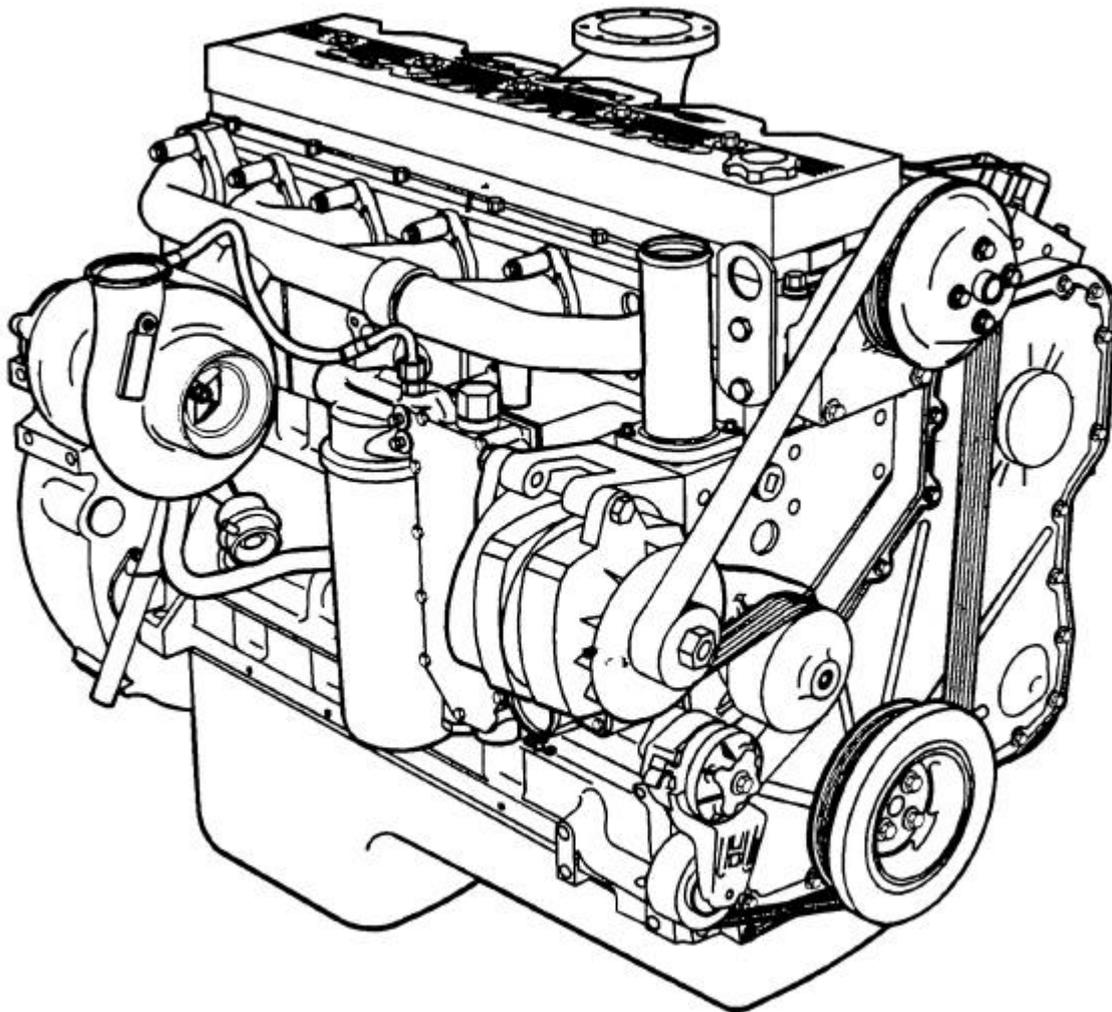


Operation and Maintenance Manual

6IRQ9AE



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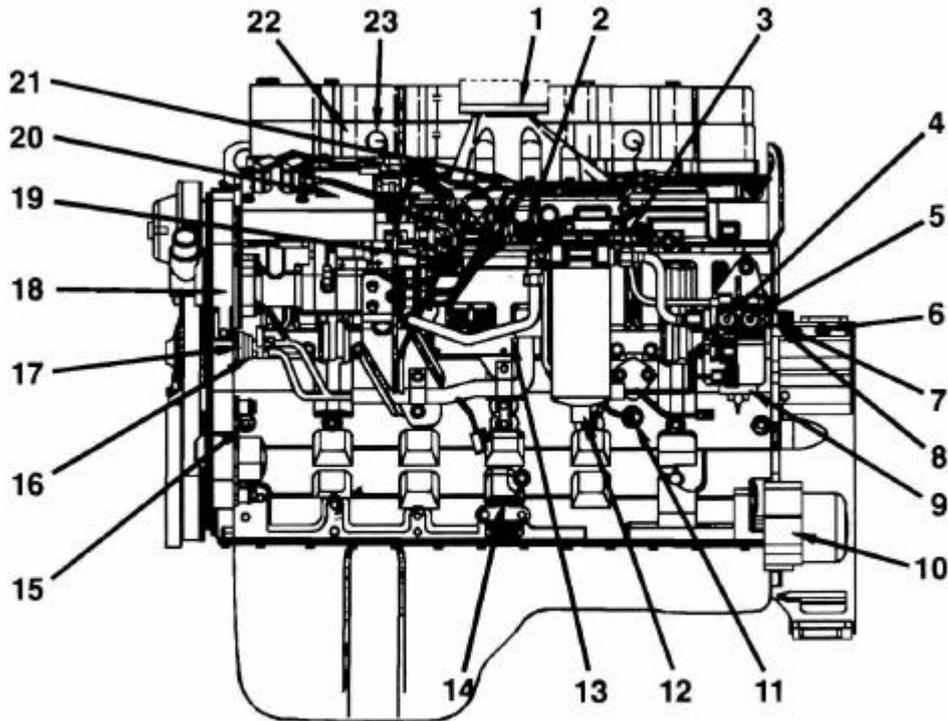
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ENGINE DIAGRAMS

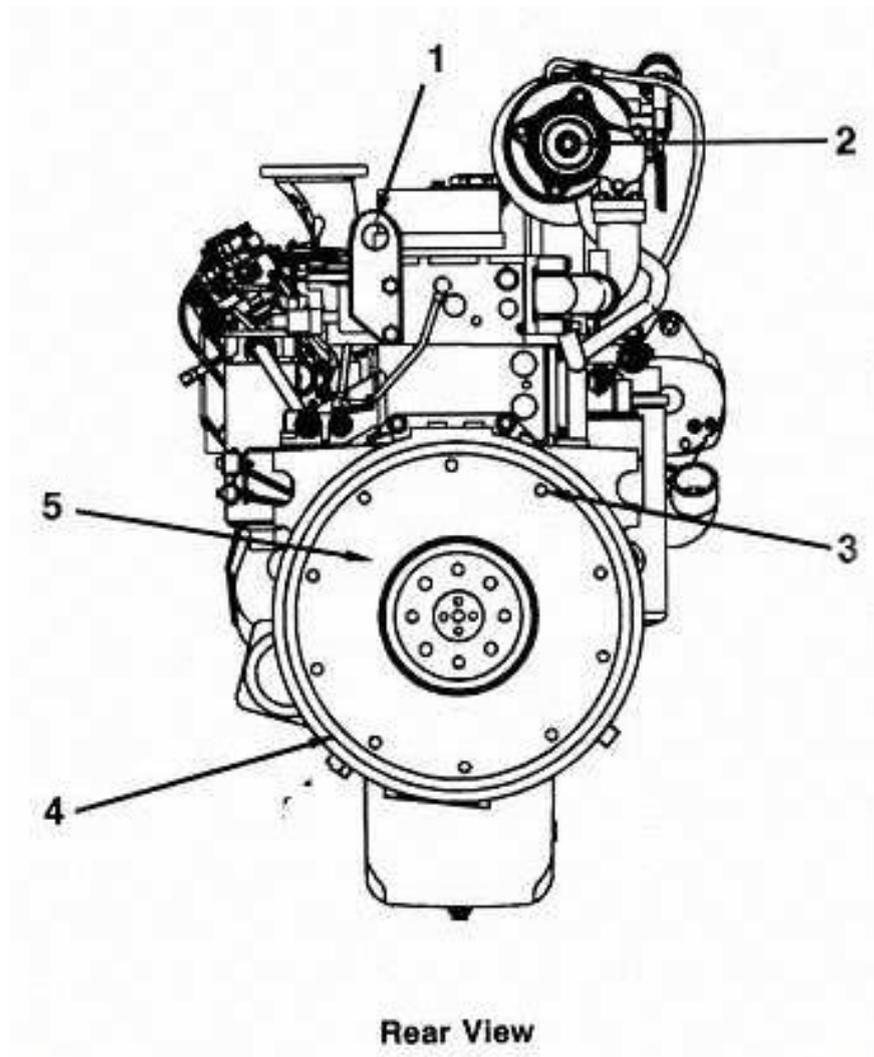
Engine Views

The following illustrations provide the locations of the major external engine components, filters, and other service and maintenance points.

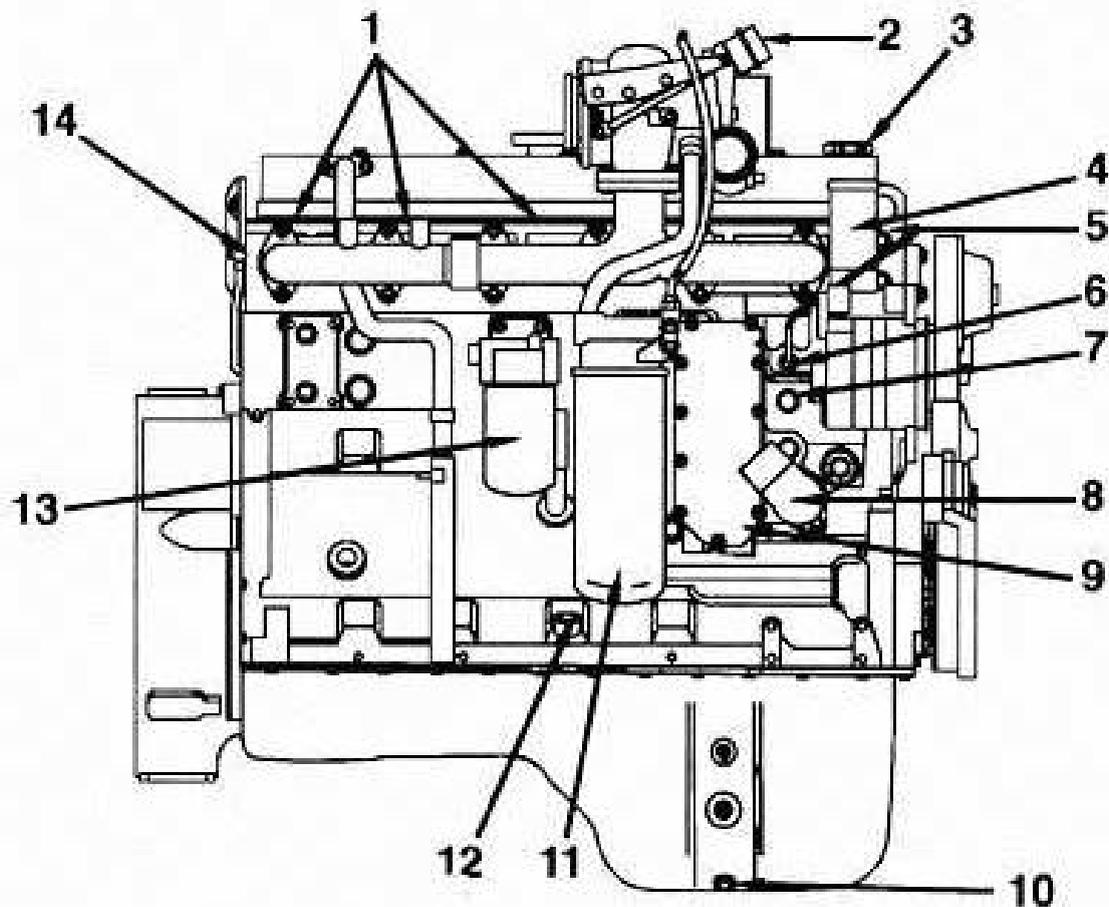


Fuel Pump Side View

- | | |
|--|---|
| 1. Engine air inlet | 13. Electronic Control Module (ECM) |
| 2. Intake manifold pressure sensor | 14. Dipstick Location |
| 3. Intake manifold temperature sensor | 15. M10 (STOR) Oil Pressure Point |
| 4. M10 (STOR) fuel pressure after-lift pump | 16. Engine Position Sensor (EPS) - (Inboard) |
| 5. M10 (STOR) fuel pressure before-lift pump | 17. Engine Position Sensor (EPS) - (Outboard) |
| 6. Magnetic pickup location 3/4-16 UNF | 18. Engine Dataplate |
| 7. Fuel Return Connection | 19. High-pressure fuel lines |
| 8. Fuel Inlet Connection | 20. Injection Pump |
| 9. Fuel Lift Pump | 21. Intake Air Heater |
| 10. Starter Mounting Flange | 22. Engine Brake Spacer |
| 11. Oil Pressure Sensor | 23. Engine Brake Harness – Pass through |
| 12. Fuel Filter/ Water Separator | |

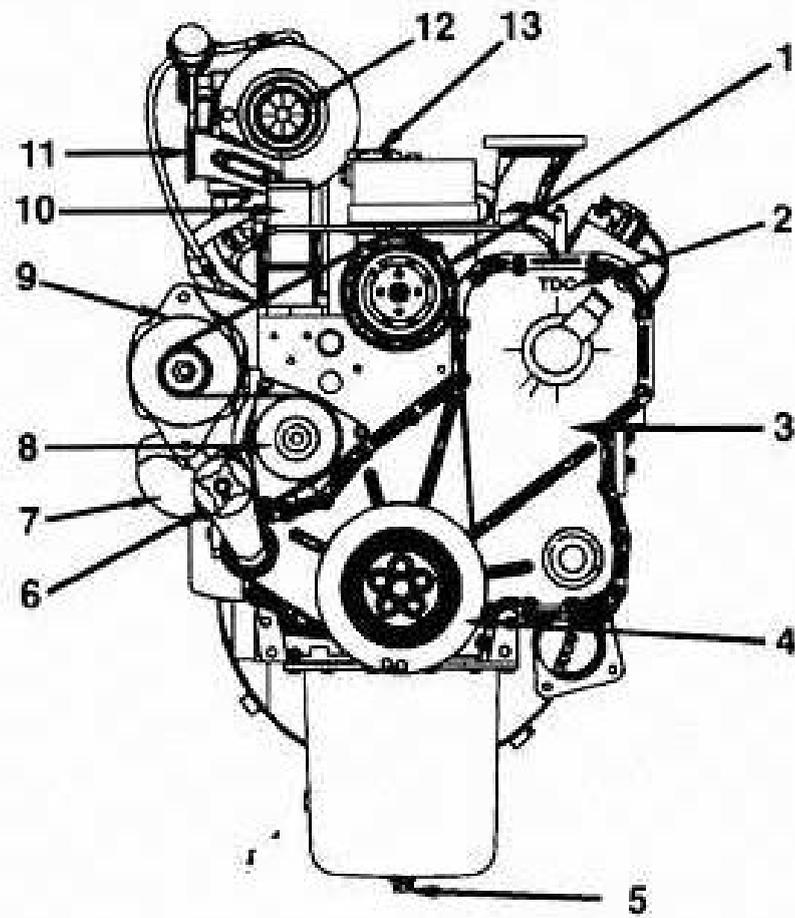


1. Rear engine lifting bracket
2. Turbocharger exhaust outlet
3. Clutch mounting holes
4. Flywheel housing
5. Flywheel



Exhaust Side View

- | | | | |
|----|---------------------------------|-----|---------------------------------------|
| 1. | 1/2-inch (NPTF) coolant taps | 8. | Coolant inlet |
| 2. | Turbocharger wastegate actuator | 9. | Lubricating oil cooler |
| 3. | Engine oil Fill | 10. | Engine oil pan drain plug |
| 4. | Coolant outlet | 11. | Lubricating oil filter |
| 5. | Front engine lifting bracket | 12. | Dipstick location |
| 6. | Coolant temperature sensor | 13. | Coolant filter |
| 7. | Coolant heater port | 14. | Injector drain fuel outlet connection |



Front View

- | | |
|-------------------------------|-----------------------------|
| 1. Fan pulley | 8. Water pump |
| 2. Top dead center (TDC) mark | 9. Alternator |
| 3. Front gear cover | 10. Water outlet |
| 4. Vibration damper | 11. Turbocharger air outlet |
| 5. Engine oil pan drain plug | 12. Turbocharger air inlet |
| 6. Automatic belt tensioner | 13. Engine oil fill |
| 7. Water inlet | |

Operating Instructions

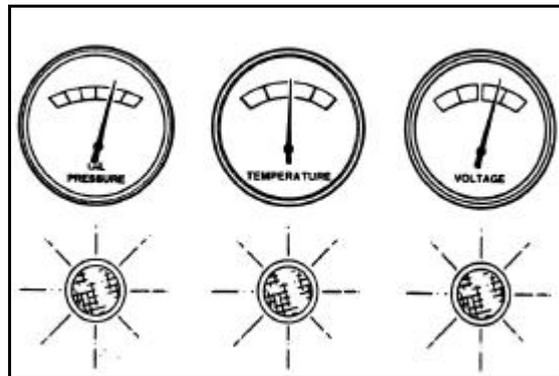
General Information

Ingersoll Rand does not know how you will use your compressor. The equipment owner and operator, therefore, is responsible for the safe operation in a hostile environment. Consult your local authorized Ingersoll Rand service distributor for further information.

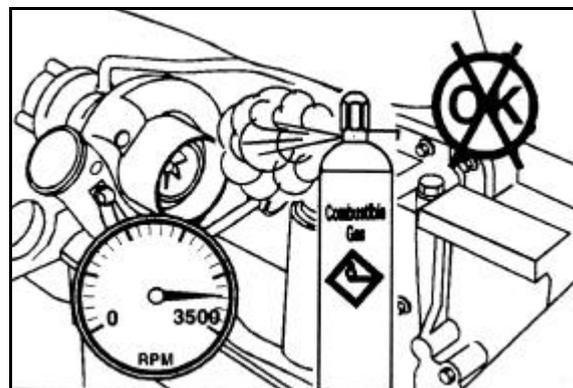
Correct care of the engine will result in longer life, better performance, and more economical operation.

- Always follow the daily maintenance checks.
- Avoid exposing the compressor to corrosive chemicals.

Check the oil pressure indicator, temperature indicator, warning lights, and other gauges daily to make sure that they are operational.



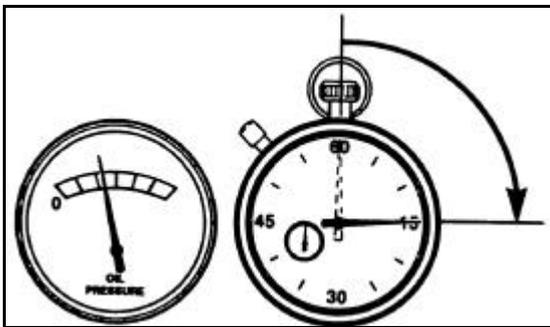
Do not operate the compressor where there are or can be combustible vapours. These vapours can be sucked through the air intake system and cause engine acceleration and over-speeding, which can result in a fire, an explosion, and extensive damage to the unit.



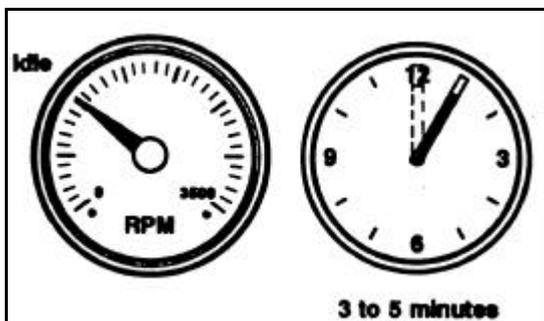
Normal Starting Procedure

To prevent damage to the starter motor, do not engage the starter motor for more than 30 seconds, Wait at least 1 minute between each attempt to start.

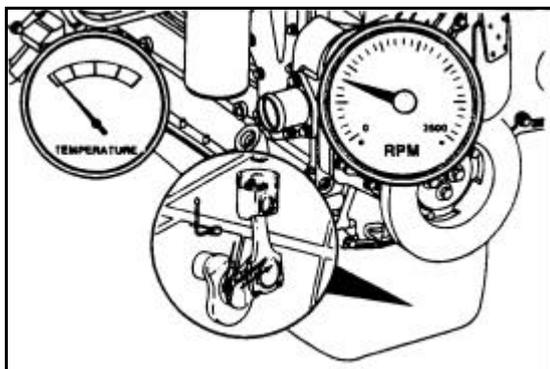
- If the engine does not start after three attempts, check the fuel supply system. An absence of blue or white exhaust smoke during cranking indicates that no fuel is being delivered to the combustion chambers.



The engine must have adequate oil pressure within 15 seconds after starting. If the WARNING lamp indicating low oil pressure has not extinguished, or there is no oil pressure indicated on the gauge within 15 seconds, shut off the engine immediately to avoid engine damage. Confirm the correct oil level in the sump.

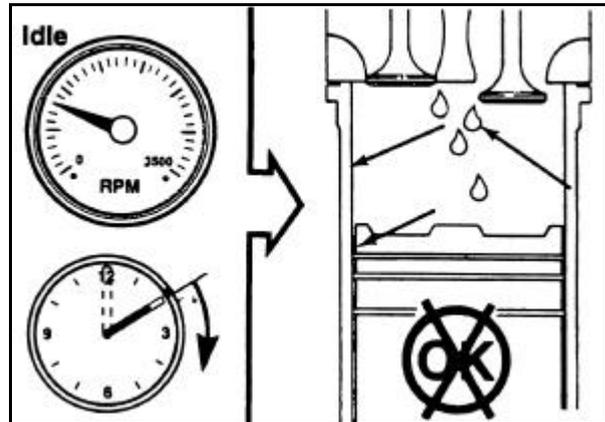


Idle the engine for 3 to 5 minutes before operating the compressor with a load.



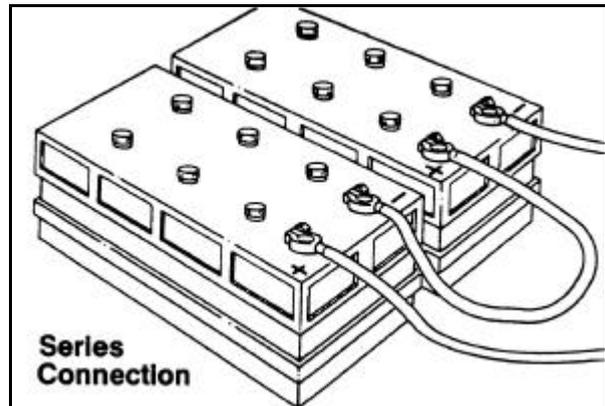
Try to load the compressor slowly to provide adequate lubrication to the bearings and to allow the oil pressure to stabilise.

Do not keep the engine at low idle for long periods. Long periods at low idle, more than 10 minutes, can damage an engine because the combustion chamber temperatures can drop so low that the fuel will not burn completely. This will cause carbon to build up around the injector spray holes and piston rings, which can cause the valves to stick.



Batteries can emit explosive gases. To avoid personal injury, always ventilate the battery compartment before servicing the batteries. To avoid arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.

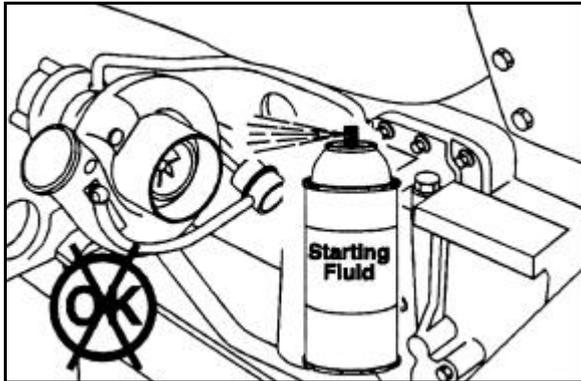
To avoid damage to the 6IRQ9AE engine parts, do not connect jumper starting or battery charging cables to any 6IRQ9AE parts. When using an external electrical source to start the engine, turn the disconnect switch to the OFF position.



The illustration opposite shows a typical series battery connection as used Ingersoll Rand 24 volt systems.

This arrangement, positive (+) to negative (-), doubles the voltage.

Cold Weather Starting & Operation

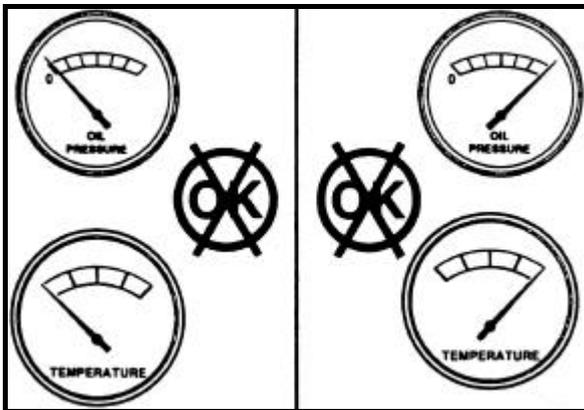


ETHER STARTING AIDS

To avoid personal injury and property damage, never use starting fluid if the grid heater is being used. Starting fluid, which contains ether, can cause an explosion.

GENERAL INFORMATION

Continuous operation with low coolant temperature, below 60°C (140°F), or a high coolant temperature, above 100°C (212°F), can damage the engine.

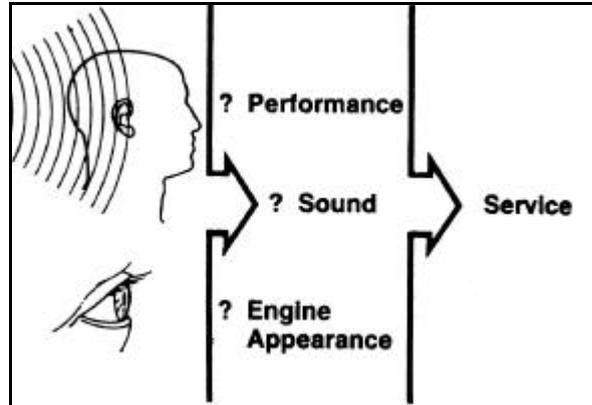


Monitor the oil pressure and coolant temperature gauges frequently. Refer to *Lubricating Oil System Specifications* for recommended operating pressures and temperatures. Shut off the compressor if any pressure does not meet the specifications.

If an overheating condition starts to occur, reduce to load on the engine by closing

Most failures give an early warning. Look and listen for changes in performance, sound or engine appearance that can indicate service or engine repair is needed. Some changes to look for are as follows:-

- Engine misfires
- Vibration
- Unusual engine noises
- Sudden changes in engine operating temperatures
- Excessive smoke
- Loss of power
- An increase in oil consumption
- An increase in fuel consumption
- Fuel, oil, or coolant leaks.



COLD WEATHER OPERATION

It is possible to operate diesel engines in extremely cold environments if they are properly prepared and maintained. The correct lubricants, fuels, and coolants **must** be used for the cold weather range in which the compressor is operated.

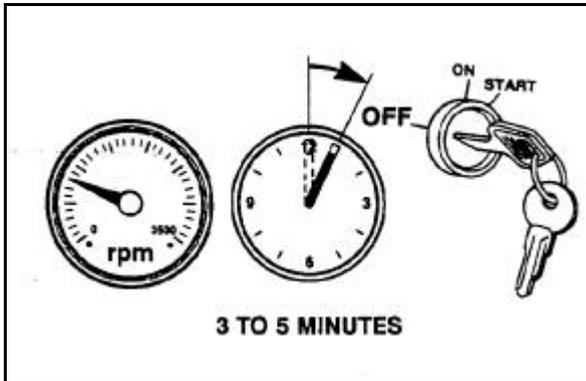
Winterise -32°C to 0°C (-26°F to 32°F)

Use 50 percent ethylene glycol or propylene glycol antifreeze and 50 percent water in the coolant mixture.

Use multiviscosity oil meeting API CG-4 or CH-4 specifications.

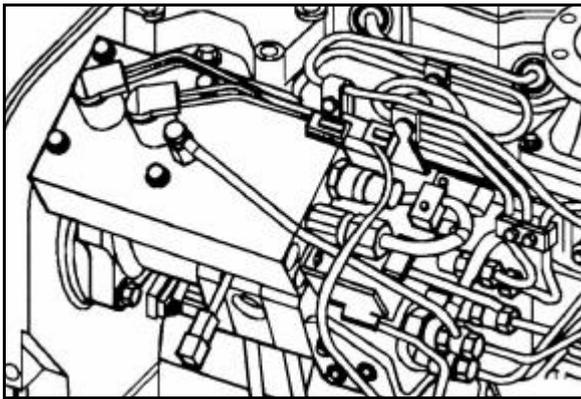
Fuel to have maximum cloud and pour points 6°C (43°F) lower than ambient temperature in which the compressor operates.

ENGINE SHUTDOWN



- Allow the engine to idle for 3 to 5 minutes after a full load operation before shutting it off. This allows the engine to cool gradually and uniformly.
- Turn the ignition keyswitch to the OFF position.

ELECTRONIC CONTROLLED FUEL SYSTEM

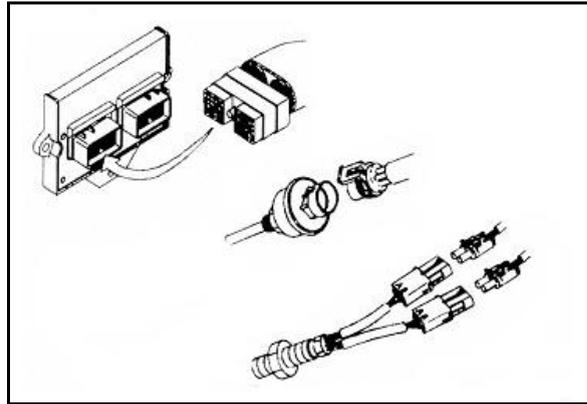


The Ingersoll-Rand 6IRQ9AE engine control System is electronically controlled and also provides many unit features.

The basic functions of the control system include fuelling and timing control, limiting of engine speed operating range between low and high idle set points and re-introducing exhaust emissions while optimising engine performance.

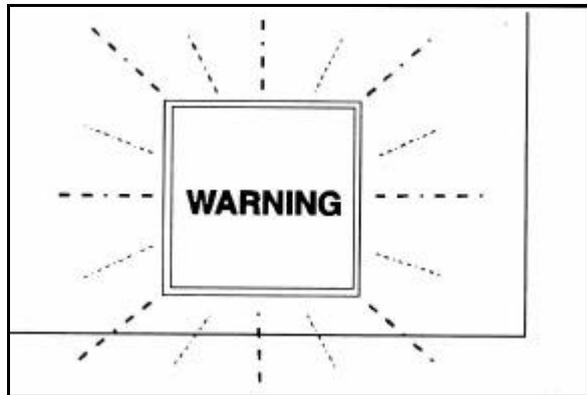
The control system uses inputs from the operator and engine sensors to determine the fuelling and timing required to operate the desired engine speed.

The electronic control module (ECM) is the control centre of the system. It processes all of the inputs and sends commands to the fuel system and engine control devices.



The electronic control module (ECM) performs diagnostic tests on most of its circuits and will activate a fault code if a problem is detected in one of these circuits. Along with the fault code identifying the problem, a snapshot of the engine operating parameters at the time of the fault activation is stored in memory.

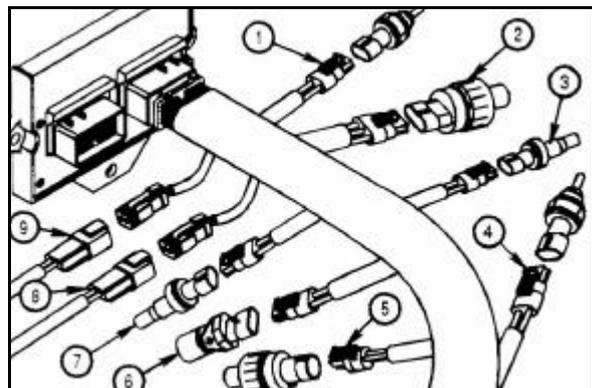
Most fault codes will activate a diagnostic lamp to signal the driver.

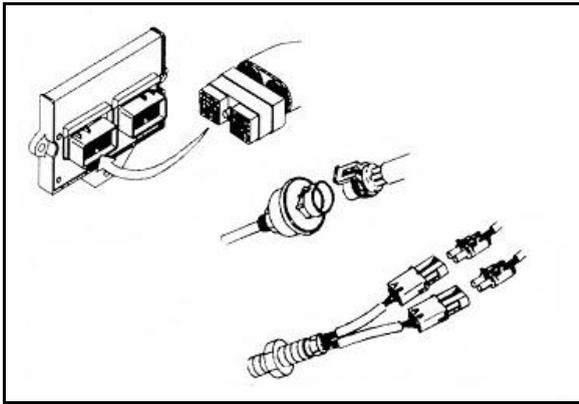


Operating Instructions

The control system utilises a number of sensors to provide data on engine parameters. These sensors include the following: -

1. Coolant temperature sensor
2. Oil pressure sensor
3. Accumulator Pump System fuel pressure sensor
4. Intake air temperature sensor
5. Intake manifold pressure sensor
6. Engine speed and position sensors
7. Fuel temperature sensor
8. Injection control valve (ICV)
9. Pumping control valves (PCV's)



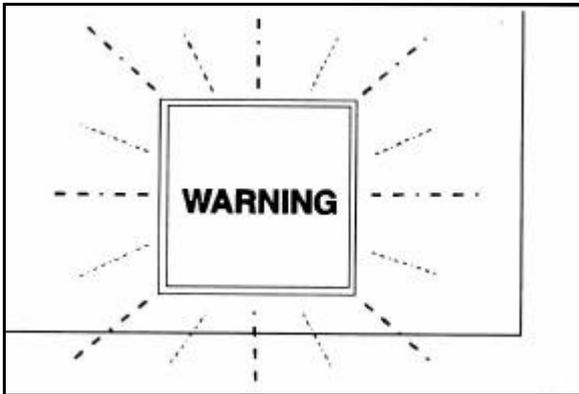


Engine Protection System

The 6IRQ9AE Engine is equipped with an engine protection system. The system monitors critical engine temperatures and pressures, and it will log diagnostic faults if an over or under normal operating condition occurs. If an out-of-range condition exists, and engine derate action is initiated, the operator will be alerted by a warning lamp. The warning lamp will blink or flash if the condition worsens.

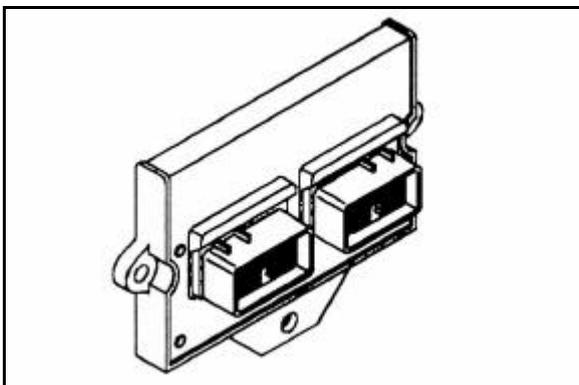
The engine protection system monitors the following data: -

- Coolant temperature
- Coolant level
- Oil pressure
- Intake manifold temperature
- Engine overspeed
- Fuel temperature



NOTE: Engine power and speed will gradually reduce depending on the severity of the observed condition.

The engine protection system will not shut down the engine unless the engine protection shutdown feature has been enabled.

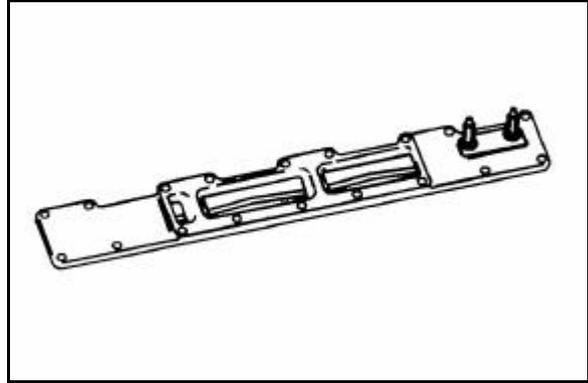


Basic Features

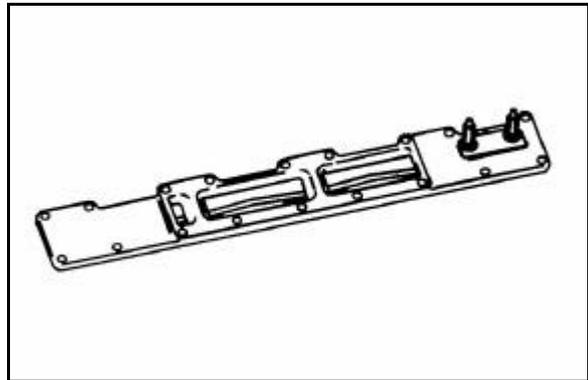
The electronic control module (ECM) for the 6IRQ9AE engine provides some basic electronic features that are calibration dependent. The following section describes the function of each feature. Whether a feature is available in a given application is calibration dependent.

Intake Air Heater

This feature controls the heating elements that are located in the engine intake air stream. These elements heat the intake air when starting the engine in cold ambient conditions. Start ability and white smoke control is enhanced by the use of an air intake heater. A WAIT TO START lamp is located on the operator's controls to indicate when to crank the engine.



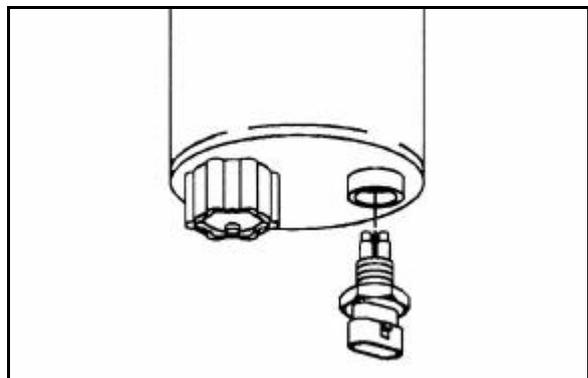
The ECM checks the intake manifold temperature to determine how long to energise the air heater before extinguishing the WAIT TO START lamp. (This is for the pre-heat phase).

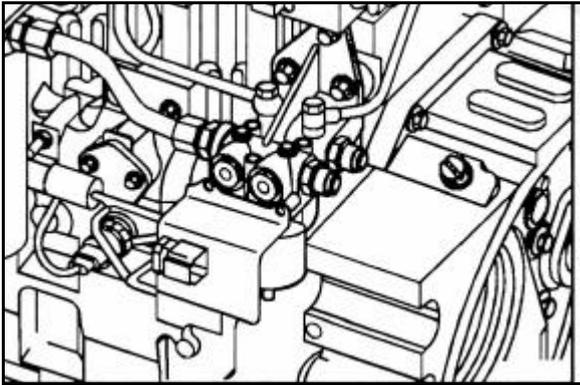


Once again the engine is started, the heater will be energised again for a period determined by air intake temperature and fuel temperature (This is for the post-heat phase). To minimise the cranking time in cold weather, the engine can not be started until the WAIT TO START lamp is extinguished.

Water – in – Fuel Sensor

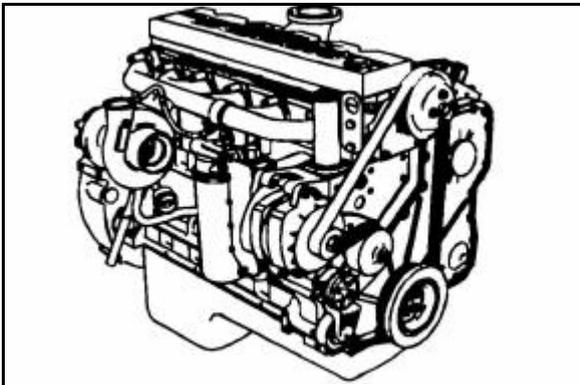
This sensor is located in the canister of the fuel filler housing. Once the storage space in the bottom of the filter housing fills with a certain amount of water, the sensor will signal the ECM. A WATER IN FUEL lamp will illuminate at the operator controls indicating the water needs to be drained from the fuel filter assembly.





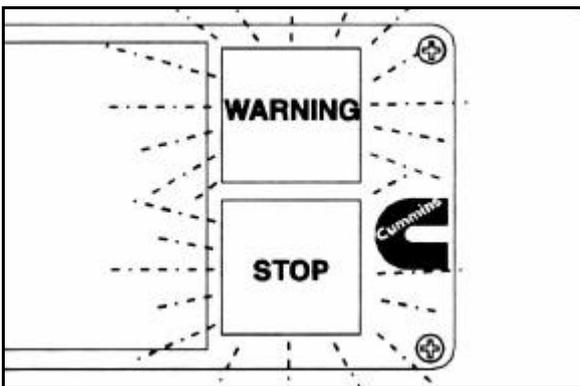
Electric Lift Pump

The ECM controls the electric lift pump (located between the fuel tank and the injection pump) When the keyswitch is turned on, the lift pump will be energised for 30 seconds to make sure that the low pressure lines are fully primed. The electric lift pump does not start again unless the keyswitch is cycled off for 30 seconds allowing the ECM to power down and cycle back on.



Engine Warm-up Protection

This feature inhibits the throttle, datalink control, and intermediate speed control switches to keep the engine at low idle for a brief time after the engine starts or until adequate oil pressure is obtained. This allows oil to reach all the critical engine components before the engine speed is increased above low idle.



Engine Protection Shutdown

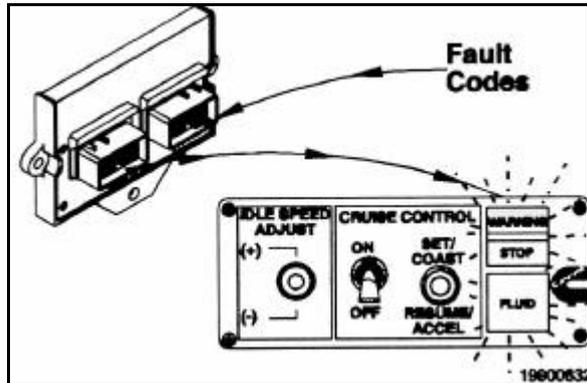
This feature automatically shuts off the engine when the temperature, pressure or coolant sensors indicate that the engine is operating over or under normal operating conditions.

