

Automotive Technology 5th Edition

Chapter 21 Cooling System Operation & Diagnosis

Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This Automotive Technology 5 th text provides complete coverage of automotive 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: <ol style="list-style-type: none"> 1. Explain the purpose and function of the cooling system, and cooling system operation. 2. Explain the purpose and function of thermostats, radiators, and pressure caps. 3. Explain coolant flow in the engine, water pumps, and coolant recovery systems. 4. Explain the purpose and function of cooling fans and heater cores. 5. Describe cooling system testing and explain the purpose of coolant temperature warning light. 6. Explain cooling system inspection and cooling system service.
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.

NOTE: This lesson plan is based on the 5th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

LINK CHP 21: [ATE5 Chapter Images](#)

ICONS



CH21 Cooling System Operation & Diagnosis

1. SLIDE 1 CH21 COOLING SYSTEM OPERATION

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

Cooling System Videos

2. **SLIDE 2 EXPLAIN** Figure 21-1 Typical combustion and exhaust temperatures.

Coolant Replacement (View) (Download)

Cooling System Heat Store (View) (Download)

DISCUSSION: Have students discuss heat generated in an engine. Ask: "If one-third of the heat is removed through the cooling system, and one-third is removed through the exhaust system, what is the other one-third used for?" (Answer: Pushing pistons down.)

Engines that do not reach proper operating temperature may leave water in oil, which cause engine bearing failure.

DISCUSSION: Discuss with students how improper coolant temperature can harm fuel economy. Why does temperature affect fuel economy? (ANS: Changes fuel vaporization rate)

3. **SLIDE 3 EXPLAIN** Figure 21-2 Coolant circulates through water jackets in engine block and cylinder head.

4. **SLIDE 4 EXPLAIN** Figure 21-3 Coolant flow through a typical engine cooling system

DISCUSSION: Discuss reasons that older engines were less likely to have engine failure from overheating. (Steel blocks and heads displaced heat better & able to take higher temperatures without damage due to amount of metal.)

ICONS



QUESTION



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[Coolant Flow-World Engine \(View\) \(Download\)](#)

[Coolant Replacement \(View\) \(Download\)](#)

DEMONSTRATION: Show students a bypass hose and where it is located on different engines.











DISCUSSION: Discuss with students why the bypass hose is so important. Why is it important? (ANS: Allows for rapid engine warm up)

ON-VEHICLE NATEF Task: Research applicable vehicle and service information, vehicle service history, service precautions, and technical service bulletins (P-1), P.47

5. **SLIDE 5 EXPLAIN Figure 21-4** A cross section of a typical wax-actuated thermostat showing the position of the wax pellet and spring.
6. **SLIDE 6 EXPLAIN Figure 21-5 (a)** When the engine is cold, the coolant flows through the bypass. **(b)** When the thermostat opens, the coolant can flow to the radiator.
7. **SLIDE 7 EXPLAIN Figure 21-6** A thermostat stuck in open position caused engine to operate too cold. If a thermostat is stuck closed, this can cause engine to overheat.
8. **SLIDE 8 EXPLAIN Figure 21-7** This internal bypass passage in the thermostat housing directs cold coolant to the water pump.
9. **SLIDE 9 EXPLAIN Figure 21-8** cutaway of a small block Chevrolet V-8 showing passage from cylinder head through the front of the intake manifold to the thermostat.
10. **SLIDE 10 EXPLAIN Figure 21-9** Checking opening temperature of a thermostat.

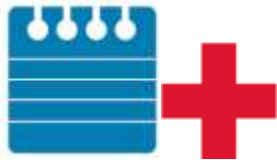
Removing a thermostat may cause overheating issues because coolant flows so quickly that it cannot absorb the heat.

11. **SLIDE 11 EXPLAIN Figure 21-10** Some thermostats are an integral part of housing. This thermostat and radiator hose housing is serviced as assembly. Some thermostats snap into engine radiator fill tube underneath pressure cap.

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         	<p>When checking a thermostat for an overheating condition, be sure the thermostat is installed correctly.</p> <p>Thermostat Electric Assist (View) (Download) Thermostat Operation (View) (Download)</p> <p><u>DISCUSSION:</u> Discuss with students the 3 methods of testing thermostats & positive and negatives of each.</p> <p><u>DEMONSTRATION:</u> Using the hot water method, show how a thermostat opens and closes.</p> <p><u>HANDS-ON TASK:</u> Have students perform thermostat testing using at least one of 3 methods listed in the text on page 185 of Chapter 21. When replacing thermostat, be sure sensing pellet is facing engine block.</p> <p><u>ON-VEHICLE NATEF TASK:</u> Inspect, test, remove and replace thermostat and gasket/seal. (P-1) page 52</p> <ol style="list-style-type: none"> 12. SLIDE 12 EXPLAIN Figure 21-11 tubes and fins of radiator core. 13. SLIDE 13 EXPLAIN Figure 21-12 radiator may be either a down-flow or a crossflow type. 14. SLIDE 14 EXPLAIN Figure 21-13 Many vehicles equipped with automatic transmission use a transmission fluid cooler installed in one of radiator tanks. <p>Older steel radiators could often be repaired. Most newer radiators cannot be repaired, due to cost, & must be replaced</p> <p><u>DEMONSTRATION:</u> Show students different styles of radiators.</p>

