap that is pushed too far onto the inlet pipe.
<i>EXCESSIVE OIL CONSUMPTION</i>	
CAUSE	REMEDY
Exhaust system restriction.	Inspect piping and muffler. Perform exhaust back pressure test. Locate the source of any restriction.
Failure of seal rings in turbocharger.	Check intake manifold for oil and make.

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**REVIEW QUESTIONS
FOR
TROUBLESHOOT INTAKE AND EXHAUST SYSTEM**

QUESTION	ANSWER
1. The primary function of the air intake system is to?	<ul style="list-style-type: none"> a. Remove airborne particles. b. Supply the air needed for combustion. c. Collect exhaust gases. d. Eliminate back pressure.
2. The turbocharger is driven by exhaust gases.	<ul style="list-style-type: none"> a. True. b. False.
3. What are two types of air filters?	<ul style="list-style-type: none"> a. Paper/Oil. b. Impingement/Paper. c. Oil bath/Dry.
4. What item of the exhaust system removes noise?	<ul style="list-style-type: none"> a. Turbocharger. b. Related piping. c. Air Box. d. Muffler/Silencer.
5. What item of the intake/exhaust system carries air to the cylinders?	<ul style="list-style-type: none"> a. Exhaust manifold. b. Air box. c. Intake manifold. d. Both b and c.

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TROUBLESHOOT INTAKE AND EXHAUST SYSTEM

PERFORMANCE CHECKLIST

INSTRUCTIONS:

The trainee must satisfactorily perform all parts of the task without assistance. Evaluate the trainee's performance using this checklist.

DID THE TRAINEE....?	YES	NO
1. Have equipment and scenario available to perform task		
2. Perform an operational check		
3. Analyze the malfunction		
4. Locate the malfunction		
5. Perform corrective action		
6. Perform an operational check		
7. Document maintenance action on AF Form 719		
8. Comply with all safety requirements		

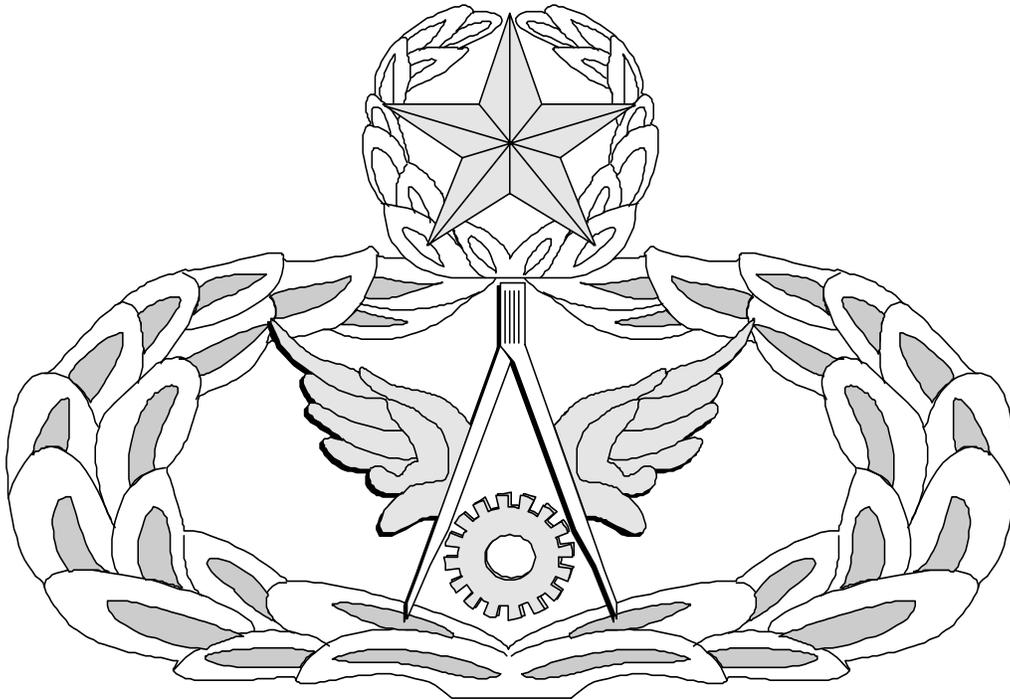
FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

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Air Force Civil Engineer

QUALIFICATION TRAINING PACKAGE (QTP)

REVIEW ANSWER KEY



FOR
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MODULE 23

INTAKE AND EXHAUST SYSTEMS

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Key-1

**TROUBLESHOOT INTAKE AND EXHAUST SYSTEMS
(3E0X2-23.2.)**

QUESTION	ANSWER
1. The primary function of the air intake system is to?	c. Supply the air needed for combustion.
2. The turbocharger is driven by exhaust gases.	a. True.
3. What are two types of air filters?	c. Oil bath/Dry.
4. What item of the exhaust system removes noise?	d. Muffler/Silencer.
5. What item of the intake/exhaust system carries air to the cylinders?	d. Both b and c.

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MEMORANDUM FOR HQ AFCESA/CEOF
139 Barnes Drive Suite 1
Tyndall AFB, FL 32403-5319

FROM:

SUBJECT: Qualification Training Package Improvement

1. Identify module.

Module # and title _____

2. Identify improvement/correction section(s):

_____ STS Task Reference	_____ Performance Checklist
_____ Training Reference	_____ Feedback
_____ Evaluation Instructions	_____ Format
_____ Performance Resources	_____ Other
_____ Steps in Task Performance	

3. Recommended changes--use a continuation sheet if necessary.

4. You may choose to call in your recommendations to DSN 523-6392 or FAX DSN/Commercial 523-6488 or (850) 283-6488 or email ceof.helpdesk@tyndall.af.mil.

5. Thank you for your time and interest.

YOUR NAME, RANK, USAF
Title/Position