The red STOP lamp will flash for 30 seconds prior to shutdown to alert the operator.

Diagnostic Fault Codes

The 6IRQ9AE Control system can show and record operation anomalies that present themselves as fault codes. These codes will make troubleshooting easier. The fault codes are recorded in the ECM. They can be read using the fault lamps in the control panel or with using the N-SITE service tool.

NOTE: Not all 6IRQ9AE Control system anomalies are shown as fault codes.

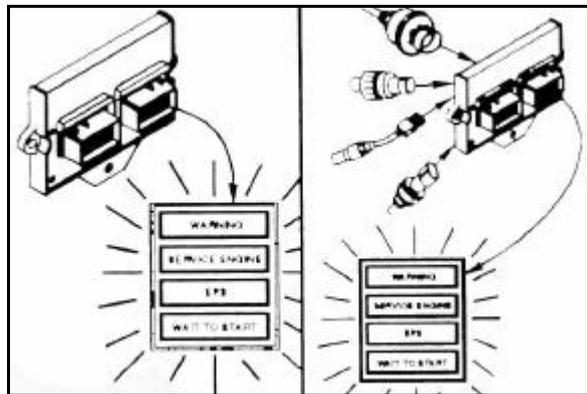


There are three types of system codes:

- Engine electronic control system faults codes
- Engine protection system fault codes
- Engine maintenance indicator codes.

All fault codes recorded with either be active (fault code is currently active on the engine) or inactive (fault code was active at some time but at the moment is NOT active)

Most, but not all, of the electronic fault codes will light a lamp on the Wedge controller when they are active.



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Maintenance Guidelines

General Information

Ingersoll Rand Company Ltd. Recommends that the engine be maintained according to the Maintenance Schedule in this section.

If the engine is operating in ambient temperatures consistently below -18°C (0°C) or above 38°C (100°F), perform the maintenance at shorter intervals. Shorter maintenance intervals are also required if the engine is operated in a dusty environment or if frequent stops are made.

Use the chart provided at the end of this section as a convenient way to keep a record of the maintenance performed.

NOTE: The 6IRQ9AE engine features a no-adjust overhead. The 6IRQ9AE valve train is designed such that adjustment of the valve lash is **not** required for normal service within the first 5000 hours. The valve train operates acceptably within the limits of 0.152 to 0.559 mm (0.006 to 0.022 in) intake valve lash and 0.381 to 0.813 mm (0.015 to 0.032 in)

6IRQ9AE Engine Maintenance Schedule					
Daily	250 Hours or 3 Months	500 Hours or 6 Months	1000 Hours or 1 Year	2000 Hours or 2 Years	5000 Hours or 4 Years
Maintenance Check	Check/ Inspect	Change/ Replace/ Inspect	Check/ Inspect	Change/ Replace/ Inspect	Check/ Inspect
<ul style="list-style-type: none"> • Check and Correct 1. Engine Oil Level 2. Coolant Level • Drain Fuel-Water Separator • Inspect Cooling Fan • Check Crankcase Breather • Check Intake Piping 	<ul style="list-style-type: none"> • Mounting hardware such as the injection pump • Operate engine and check air intake system 	<ul style="list-style-type: none"> • Fuel filter • Lubricating oil • Lubricating oil filter • Coolant Filter • Check engine coolant SCA concentration level 	<ul style="list-style-type: none"> • Fan hub • Belt tensioner • Drive belts 	<ul style="list-style-type: none"> • Anti-freeze • Vibration damper 	<ul style="list-style-type: none"> • Overhead valve lash

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DAILY MAINTENANCE PROCEDURES

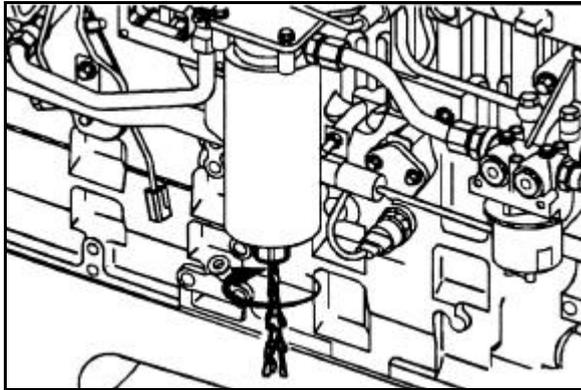
GENERAL INFORMATION

Preventive maintenance begins with day-to-day awareness of the condition of the engine and its systems. Before starting the engine, check the oil and coolant levels. Look for the following:

- Leaks
- Loose or damaged parts, especially in fuel or exhaust systems
- Worn or damaged belts
- Any change in engine appearance
- Odour of fuel.

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Fuel-Water Separator Drain



Warning: Drain the fuel-water separator into a container, and dispose of the contents in accordance with local environmental regulations. Avoid contact with skin.

NOTE: The water and sediment can contain petroleum products. Please consult the local environmental agency for recommended disposal guidelines.

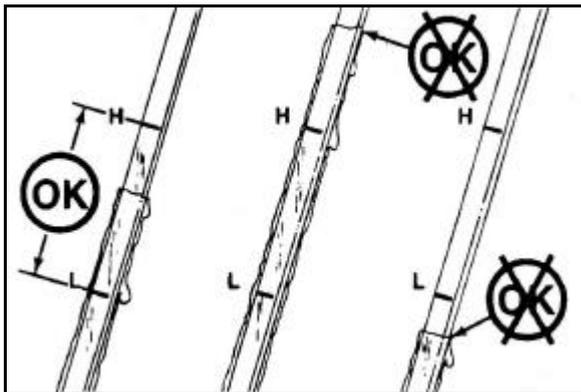
Ingersoll Rand Ltd. Requires the a fuel-water separator be installed in the fuel supply system. Drain the water and sediment from the separator daily.

Shut off the engine. Open the drain valve by hand.

Open the drain valve until the fluid drains out of the drain tube.

Drain the filter sump until clear fuel is visible.

Lubricating Oil Level Maintenance Check



The compressor must be level when checking the oil level to make sure the measurement is correct.

Shut off the engine for an accurate reading.

Do not operate the engine with the oil level below the 'L' (low) mark or above the 'H' (High) mark. Wait at least 10 minutes after shutting off the engine to check the oil. This allows time for the oil to drain into the pan.

Coolant Level Maintenance Check

Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C (122°F) before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

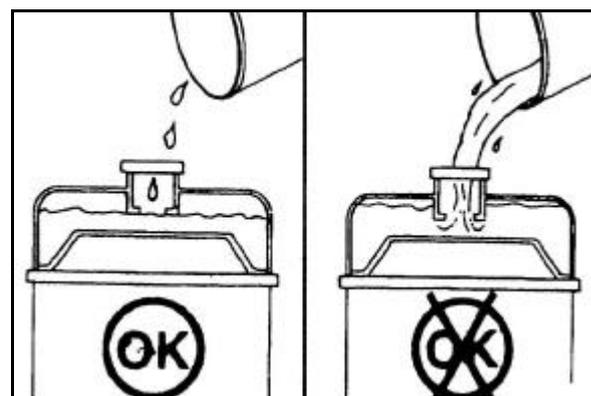
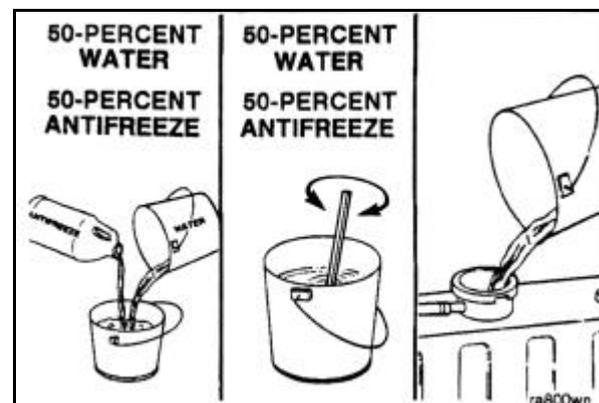
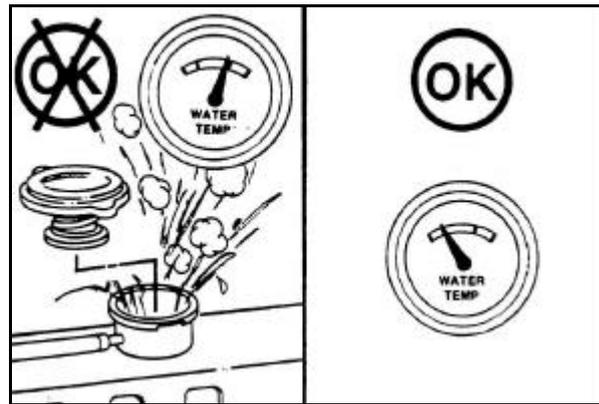
Never use a sealing additive to stop leaks in the cooling system. This can result in cooling system plugging and inadequate coolant flow, causing the engine to overheat and the cooling system to fail.

The coolant level must be checked daily.

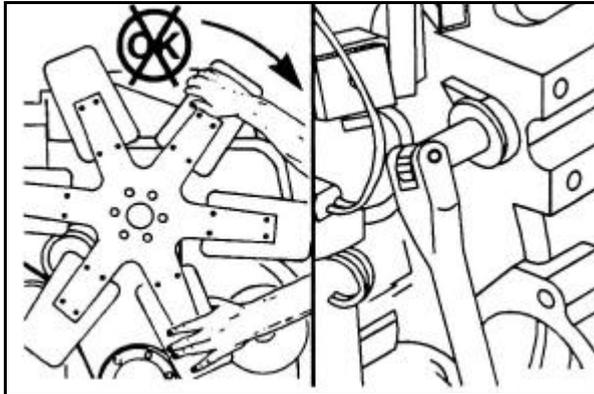
Do not add cold coolant to a hot engine. Engine castings can be damaged. Allow the engine to cool to below 50°C (122°F) before adding coolant.

If additional coolant is added to the cooling system, a 50-percent mixture of water and antifreeze must be premixed before being added to the system. Since the ability of antifreeze to remove the heat from the system is not as good as water, pouring antifreeze into the engine first could contribute to an overheated condition before the liquids are completely mixed.

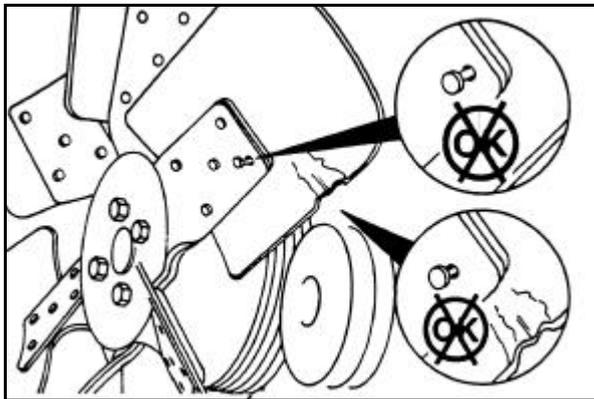
Fill the cooling system with coolant to the bottom of the fill neck on the radiator.



Cooling Fan Inspect

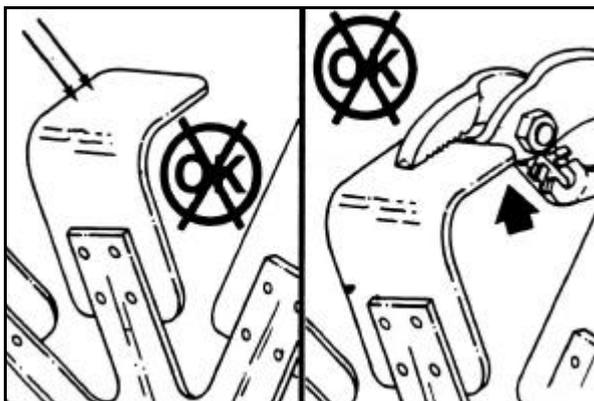


Do not rotate the engine by pulling or prying on the fan. The fan blade(s) can be damaged and cause serious personal injury or property damage. Use the engine barring gear to rotate the crankshaft.



Inspect the cooling fan daily. Check for cracks, loose rivets, and bent or loose blades. Check the fan to make sure that it is securely mounted. Tighten the cap-screws, if necessary.

Do not straighten a bent fan blade or continue to use a damaged fan. A bent or damaged fan blade can fail during operation and cause serious personal injury or damage to property.



Replace any original equipment fan that is damaged with a fan of the identical part number. Ingersoll Rand Ltd. must approve any other fan changes.

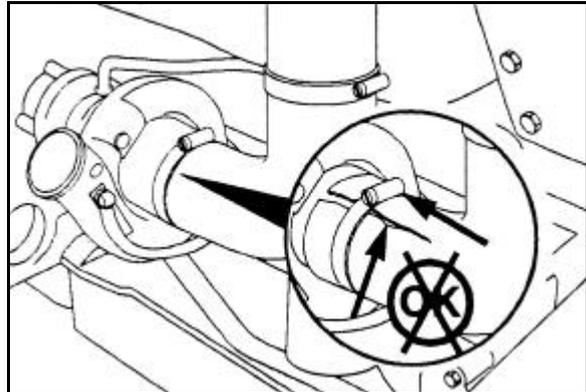
Air Intake Piping Maintenance Check

Inspect the intake piping daily for wear points, damage to piping, loose clamps, and punctures that can damage the engine.

Replace damaged pipes, and tighten loose clamps, as necessary, to prevent the air system from leaking.

Torque Value: 8Nm

Check for corrosion under the clamps and hoses of the intake system piping. Corrosion can allow corrosive product and dirt to enter the intake system. Remove clamps and hoses, and clean as required.

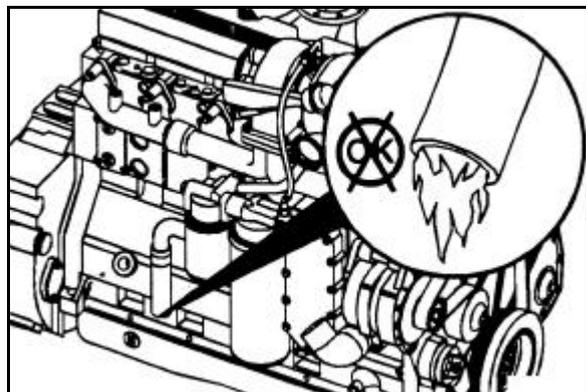


Crankcase Breather Tube Maintenance Check

Check the crank case breather tube daily during cold weather operation for ice build-up, that can obstruct the tube.

If an ice build-up is present, remove the breather tube, if necessary, and clear the obstruction.

The 6IRQ9AE engine is equipped with a block-mounted breather tube.

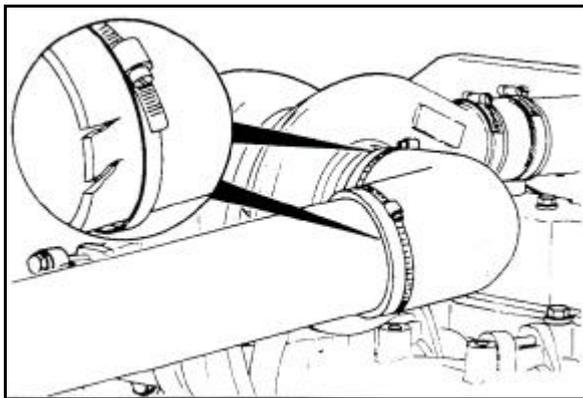


MAINTENANCE PROCEDURES AT 250 HOURS OR 3 MONTHS

GENERAL INFORMATION

All checks or inspections listed under daily or periodic maintenance intervals must also be performed at this time, in addition to those listed under this maintenance interval.

Ingersoll Rand can not be responsible for problems caused by non-genuine filters that do not meet Ingersoll Rand's performance or durability requirements.

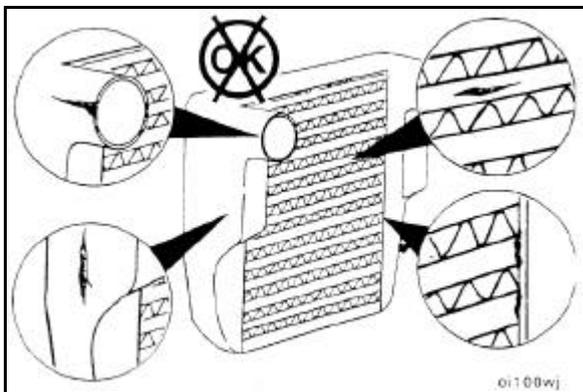


Charge-Air Piping Maintenance Check

Inspect the charge-air piping and hoses for holes, cracks and loose connections.

Tighten the hose cracks if necessary.

Torque Value: 8Nm (71 in-lb)



Charge-Air Cooler Maintenance Check

Inspect the charge-air cooler for dirt and debris blocking the fins. Check for cracks, holes, and other damage. If damage is found. The cooler must be repaired or replaced.

Air Intake Restriction Maintenance Check

The maximum intake restriction is 635 mm (25 in) of water for turbocharged engines.

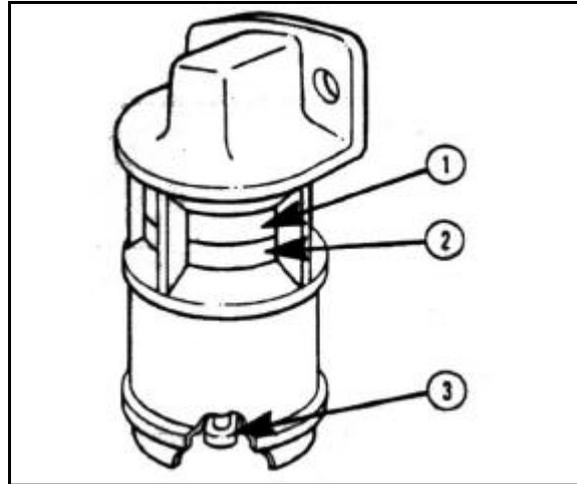
Turbocharged engines must be operated at rated rpm and full load to check maximum intake air restriction. Replace the air cleaner element when the restriction reaches the maximum allowable limit.

Never operate the engine without an air cleaner. Intake air must be filtered to prevent dirt and debris from entering the engine and causing premature wear.

NOTE: Follow the instructions carefully when cleaning or replacing the air cleaner element.

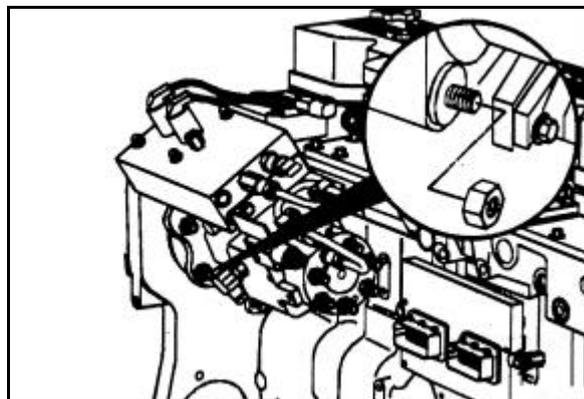
Check the air cleaner service indicator, if equipped. Change the filter element when the red indicator flag (2) is at the raised position in the window (1).

After the air cleaner has been serviced, push the button (3) to reset the service indicator.



FUEL PUMP Maintenance Check

Inspect the fuel injection pump mounting nuts, including the tail support bracket and the top support bracket, for loose and damaged hardware.



MAINTENACE PROCEDURES AT 500 HOURS OR 6 MONTHS

GENERAL INFORMATION

All checks or inspections listed under daily or periodic maintenance intervals must also be performed at this time, in addition to those listed under this maintenance interval.

Ingersoll Rand can not be responsible for problems caused by non-genuine filters that do not meet Ingersoll Rand's performance or durability requirements.

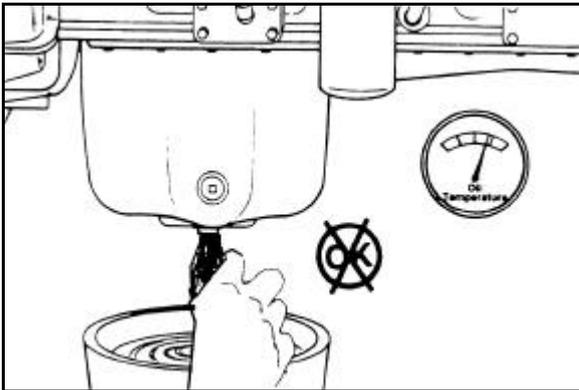
OIL DRAIN INTERVALS

Warning

Used engine oil can be carcinogenic and cause reproductive toxicity. Avoid inhalation of vapours, ingestion, and prolonged contact with used engine oil.

To avoid personal injury, avoid direct contact of hot oil with your skin.

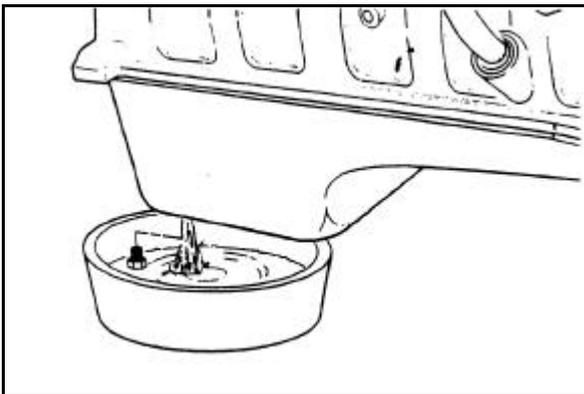
Change the lubricating oil and filter(s) at the specified oil change interval.



Operate the engine until the engine coolant temperature reaches 60° (140°F). Shut off the engine.

NOTE: use a container that can hold at least 24 litres of lubricating oil.

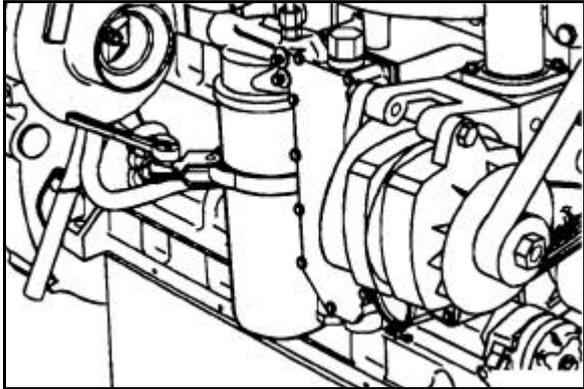
Remove the oil drain plug from the bottom of the lubricating oil sump.



Remove the Oil Filter

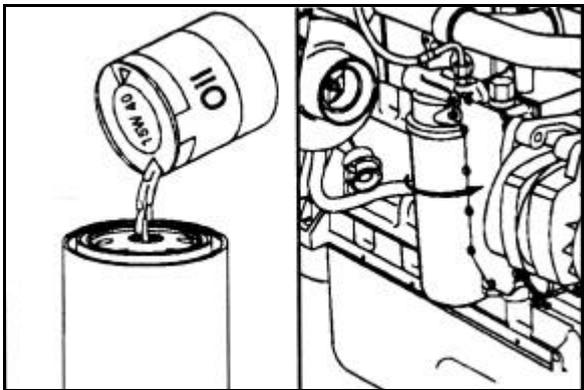
Clean the area around the lubricating oil filter head. Remove the filter. Clean the gasket surface of the filter head.

NOTE: The O-ring can stick on the filter head. Make sure that it is removed before installing the new filter.



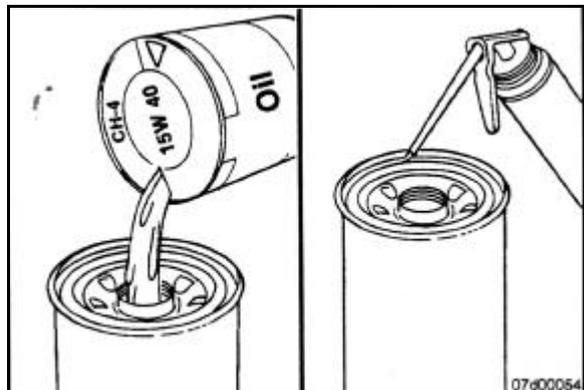
Make sure that the correct oil filter is used:

Ingersoll Rand CPN: 22177737



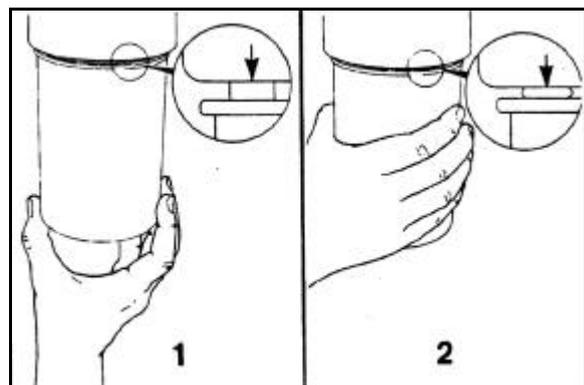
NOTE: Fill the filter with clean lubricating oil before installation.

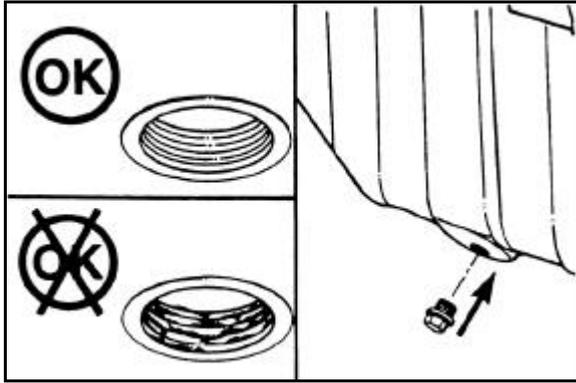
Apply a light film of lubricating oil to the gasket sealing surface before installing the filter.



Mechanical over tightening can distort the threads or damage the filter element seal.

Install the filter by hand as specified.

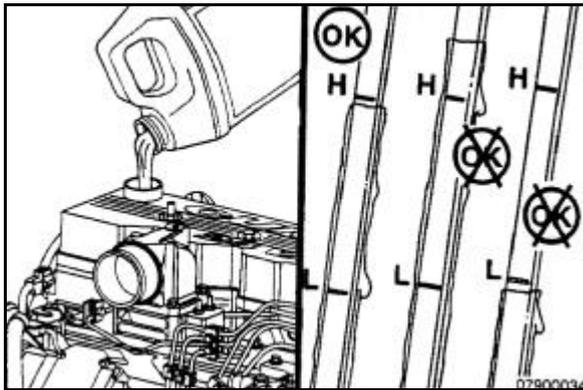




Check and clean the oil drain plug threads and sealing surface.

Install the drain plug.

Torque Value: 80 Nm (59 ft-lb)

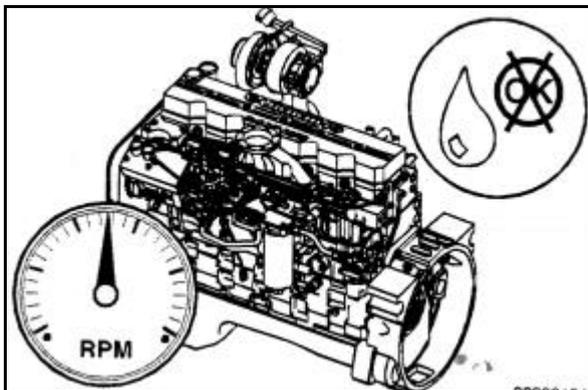


Always use Ingersoll Rand Protec engine oil.

Fill the engine with clean lubricating oil to the proper level.

NOTE: Total system capacity assumes lubricating oil sump plus lubricating oil filter.

6IRQ9AE lubricating oil capacity:-
24 Litres (6.34 US Gallons).

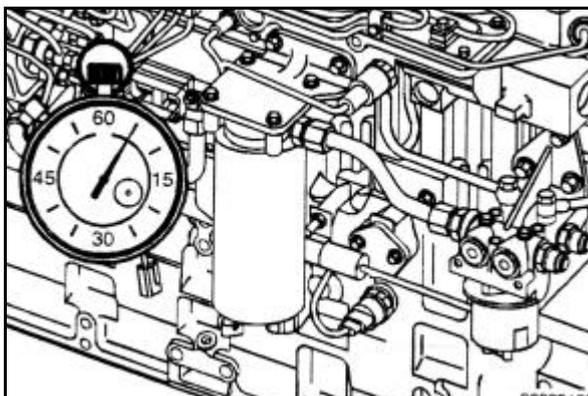


Operate the engine and check for leaks at the filters and the oil drain plug.

FUEL FILTER

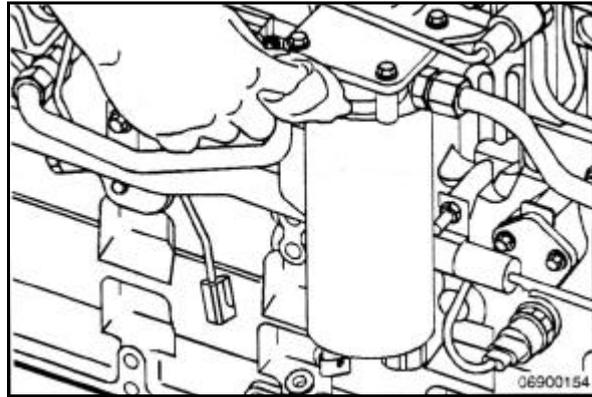
Preparatory

Water can contain toxic and carcinogenic material. Avoid contact with skin. Drain the fuel filter into a container and dispose of in accordance with local environmental regulations.



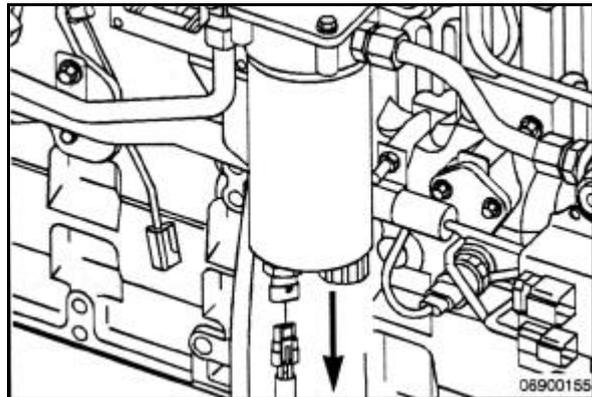
Use the filter drain valve to drain fuel out of the filter for approximately 5 seconds. This will prevent fuel from running over the top of the filter upon removal.

Clean all debris from around the fuel filter head.

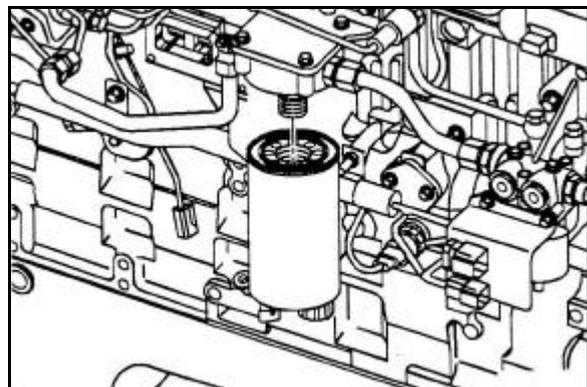


Remove

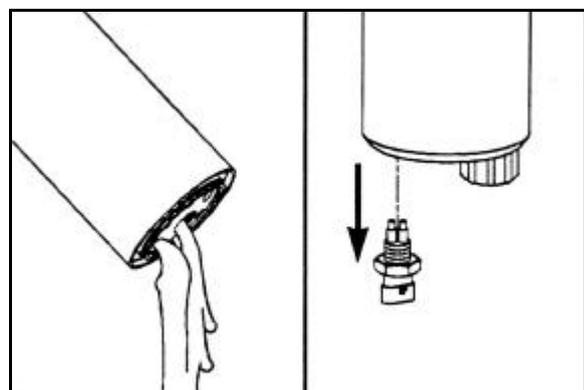
Disconnect the water-in-fuel sensor from the wiring harness.

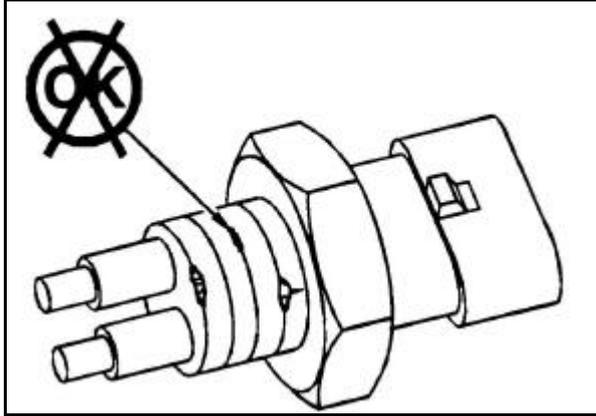


Remove the fuel filter



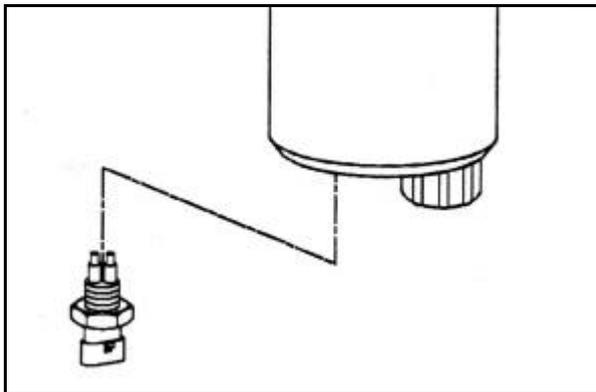
Drain the fuel filter.
Remove the water-in-fuel sensor from the fuel filter.





Inspect for Reuse

Inspect the water-in-fuel sensor for cracks and damage.



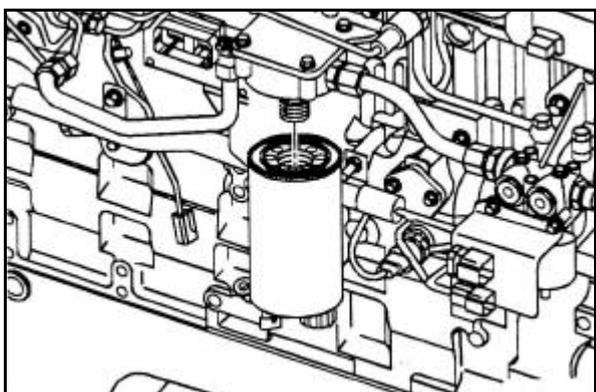
Install

Install the water-in-fuel sensor into the new fuel filter. Ingersoll Rand CPN 22177711. If necessary.



The 6IR9QAE engine has a self-priming, low pressure system that purges the air from the fuel system. Do not pre-fill the fuel filter. Pre-filling the fuel filter can cause fuel pump damage.

Lubricate the o-ring with clean lubricating oil.

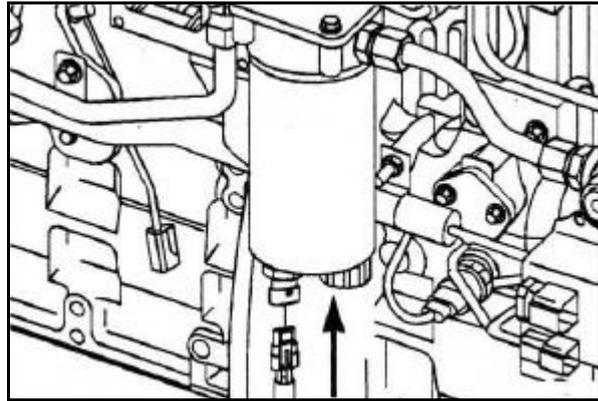


Mechanical over tightening can distort the threads as well as damage the filter element seal or filter canister.

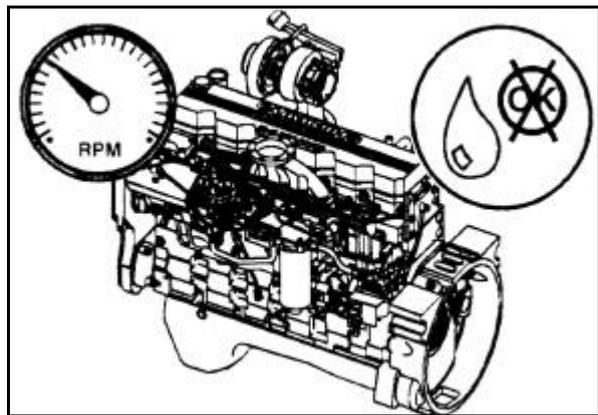
Install the filter as specified.

Connect the water-in-fuel sensor to the wiring harness.

Connect the wiring harness to the heater (if equipped).



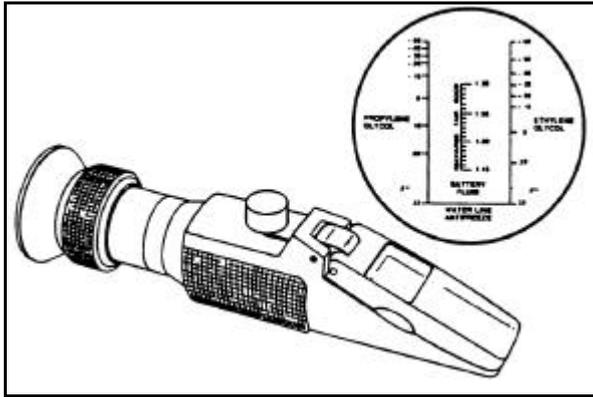
Turn the key to the RUN position, but do **not** attempt to start the engine for 30 seconds. The electric fuel transfer pump will run and purge air from the system for about 30 seconds. After 30 seconds, attempt to start the engine. If the engine does not start, turn the key to the OFF position for approximately 30 seconds to allow the electronic module to power down. Turn the key to the ON position allowing the electric fuel transfer pump to cycle again. After 30 seconds attempt to start the engine again.



If the engine cranks for 30 seconds without starting, vent the fuel supply lines.

To vent the fuel supply lines, loosen the banjo fitting on the fuel pump inlet. Run the electric fuel transfer pump until the air has been bled from the system.

Operate the engine, and check for leaks.



Cooling System Maintenance Check

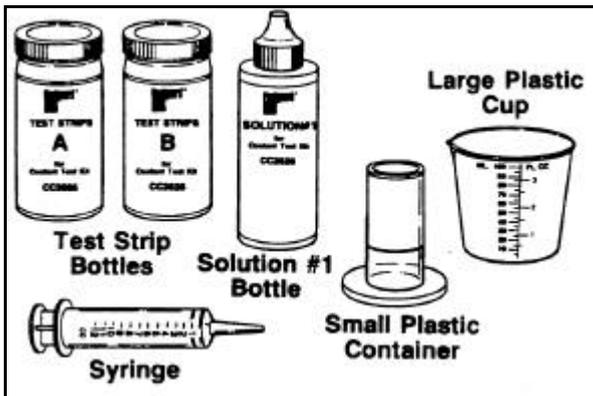
Over concentration of antifreeze or use of high-silicate antifreeze can cause engine damage.

Check the antifreeze concentration. Use a mixture of 50 percent water and 50 percent ethylene glycol or propylene-glycol-based antifreeze to protect the engine to -32°C (-26°F) year-around.

NOTE: Antifreeze is essential in every climate.

Antifreeze broadens the operating temperature range by lowering the coolant freezing point and by raising its boiling point.

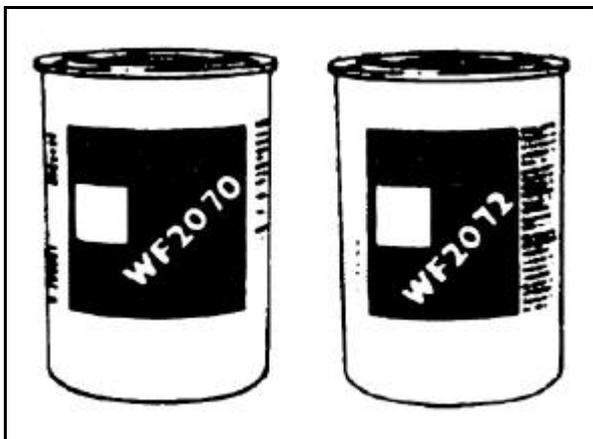
The corrosion inhibitors also protect the cooling system components from corrosion and prolong components life.



Inadequate concentration of the coolant additive can result in major corrosive damage to the cooling system components. Over concentration can cause formation of a 'gel' that can cause restriction, plugging of coolant passages, or overheating.

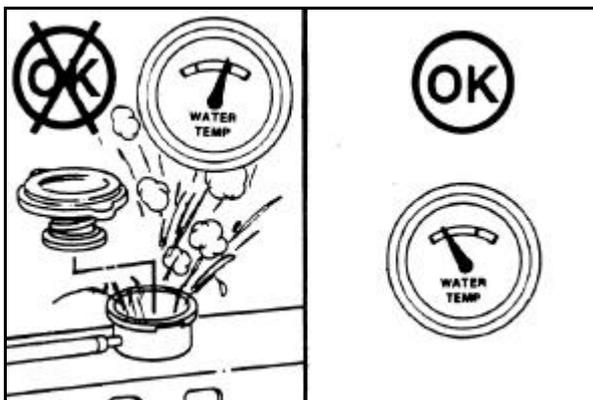
NOTE: If the engine coolant is changed, the coolant filters **must** also be changed.

Ingersoll Rand CPN: 36868156



Coolant Filter Preparatory

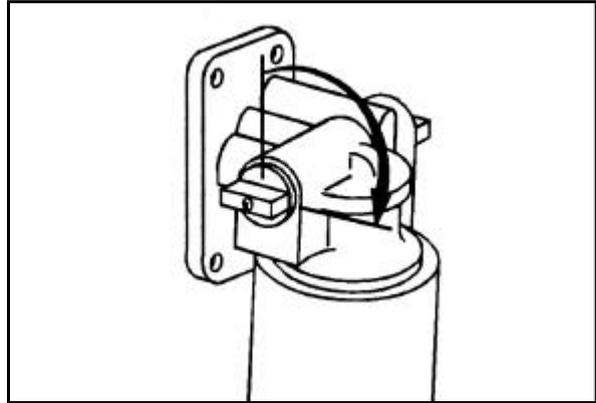
Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C (122°F) before removing the pressure cap. Heated coolant spray or steam can cause personal injury.



