

Automotive Engines

Chapter 20 Intake & Exhaust Systems

Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This engine systems course or class provides complete coverage of the components, operation, design, and troubleshooting. It correlates material to task lists specified by ASE and NATEF and emphasizes a problem-solving approach. Chapter features include Tech Tips, Frequently Asked Questions, Real World Fixes, Videos, Animations, and NATEF Task Sheet references.
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge to figure why the engine does not work correctly and how this saves diagnosis time, which translates into more money.
State the learning objectives for the chapter or course you are about to cover and explain this is what they should be able to do as a result of attending this session or class.	Explain the chapter learning objectives to the students as listed on the second SLIDE. <ol style="list-style-type: none">1. Prepare for ASE Engine Performance (A8) certification test content area "C" (Air Induction and Exhaust Systems Diagnosis and Repair).2. Discuss the purpose and function of intake air system components.3. Explain the differences between throttle-body fuel-injection manifolds and port fuel-injection manifolds.4. List the materials used in exhaust manifolds and exhaust systems.5. Describe the purpose and function of the exhaust system components.
Establish the Mood or Climate	Provide a WELCOME , Avoid put downs and bad jokes.
Complete Essentials	Restrooms, breaks, registration, tests, etc.
Clarify and Establish Knowledge Base	Do a round robin of the class by going around the room and having each student give their backgrounds, years of experience, family, hobbies, career goals, or anything they want to share.

ICONS



Chapter 20 Intake & Exhaust Sys.

1. SLIDE 1 CH20 INTAKE & EXHAUST SYSTEMS
2. SLIDES 2-3 EXPLAIN Objectives & KEY TERMS

Check for **ADDITIONAL VIDEOS & ANIMATIONS @**
<http://www.jameshalderman.com/>
WEB SITE IS UPDATED REGULARLY

4. SLIDE 4 EXPLAIN Air Intake Filtration
5. SLIDE 5 EXPLAIN FIGURE 20-1 Downward movement of the piston lowers the air pressure inside the combustion chamber. The pressure differential between the atmosphere and the inside of the engine forces air into the engine.
6. SLIDE 6 EXPLAIN FIGURE 20-2 Dust and dirt in the air are trapped in the air filter so they do not enter the engine.
7. SLIDE 7 EXPLAIN FIGURE 20-3 Most air filter housings are located on the side of the engine compartment and use flexible rubber hose to direct the airflow into the throttle body of the engine.

DISCUSSION: Have your students discuss the pros and cons of not using an air filter on a racing engine.

DEMONSTRATION: Show students a variety of air filters and point out the differences between those used on a carbureted or throttle used for port fuel injection.

Reusable filters that are coated with an oil film can damage some engine sensors and lead to Diagnostic Trouble Codes (DTC).

8. SLIDE 8 EXPLAIN FIGURE 20-4 typical air filter restriction indicator used on a GM truck DIESEL engine. The indicator turns red when it detects enough restriction to require a filter replacement.

HANDS-ON TASK: Have your students apply vacuum to the back of a restriction indicator to observe its operation.

ICONS



Chapter 20 Intake & Exhaust Sys.

9. SLIDE 9 **EXPLAIN TECH TIP**

5. **SLIDE 5 EXPLAIN FIGURE 20-5 (a)** Note the discovery as the air filter housing was opened during service on a Pontiac. The nuts were obviously deposited by squirrels (or some other animal). **(b)** Not only was the housing filled with nuts, but also this air filter was extremely dirty, indicating that this vehicle had not been serviced for a long time.

6. SLIDE 6 **EXPLAIN FREQUENTLY ASKED QUESTION**

7. **SLIDE 7 EXPLAIN FREQUENTLY ASKED QUESTION EXPLAIN FIGURE 20-6** A resonance tube, called a Helmholtz resonator, is used on the intake duct between the air filter and the throttle body to reduce air intake noise during engine acceleration.

Installing an aftermarket air intake without a resonance tube can lead to an increase in induction noise

8. **SLIDE 8 EXPLAIN** Throttle-Body Injection Intake Manifolds & **EXPLAIN FIGURE 20-7** throttle-body injection (TBI) unit used on a GM V-6 engine.

9. **SLIDE 9 EXPLAIN FIGURE 20-8** Heavy fuel droplets separate as they flow around an abrupt bend in an intake manifold

DISCUSSION: Throttle-body injection relies on a manifold with unequal-length runners to distribute fuel from a central location. Have students discuss how this might affect cold-engine drivability and fuel balance between cylinders

10. **SLIDE 10 EXPLAIN** Port Fuel-Injection Intake Manifolds & **EXPLAIN FIGURE 20-9** graph shows effect of sonic tuning of intake manifold runners. The longer runners increase the torque peak and move it to a lower RPM. The 600 mm intake runner is about 24 in. long.

11. **SLIDE 11 EXPLAIN FIGURE 20-10** Airflow through the large diameter upper intake manifold is distributed to smaller diameter individual runners in the

ICONS



Chapter 20 Intake & Exhaust Sys.

lower manifold in this two-piece manifold design.