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DISCUSSION: Discuss importance of heat transfer. What are the 3 forms of heat transfer from Physics Class? (**ANS:** Conductance, Convection, & Radiation. Radiators despite their name, generally transfer the bulk of their heat via convection, not by thermal radiation. **Convection** is transfer of heat from one place to another by movement of fluids. Convection is usually dominant form of heat transfer in liquids and gases)

ON-VEHICLE NATEF TASK: Remove and replace radiator (P-2) Page 53

15. **SLIDE 15 EXPLAIN** Figure 21-14 pressure valve maintains system pressure and allows excess pressure to vent. The vacuum valve allows coolant to return to the system from the recovery tank.

SAFETY TIP: Always remove a pressure cap slowly using rags or heavy gloves for protection. A hot cooling system can spray coolant or steam under pressure. Even a cold system may have pressure that can spray coolant into eyes or damage paint. Overheating transmissions can cause engine overheating issues.

DEMONSTRATION: Demonstrate how a pressure cap vents at the pressure listed.

16. **SLIDE 16 EXPLAIN** Figure 21-15 level in the coolant recovery system raises and lowers with engine temperature.

17. **SLIDE 17 EXPLAIN** Figure 21-16 Some vehicles use a surge tank, which is located at the highest level of the cooling system, with a radiator cap.

Pressure Cap Operation (View) (Download)

Water Pump Operation (View) (Download)

ICONS



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DEMONSTRATION: Show students different types of coolant recovery bottles

DISCUSSION: Discuss with students why the recovery bottle is important to longevity of the cooling system's effectiveness.

Collapsed hoses may be caused by pressure cap not venting correctly.

ON-VEHICLE NATEF Task: Inspect and replace engine cooling and heater system hoses (P-1) Page 51

18. **SLIDE 18 EXPLAIN Figure 21-17** Coolant flow through impeller & scroll of coolant pump for a V-type
19. **SLIDE 18 EXPLAIN FIGURE 21-18 DEMO** engine running on a stand, showing the amount of coolant flow that actually occurs through cooling system.
20. **SLIDE 20 EXPLAIN Figure 21-19** This severely corroded water pump could not circulate enough coolant to keep the engine cool. As a result, the engine overheated and blew a head gasket.
21. **SLIDE 21 EXPLAIN Figure 21-20** bleed weep hole in the water pump allows coolant to leak out of the pump and not be forced into the bearing. If the bearing failed, more serious damage could result.
22. **SLIDE 22 EXPLAIN Figure 21-21** cutaway of a typical water pump showing the long bearing assembly and the seal. The weep hole is located between the seal and the bearing. If the seal fails, then coolant flows out of weep hole to prevent the coolant from damaging the bearing.

On vehicles that use a timing belt to run water pump, it is strongly recommended that the water pump be replaced when the timing belt is replaced.

DISCUSSION: Discuss water pump operation with students

ICONS

DEMO



DEMO



DEMO



DEMO

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DEMONSTRATION: Show students different variations of a water pump.

[Pressure Cap Operation \(View\) \(Download\)](#)
[Water Pump Operation \(View\) \(Download\)](#)

DEMONSTRATION: Show students water pump weep hole.

Be sure to install the serpentine belt correctly when replacing water pump; otherwise, pump may turn backwards.

ON-VEHICLE NATEF Task: Inspect, test, remove, and replace water pump. (P-1) PAGE 75

23. **SLIDE 23 EXPLAIN** Figure 21-22 Chevrolet V-8 block that shows the large coolant holes and the smaller gas vent or bleed holes that must match the head gasket when the engine is assembled.

DISCUSSION: Discuss with students differences in coolant flow systems.

DEMONSTRATION: Show students different head gasket designs and the coolant passages through them.

24. **SLIDE 24 EXPLAIN** Figure 21-23 typical electric cooling fan assembly showing the radiator and related components.

25. **SLIDE 25 EXPLAIN** Figure 21-24 A typical engine-driven thermostatic spring cooling fan.

SAFETY: Electrical cooling fans can come on unexpectedly. Always keep hands and objects clear of them. Spring-type fans should spin freely on a cold engine.

DEMONSTATION: Show students how to remove and replace a cooling fan assembly.