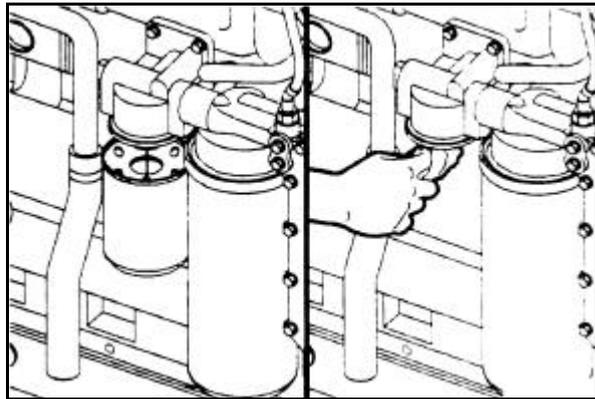
Remove

Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C (122°F) before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

Turn the shutoff valve to the OFF position by rotating the knob from vertical to horizontal in the direction shown in the illustration.

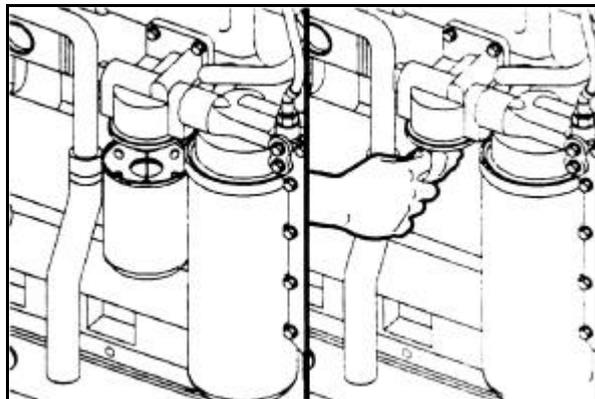


Remove and discard the coolant filter.



Clean

Clean the gasket surface.



Install

Do not allow oil to get into the filter. Oil will damage the DCA.

Mechanical over tightening can distort the threads or damage the filter head.

Apply a thin film of lubricating oil to the gasket sealing surface before installing the new coolant filter.

Install the coolant filter on the filter head. Tighten the filter until the gasket contacts the filter head surface.

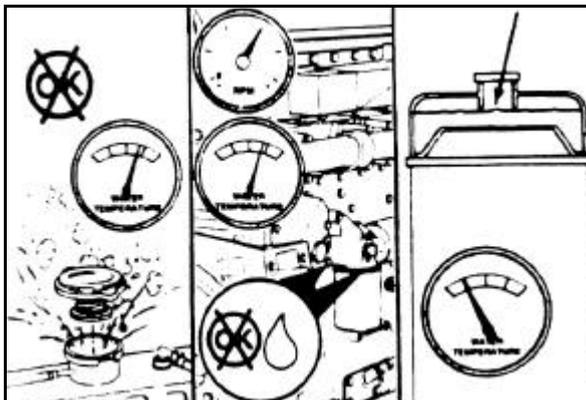
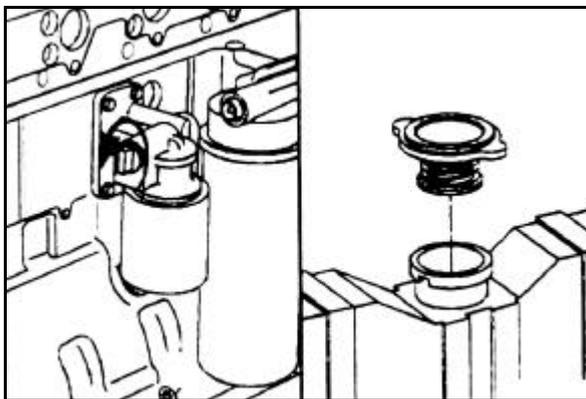
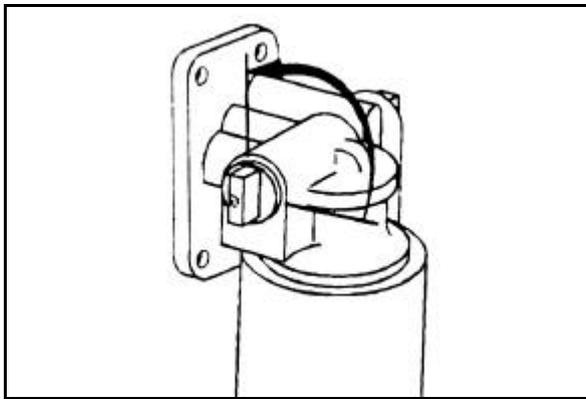
Tighten the coolant filter an additional $\frac{1}{2}$ to $\frac{3}{4}$ of a turn.

The valve must be in the ON position to prevent engine damage.

Turn the shutoff valve to the ON position by rotating the knob from horizontal to vertical in the direction shown in the illustration.

Install the coolant system pressure cap.

Operate the engine, and check for coolant leaks. After the air has been purged from the system, check the coolant level again.



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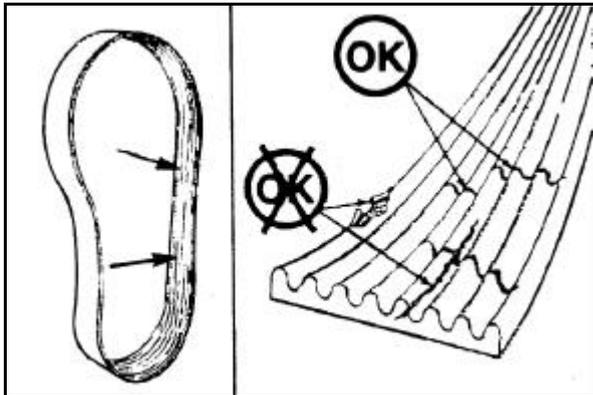
MAINTENACE PROCEDURES AT 1000 HOURS OR 1 YEAR

GENERAL INFORMATION

All checks or inspections listed under daily or periodic maintenance intervals **must** also be performed at this time, in addition to those listed under this maintenance interval.

Ingersoll Rand can not be responsible for problems caused by non-genuine filters that do not meet Ingersoll Rand's performance or durability requirements.

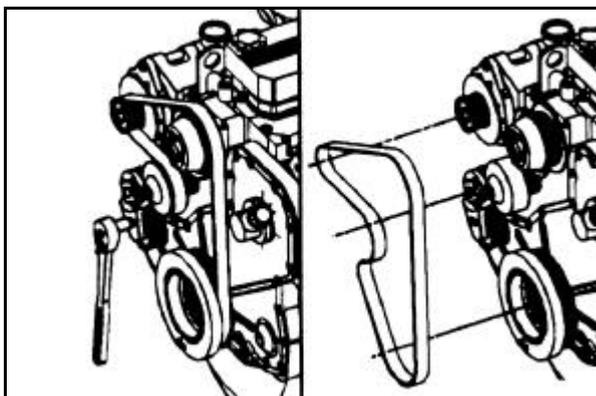
Drive Belts Maintenance Check



Inspect the belts daily. Check the belts for intersecting cracks. Transverse (across the belt width) are acceptable. Longitudinal (direction of the belt length) cracks that intersect the traverse cracks are **not** acceptable. Replace the belt if it is frayed or has pieces of material missing. Refer to section X for belt adjustment and replacement procedures.

Belt damage can be caused by

- Incorrect tension
- Incorrect size or length
- Pulley misalignment
- Incorrect installation
- Severe operating environment
- Oil and grease on the belts



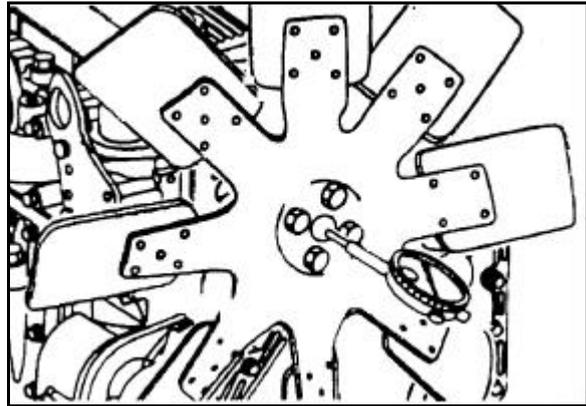
Fan Hub, Belt Driven Maintenance Check

Remove the drive belt

NOTE: The fan hub **must** rotate without any wobble or excessive end play.

- Check the fan hub bearing.

**Max Fan Hub End Play:-
0.15mm (0.006in)**



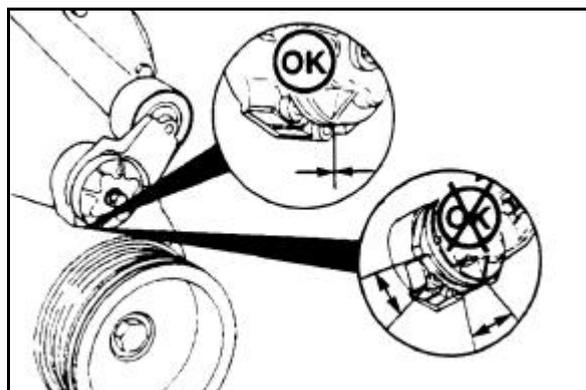
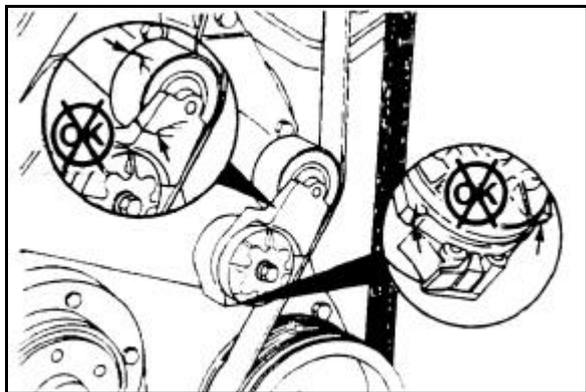
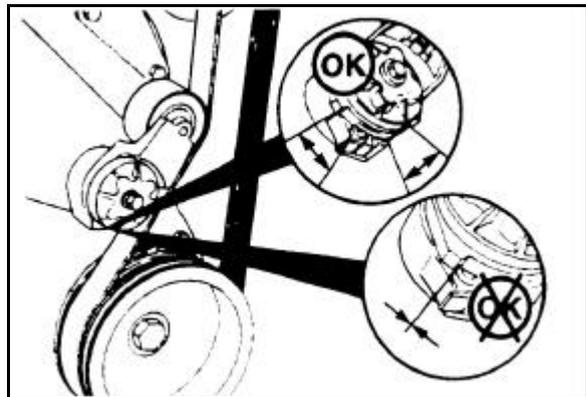
Belt Tensioner, Automatic Maintenance Check

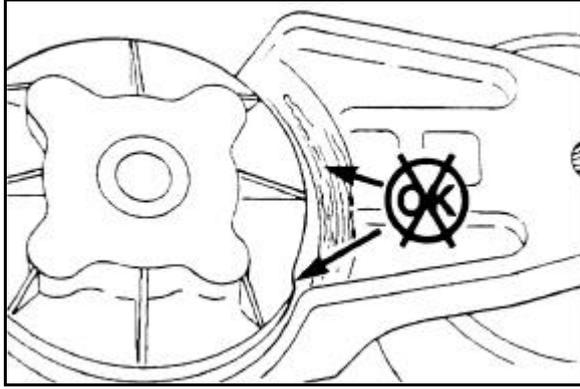
Every 1000 hours or 1 year, whichever occurs first, inspect the automatic belt tensioner.

With the engine turned off, check that neither the top nor the bottom tensioner arm stop is touching the cast boss on the tensioner body. If either of the stops is touching a boss, the alternator belt **must** be replaced. Check to make sure that the correct belt part number is being used if either condition exists.

Check the tensioner pulley and body for cracks. If any cracks are noticed, the tensioner **must** be replaced. Check the tensioner for dirt build-up. If this condition exists, the tensioner **must** be removed and steam-cleaned.

Check that the bottom tensioner arm stop is in contact with the bottom tensioner arm stop boss on the tensioner body. If these two are **not** touching, the tensioner **must** be replaced.





Inspect the tensioner for evidence of the pivoting tensioner arm contacting the stationary circular base. If there is evidence of these two areas touching, the pivot tube bushing has failed, and the tensioner **must** be replaced.

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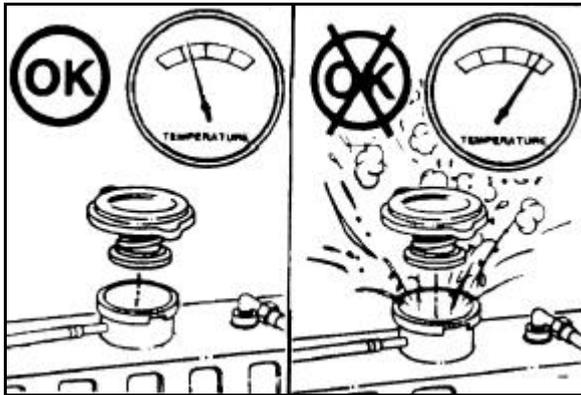
MAINTENACE PROCEDURES AT 2000 HOURS OR 2 YEARS

GENERAL INFORMATION

All checks or inspections listed under daily or periodic maintenance intervals must also be performed at this time, in addition to those listed under this maintenance interval.

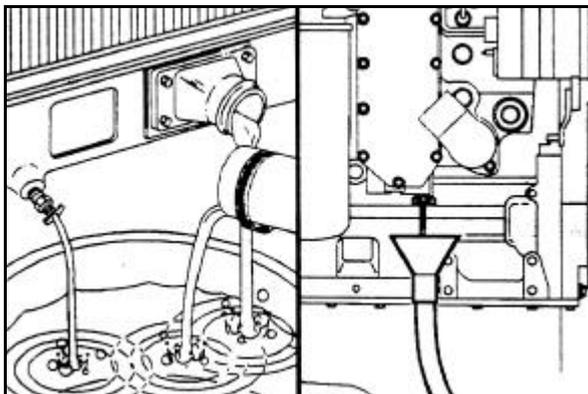
Ingersoll Rand can not be responsible for problems caused by non-genuine filters that do not meet Ingersoll Rand's performance or durability requirements.

Cooling System Drain



Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C (122°F) before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

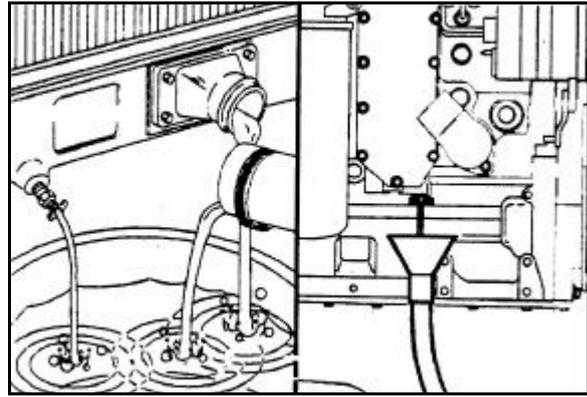
Avoid prolonged or repeated skin contact with used antifreeze. Such prolonged, repeated contact can cause skin disorders or other bodily injury. Wash skin thoroughly after contact.



Protect the environment: Handling and disposing of used antifreeze is subject to federal, state, and local regulations. Use authorised waste disposal facilities, including civil amenity sites and garages providing authorised facilities for the receipt of used antifreeze. If in doubt, contact local authorities of the Environmental Protection Agency (EPA) for guidance as to proper handling of antifreeze.

Coolant is toxic. If not reused, dispose of in accordance with local environmental regulations.

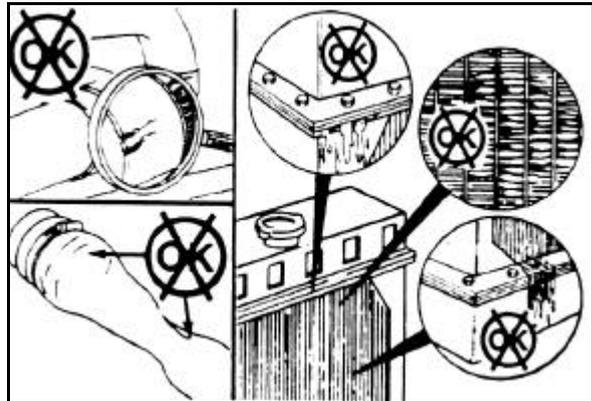
Drain the cooling system by opening the drain valve on the radiator and removing the plug in the bottom of the water inlet hose. A drain pan with a capacity of 19 litres (5 gal) will be adequate.



Check for damaged hoses and loose or damaged hose clamps. Replace as required.

Check the radiator for leaks, damage, and build-up of dirt.

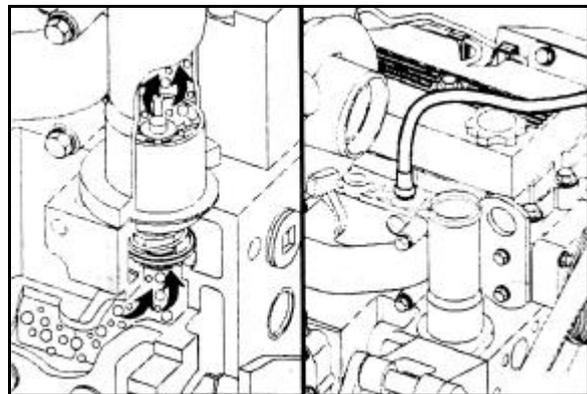
Clean and replace as required.



Flush

The system must be filled properly to prevent air locks. During filling, air must be purged from the engine coolant passages. Be sure to open the pet-lock on the aftercooler. Wait 2 to 3 minutes to allow air to be vented; then add mixture to bring the level to the top.

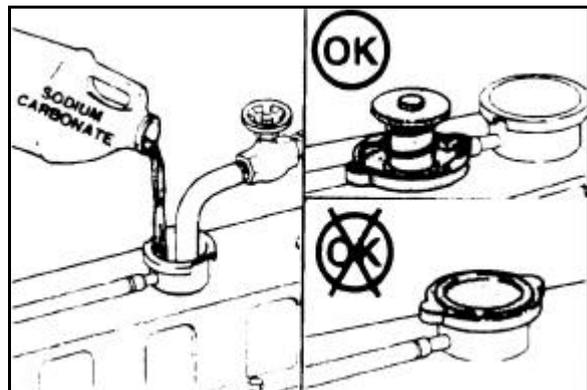
Note: Adequate venting is provide for a fill rate of 19 litres (5 gal) per minute.

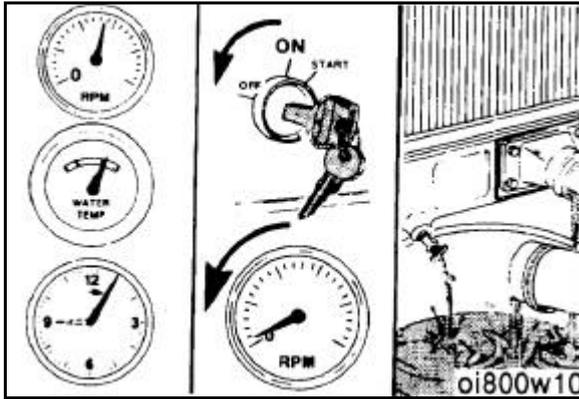


Do not install the radiator cap. The engine is to be operated without the cap for this process.

Fill the system with a mixture of sodium carbonate and water (or a commercially available equivalent).

NOTE: Use 0.5 Kg (1lb) of sodium carbonate for every 23 litres (6 gal) of water.

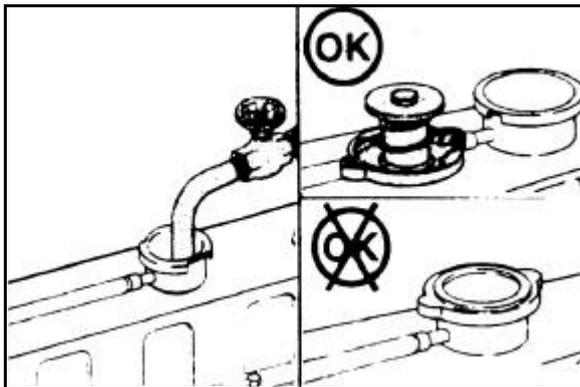




Coolant is toxic. If not reused, dispose of in accordance with local environmental regulations.

Operate the engine for 5 minutes with the coolant temperature above 80°C (176°F).

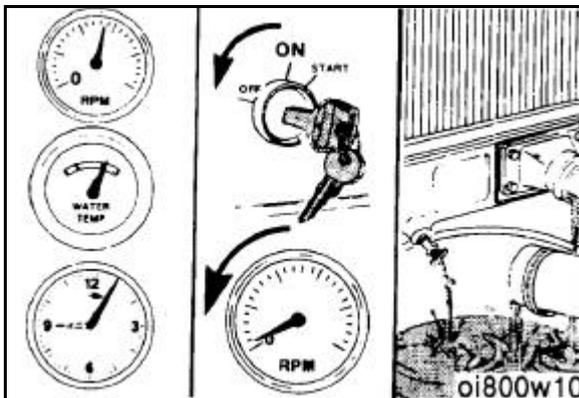
Shut the engine off, and drain the cooling system.



Fill the cooling system with high-quality water.

Note: Be sure to vent the engine and aftercooler for complete filling.

Note: Do **not** install the radiator cap or the new coolant filter.



Operate the engine for 5 minutes with the coolant temperature above 80°C (176°F).

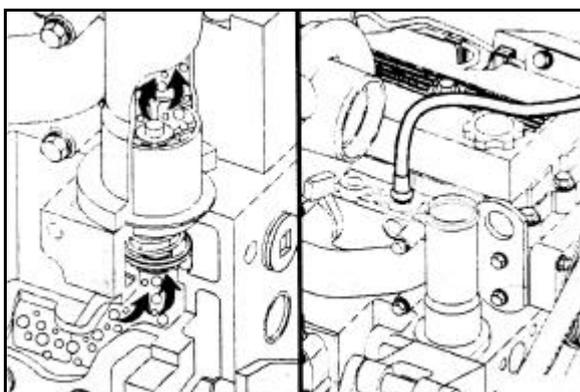
Shut the engine off, and drain the cooling system.

NOTE: If the water being drained is still dirty, the system **must** be flushed again until the water is clean.

Fill

The system must be filled properly to prevent air locks. During filling, the air must be vented from the engine coolant passages. Be sure to open the pet lock on the aftercooler. Wait 2 to 3 minutes to allow the air to be vented; then add the mixture to bring the level to the top.

The system is designed to use a specific quantity of coolant. If the coolant level is low, the engine will run hot.



If frequent additional coolant is necessary, the engine or system has a leak. Find and repair the leak.

The system is designed for a fill rate of 19 litres (5 gal) per minute.

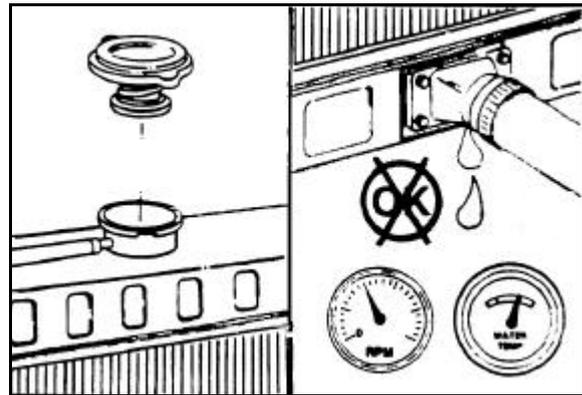
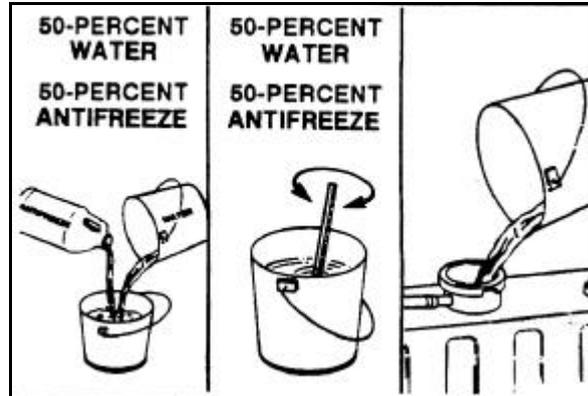
Never use water alone for engine coolant. This can result in damage from corrosion.

Use a mixture of 50 percent water and 50 percent ethylene glycol or propylene-glycol-based antifreeze to fill the cooling system.

Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C (122°F) before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

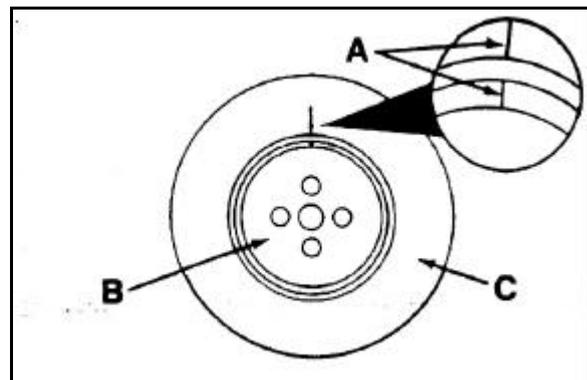
Install the pressure cap. Operate the engine until the coolant reaches a temperature of 80°C (176°F), and check for coolant leaks.

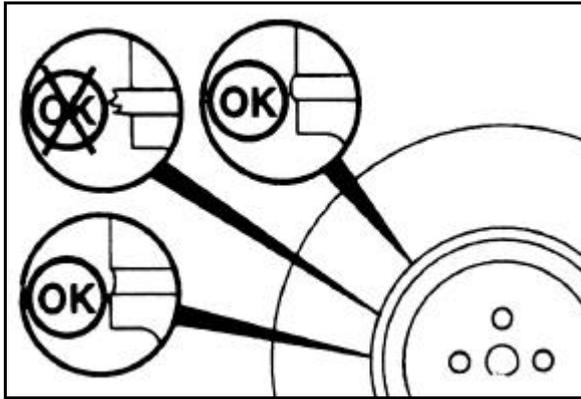
Check the coolant level again to make sure that the system is full of coolant or that the coolant level has risen to the hot level in the recovery bottle on the compressor.



Vibration Damper, Rubber Inspect

Check the index lines (A) in the vibration damper hub (B) and the inertia member (C). If the lines are more than 1.59mm (0.06in) out of alignment, replace the vibration damper.

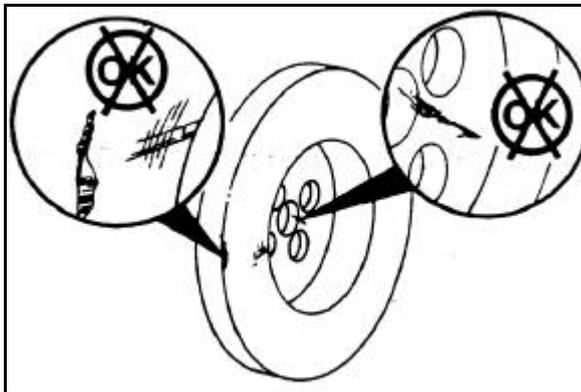




Inspect the rubber member for deterioration. If pieces of the rubber are missing, or if the elastic member is more than 3.18 mm (0.13 in) below the metal surface, replace the damper.

NOTE: Look for forward movement on the damper ring on the hub. Replace the vibration damper if any movement is detected.

Vibration Damper Inspect



The silicone fluid in the vibration damper will become solid after extended service and will make the damper inoperative. An inoperative damper can cause major engine or drivetrain failures.

Check the vibration damper for evidence of fluid loss, dents, and wobble. Inspect the vibration damper thickness for any deformation or raising of the damper cover plate.

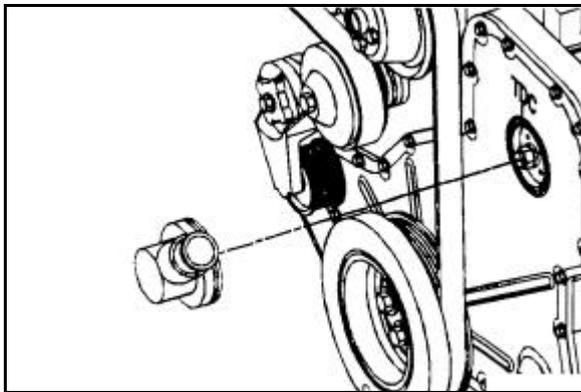
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MAINTENANCE PROCEDURES AT 5000 HOURS OR 4 YEARS

GENERAL INFORMATION

All checks or inspections listed under daily or periodic maintenance intervals must also be performed at this time, in addition to those listed under this maintenance interval.

Ingersoll Rand can not be responsible for problems caused by non-genuine filters that do not meet Ingersoll Rand's performance or durability requirements.

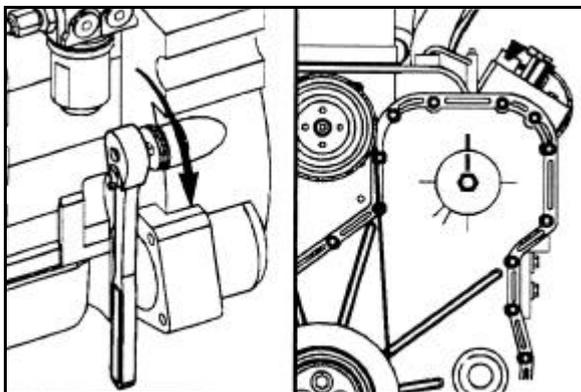


Overhead Set General Information

A valve lash check **must** be performed at 5000 hours and at 1500 hours thereafter.

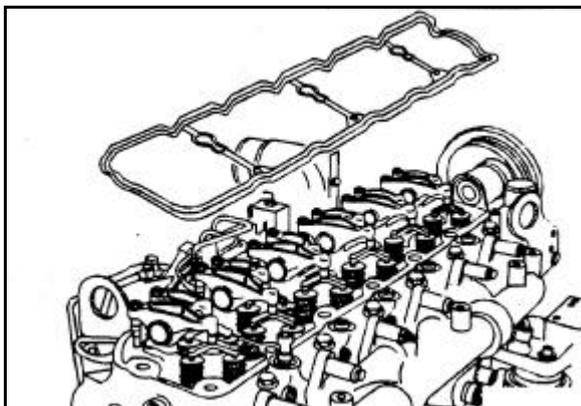
Measure

Engine coolant temperature must be less than 60°C (140°F).



Remove then plastic fuel pump drive cover located on the front of the engine.

Use the engine barring tool, to rotate the crankshaft to align top dead centre (TDC) marks on the gear cover and fuel pump gear.

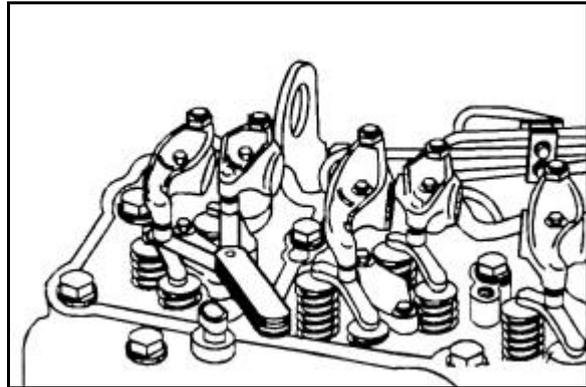


Remove the rocker lever cover and gasket.

With the engine in this position, the lash can be reset on the following rocker: 1I, 1E, 2I, 3E, 4I and 5E.

Nominal Valve Lash

Intake	0.305mm	nominal	0.012in
Exhaust	0.559mm	nominal	0.022in

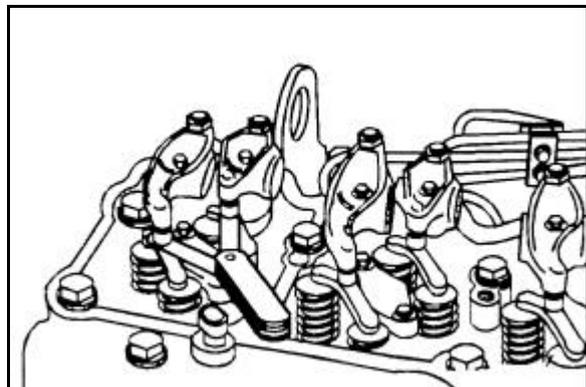


Reset the lash to the nominal specification above.

NOTE: Valve lash measurements are sometimes performed as part of a troubleshooting procedure. If the lash measurement does **not** coincide with a scheduled lash reset (5000 hours or 1500 hours thereafter), and the measurement falls within the following range the lash does not need to be reset. Lash measurements in this range will not affect engine performance, noise, emissions, or durability.

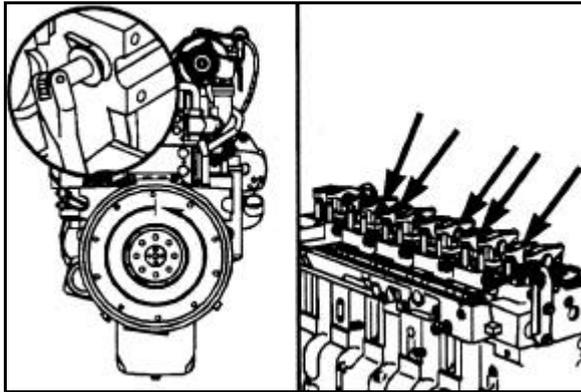
Valve Lash Acceptable Range

Intake	0.152mm	MIN	0.012in
	0.559mm	MAX	0.022in
Exhaust	0.381mm	MIN	0.015in
	0.813mm	MAX	0.032in



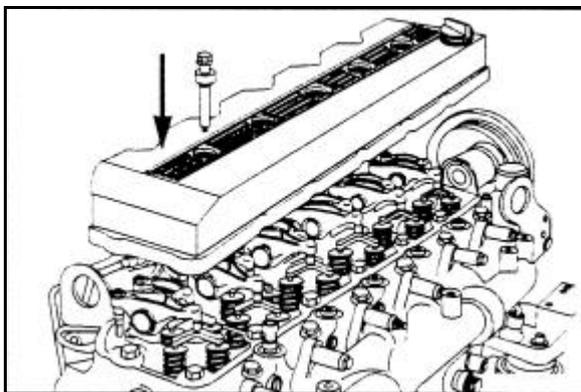
Reset the valve lash by inserting the proper feeler gauge between the crosshead and the rocker lever ball insert and socket. If the lash measurement is out of specification, loosen the locknut, and adjust the lash to nominal specifications.

Tighten the locknut to the rocker lever, and measure again.



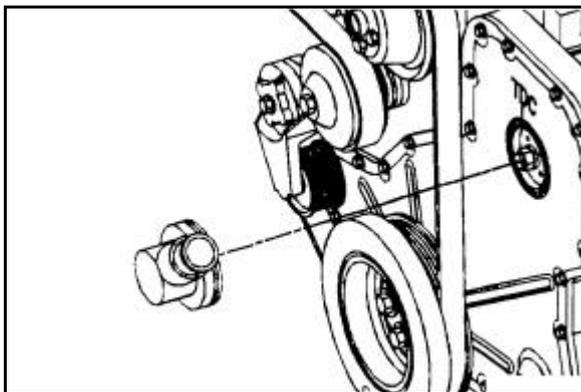
Use a barring tool to rotate the crankshaft 360 degrees (the mark on the fuel pump gear rotates 180 degrees), and measure the lash for rocker arms 2E, 3I, 4E, 5I, 6I and 6E.

Reset to nominal specifications.



Install the gasket and rocker lever cover.

Torque Value: 12 Nm (106 in-lb)



Install the fuel pump drive cover.

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TROUBLESHOOTING PROCEDURES AND TECHNIQUES

GENERAL INFORMATION

This guide describes some typical engine operating problem, their causes and some acceptable corrections to those problems. Unless noted otherwise, the problems listed are those which an operator can diagnose and repair.

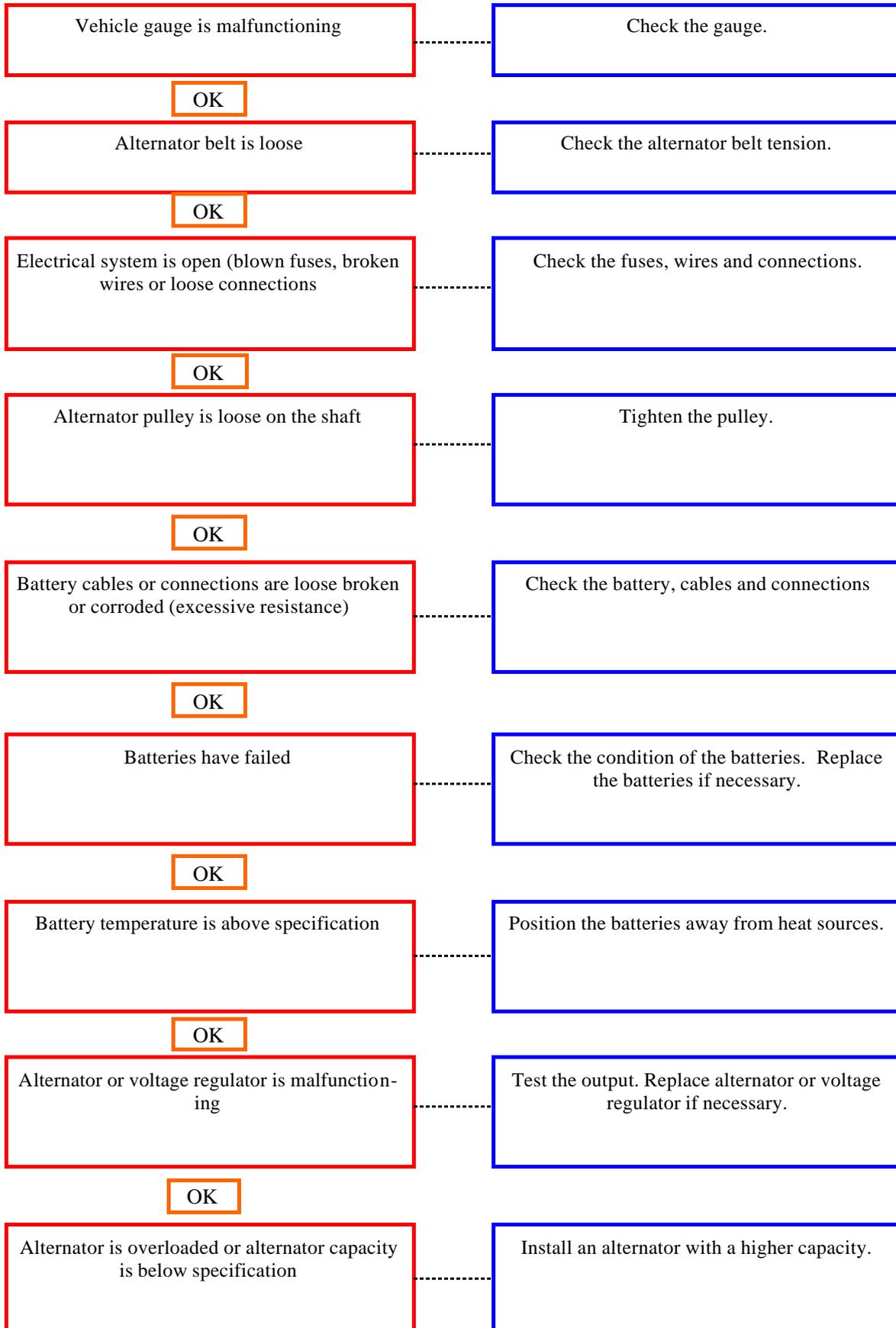
Performing troubleshooting procedures NOT outlined in this section can result in equipment damage or personal injury or death. Troubleshooting must be performed by trained, experienced technicians. Consult an Ingersoll Rand Authorised Service Location for diagnosis and repair beyond that which is outlined and for symptoms not listed in this section.

Follow the suggestions below for troubleshooting:

- Study the complaint thoroughly before acting
- Refer to the engine system diagrams
- Do the easiest and most logical things first
- Find and correct the cause of the complaint

Use the following charts to aid in diagnosing specific engine symptoms. Read each row of blocks from top to bottom. Follow the arrows through the chart to identify corrective action.