12. **SLIDE 12 EXPLAIN** FIGURE 20-11 air flowing into the engine can be directed through long or short runners for best performance and fuel economy. **FIGURE 20-12** Many plastic intake manifolds are constructed using many parts glued together to form complex passages for airflow into the engine.

DEMONSTRATION: Show students examples of cast iron, aluminum, and plastic intake manifolds. Be sure to point out differences between TBI & port fuel-injection manifolds.

DISCUSSION: Ask students to discuss how smooth finish of a plastic manifold can help engine performance.

Plastic manifolds are fragile and care must be taken to follow correct tightening sequence and torque specifications. EGR coolers are frequently used on diesel motors.

Show **TBI vs. MPI VIDEO: 2 MINUTES**

www.myautomotivelab.com

http://media.pearsoncmg.com/ph/chet/chet_mylibs/akamai/template/video640x480.php?title=TBI%20Versus%20MPI&clip=pandc/chet/2012/automotive/Installing_EFI_System/T12CD1.mov&caption=chet/chet_mylibs/akamai/2012/automotive/Installing_EFI_System/xml/T12CD1.xml

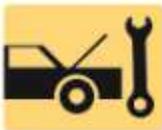
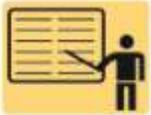
Video shows the installation of an Edelbrock MPI system on a TBI system

ON-VEHICLE TASK: Replace intake manifold gasket

DEMONSTRATION: Demonstrate use of propane to diagnose an intake leak

Many “cold-air” intakes sold through performance companies can actually draw in engine compartment heat if the air box is replaced with an open filter element.

ICONS



Chapter 20 Intake & Exhaust Sys.

18. **SLIDE 18 EXPLAIN** Exhaust Manifolds **FIGURE 20-13** typical long exhaust gas line used to cool exhaust gases before being recirculated back into intake manifold.
19. **SLIDE 19 EXPLAIN FIGURE 20-14** exhaust gases are pushed out of cylinder by piston on exhaust stroke.
20. **SLIDE 20 EXPLAIN** Exhaust Manifolds & **FIGURE 20-15** This exhaust manifold (red area) is equipped with a heat shield to help retain heat and reduce exhaust emissions
21. **SLIDE 21 EXPLAIN FIGURE 20-16** Many exhaust manifolds are constructed of steel tubing and are free flowing to improve engine performance.

DISCUSSION: Ask students to discuss advantages of using stainless steel for exhaust systems

22. **SLIDE 22 EXPLAIN FREQUENTLY ASKED QUESTION**
23. **SLIDE 23 EXPLAIN FREQUENTLY ASKED QUESTION FIGURE 20-17** A crack in an exhaust manifold is often not visible because a heat shield usually covers the area. A crack in the exhaust manifold upstream of the oxygen sensor can fool the sensor and affect engine operation
24. **SLIDE 24 EXPLAIN FIGURE 20-18** Typical exhaust manifold gaskets. Note how they are laminated to allow the exhaust manifold to expand and contract due to heating and cooling.
25. **SLIDE 25 EXPLAIN TECH TIP**
26. **SLIDE 26 EXPLAIN FIGURE 20-19** exhaust manifold spreader tool is absolutely necessary when reinstalling exhaust manifolds. When they are removed from the engine, the manifolds tend to warp slightly even though the engine is allowed to cool before being removed. The spreader tool allows the technician to line up the bolt holes without harming the manifold

HANDS-ON TASK: Have students remove and install an exhaust manifold.

ICONS

DEMO



Chapter 20 Intake & Exhaust Sys.

DEMONSTRATION: Show students correct use of an exhaust manifold spreader

HANDS-ON TASK: Have students practice using a manifold spreader, noting change in port position with a Vernier Caliper.

ON-VEHICLE TASK: EXHAUST SYSTEM INSPECTION

27. **SLIDE 27 EXPLAIN** Mufflers & **EXPLAIN FIGURE 20-20** Exhaust gases expand and cool as they travel through passages in the muffler.
28. **SLIDE 28 EXPLAIN FREQUENTLY ASKED QUESTION**
29. **SLIDE 29 EXPLAIN FREQUENTLY ASKED QUESTION FIGURE 20-21** hole in the muffler allows condensed water to escape.
30. **SLIDE 30 EXPLAIN TECH TIP**
31. **SLIDE 31 EXPLAIN FIGURE 20-22** high-performance aftermarket air filter often can increase airflow into the engine for more power.

HOMEWORK: SEARCH INTERNET:

Have students research the use of tuned intakes for racing use. Students should pick a specific application and present their findings to the class.

Talk through **SUMMARY** and questions

HOMEWORK: complete Ch20 crossword puzzle:
http://www.jameshalderman.com/links/book_engine_theory_serv_7/cw/crossword_ch_20.pdf