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DEMO



DEMO



ON-VEHICLE NATEF TASK: Inspect and test fans(s) (electrical or mechanical), fan clutch, fan shroud, and air dams. (P-1) Page 54

DEMONSTRATION: Show students how fan shroud helps direct airflow through radiator.

26. **SLIDE 26 EXPLAIN Figure 21-25** A typical heater core installed in a heating, ventilation, and air-conditioning (HVAC) housing assembly

DEMONSTRATION: Show students examples of heater cores and their locations.

Coolant on the passenger floor or a mist out of the vents may be caused by a leaking heater core.















Some vehicles, especially hybrids, use a form of electrical heater core

27. **SLIDE 27 EXPLAIN Figure 21-26** heavily corroded radiator from a vehicle that was overheating. A visual inspection discovered that the corrosion had eaten away many of the cooling fins, yet did not leak. This radiator was replaced and it solved the overheating problem.

If using a dye to leak test, it may be necessary to remove the blower resistor to access the heater core for inspection.

28. **SLIDE 28 EXPLAIN Figure 21-27** Pressure testing cooling system. Hand operated pressure tester applies pressure equal to radiator cap pressure. The pressure should hold; if it drops, this indicates a leak somewhere in cooling system. An adapter is used to attach pump to cap to determine if radiator can hold pressure, & release it when pressure rises above max rated pressure setting.

29. **SLIDE 29 EXPLAIN Figure 21-28** pressure cap should be checked for proper operation using a pressure tester as part of the cooling system diagnosis.

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 	<p><u>ON-VEHICLE NATEF TASK (A1D3)</u> Perform cooling system pressure tests; determine necessary action (P-1), Page 34</p>
	<p><u>ON-VEHICLE NATEF TASK (A1A2)</u> Identify and interpret engine concern; determine necessary action (P-1), Page 46</p>
	<p><u>DISCUSSION:</u> Discuss with students how incorrect ignition timing can cause overheating issues (i.e., cause a lean condition, which leads to the engine running at hotter temperatures.)</p>
 	<p><u>ON-VEHICLE NATEF TASK (A1-D-14)</u> Identify causes of engine overheating (P-1) Page 55</p>
	<p>30. SLIDE 30 EXPLAIN Figure 21-29 Use dye specifically made for coolant when checking for leaks using a black light.</p>
	<p><u>DEMONSTRATION:</u> Show students how dye illuminates with a black light.</p>
	<p>31. SLIDE 31 EXPLAIN Figure 21-30 When an engine overheats, often the coolant overflow container boils.</p>
	<p>32. SLIDE 32 EXPLAIN Figure 21-31 Typical marks on an accessory drive belt tensioner.</p>
	<p><u>DEMONSTRATION:</u> Show students proper procedure for using a belt tension gauge.</p>
 	<p><u>ON-VEHICLE NATEF TASK (A1-D-4)</u> Inspect, replace, and adjust drive belts, tensioners and pulleys; check pulley and belt alignment (P-1) Page 50</p>
	<p>33. SLIDE 33 EXPLAIN Figure 21-32 (a) Many vehicle manufacturers recommend that the bleeder valve be opened whenever refilling the cooling system. (b) Chrysler recommends that a clear plastic hose (1/4 in. ID) be attached to the bleeder valve and directed into a suitable container to keep from spilling coolant onto the</p>

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ground and on the engine and to allow the technician to observe the flow of coolant for any remaining oil bubbles.

34. **SLIDE 34 EXPLAIN Figure 21-33** Using a coolant exchange machine helps eliminate the problem of air getting into the system which can cause overheating or lack of heat due to air pockets getting trapped in the system.

DISCUSSION: Discuss proper coolant disposal procedures.

DEMONSTRATION: Show students proper procedure for using a coolant exchange machine.

Air pockets around thermostat can cause thermostat to malfunction, causing an overheating condition.

35. **SLIDE 35 EXPLAIN Figure 21-34** All cooling system hoses should be checked for wear or damage.

DEMONSTRATION: Show students where radiator petcock is located and how to properly open and close it without breaking it.


DEMONSTRATION: Show students different types of heater hoses.

When checking radiator hoses, remember that the bottom hose may have a spring inside to keep it from collapsing.

HANDS-ON TASK: Have students remove and replace a radiator hose.

HOMEWORK: Have students research the Internet and find out how hybrid vehicles keep the engine coolant warm even though the engine is not always running. Have them report their findings to the class.



ICONS	CH21 Cooling System Operation & Diagnosis
	<u>HOMEWORK</u> <u>CROSSWORD PUZZLE (MICROSOFT WORD) (PDF)</u> <u>WORD SEARCH PUZZLE (MICROSOFT WORD) (PDF)</u>

Crossword