ALTERNATOR NOT CHARGING OR INSUFFICIENT CHARGING



ALTERNATOR OVERCHARGING

Cause

Battery cell is damaged (open circuit)

OK

Voltage regulator is malfunctioning

Correction

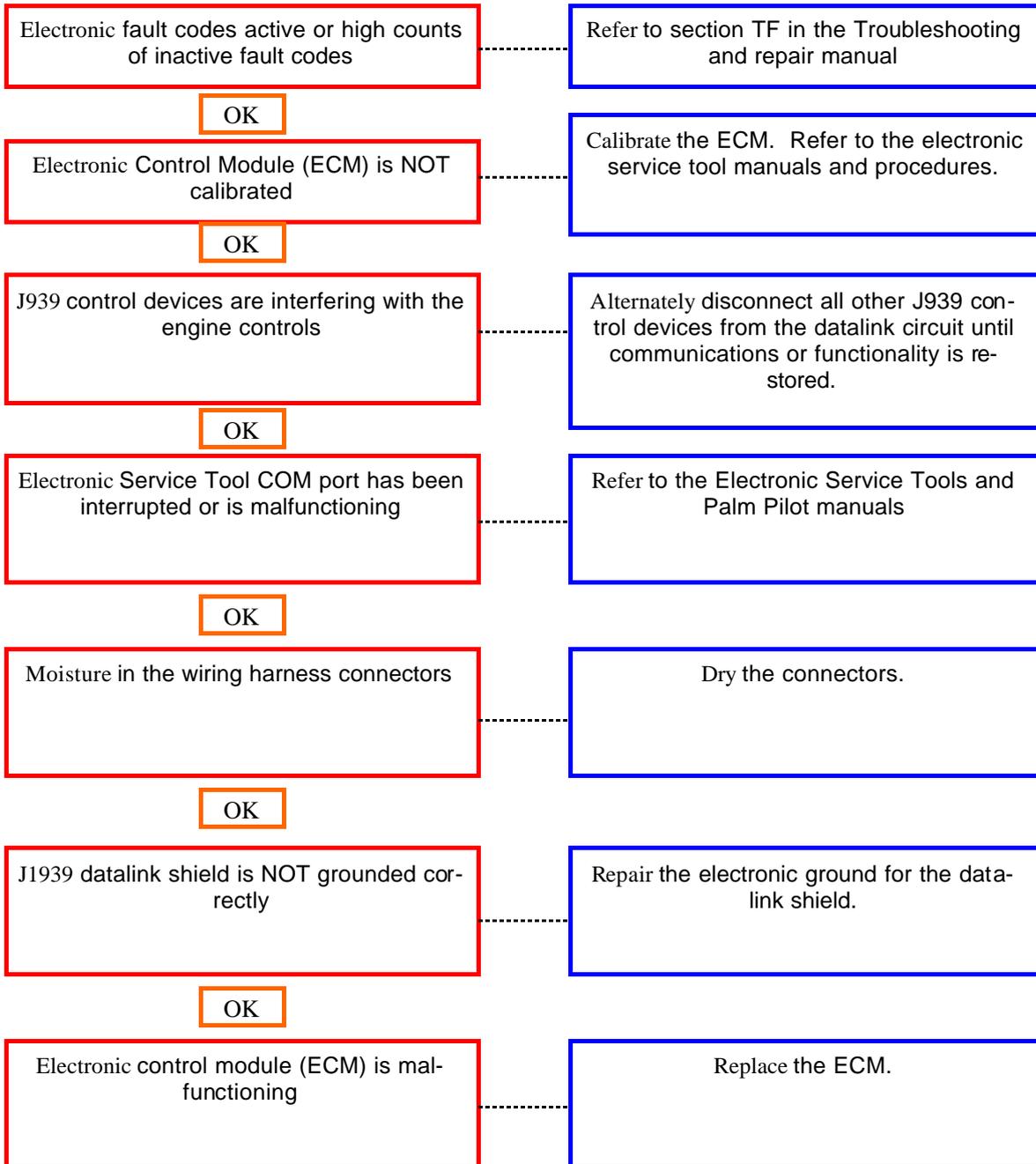
Check condition of the batteries. Replace the batteries if necessary.

Check the voltage regulator. Replace the voltage regulator if necessary.

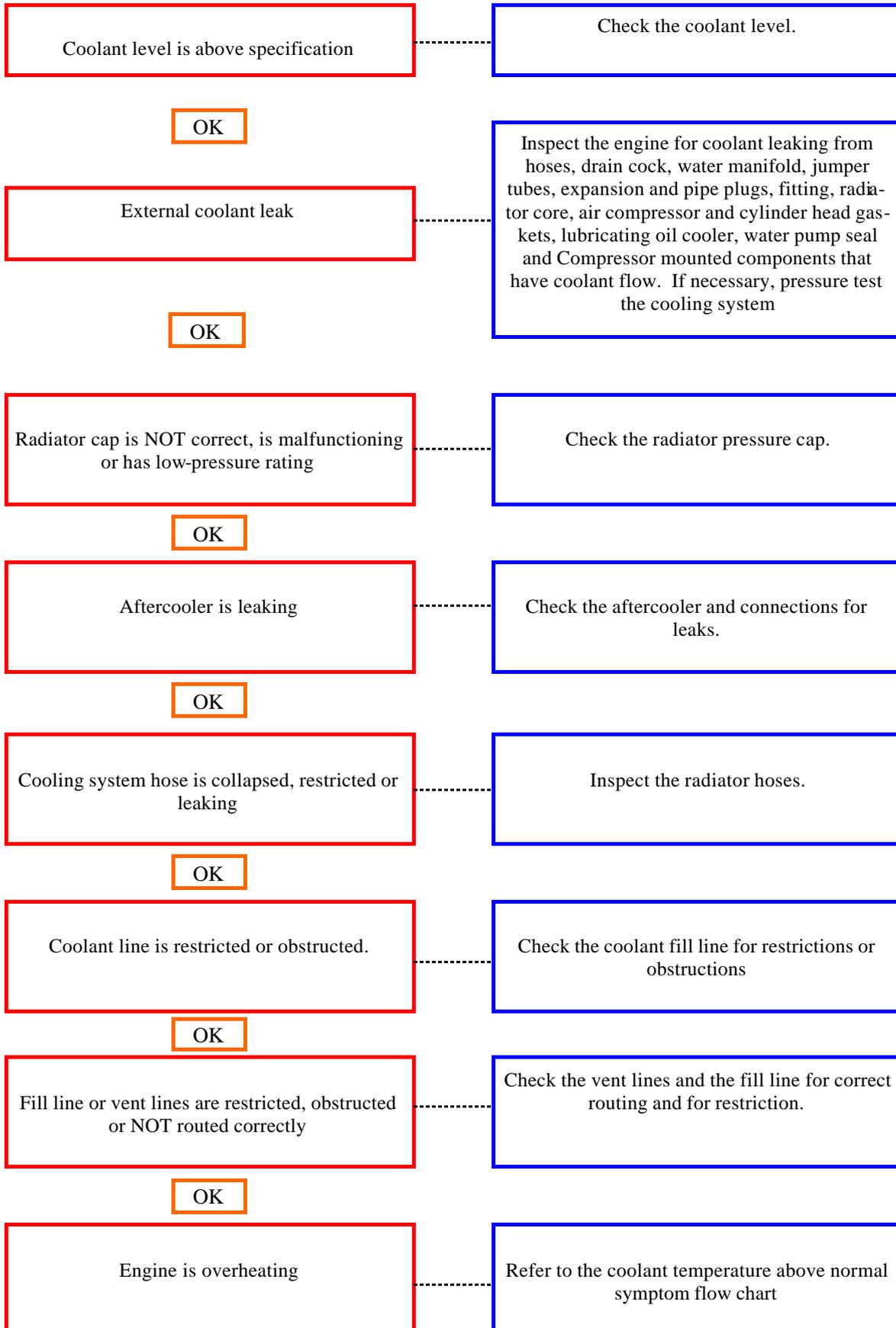
COMMUNICATION ERROR—ELECTRONIC SERVICE TOOL

Keyswitch is in the OFF position	Turn the keyswitch to the ON position
OK	
Keyswitch circuit is malfunctioning	Check the circuit. Refer to procedure 019-064 in the Troubleshooting and repair manual.
OK	
Datalink cable is NOT connected properly	Refer to INSITE
OK	
INLINE adapter (datalink adapter) is not connected to the battery voltage supply	Check the power light on the INLINE adapter. If the light is not aluminates, connect the battery voltage to the INLINE adapter. Refer to
OK	
INSITE™ is addressing the wrong communication port	Select systems menu/user options and change the communication port setting. Refer to the communications messages in the INSITE help menu and user guide
OK	
Verify that the electronic service tool is working and the correct software or cartridge is being used.	Refer to the appropriate electronic service tool and software.
OK	
Fuses malfunctioning	Replace the fuses in the OEM interface harness. Refer to Procedure 019-198 in the troubleshooting and repair manual.
OK	
Battery voltage supply to the electronic control module (ECM) is low, interrupted or open	Check the battery connections. Refer to procedures 019-198 and 019-087 in the troubleshooting and repair manual. Check the switches and the unswitched battery supply circuit.
OK	
Datalink circuit is malfunctioning	Check the battery connections. Refer to procedure 019-028 in the troubleshooting and repair manuals.

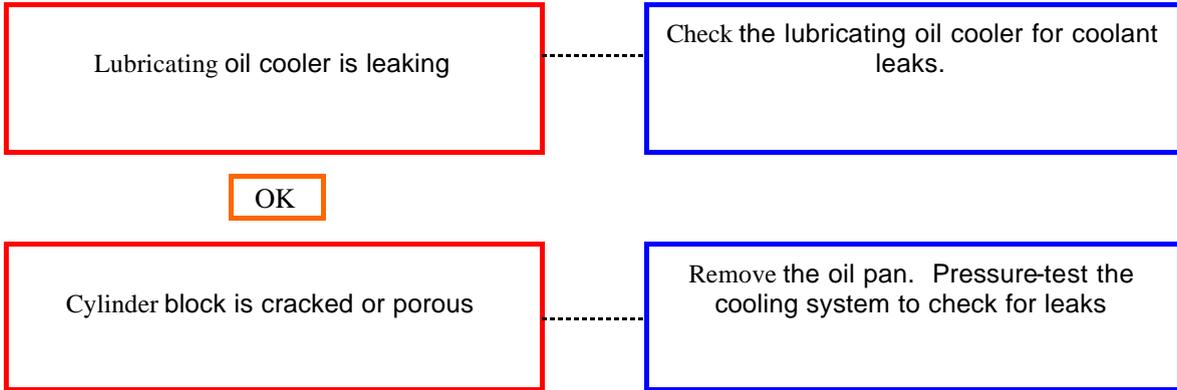
COMMUNICATION ERROR—ELECTRONIC SERVICE TOOL (CONT)



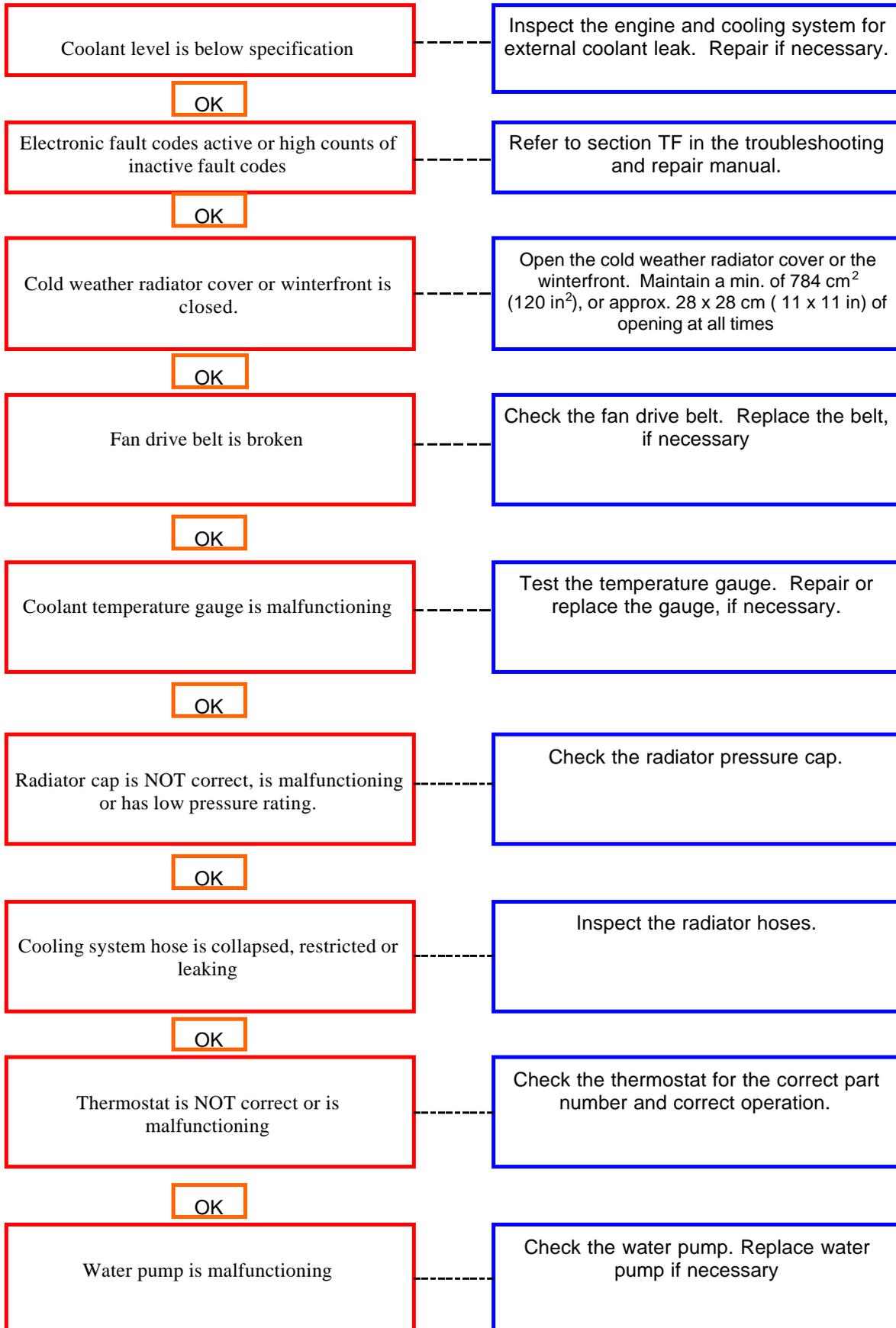
COOLANT LOSS—EXTERNAL



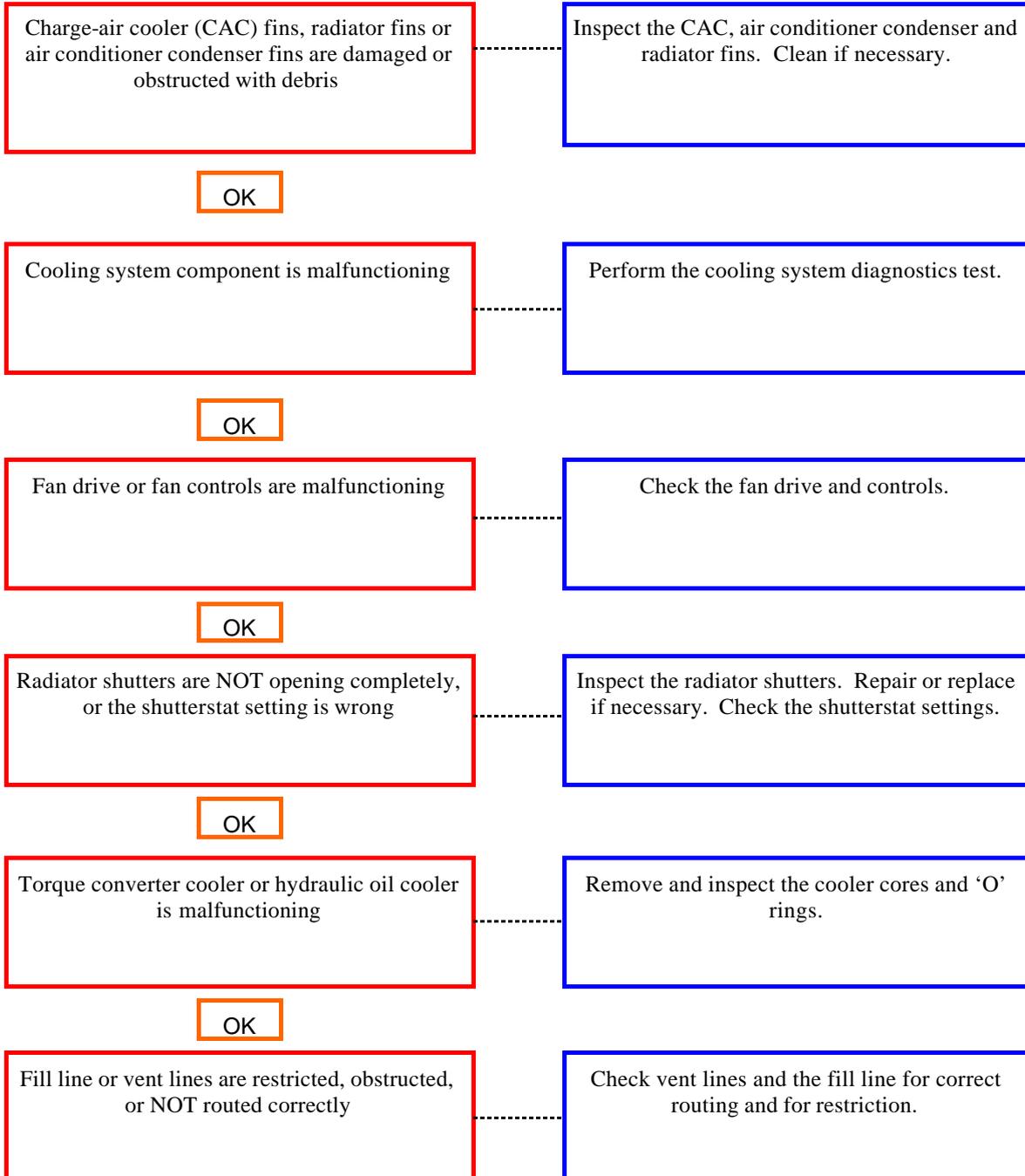
COOLANT LOSS—INTERNAL



COOLANT TEMPERATURE IS ABOVE NORMAL—SUDDEN OVERHEAT



COOLANT TEMPERATURE IS ABOVE NORMAL—SUDDEN OVERHEAT



COOLANT TEMPERATURE IS BELOW NORMAL

Cause

Correction

Coolant temperature gauge or sensor is malfunctioning	Test the gauge and the sensor. Repair or replace if necessary.
OK	
Electronic fault codes active or high counts or inactive fault codes	Refer to section TF in the troubleshooting and repair manual
OK	
Engine operating at a low ambient temperature	Check the winterfront, shutters and canopy air. Use intake air from under the canopy in cold weather.
OK	
Thermostat is NOT correct or is malfunctioning	Check the thermostat for the correct part number and correct operation.
OK	
Coolant flow through the radiator is NOT correct	Check for correct coolant flow through the radiator.
OK	
Fan drive or fan controls are malfunctioning	Check the fan drive and controls

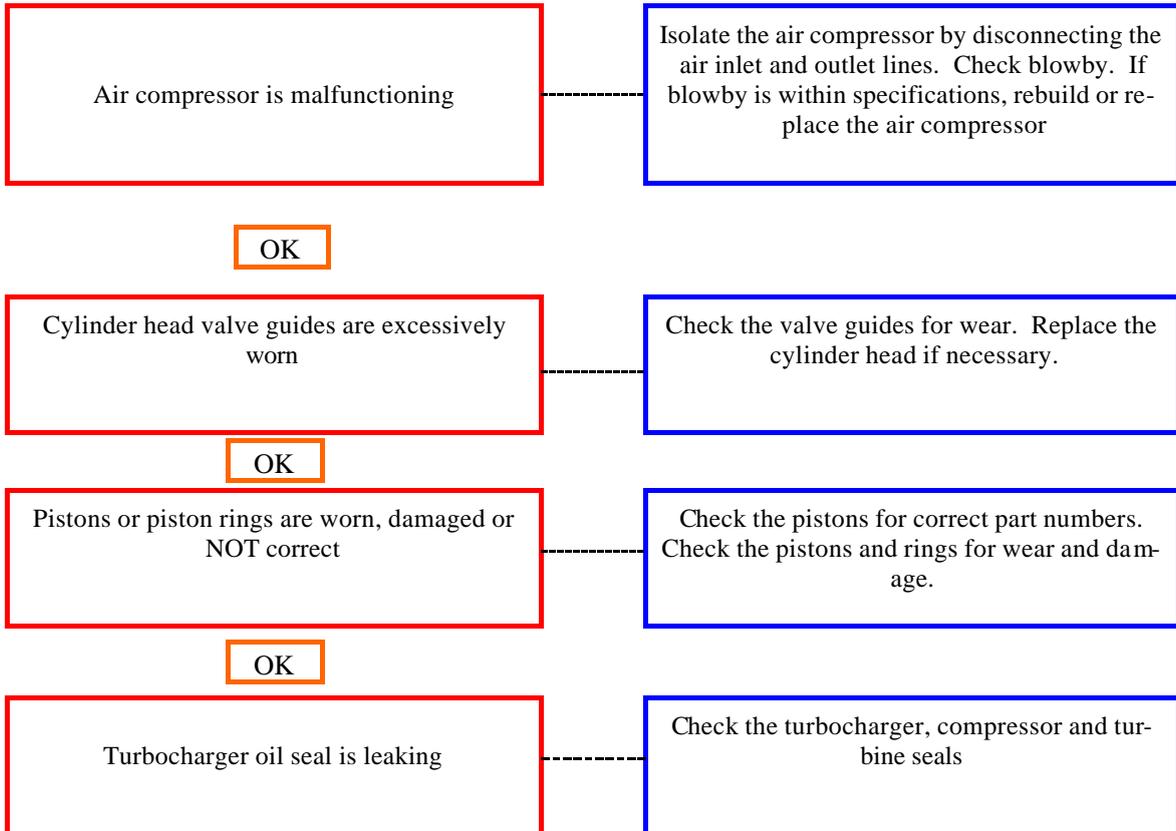
COOLANT IN THE LUBRICATING OIL

Cause

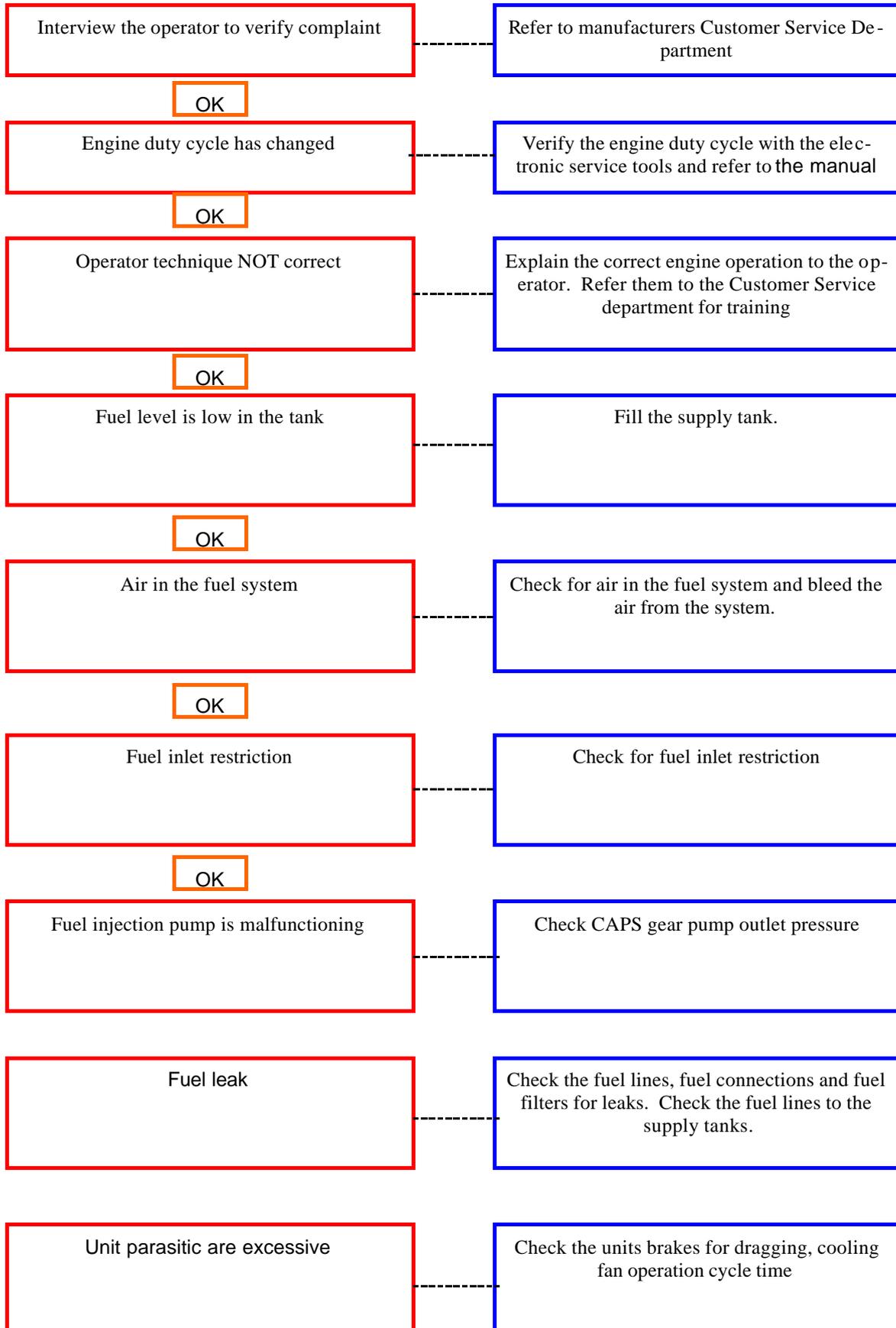
Correction

Lubricating oil cooler is malfunctioning	Check the oil cooler
OK	
Air compressor cylinder head is cracked or porous or has a leaking gasket	Inspect the air compressor cylinder head and gasket
OK	
Aftercooler is leaking (Aftercooled engines only)	Remove and pressure-test the aftercooler.
OK	
Cylinder head core and expansion plugs leaking or misassembled.	Check cylinder head
OK	
Cylinder block is cracked or porous.	Inspect the cylinder block
OK	
Cylinder liner is corroded or cracked	Check the cylinder liners for corrosion or cracks.

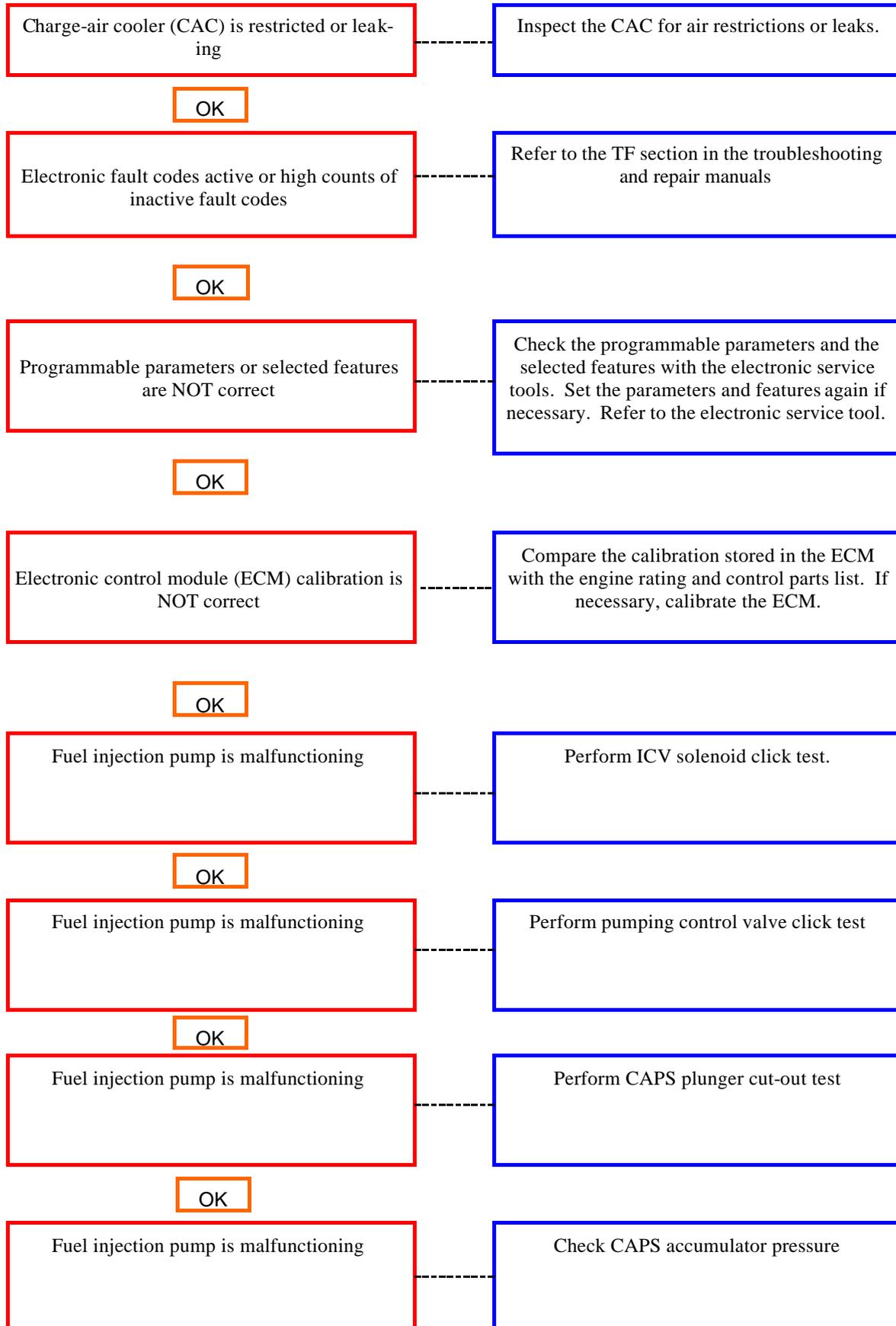
CRANKCASE GASES (BLOWBY) EXCESSIVE



ENGINE ACCELERATION OR RESPONSE POOR



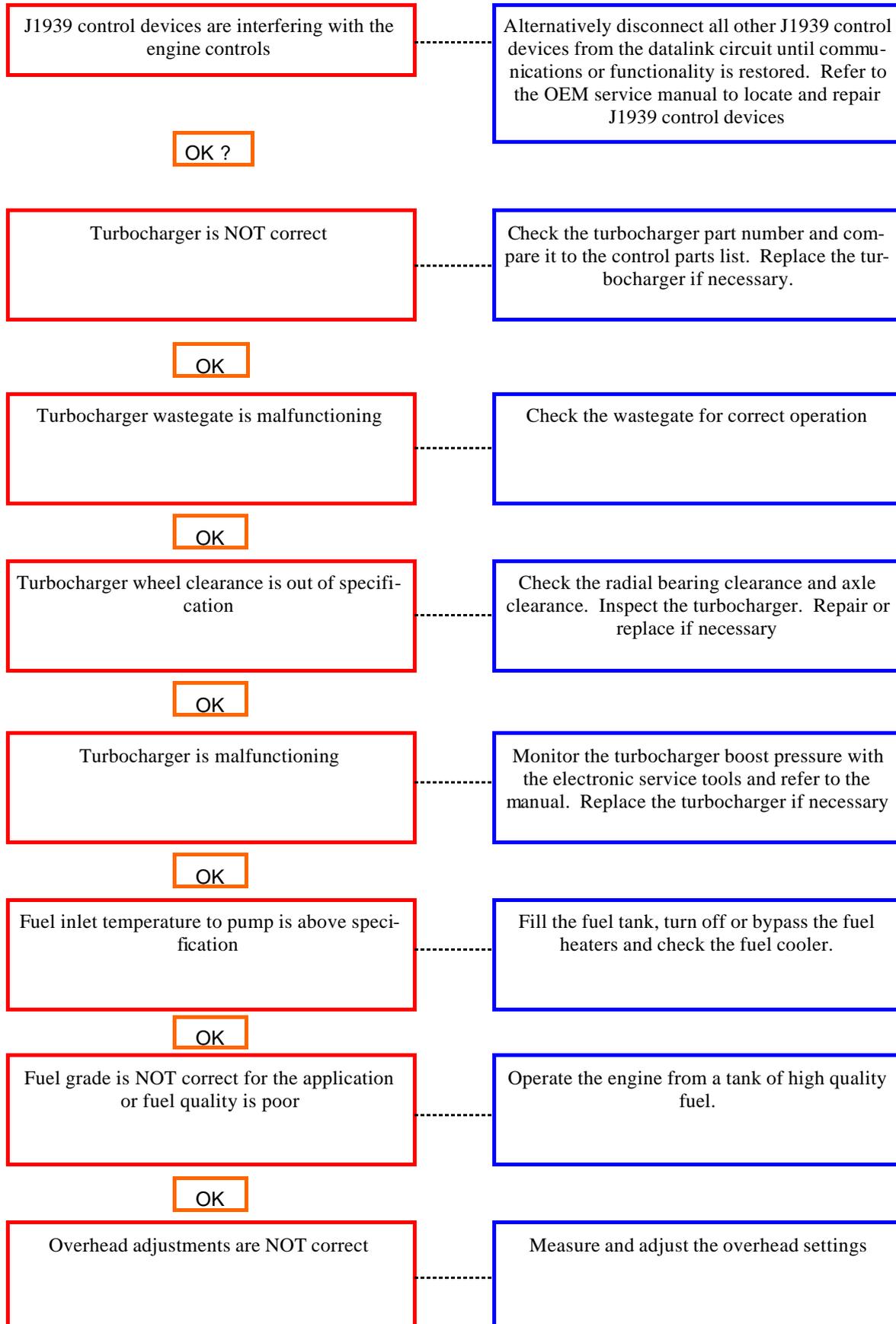
ENGINE ACCELERATION OR RESPONSE POOR (CONT)



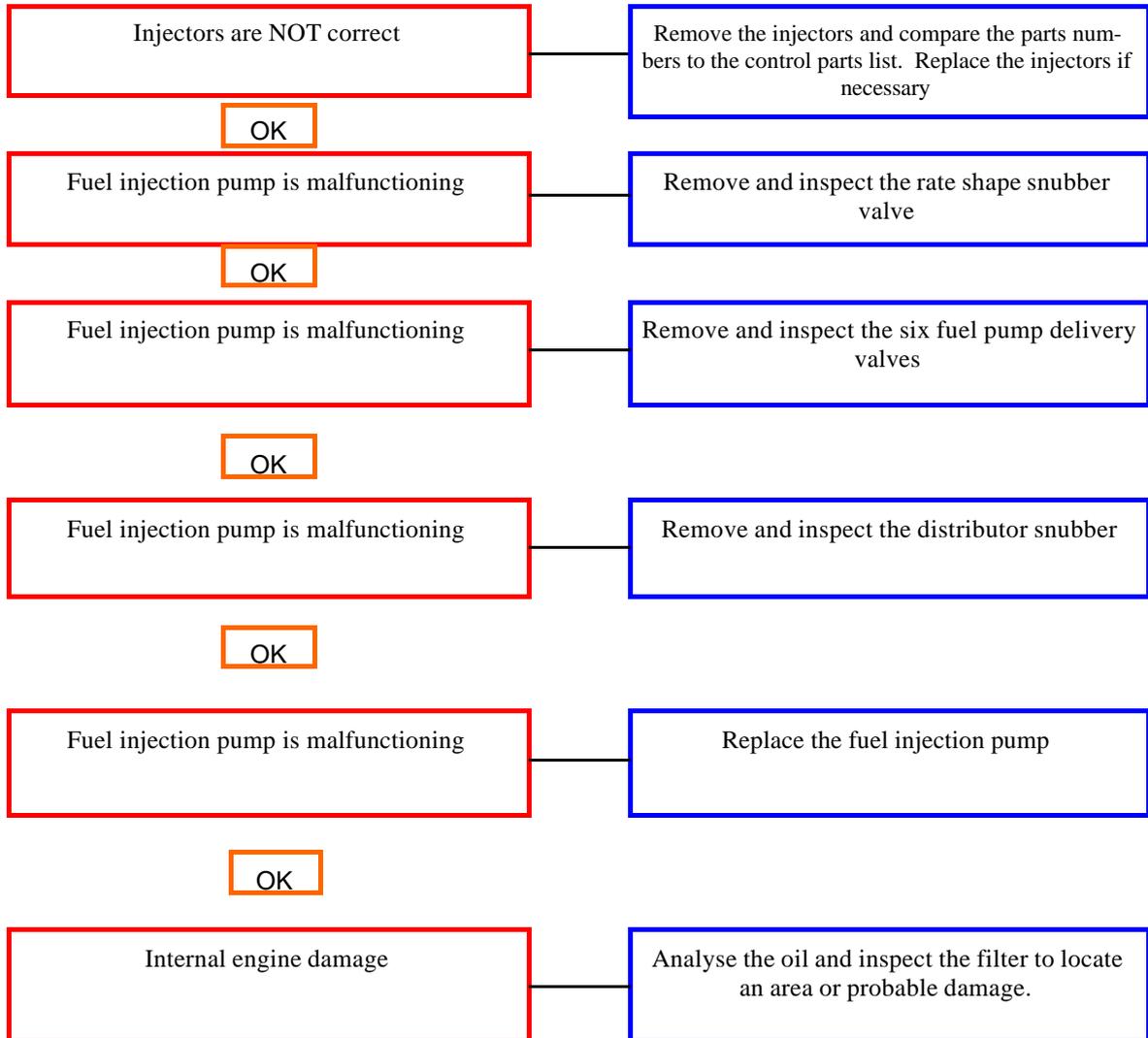
ENGINE ACCELERATION OR RESPONSE POOR (CONT)

Intake manifold pressure (boost) sensor or circuit is malfunctioning	Check boost sensor circuit
OK	
Engine speed sensor (ESS) or circuit is malfunctioning	Check ESS for correct adjustment and debris on the sensor. Check the ESS circuit.
OK	
Ambient air pressure sensor is malfunctioning (if equipped)	Check the ambient air temperature sensor.
OK	
Fuel supply line restriction between the fuel pump and the injectors.	Check the fuel supply line from the fuel pump to the cylinder head for sharp bends that can cause restrictions
OK	
Fuel connector is leaking	Perform the automated cylinder performance test to isolate the cylinder with the leaking fuel connector. Inspect the fuel connector and injector for nicks and damage that can cause fuel leaks
OK	
Injector is malfunctioning	Perform the automated cylinder performance test
OK	
Air intake or exhaust leaks	Inspect the air intake and exhaust systems for air leaks
OK	
Air intake system restriction is above specification	Check the air intake system for restriction. Clean or replace the air filter and inlet piping if necessary
OK	
Exhaust system restriction is above specification	Check the exhaust system for restrictions

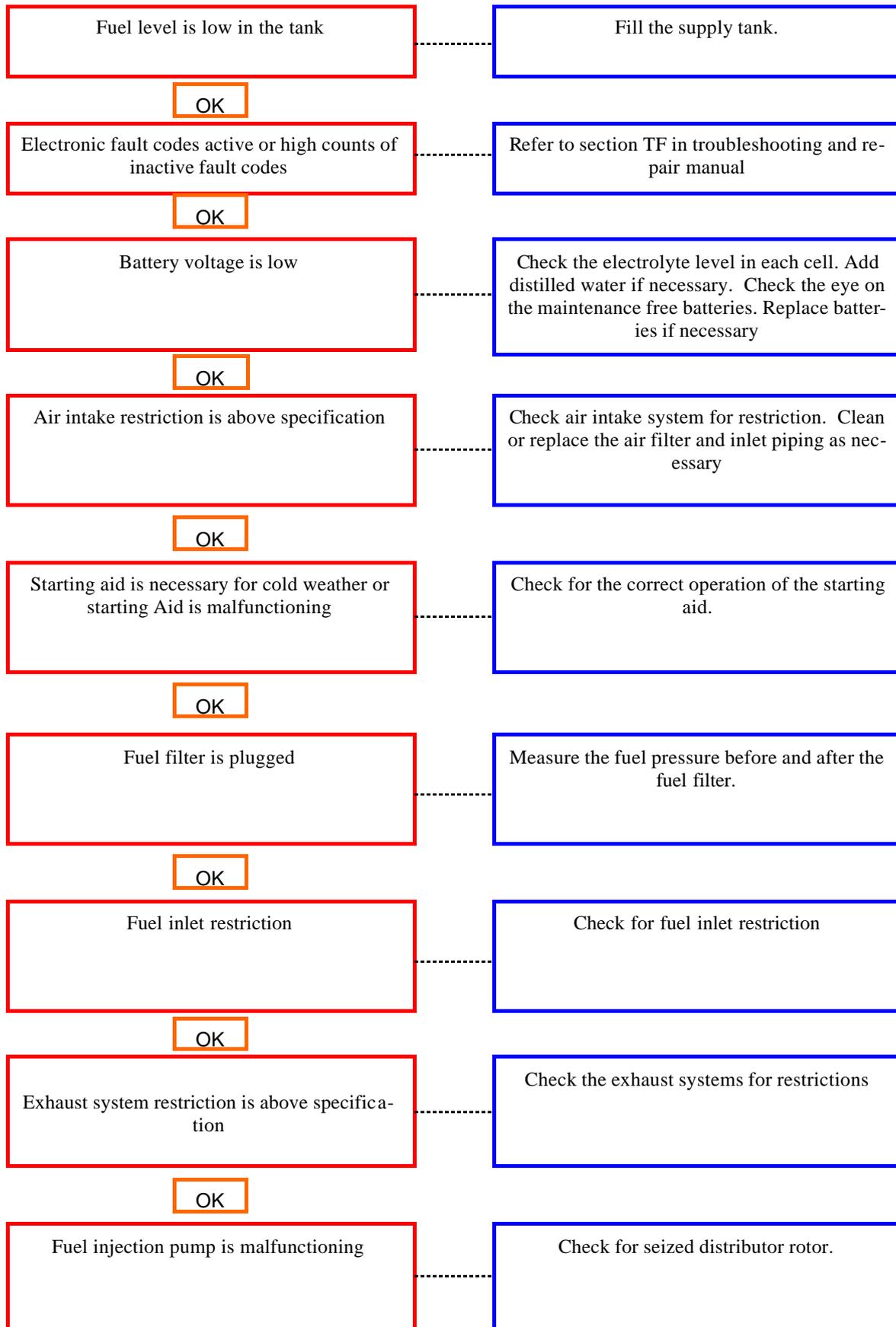
ENGINE ACCELERATION OR RESPONSE POOR(CONT)



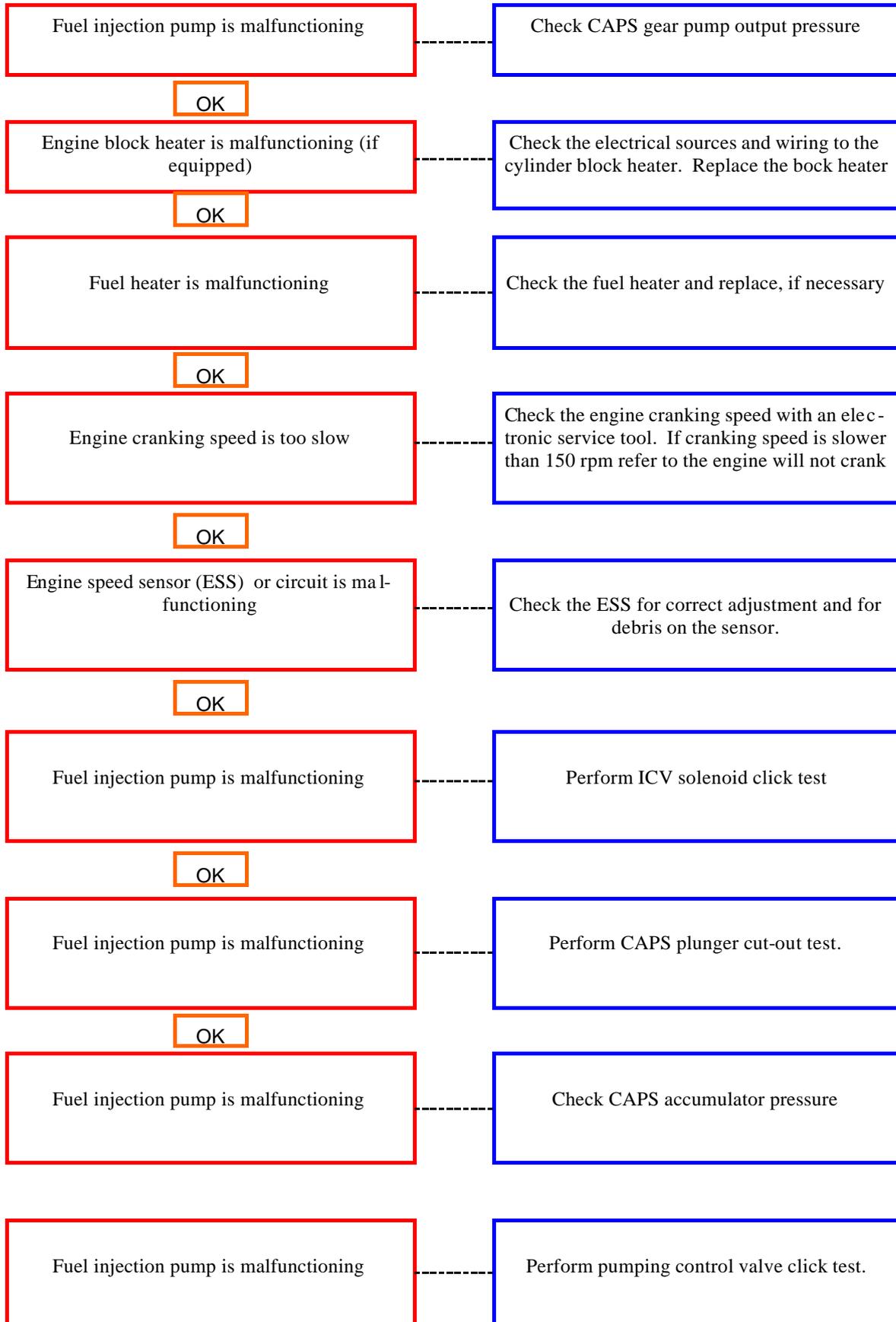
ENGINE ACCELERATION OR RESPONSE IS POOR (CONT)



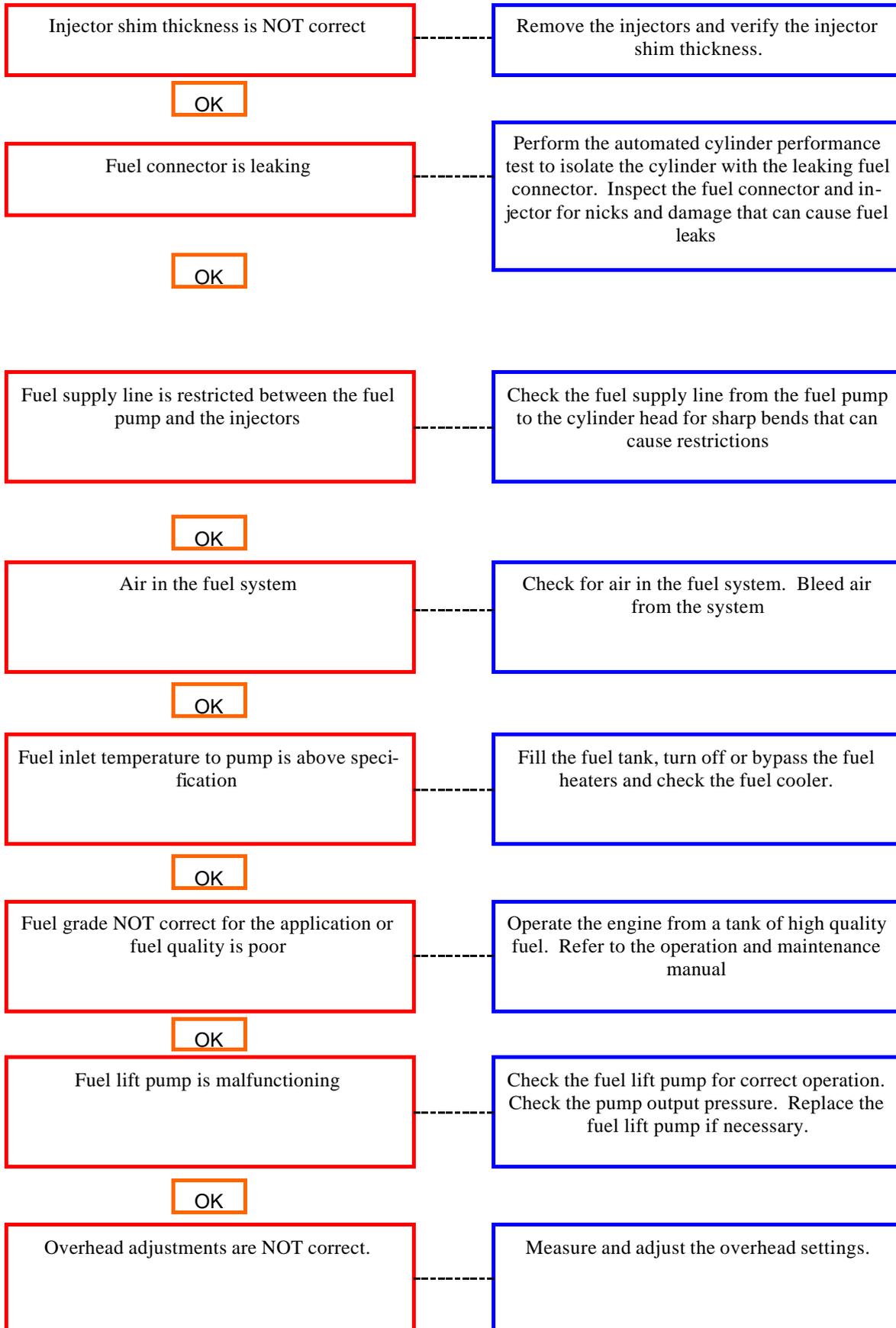
ENGINE IS DIFFICULT TO START OR WILL NOT START (EXHAUST



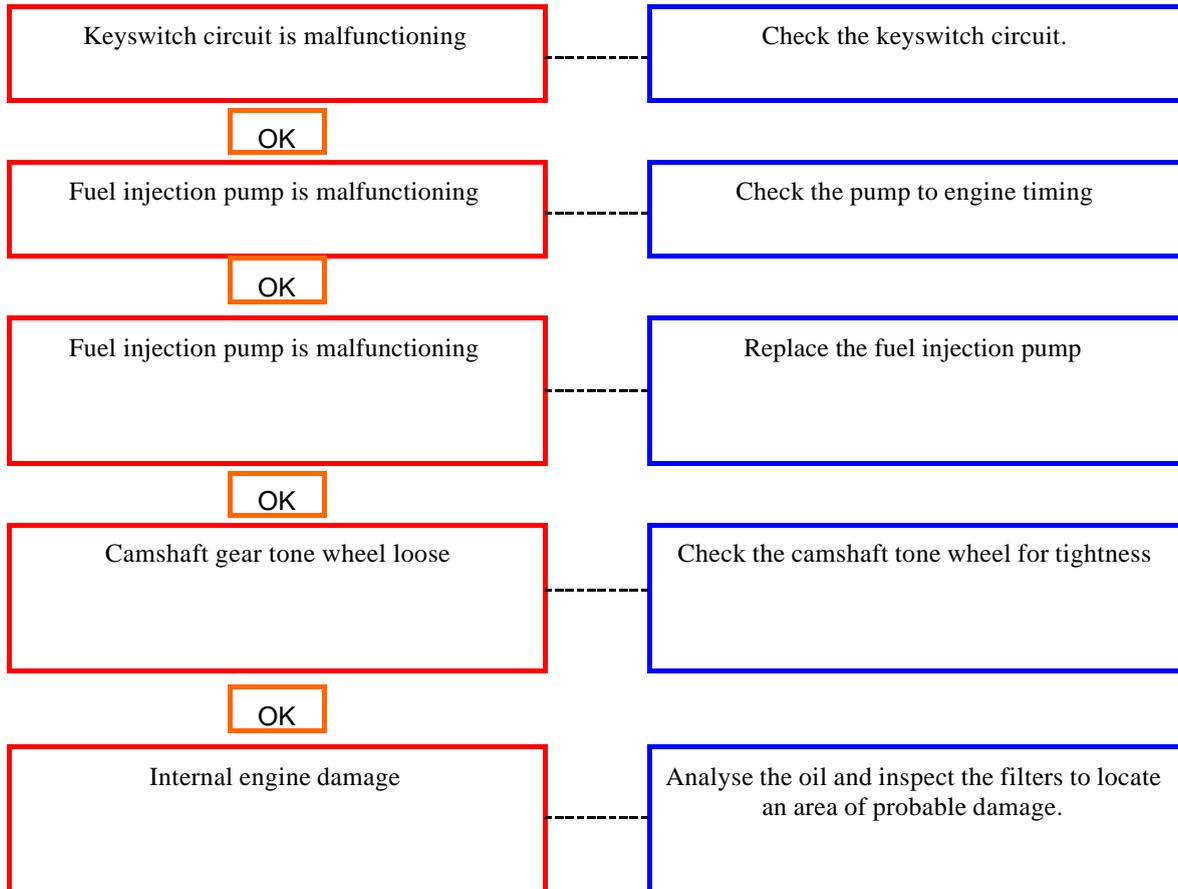
ENGINE DIFFICULT TO START OR WILL NOT START(EXHAUST SMOKE)



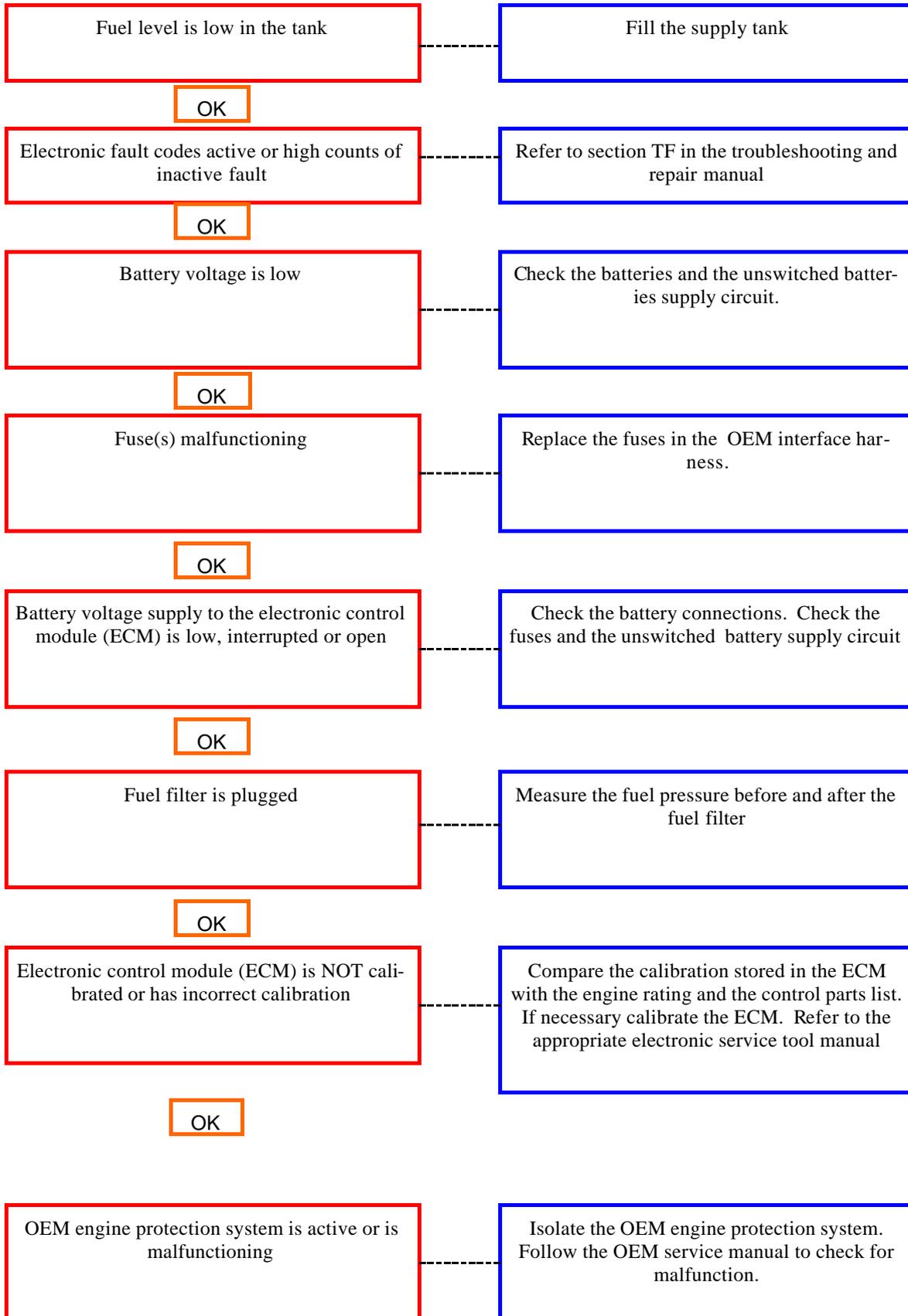
ENGINE DIFFICULT TO START OR WILL NOT START (EXHUAUST SMOKE)



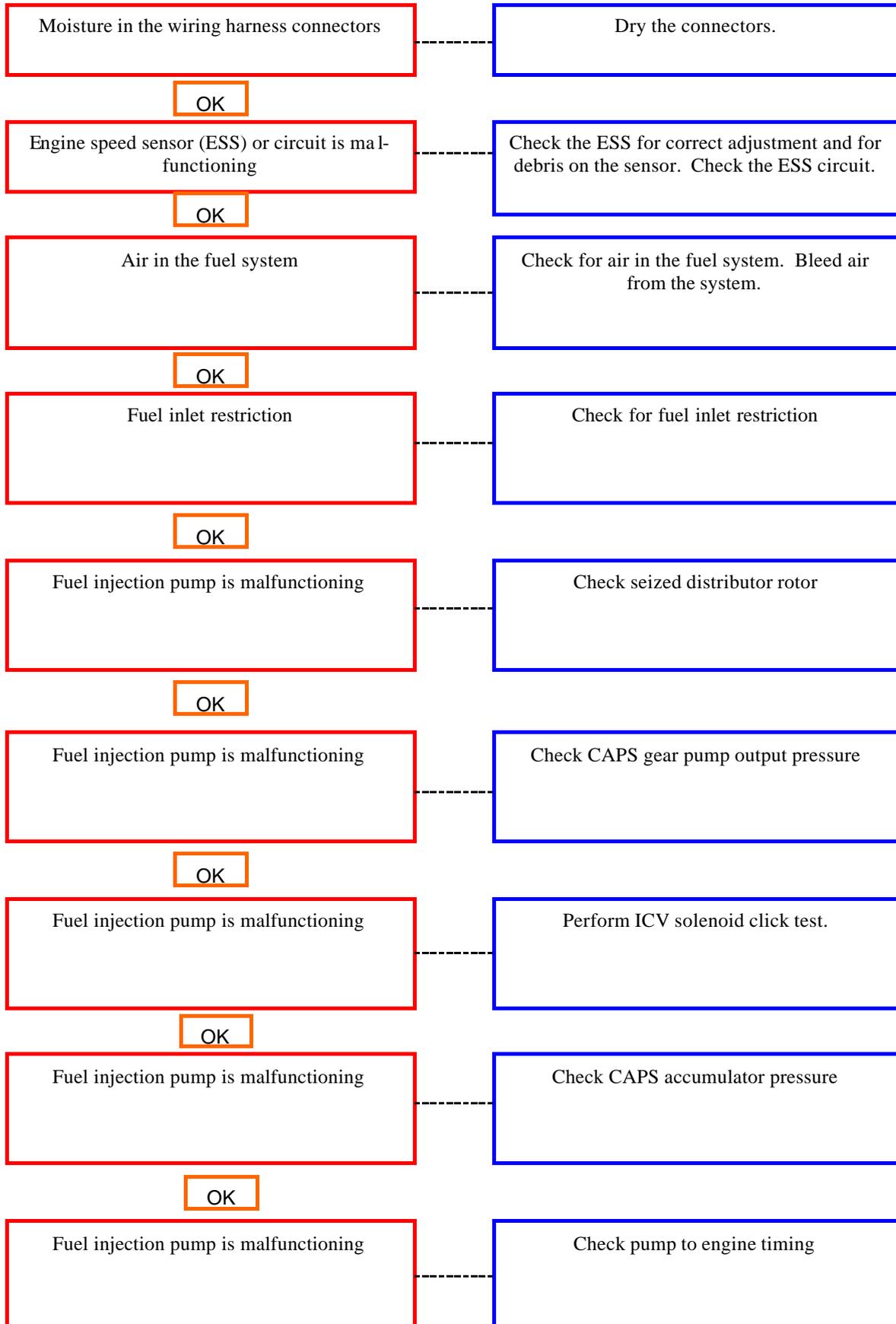
ENGINE DIFFICULT TO START OR WILL NOT START (EXHAUST SMOKE)



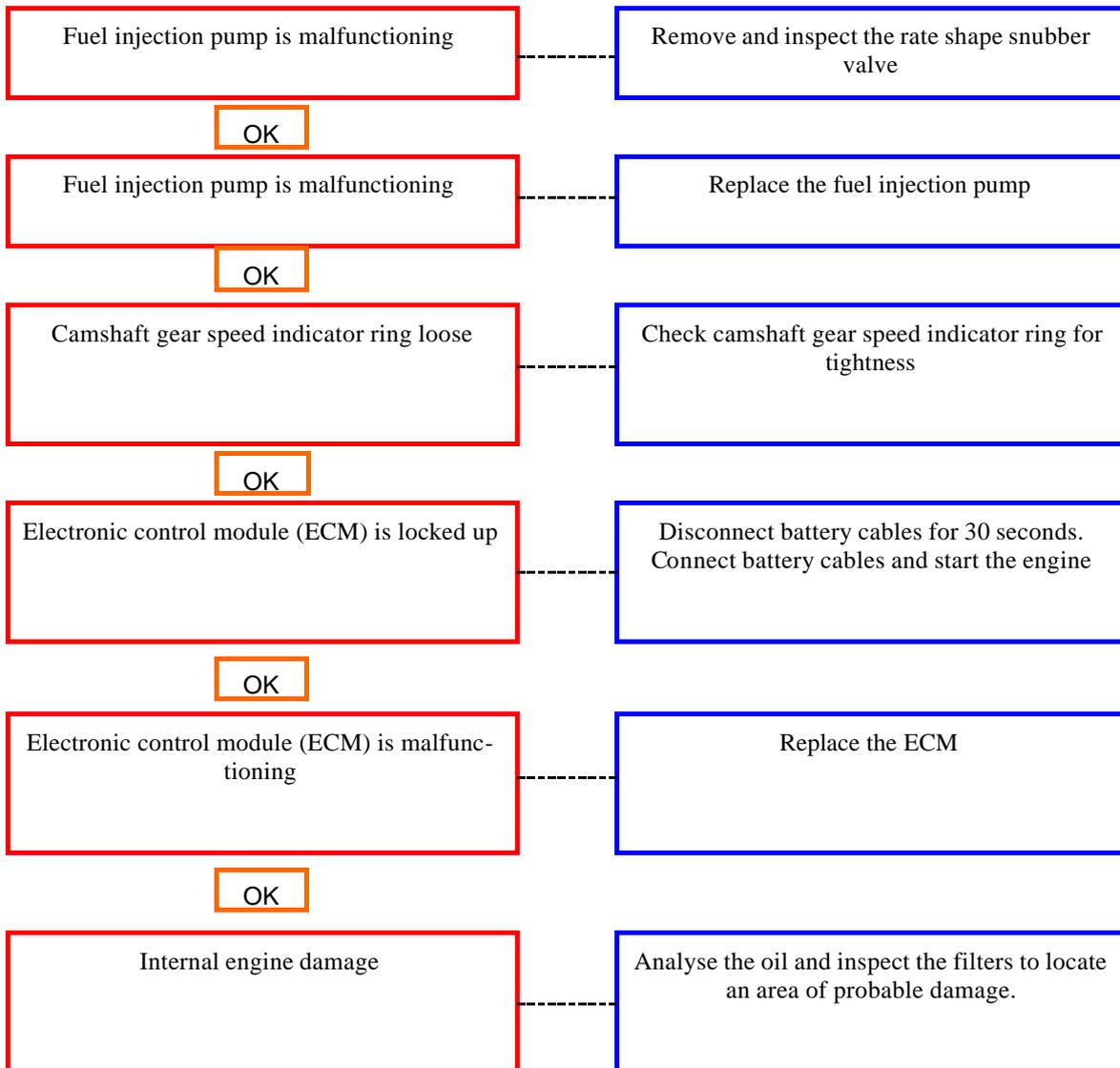
ENGINE DIFFICULT TO START OR WILL NOT START (NO EXHAUST



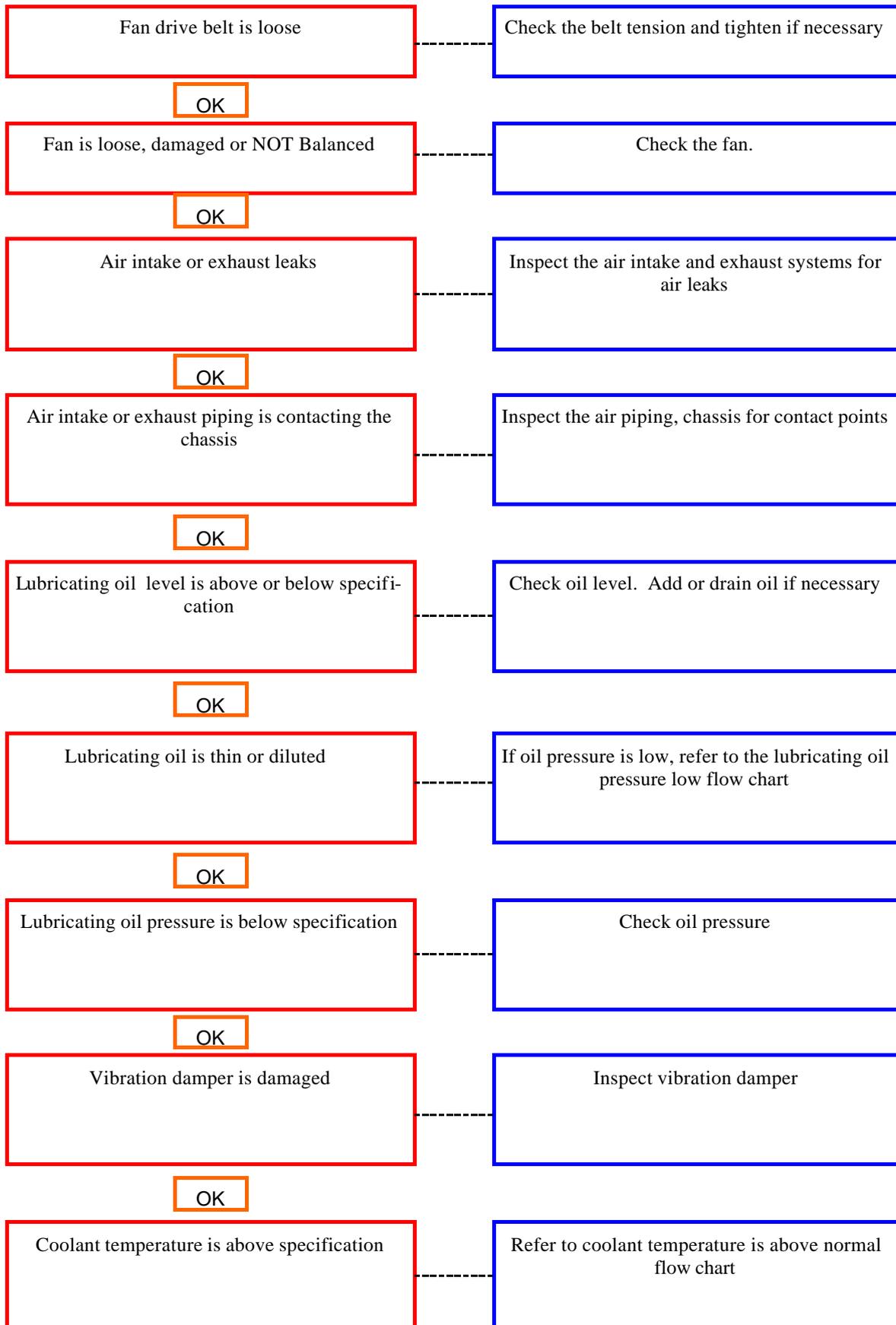
ENGINE DIFFICULT TO START OR WILL NOT START (NO EXHAUST)



ENGINE DIFFICULT TO START OR WILL NOT START (NO EXHAUST)



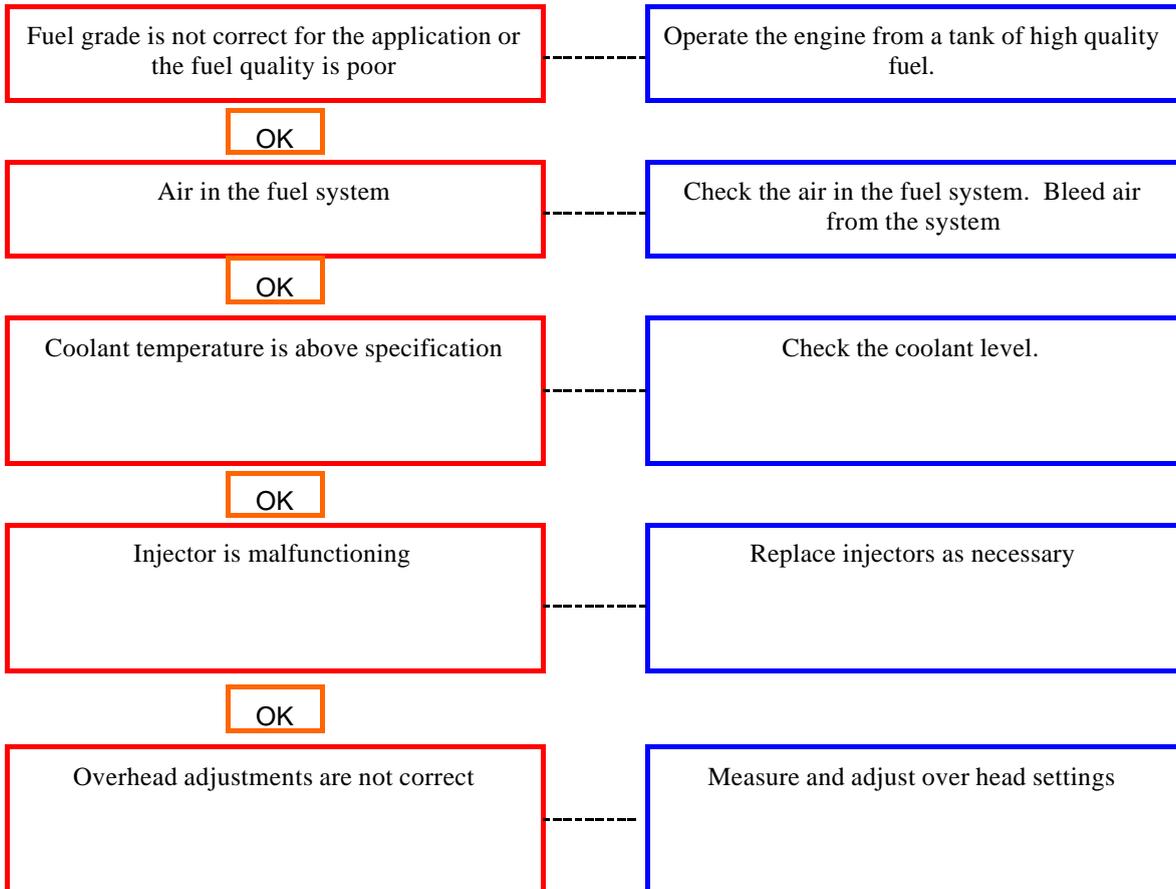
ENGINE NOISE EXCESSIVE



ENGINE NOISE EXCESSIVE (CONT)

Engine mounts are worn, damaged or not correct	Check the engine mounts
OK	
Overhead adjustments are not correct	Measure and adjust the overhead settings
OK	
Overhead components are damaged	Inspect rocker levers, rocker shafts and valves for damage or excessive wear
OK	
Injector is malfunctioning	Perform the single-cylinder cut-out test. Replace the injectors as necessary
OK	
Flywheel or flexplate capscrews are loose or broken	Check the flywheel or flexplate and the mounting capscrews.
OK	
Torque converter is loose	Check the torque converter.
OK	
Main bearing or connecting rod bearing noise	Refer to the OEM manual
OK	
Piston or piston rings are worn or damaged	Check for air intake system leaks. Check the pistons and piston rings for wear and damage.
OK	
Combustion noise excessive	Refer to engine noise excessive—combustion knock flow chart

ENGINE NOISE EXCESSIVE—COMBUSTION KNOCKS



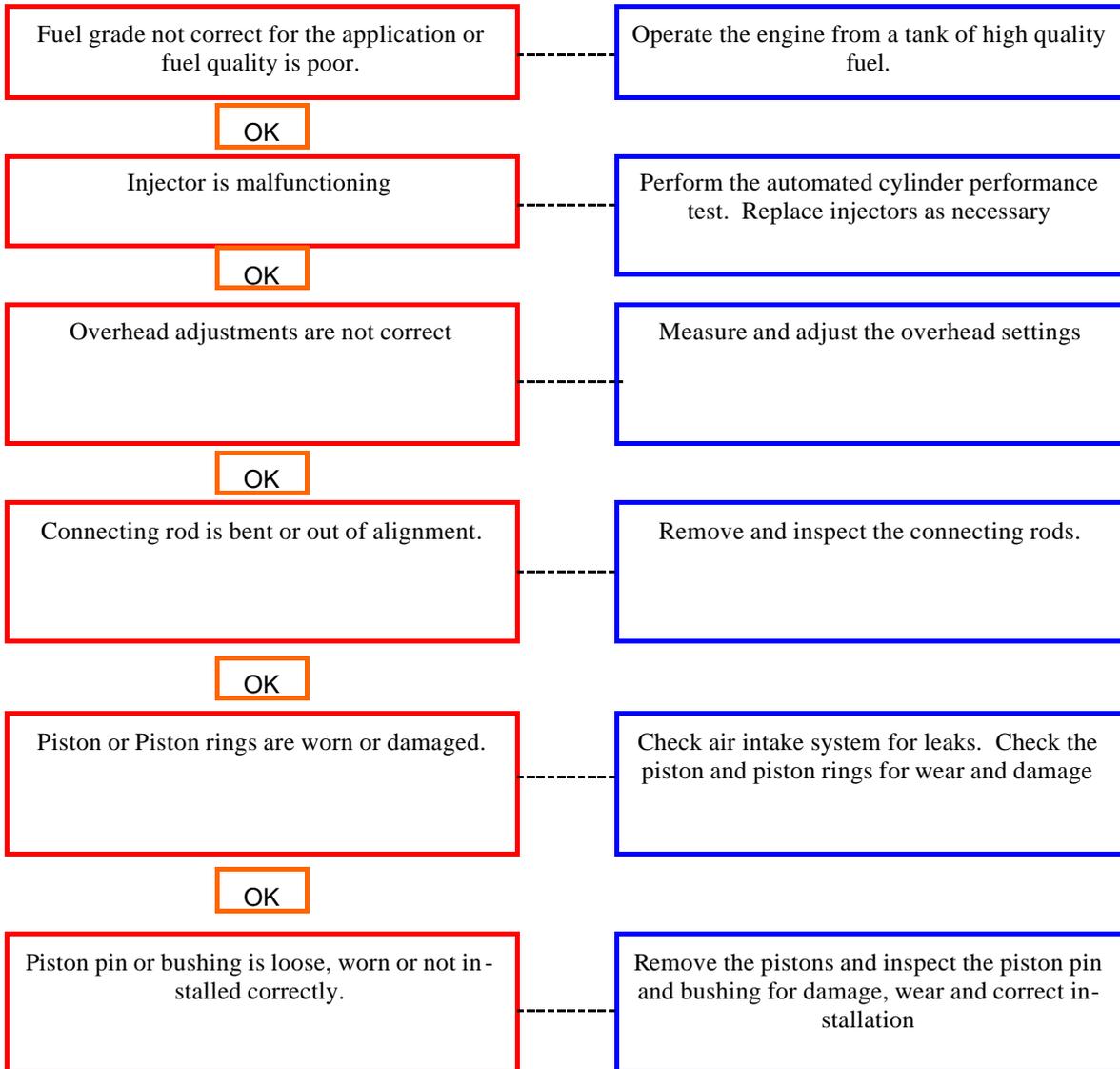
ENGINE NOISE EXCESSIVE—MAIN BEARING

Cause

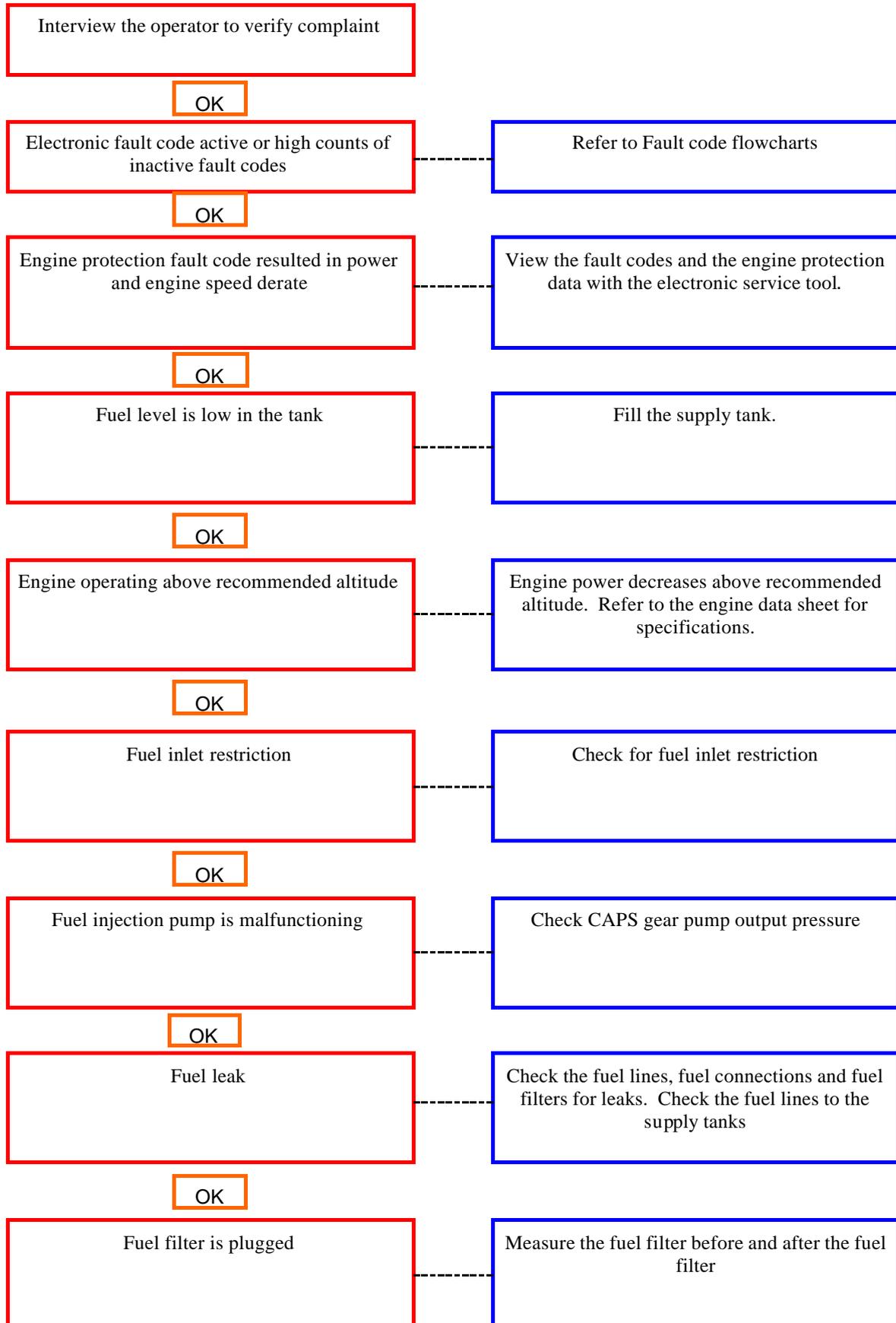
Correction

Lubricating oil pressure is below specification	Check oil pressure. Verify the dipstick calibration and the oil pan capacity. Fill the system to the specified level.
OK	
Main bearing capscrews are loose, worn or not tightened correctly	Check the torque on the main bearing capscrew. Inspect capscrews for wear
OK	
Main bearings are damaged or worn or the wrong bearings are installed.	Inspect the main bearings for damage, excessive wear and the correct part number.
OK	
Crankshaft journals are damaged or out of round	Inspect the crankshaft journals

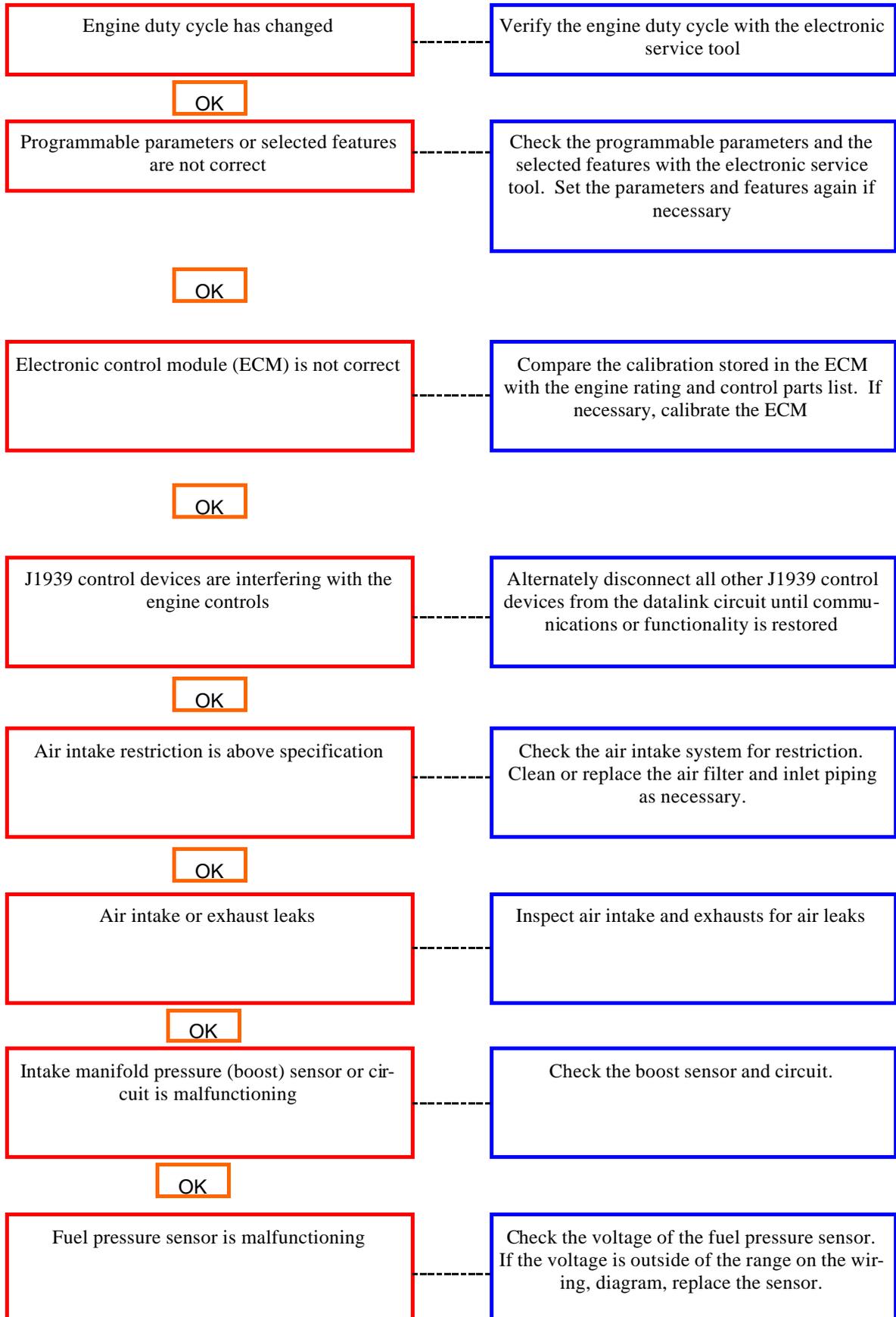
ENGINE NOISE EXCESSIVE—PISTON



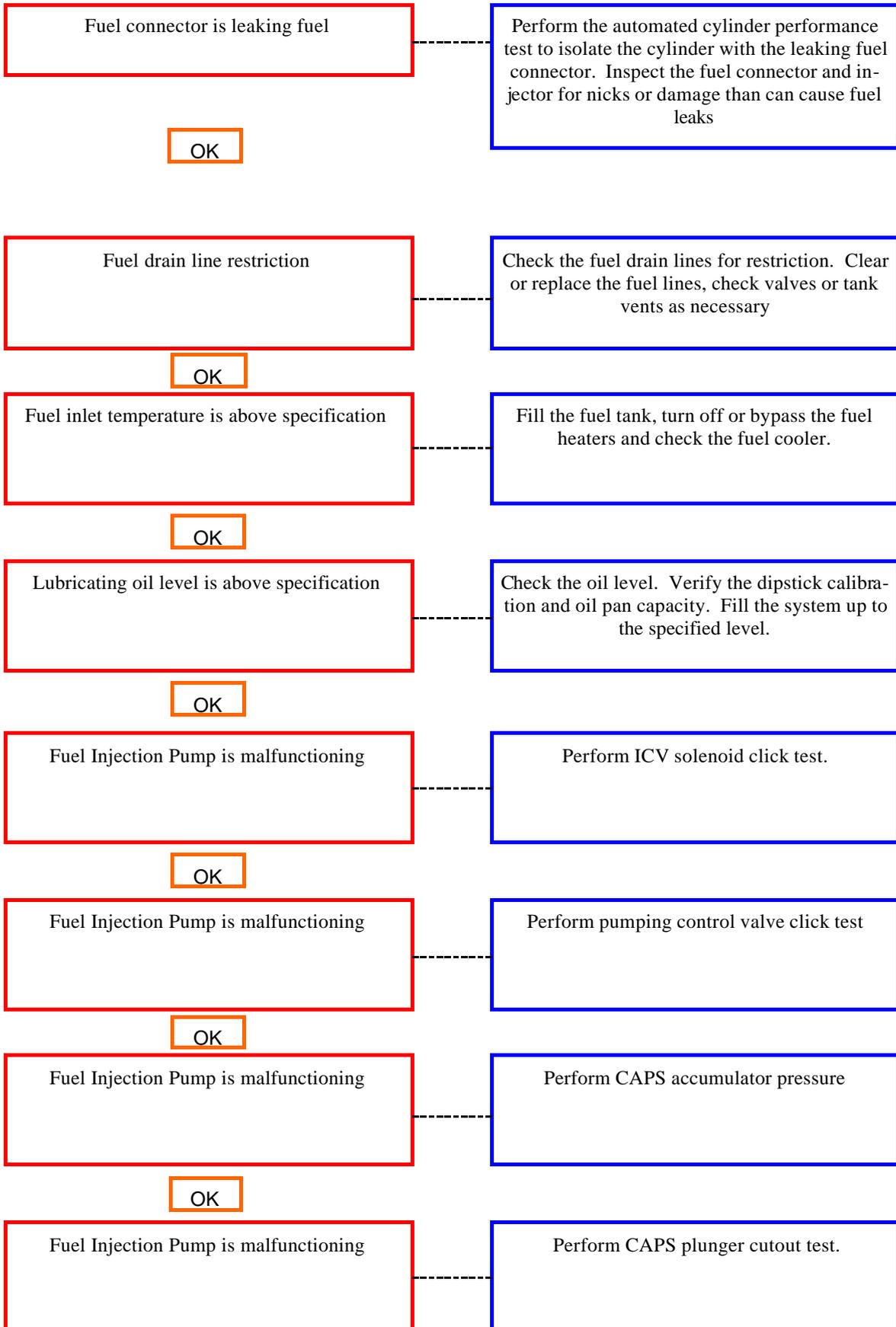
ENGINE POWER OUTPUT LOW



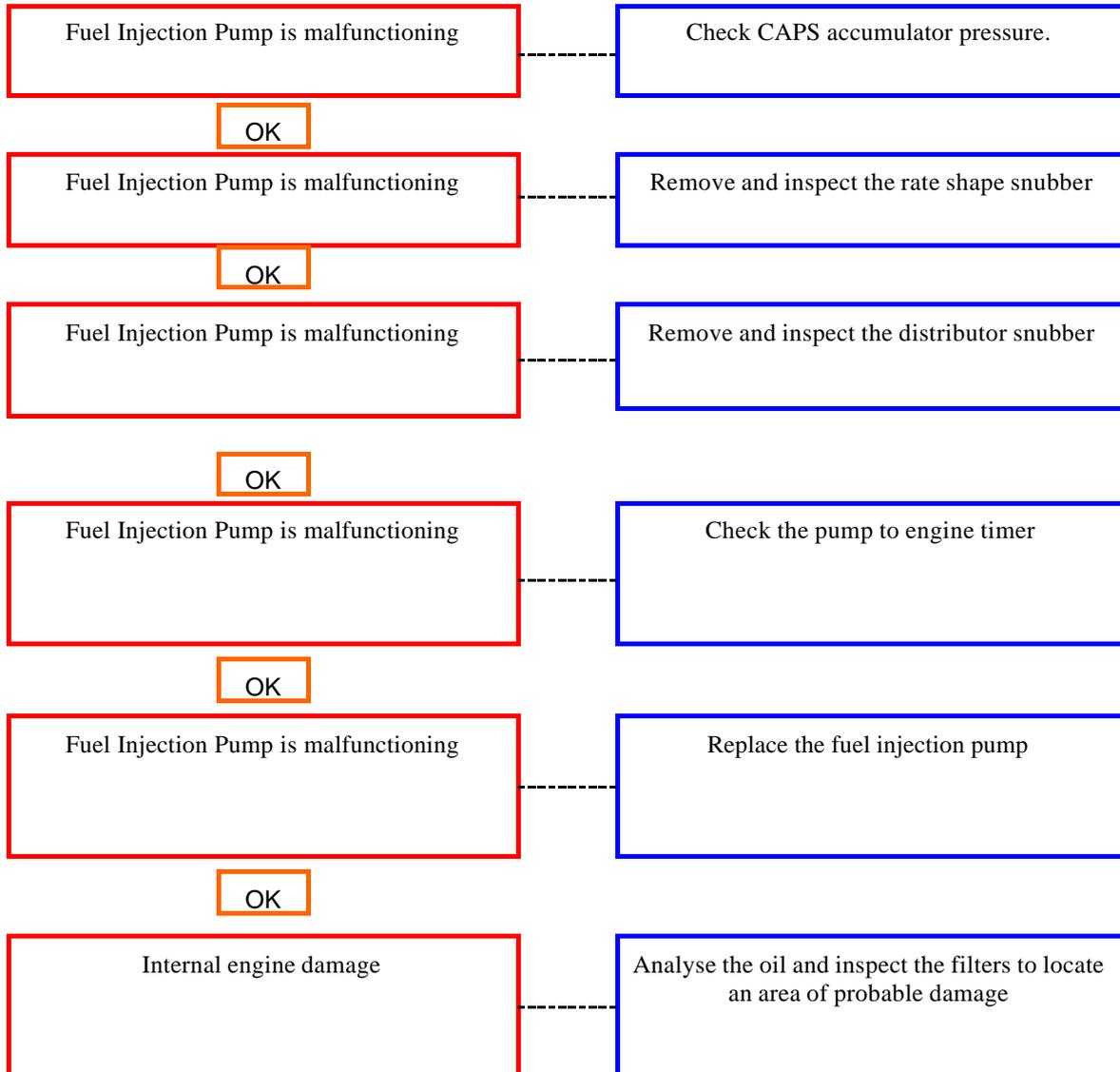
ENGINE POWER OUTPUT LOW (cont)



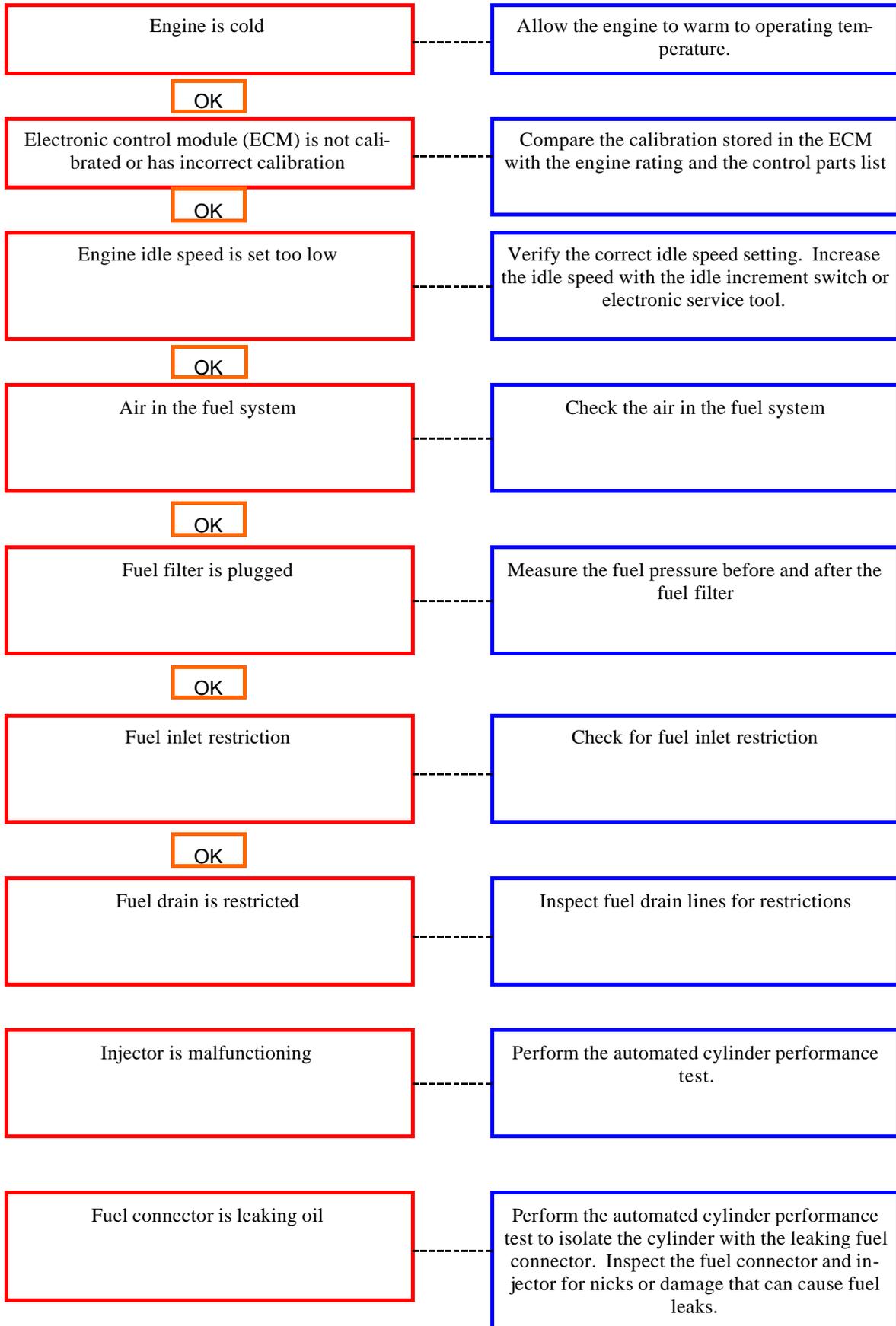
ENGINE POWER OUTPUT LOW (cont)



ENGINE POWER OUTPUT LOW (cont)



ENGINE RUNS THROUGH AT IDLE



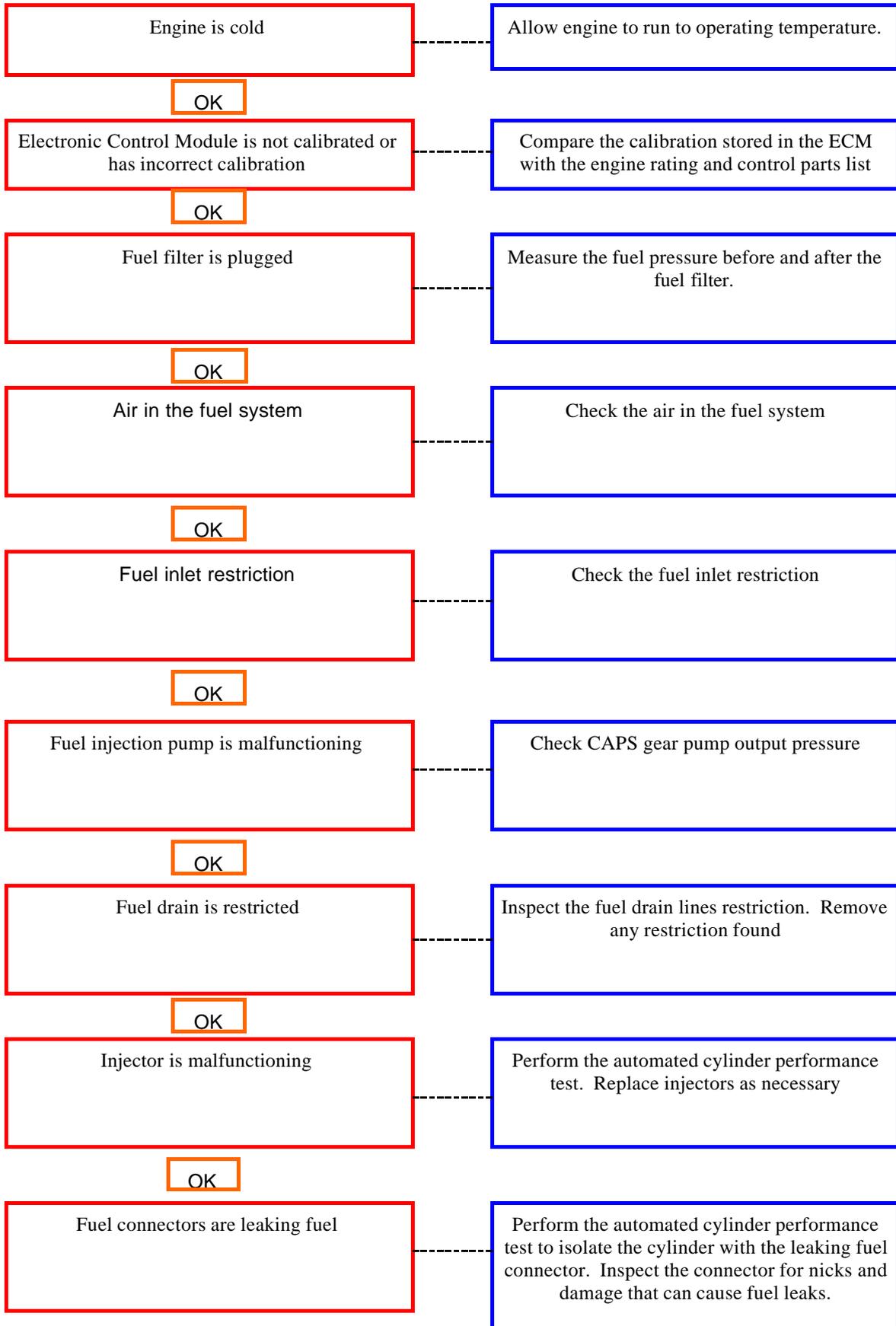
ENGINE RUNS THROUGH AT IDLE (cont)

Cause

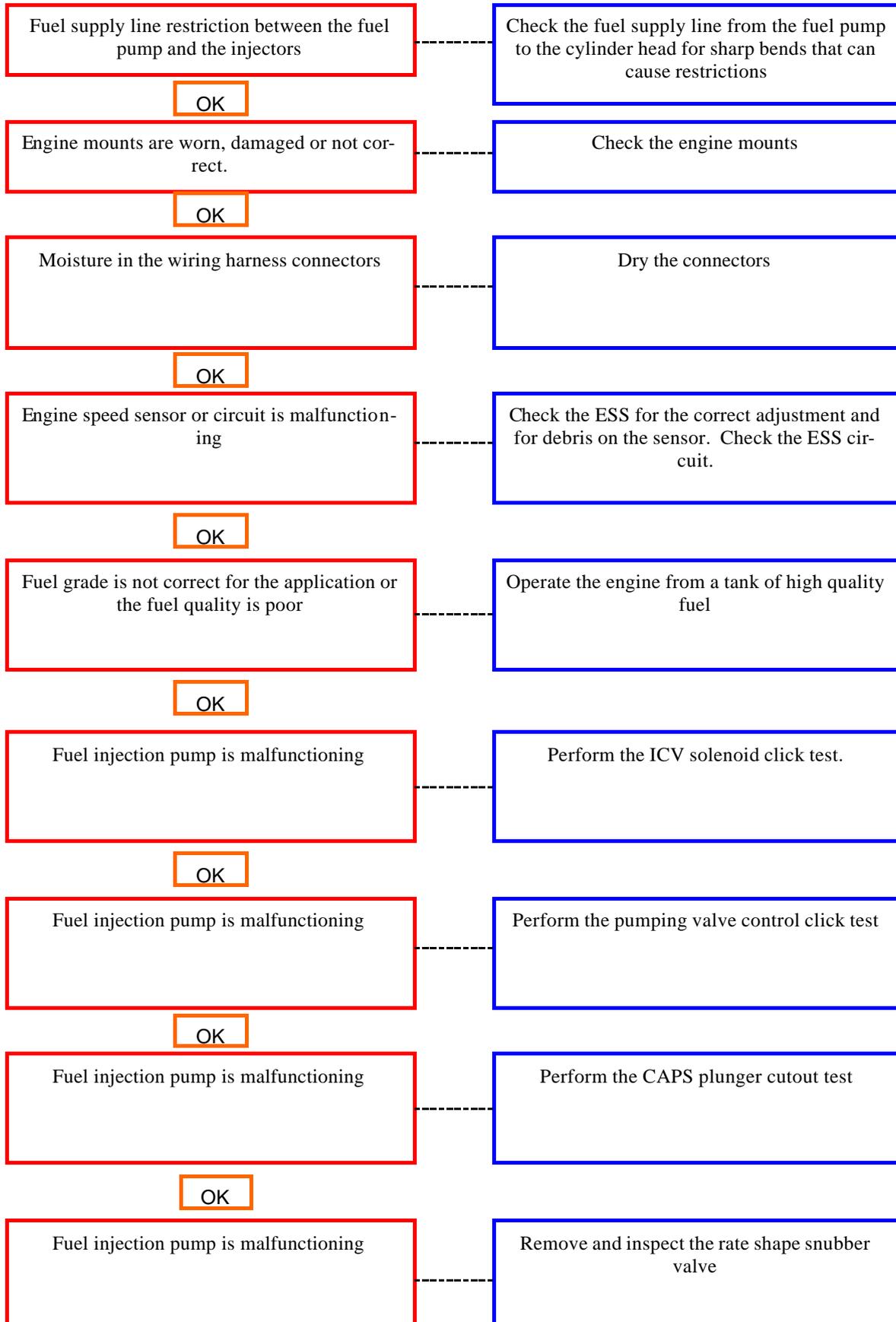
Correction

Fuel supply line restriction between the fuel pump and the injectors	Check the fuel supply line from the fuel pump to the cylinder head for sharp bends that can cause restrictions
OK	
Engine mounts are worn, damaged or not correct	Check the engine mounts.
OK	
Moisture in the wiring harness connectors	Dry the connectors
OK	
Engine speed sensor or circuit is malfunctioning	Check the ESS for correct adjustment and for debris on the sensor. Check the ESS circuit
OK	
Fuel grade not correct for the application or the fuel quality is poor	Operate the engine from a tank of high quality fuel

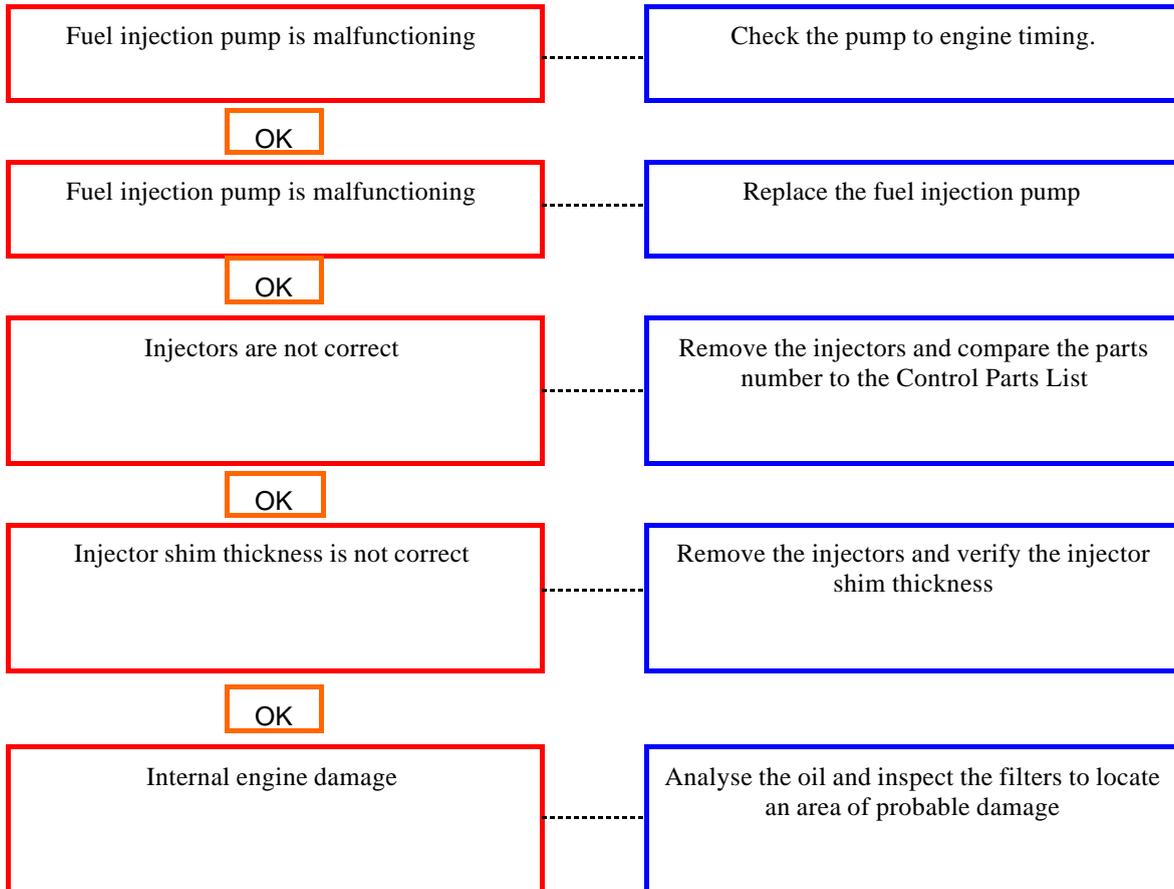
ENGINE RUNS ROUGH OR MISFIRES



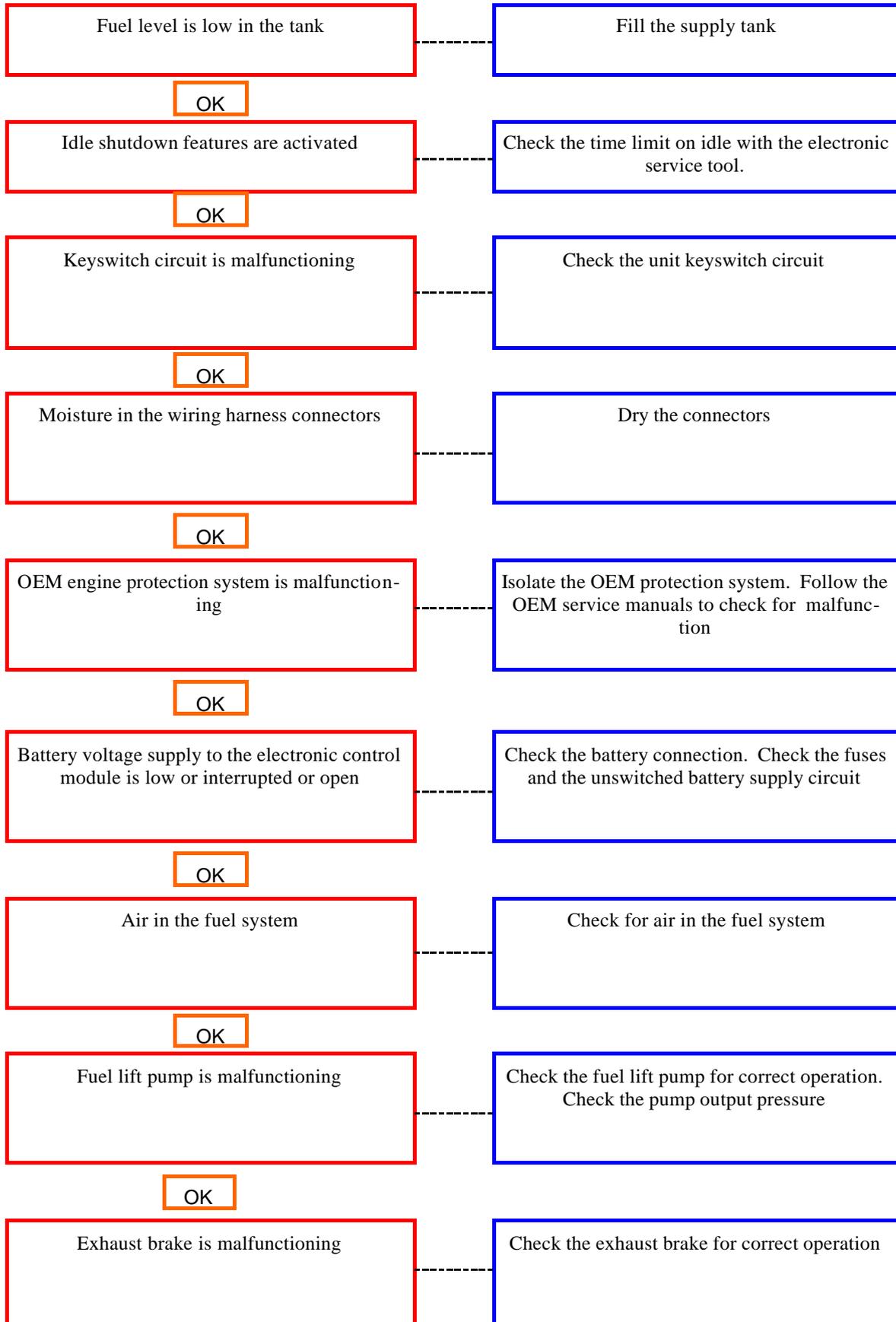
ENGINE RUNS ROUGH OR MISFIRES (cont)



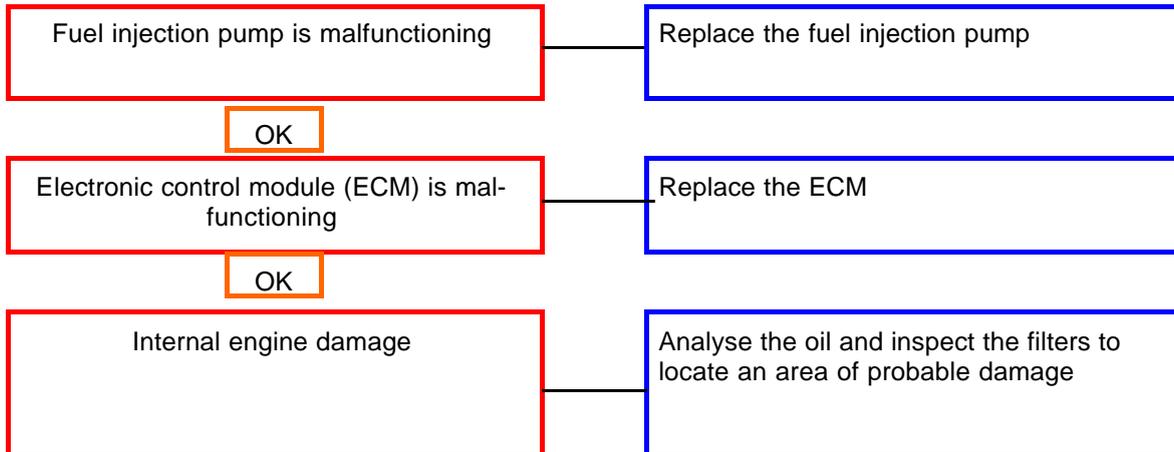
ENGINE RUNS ROUGH OR MISFIRES (cont)



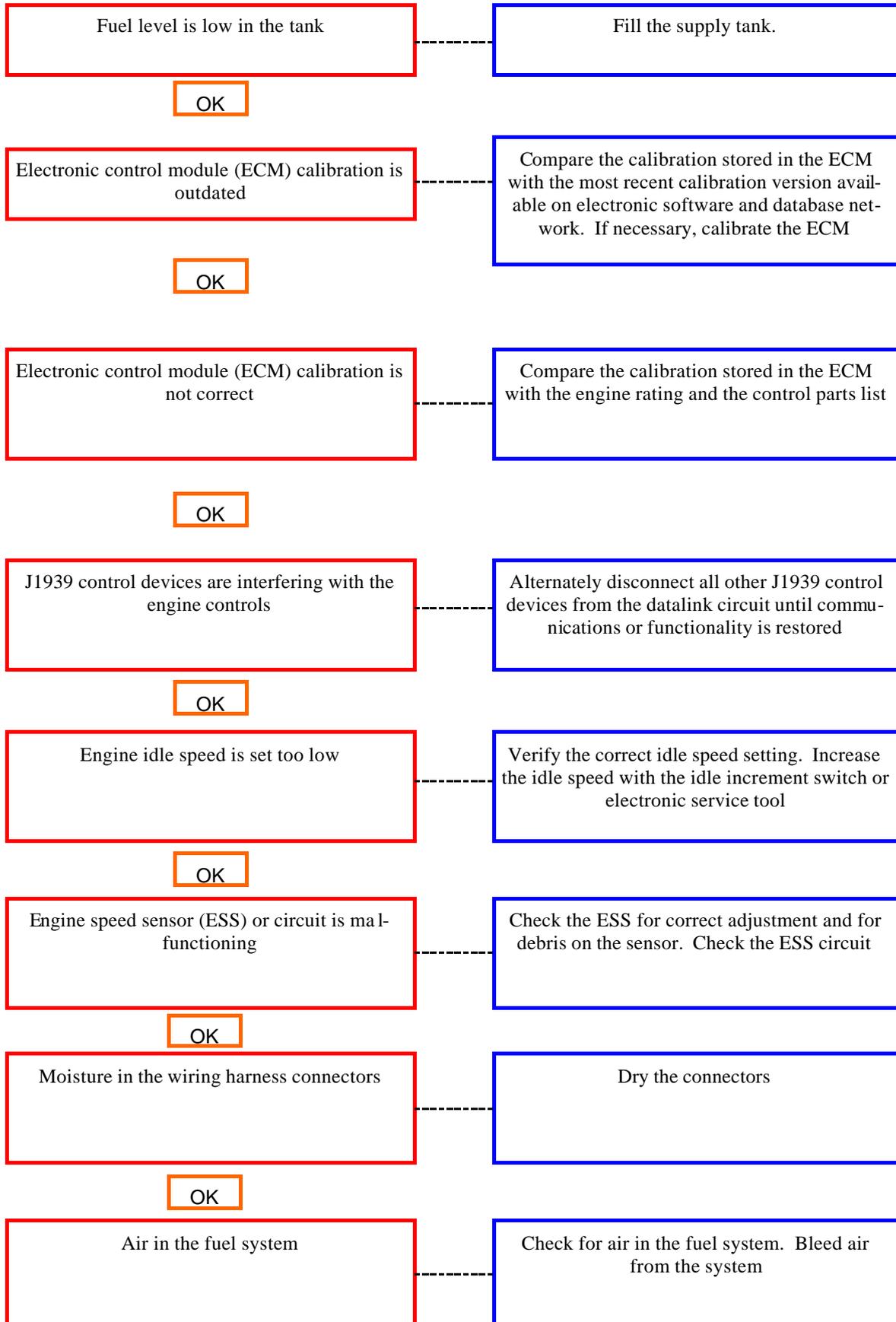
ENGINE SHUTS DOWN UNEXPECTEDLY or DIES DURING DECELERATION



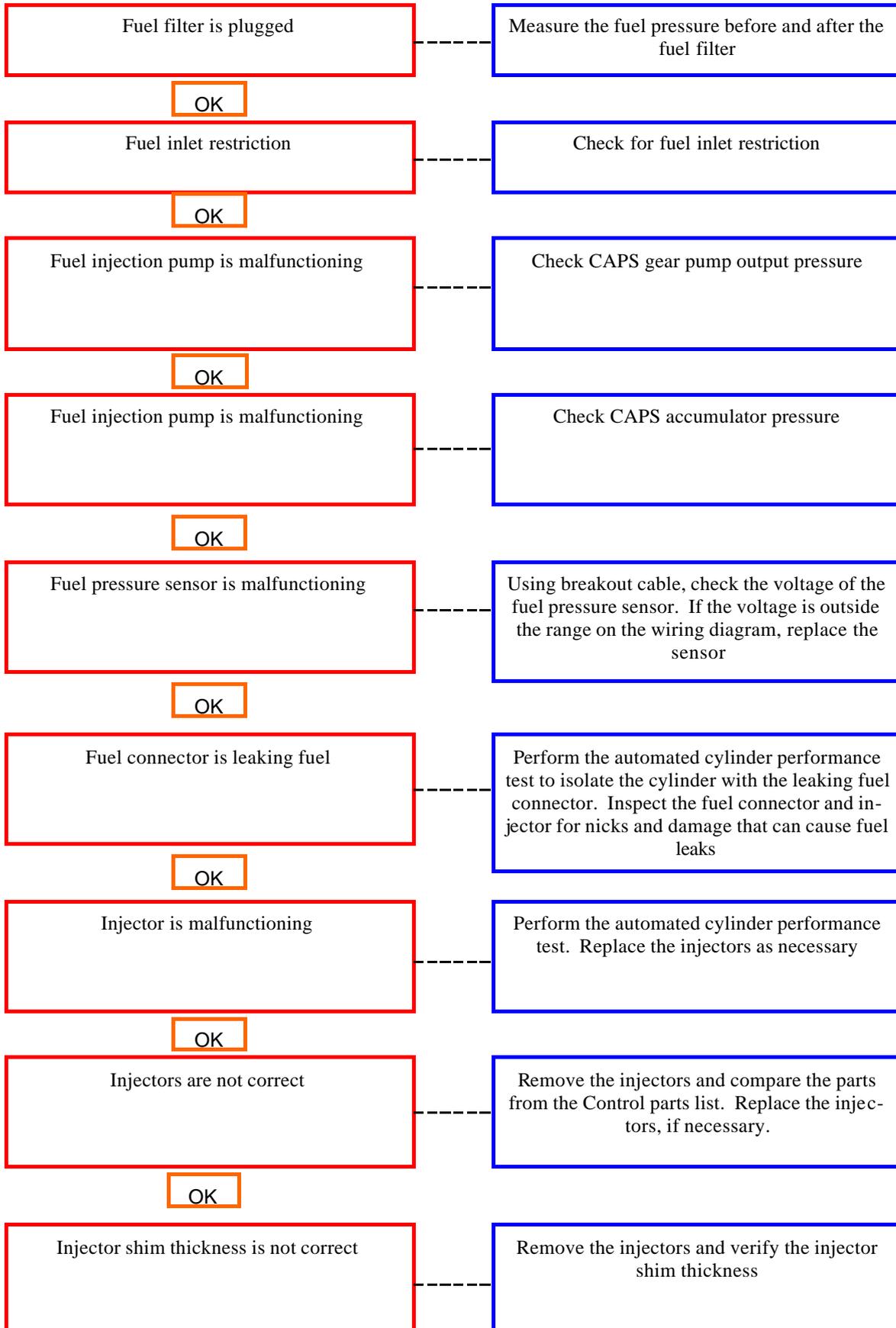
ENGINE SHUTS DOWN UNEXPECTEDLY or DIES DURING DECELERATION



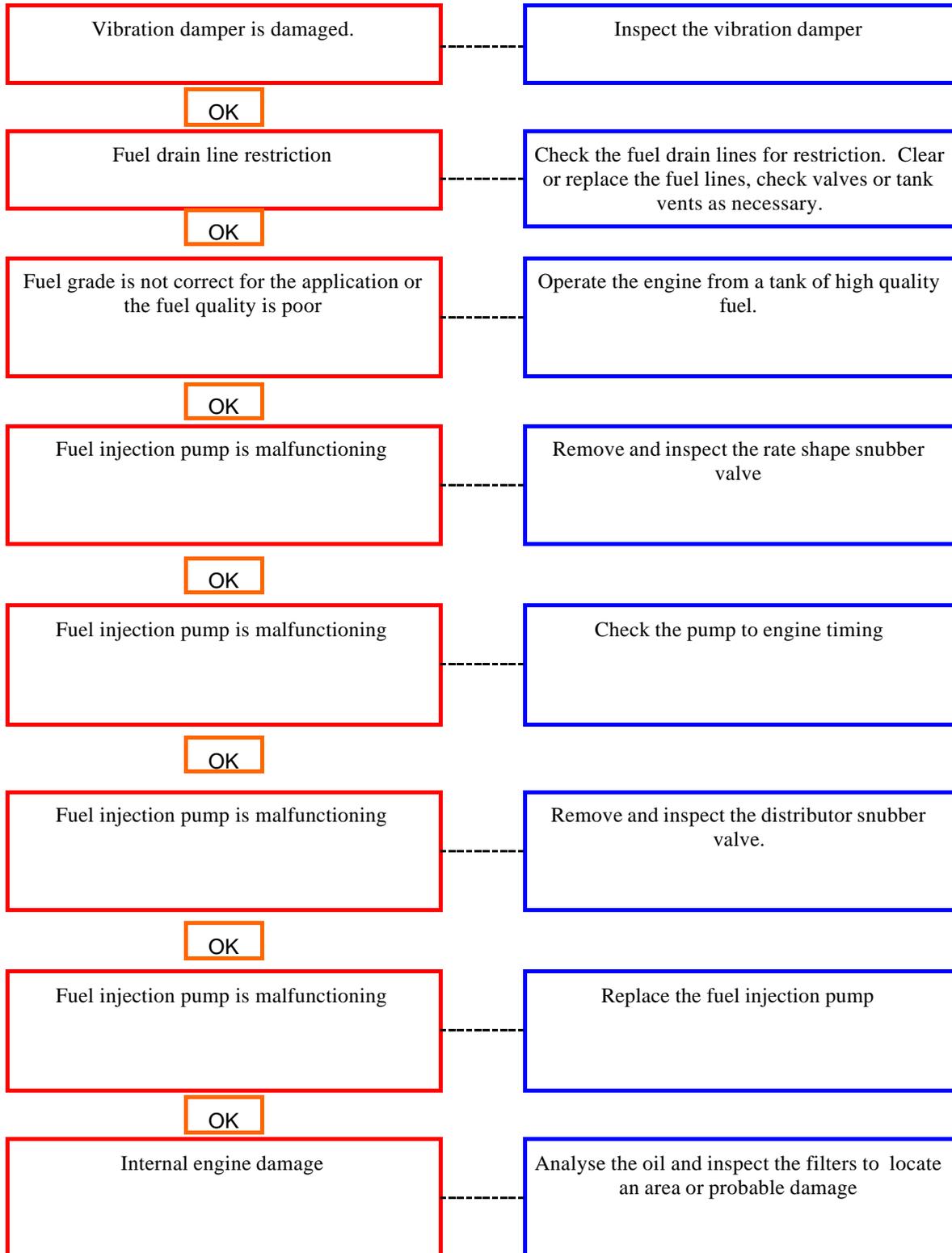
ENGINE SPEED SURGES AT LOW OR HIGH IDLE



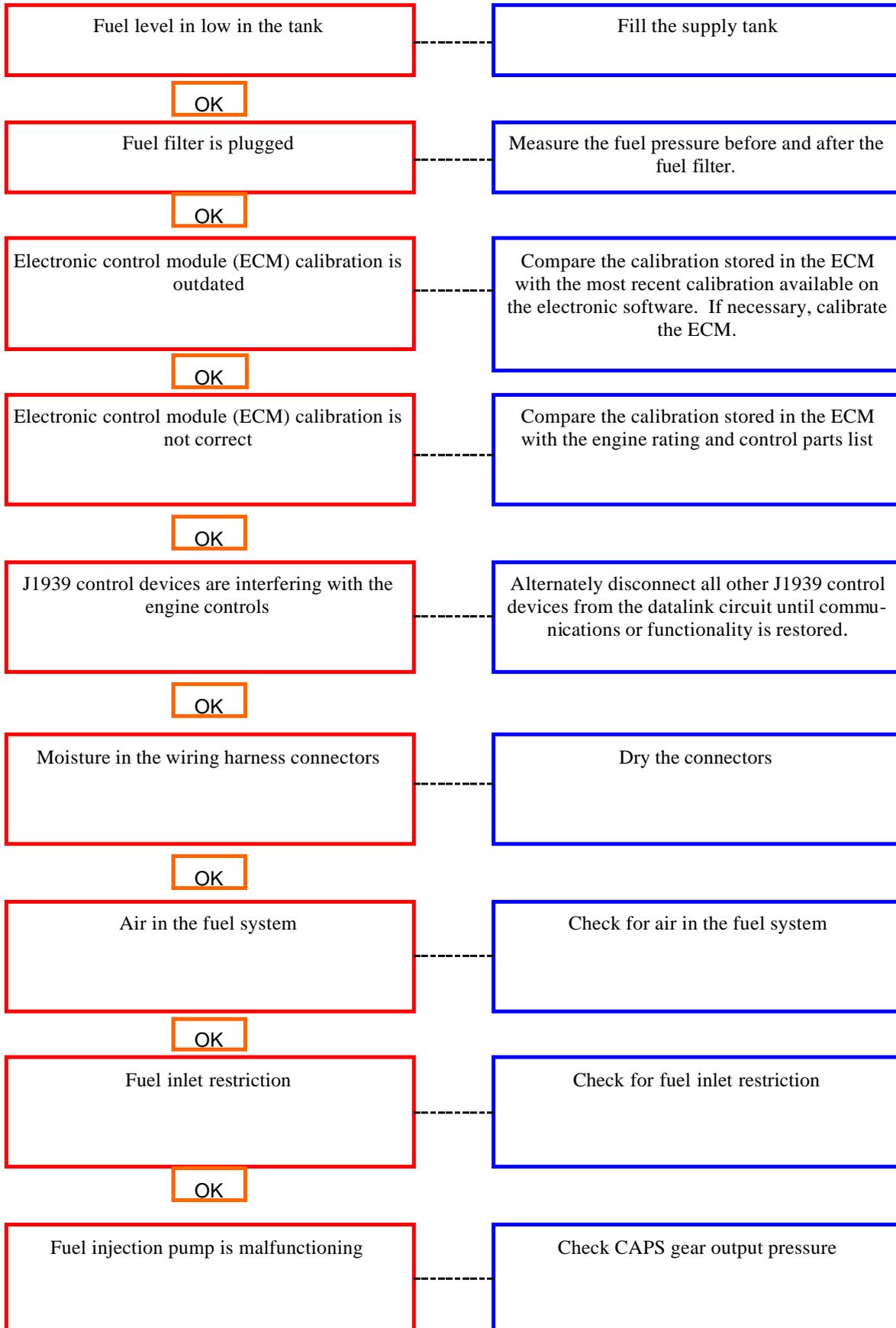
ENGINE SPEED SURGES AT LOW OR HIGH IDLE (cont)



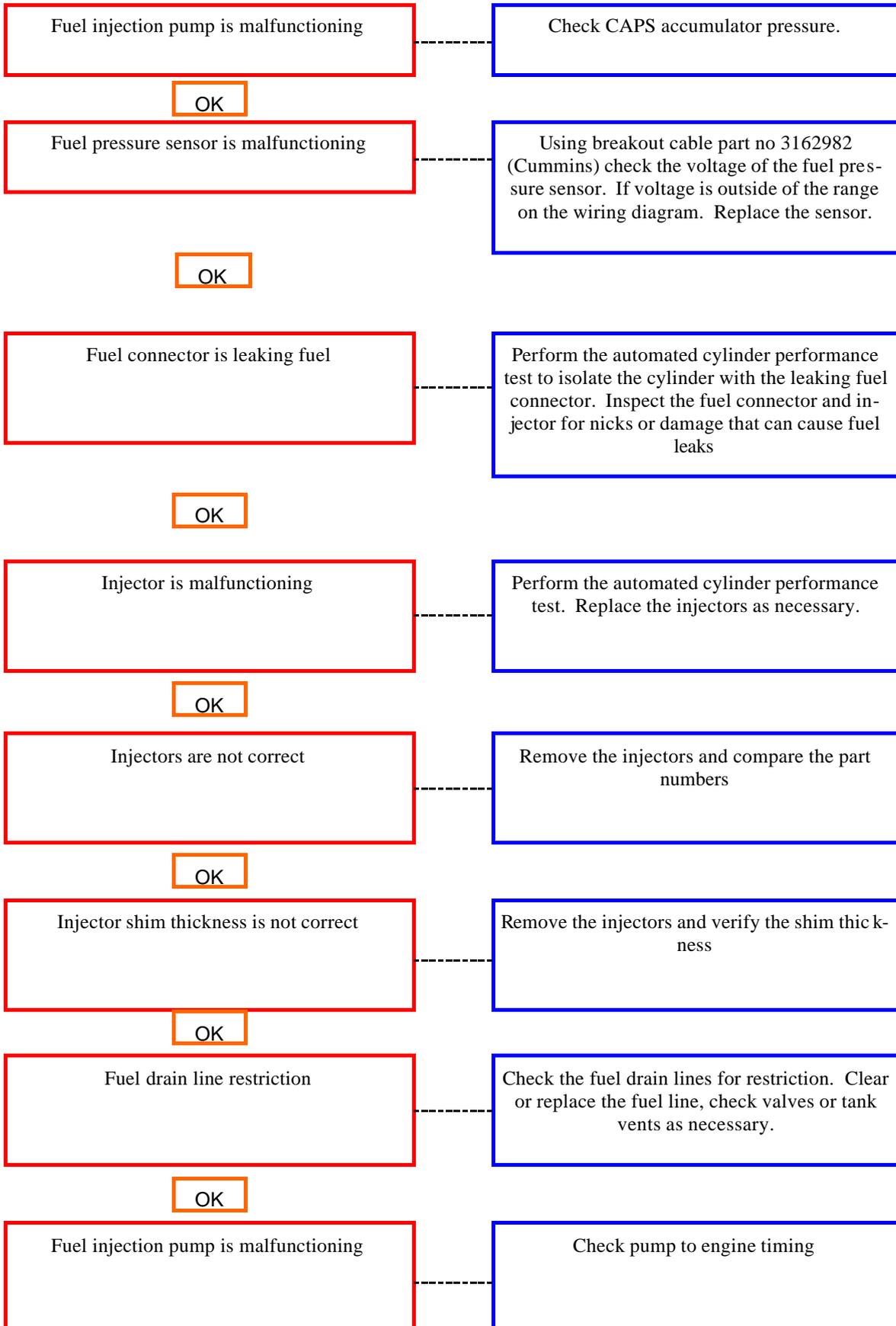
ENGINE SPEED SURGES AT LOW OR HIGH IDLE (cont)



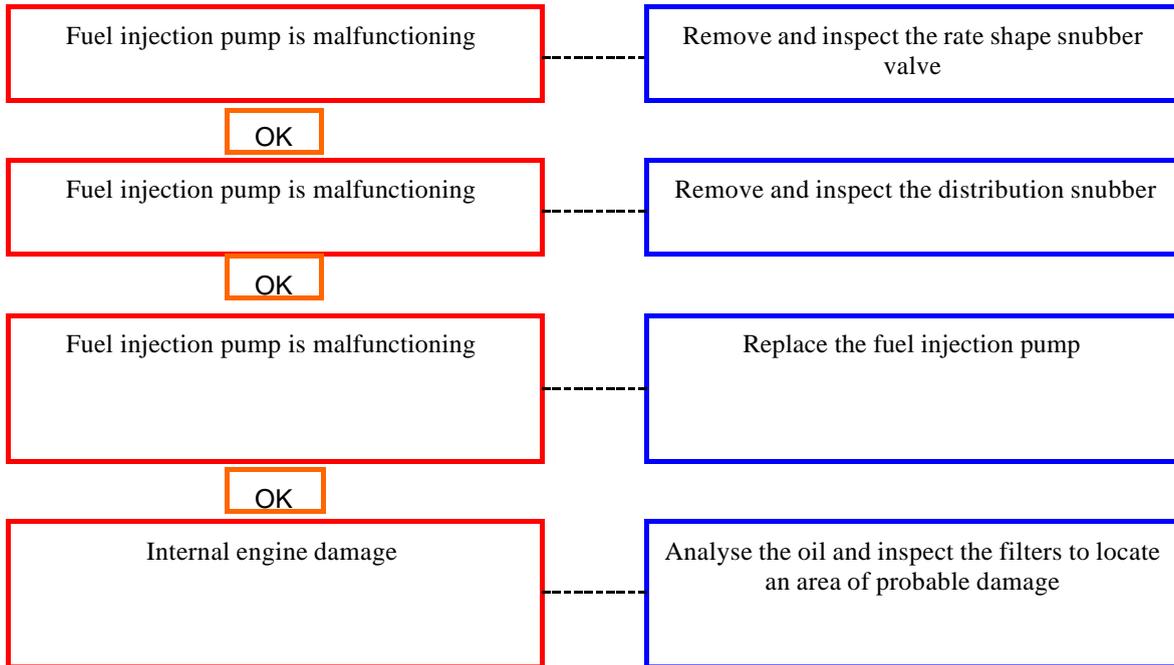
ENGINE SPEED SURGES UNDER LOAD OR IN OPERATING RANGE



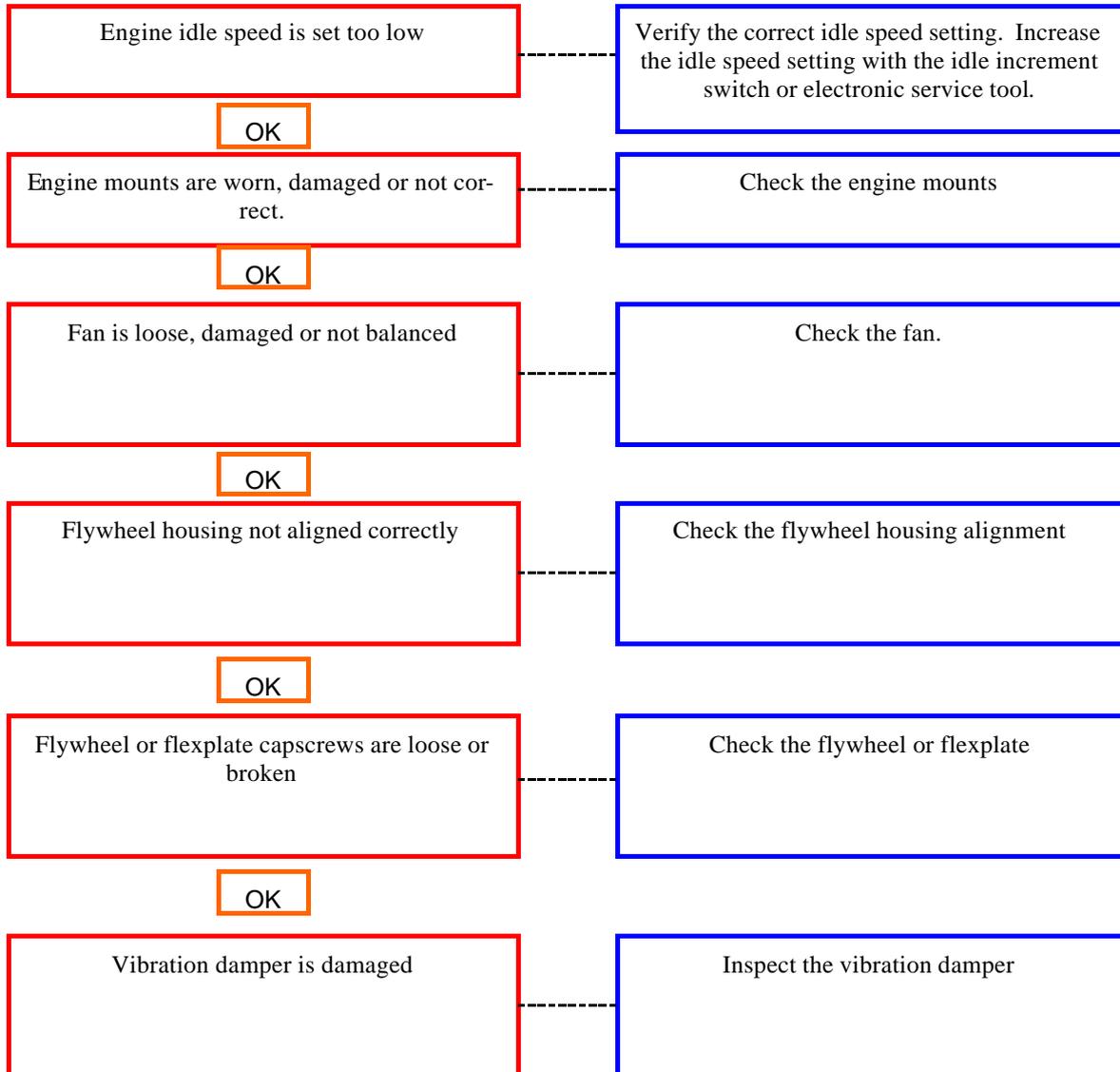
ENGINE SPEED SURGES UNDER LOAD OR IN OPERATING RANGE (cont)



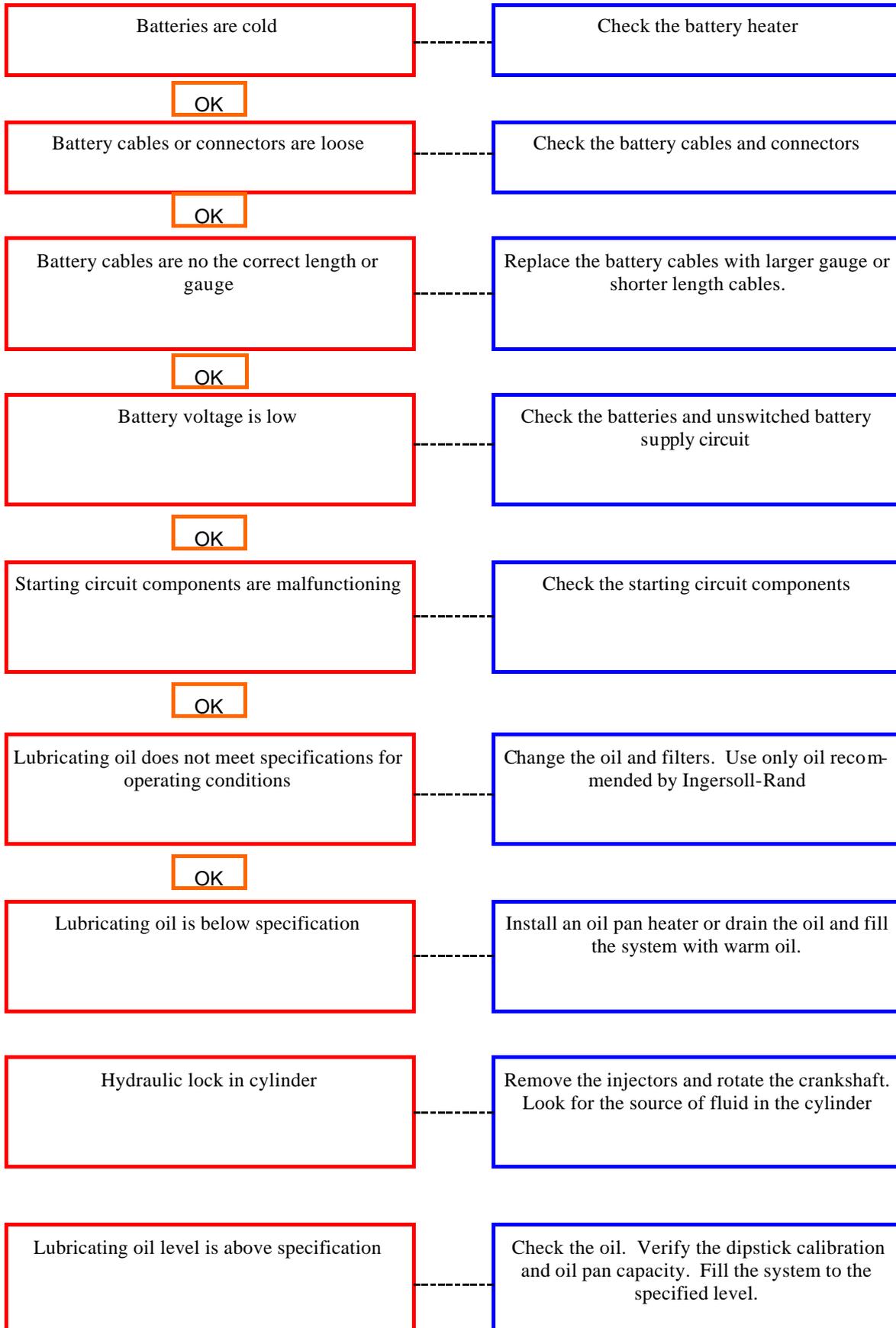
ENGINE SPEED SURGES UNDER LOAD OR IN OPERATING RANGE (cont)



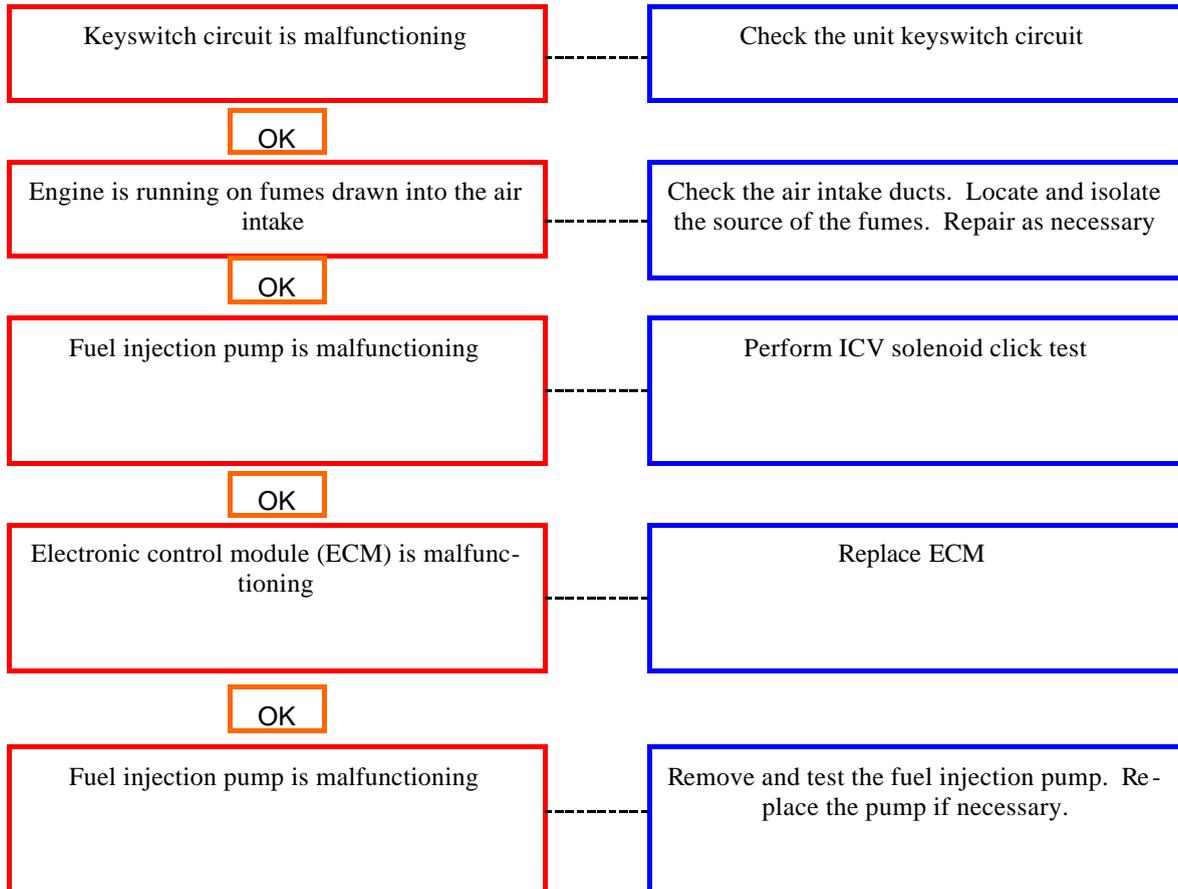
ENGINE VIBRATION EXCESSIVE



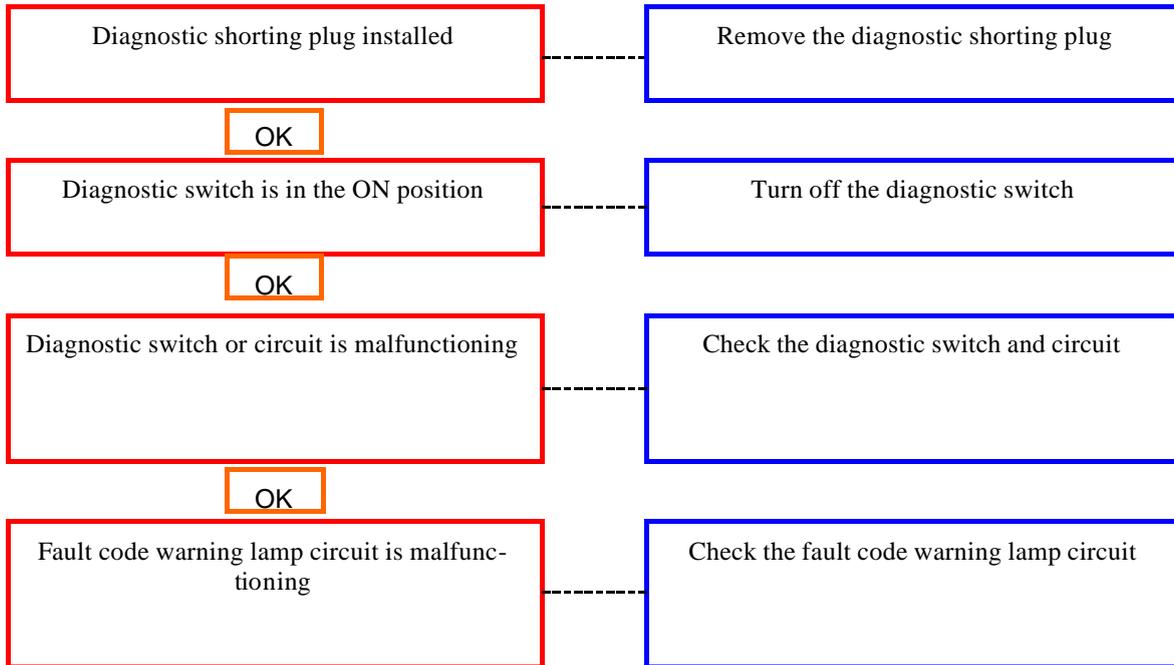
ENGINE WILL NOT CRANK OR CRANKS SLOWLY



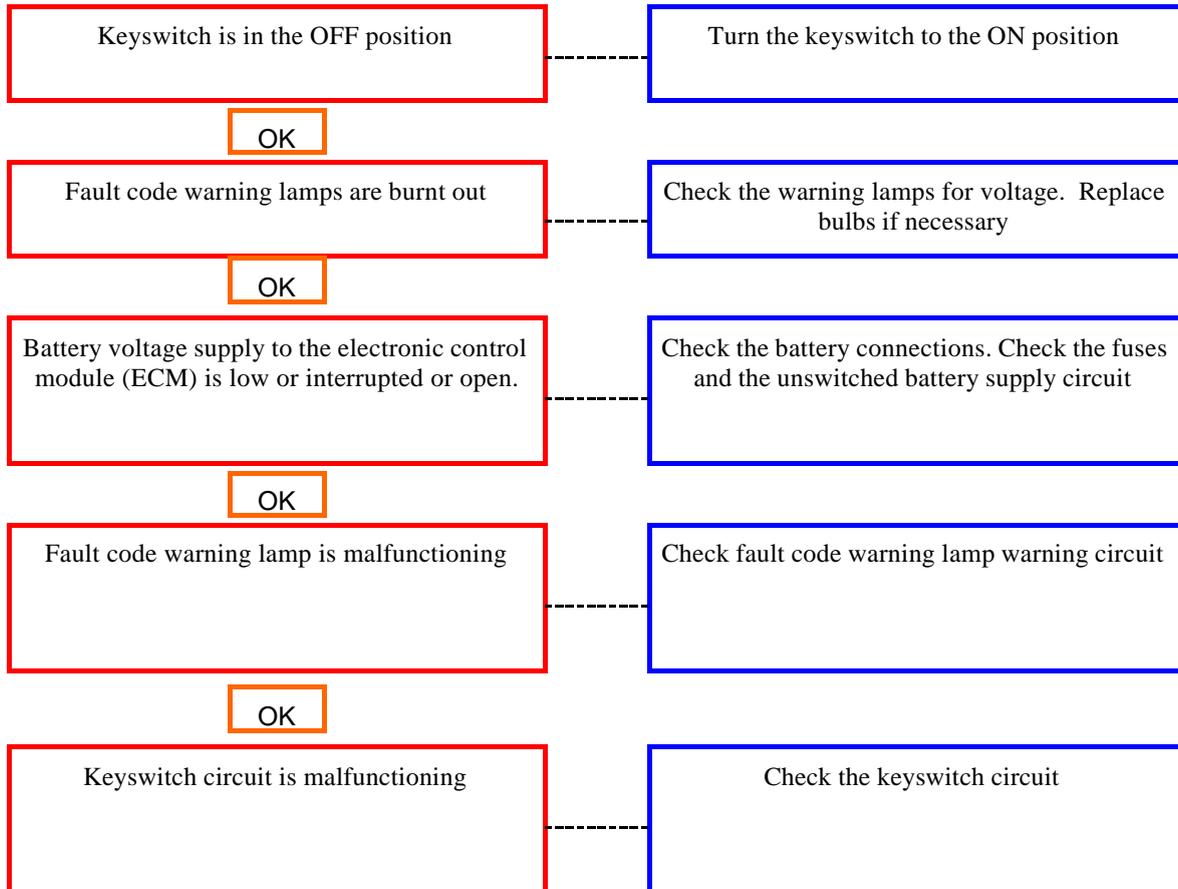
ENGINE WILL NOT SHUT OFF



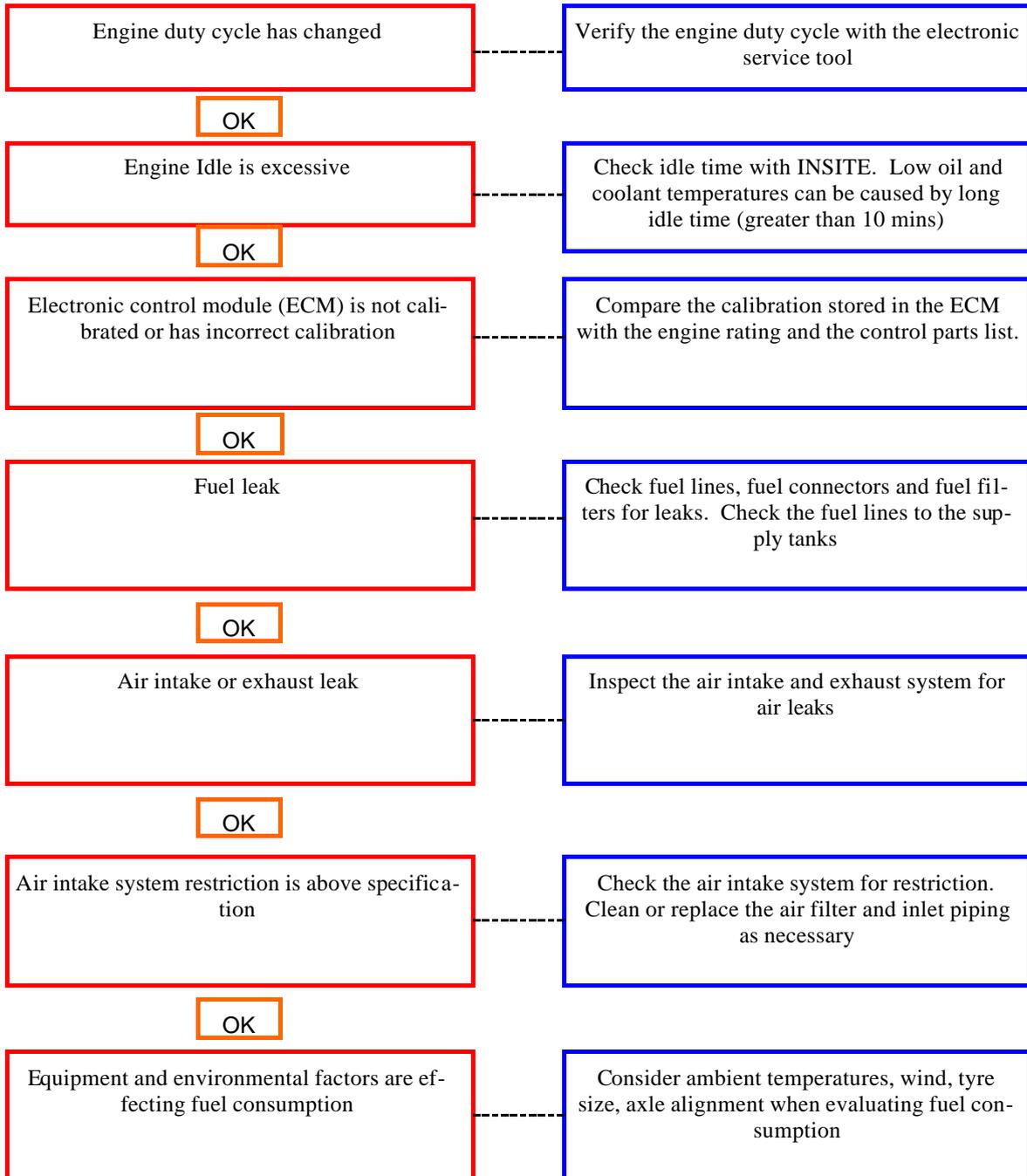
FAULT WARNING LAMPS STAY ON (NO APPARENT REASON)



FAULT CODE WARNING LAMPS DO NOT ILLUMINATE



FUEL COMSUMPTION EXCESSIVE



FUEL IN COOLANT

Cause

Cylinder head is cracked or porous

OK

Bulk coolant supply is contaminated

Correction

Pressure test the cylinder head

Check the bulk coolant supply. Drain the coolant and replace with non-contaminated coolant.

FUEL IN THE LUBRICATING OIL

Engine idle time is excessive	Low oil and coolant temperatures can be caused by long idle time (greater than 10 mins) Shut off the engine rather than idle for long periods of time. If idle time is necessary, raise the idle speed
OK	
Injector 'O' rings are damaged or missing	Remove and check the injectors. Replace the injector 'O' rings
OK	
Injector is malfunctioning	Perform the automated cylinder performance test. Replace the injectors as necessary
OK	
Fuel injection pump is malfunctioning	Inspect the cam housing for cracks and damage
OK	
Fuel injection pump is malfunctioning	Replace the accumulator module
OK	
Fuel injection pump is malfunctioning	Inspect the injection pump gear module oil seal. Replace gear pump module if there are signs or leakage
OK	
Cylinder head is cracked or porous	Pressure test the cylinder head
OK	
Bulk oil supply is contaminated	Check the bulk oil supply. Drain the oil and replace with non-contaminated oil. Replace the filters

INTAKE MANIFOLD AIR TEMPERATURE IS ABOVE SPECIFICATION

Charge air cooler fins, radiator fins or air conditioner condenser fins are damaged or obstructed with debris	Inspect the charge air cooler, air conditioner condenser and radiator fins. Clean, if necessary.
OK	
Fan drive belt is loose	Check the belt tension and tighten if necessary
OK	
Fan drive belt is broken	Check the fan drive belt and replace if necessary
OK	
Fan shroud is damaged or missing or the air recirculation baffles are damaged or missing	Inspect the shroud and the re-circulation baffles. Repair, replace or install as necessary
OK	
Radiator shutters are not opening completely	Inspect the radiator shutters. Repair or replace if necessary
OK	
Exhaust system leaking hot air into the engine compartment	Check the exhaust plumbing for leaks or broken components
OK	
Fan drive or fan controls are malfunctioning	Check the fan drive and couplings
OK	
Intake manifold pressure sensor is malfunctioning	Check the intake manifold pressure sensor.

INTAKE MANIFOLD AIR TEMPERATURE ABOVE SPECIFICATION (cont)

Cause

Correction

Fan is not adequate size for the application

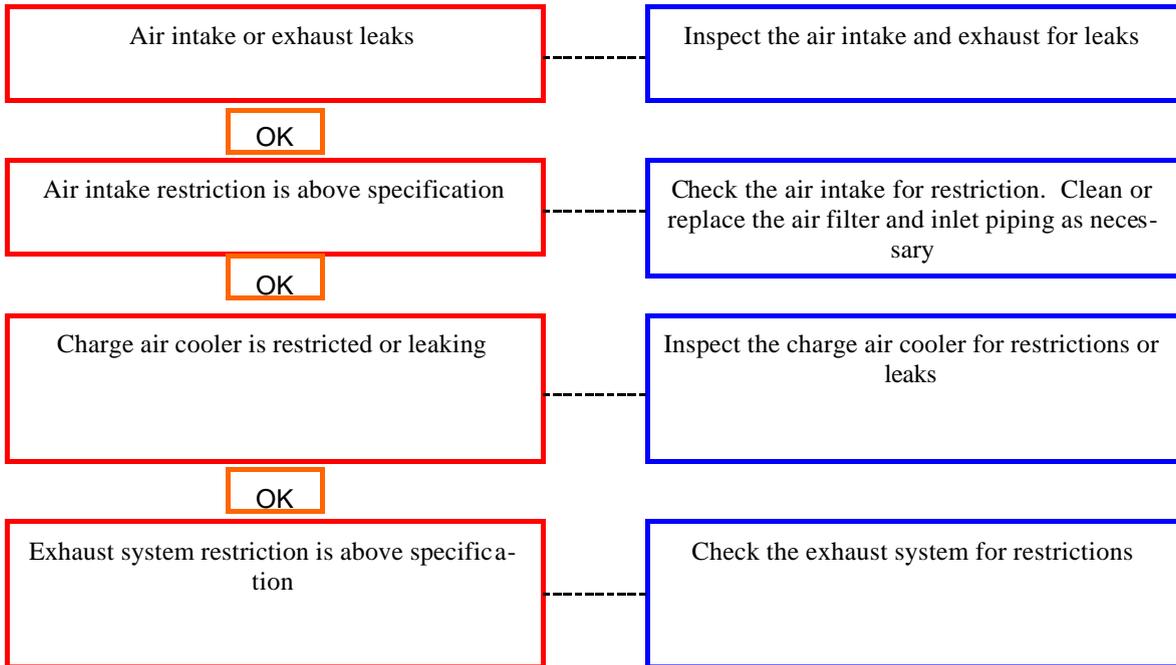
Verify the fan is the correct size

OK

Intake manifold temperature gauge is malfunctioning

Test the temperature gauge

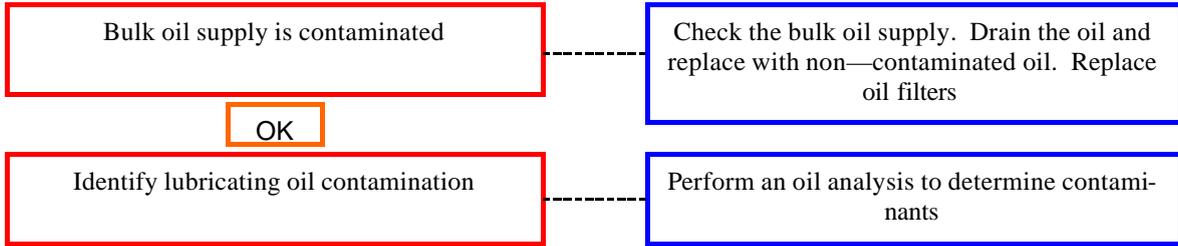
INTAKE MANIFOLD PRESSURE (BOOST) IS BELOW NORMAL



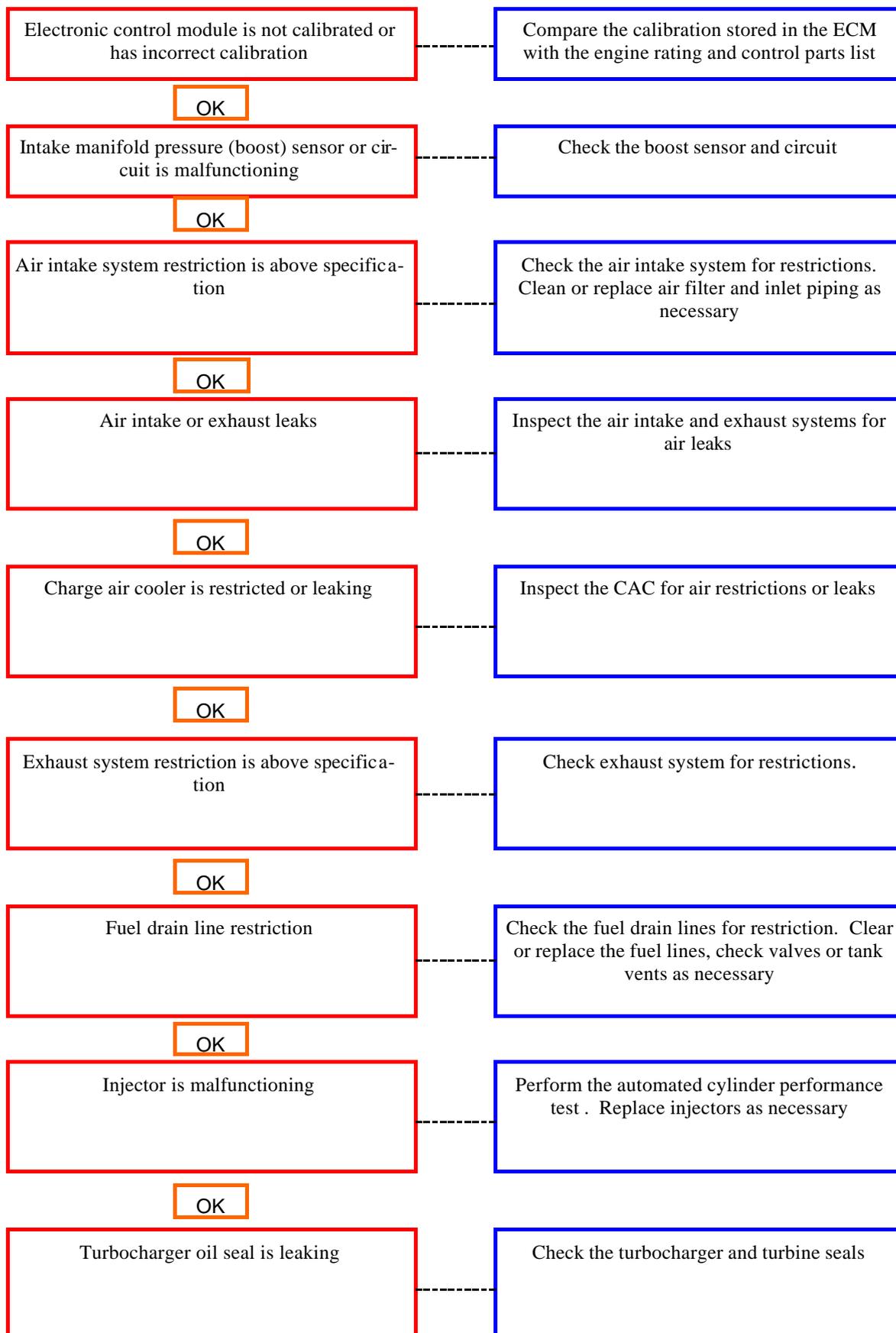
LUBRICATING OIL CONSUMPTION EXCESSIVE

Lubricating oil does not meet specifications for operating conditions	Change the oil and filters. Use recommended IR oil
OK	
Lubricating oil drain interval is excessive	Verify the correct lubricating oil drain interval
OK	
Lubricating oil leak (external)	Inspect the engine for external oil leaks. Tighten the capscrews, pipe plugs and fitting. Replace gaskets, if necessary
OK	
Verify the oil consumption rate	Check the amount of oil added verses hours run on unit
OK	
Lubricating oil is leaking	Check the lubricating oil cooler for coolant leaks
OK	
Lubricating oil level is above specification	Check the oil level. Verify the dipstick calibration and oil pan capacity. Fill the system to the specified level.
OK	
Piston rings are not seated correctly (after an engine re-build or piston installation)	Check blowby. If blowby is excessive, check piston rings for correct seating
OK	
Piston or piston rings are worn or damaged	Check air intake system for leaks. Check the pistons and piston rings for wear and damage
OK	
Internal engine damage	Analyse the oil and inspect the filters to locate an area of probable damage

LUBRICATING OIL CONTAMINATED



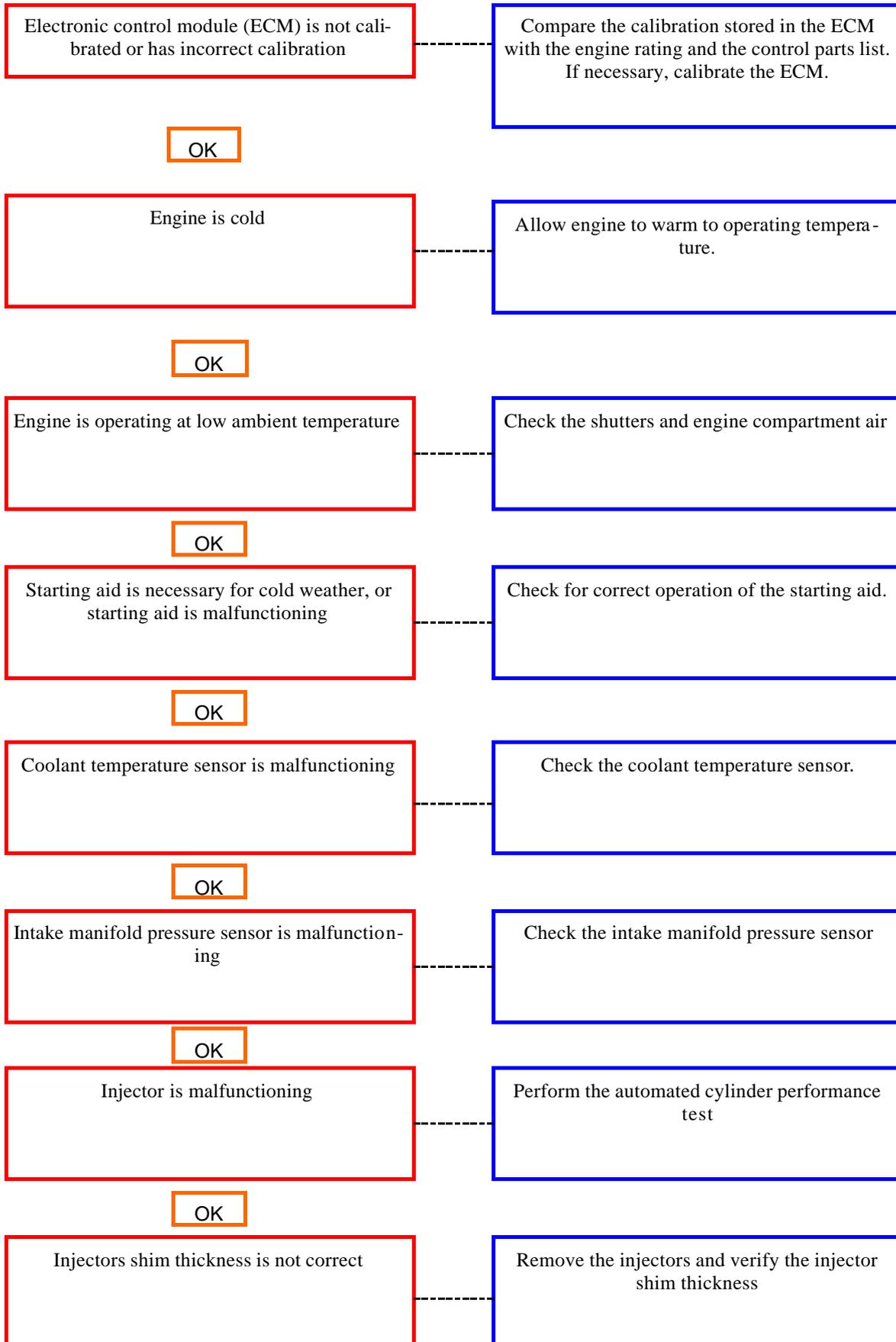
SMOKE BLACK—EXCESSIVE



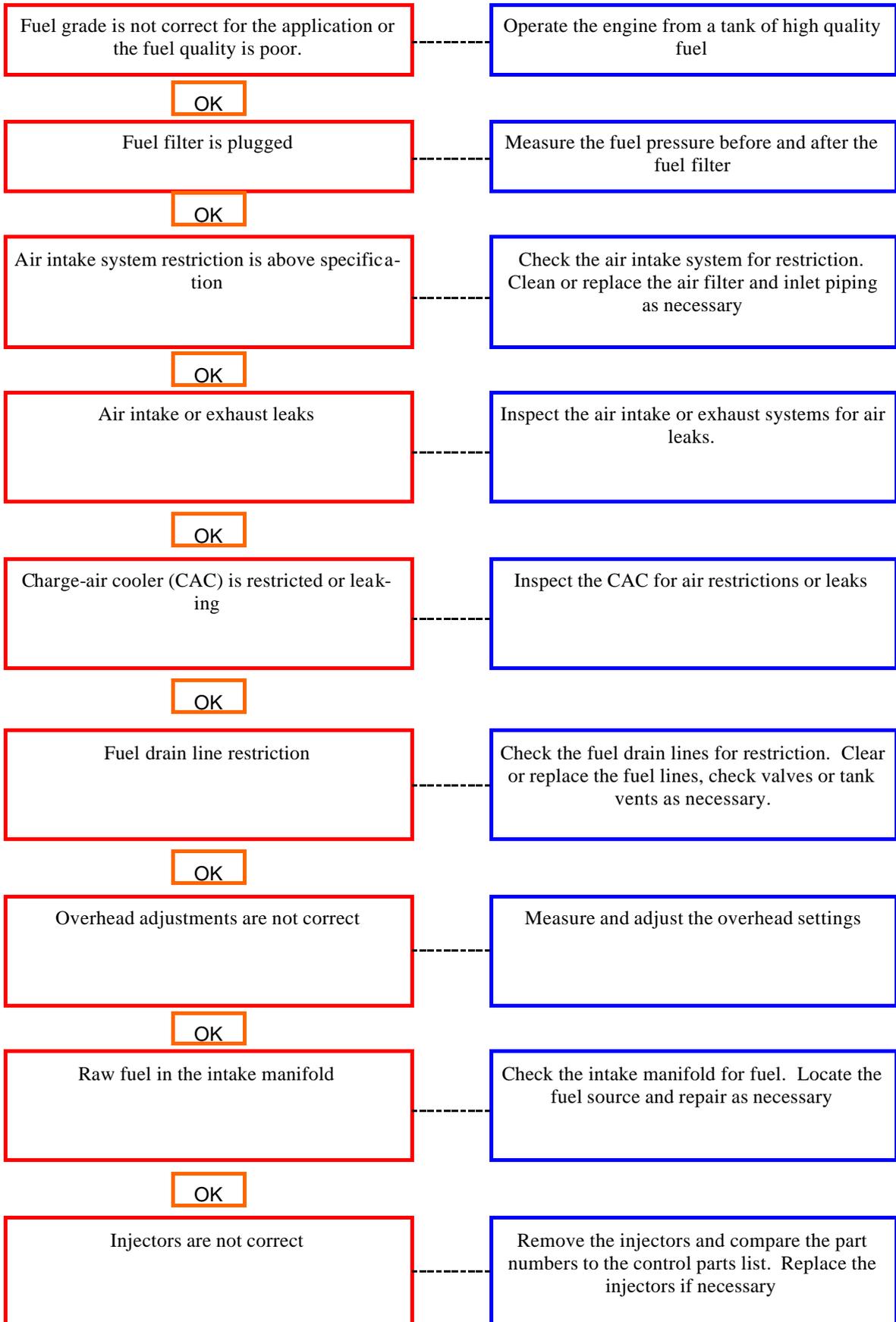
SMOKE, BLACK—EXCESSIVE (cont)

Turbocharger wheel clearance is out of specification	Check radial bearing clearance and axle clearance. Inspect the turbocharger. Repair or replace as necessary
OK	
Overhead adjustments are not correct	Measure and adjust the overhead settings
OK	
Fuel grade is not correct for the application or the fuel quality is poor	Operate engine from a tank of high quality fuel
OK	
Injector shim thickness is not correct	Remove the injectors and verify the injector shim thickness
OK	
Fuel injection timing is not correct	Check the fuel pump timing
OK	
Raw fuel in the intake manifold	Check the intake manifold for fuel. Locate the fuel source and repair as necessary
OK	
Fuel injection pump is malfunctioning	Check CAPS accumulator pressure
OK	
Fuel injection pump is malfunctioning	Replace the injection control valve module
OK	
Internal engine damage	Analyse the oil and inspect the filters to locate an area of probable damage

SMOKE, WHITE — EXCESSIVE



SMOKE, WHITE — EXCESSIVE (cont)



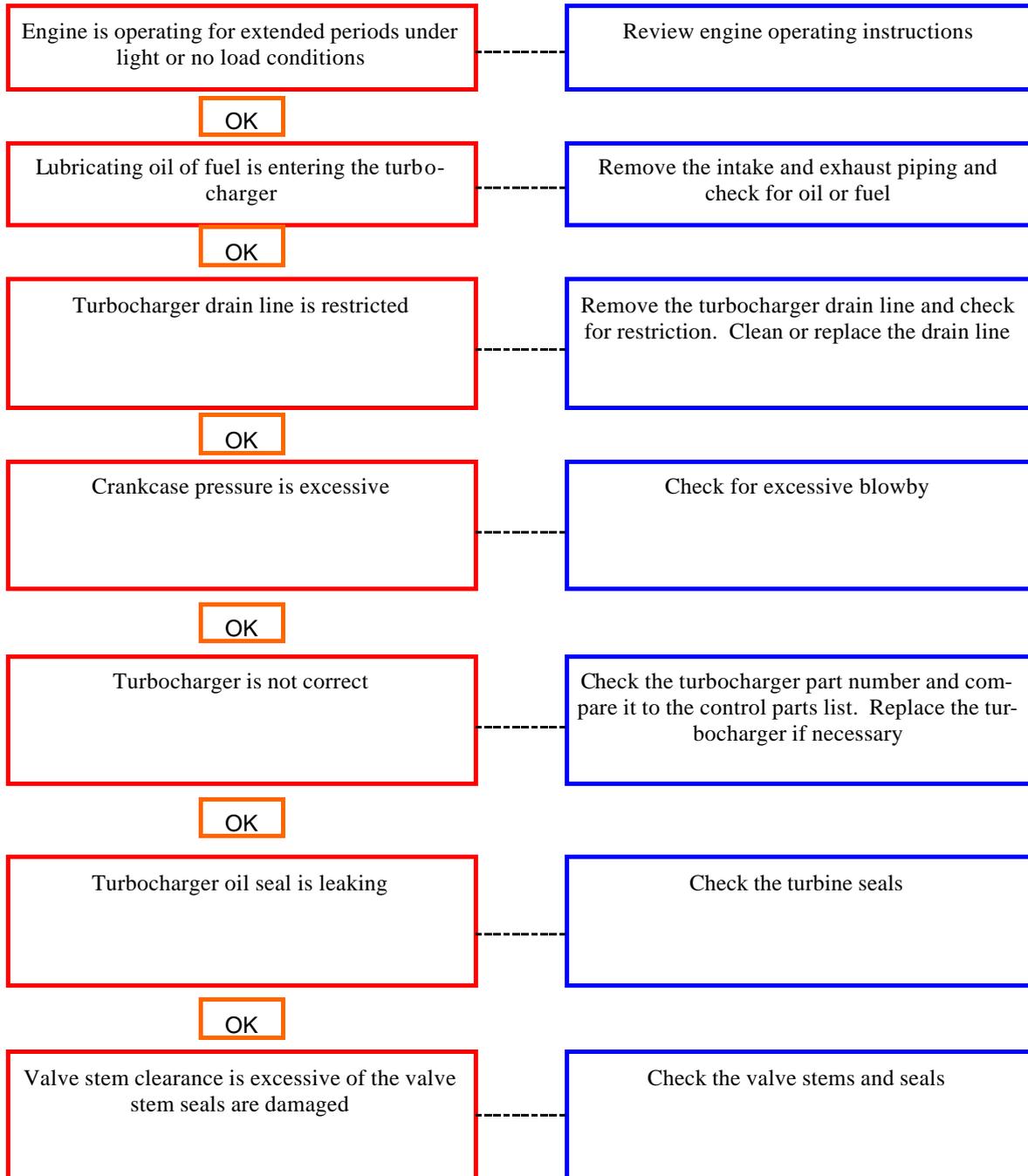
SMOKE, WHITE—EXCESSIVE (cont)

Cause

Correction

Fuel injection pump is malfunctioning	Check the pump to engine timing
OK	
Injector protrusion is not correct	Check the injector protrusion
OK	
Fuel injection pump is malfunctioning	Replace the injection control valve module
OK	
Internal engine damage	Analyse the oil and inspect the filters to locate an area of probable damage

TURBOCHARGER LEAKS ENGINE OIL OR FUEL



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ADJUSTMENT, REPAIR AND REPLACEMENT

ALTERNATOR

- Install
- Preparatory
- Remove

BELT TENSIONER, AUTOMATIC

- Install
- Preparatory
- Remove

CHARGE-AIR COOLER (CAC)

- General Information
- Leak test
- Pressure Test
- Temperature Differential Test

COOLANT THERMOSTAT

- Clean
- Install
- Preparatory
- Remove

DRIVE BELT, WATER PUMP

- Install
- Remove

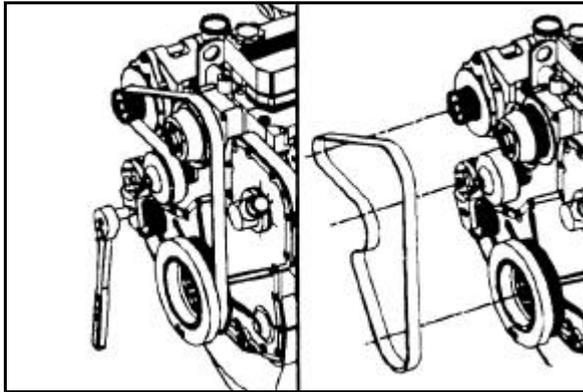
FAN SPACER AND PULLEY

- Install
- Preparatory
- Remove

STARTER MOTOR

- Install
- Preparatory
- Remove

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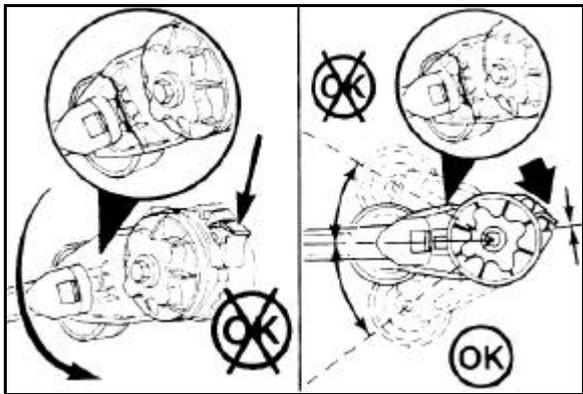
Drive Belt, Water Pump

Remove

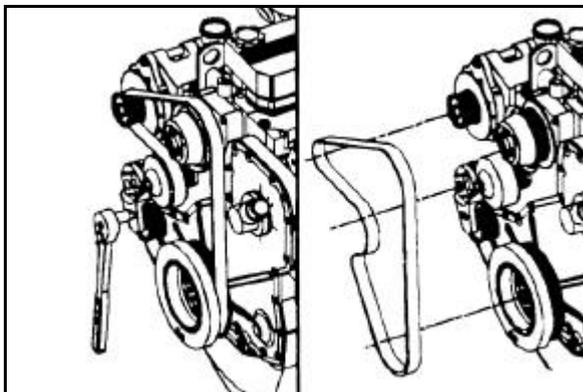
3/8-inch Square Drive

Lift the tensioner to remove the drive belt.

NOTE: The belt tensioner winds in the direction that the spring tang is bent over the tensioner body. To loosen the tension on the belt, rotate the tensioner to wind the spring tighter.



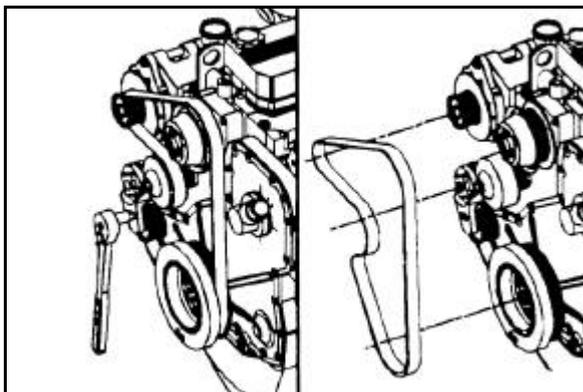
Applying excessive force in the opposite direction of the wind-up or after the tensioner has been wound-up to the positive stop can cause the tensioner arm to break.



Install

3/8-inch Square Drive

The belt tensioner is spring-loaded and must be pivoted away from the drive belt. Pivoting in the wrong direction can damage the belt tensioner.



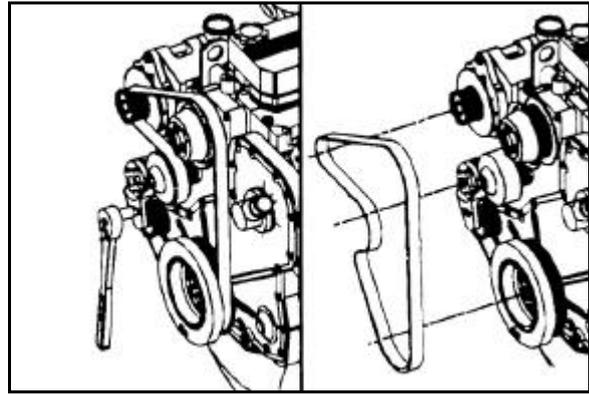
Belt Tensioner, Automatic Preparatory

Remove the drive belt

Remove
3/8-inch Square Drive

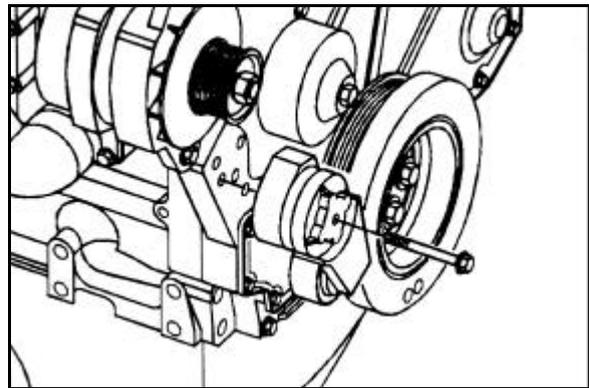
The belt tensioner is spring-loaded and must be pivoted away from the drive belt. Pivoting in the wrong direction can damage the belt tensioner.

Lift the belt tensioner to relieve tension in the belt, and remove the belt.



15 mm

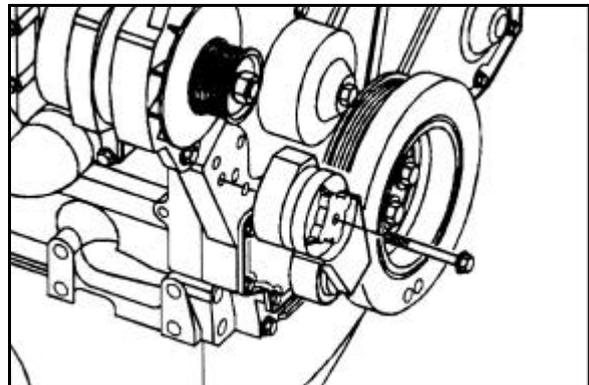
Remove the capscrew and belt tensioner from the bracket.



Install
15 mm

Install the belt tensioner and capscrews.

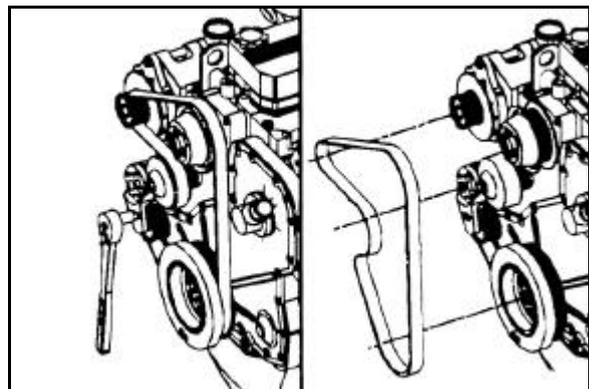
Torque Value: 43Nm (32ft-lb)

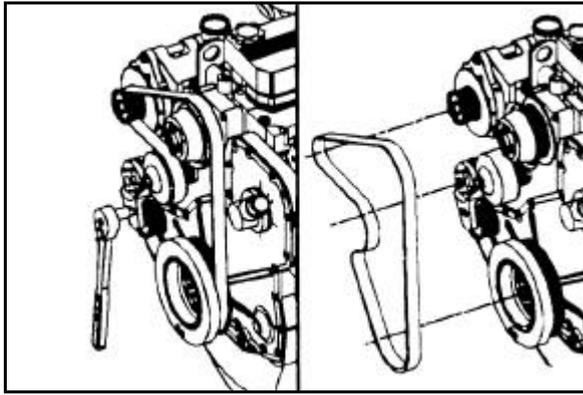


3/8-Inch Square Drive

Lift and hold the tensioner. Install the drive belt, and release the tensioner.

Service Tip. If difficulty is experienced installing the drive belt, or if the belt seems too short, position the belt over the grooved pulleys first; then, while holding the tensioner up, slide the belt over the water pump pulley.

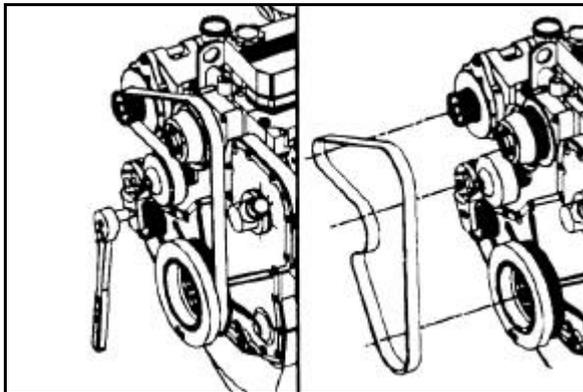




Fan Spacer and Pulley Preparatory

Remove the drive belt

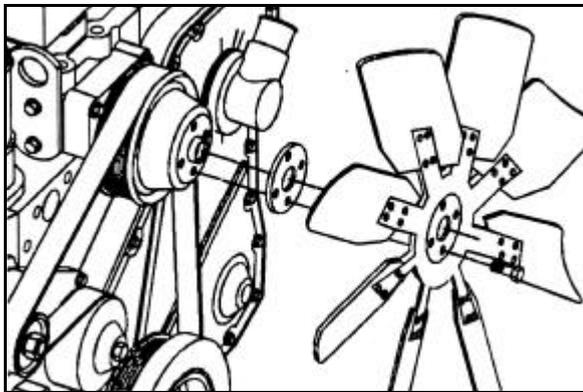
Service Tip: Loosen the capscrews before removing the belt, and tighten the capscrews after the belt is installed.



Remove 3/8-Inch Square Drive

The belt tensioner is spring-loaded and must be pivoted away from the drive belt. Pivoting in the wrong direction can result in damage to the belt tensioner.

Lift the tensioner to relieve tension in the belt. Remove the belt.

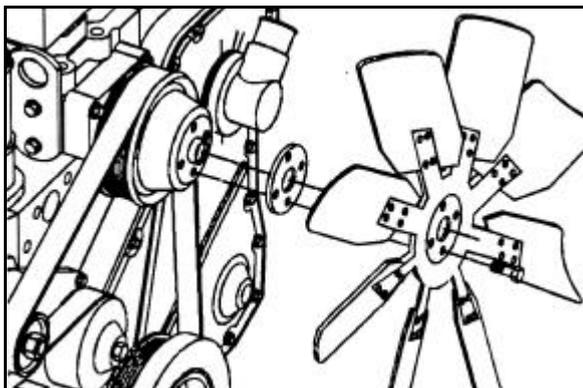


Remove the fan capscrews, fan and spacer.
Remove the fan pulley.

Install 13 mm

Install the fan pulley.
Install the spacer, fan and fan capscrews.

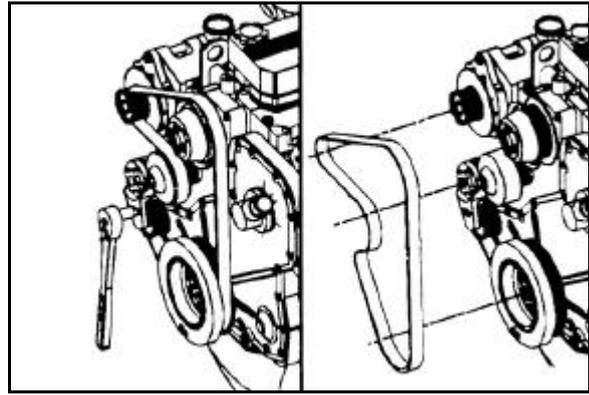
Torque Value: 24Nm (18ft-lb)



3/8-Inch Square Drive

Lift the tensioners and install the belt.

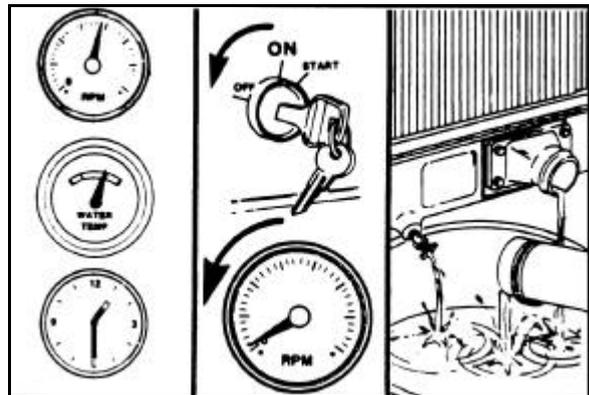
Service Tip: If difficulty is experienced installing the drive belt, or if the belt seems too short, position the belt over the grooved pulleys first; then, while holding the tensioner up, slide the belt over the water pulley.



Coolant Thermostat Preparatory

Coolant is toxic. If not reused, dispose of in accordance with local environmental regulations.

Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C (122°F) before removing the pressure cap. Heated coolant spray or steam can cause personal injury.



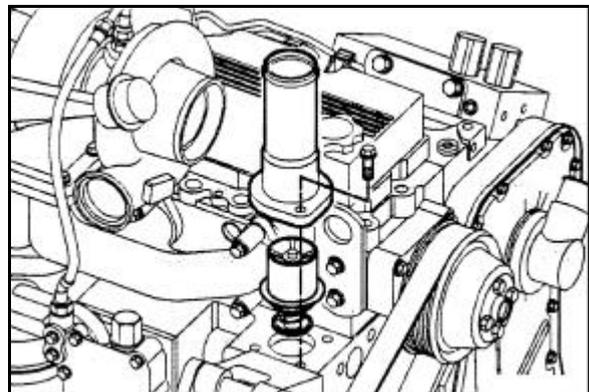
Drain the coolant from the radiator.

Disconnect the upper radiator hose.

Remove 10 mm

Remove the water outlet tube capscrews and water outlet tube.

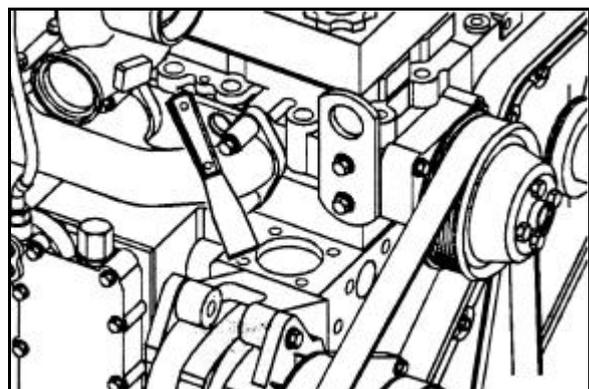
Remove the thermostat.

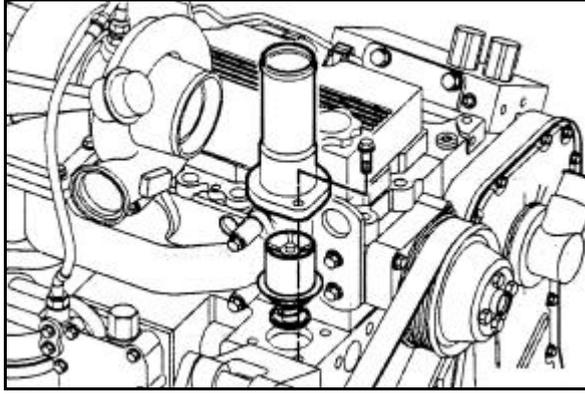


Clean

Do not let any debris fall into the thermostat cavity when cleaning the surfaces. Failure to do so will result in engine damage.

Clean all mating surfaces.





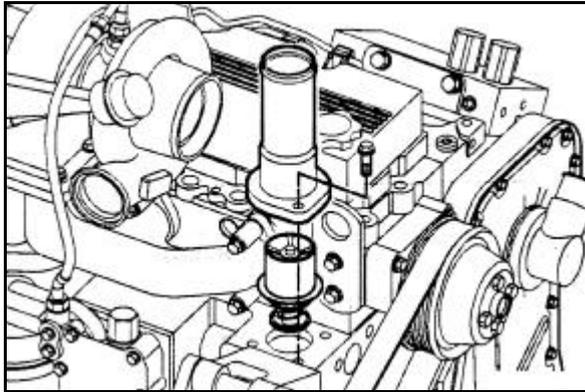
Install

Install the new thermostat into the thermostat housing. Make sure that the top and bottom o-rings are in place.

10 mm

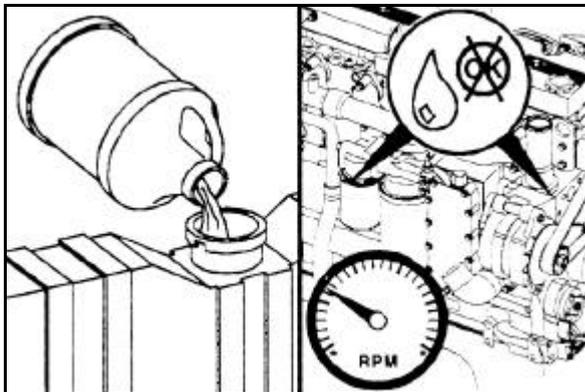
Install the water outlet tube and cap-screws.

Torque Value: 24 Nm (18 ft-lb)



Always vent the engine and aftercooler during filling to remove air from the coolant system, or overheating will result.

Fill the cooling system.



Operate the engine, and check for leaks.

Charge-Air Cooler (CAC)

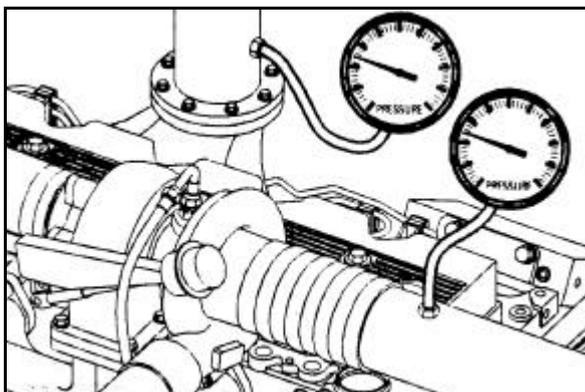
Pressure Test

Install the pressure gauge into the fitting in the turbocharger.

Install another pressure gauge into the intake manifold.

Operate the engine at rated rpm and load. Record the readings on the two gauges.

If the differential pressure is greater than 50 kPa (7 psi). Check the charge-air cooler (CAC) for plugging. Clean or replace if necessary.



Temperature Differential Test

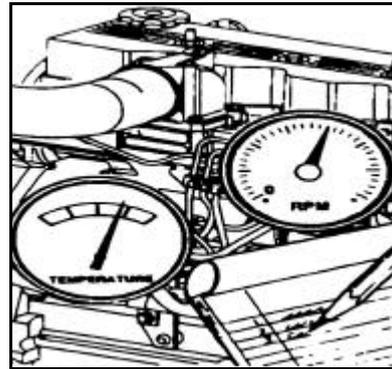
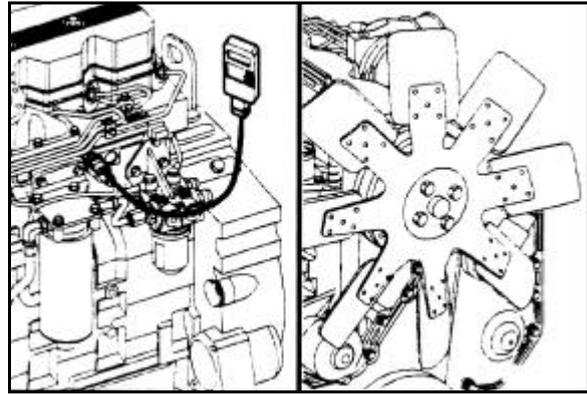
Install a temperature gauge in the intake manifold.

Operate the engine at rated rpm and load. Record the intake manifold temperature.

Measure the ambient temperature at least 2 feet in front of the compressor.

The maximum temperature differential **must not** be greater than 25°C (77°F).

If the temperature differential is greater than 25°C (77°F), check the charge-air cooler (CAC) for dirt and debris on the fins, and clean as necessary. If the problem still exists, check the cooler for internal contamination or plugging.



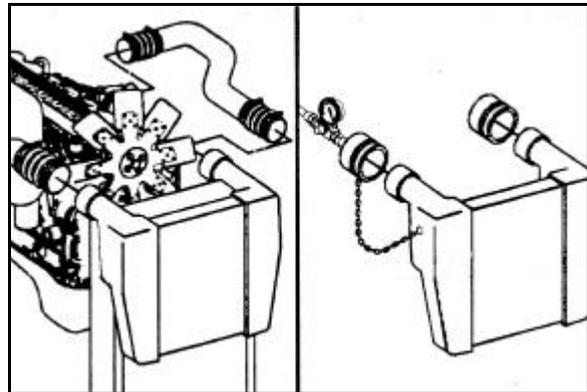
Leak Test

Pressure caps must be attached with a chain to the charge-air cooler (CAC).

To check the charge-air cooler (CAC) for cracked tubes or header, remove the inlet and outlet hoses from the cooler.

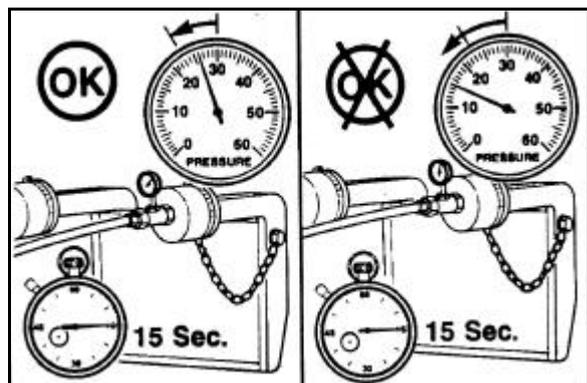
Remove the charge-air cooler.

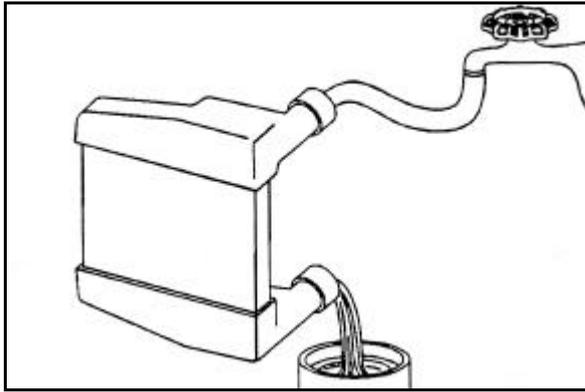
Install a cap over the outlet side of the cooler. Install a pressure gauge and a shop air supply line to the inlet side of the cooler.



Apply 207 kPa (30 psi) of air pressure to the cooler. If the pressure drop is 48 kPa (7 psi) or more in 15 seconds, the charge-air cooler (CAC) **must** be repair or replaced.

NOTE: A leak tank may be used to locate the air leak.

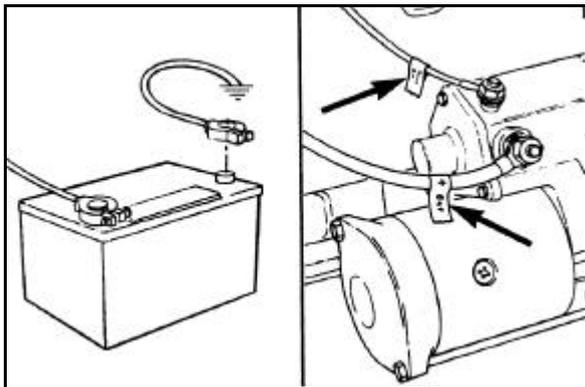




The charge-air cooler (CAC) must be cleaned following any turbocharger or air cleaner failure. Debris trapped in the charge-air cooler (CAC), if not cleaned, can cause internal engine damage.

Starting Motor Preparatory

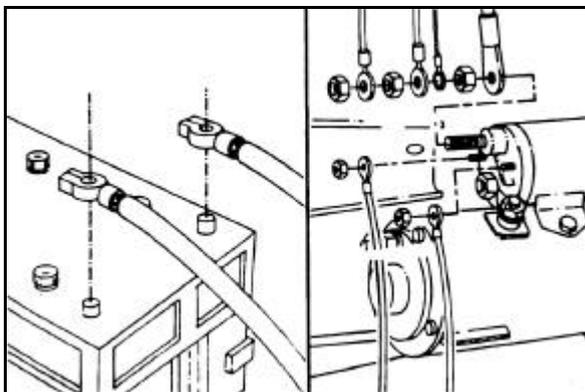
Disconnect the ground cable from the battery terminal.
Identify each electrical wire with a tag indicating location.



Remove

Remove the electrical connections from the batteries, negative (-) cable first.

Remove the electrical connections from the starter motor, and identify each wire with a tag indicating location.



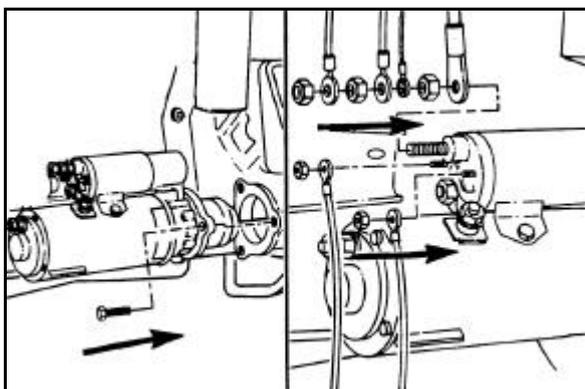
10 mm

Remove the three cap screws and the starter motor.

Install *10 mm*

Install the starter motor in the reverse order of removal.

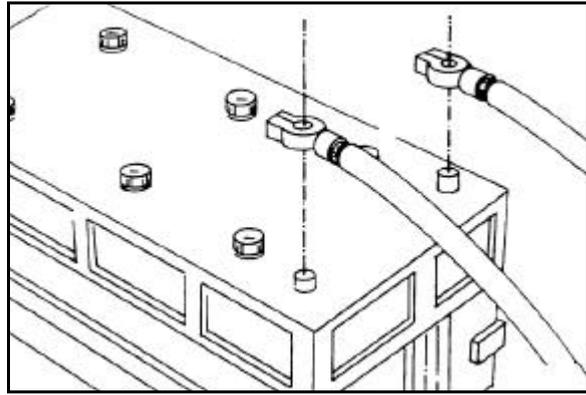
Connect all the cables. Connect the negative (-) cable last



Torque Value: 43 Nm (32 ft-lb)

Batteries can emit explosive gases. To avoid personal injury, always ventilate the compartment before servicing the batteries. To avoid arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.

Install and tighten the battery electrical connections. Connect the negative (-) last.

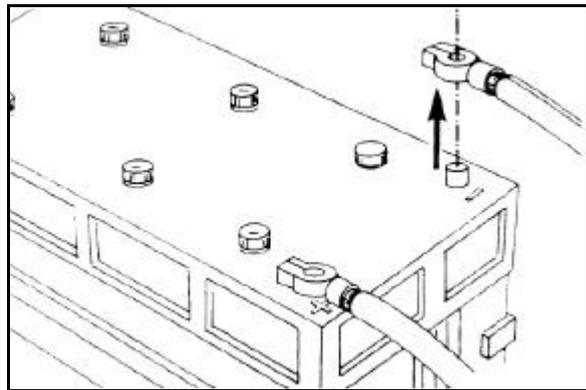


Alternator Preparatory

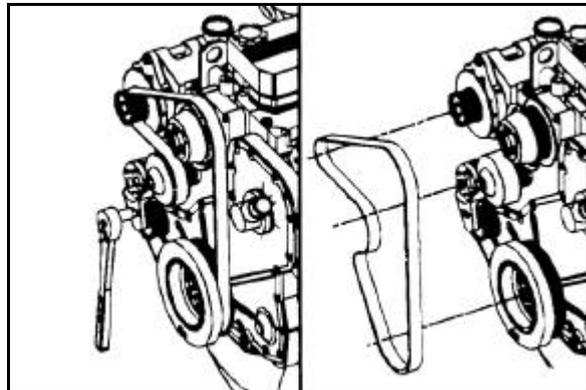
Batteries can emit explosive gases. To avoid personal injury, always ventilate the compartment before servicing the batteries. To avoid arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.

Disconnect the ground (-) cable from the battery terminal.

Remove and tag all the wires.

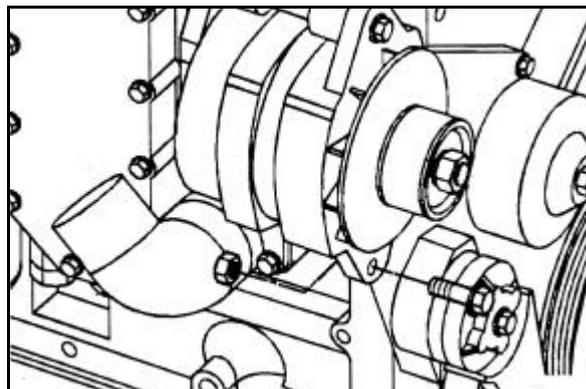


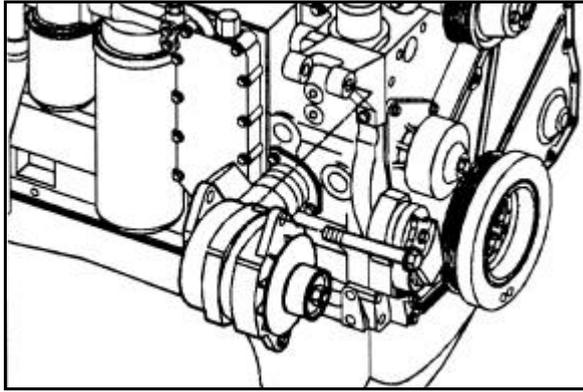
Remove the drive belt from the alternator pulley.



Remove 13 mm

Remove the alternator link capscrew.

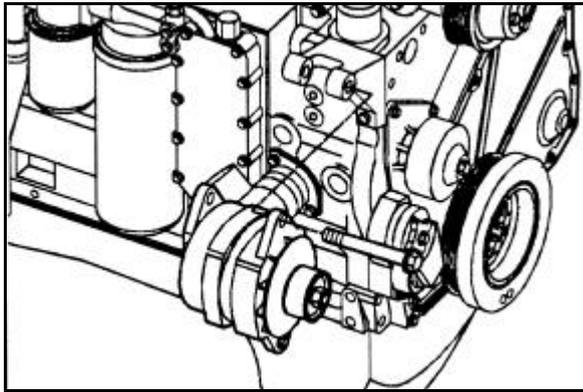




16 mm

Remove the alternator mounting cap-screw.

Remove the alternator.



Install

To install the alternator, the alternator mounting components **must** be tightened in the following sequence:

1. Alternator-to-alternator bracket cap-screw.
2. Lower brace-to-alternator cap-screw.
3. Water inlet-to-block cap-screws.

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SPECIFICATIONS

<p>General Specifications</p> <p>Horsepower</p> <p>6IRQ9AE Engine Speed @ Maximum Power Output: Standard Rating Governed Speed</p> <p>Bore and Stroke</p> <p>Displacement</p> <p>Compression Ratio</p> <p>Firing Order</p> <p>6IRQ9AE Approx. Engine Weight (with standard accessories)</p> <p>Crankshaft Rotation (viewed from front of engine)</p> <p>Valve Clearance: Intake Exhaust</p>	<p>(refer to dataplate)</p> <p>2100 rpm 2300 rpm</p> <p>114 mm (4.49 in) x 144.5 mm (5.69 in)</p> <p>8.9 Litres (543 C.I.D.)</p> <p>16.6:1</p> <p>1-5-3-6-2-4</p> <p>706 kg (1556 LB)</p> <p>Clockwise</p> <p>0.3048 mm (0.012 in) 0.5588 mm (0.022 in)</p>
<p>NOTE the 6IRQ9AE Engine features a no-adjust over-head. The 6IRQ9AE Valve train is designed that adjustment of the valve lash is not required for normal service during the first 5000 hours. The valve train operates acceptability within limits of 0.152 to 0.559-mm (0.006 to 0.022 in) intake valve lash and 0.381 to 0.813 mm (0.015 to 0.032 in) exhaust valve lash.</p>	
<p>Fuel System</p> <p>Engine Idle Speed</p> <p>Maximum Lift Pump Inlet Restriction at Rated</p> <p>Maximum Fuel Filter Outlet Restriction at Rated</p> <p>Minimum Fuel Filter Inlet Pressure during Cranking</p> <p>Maximum Fuel Drain Line Pressure</p> <p>Maximum Fuel Inlet Temperature</p> <p>Minimum Engine Cranking Speed</p>	<p>600 to 1200 rpm</p> <p>102 mm Hg (4in Hg)</p> <p>254 mm Hg (10in Hg)</p> <p>508 mm Hg (20in Hg)</p> <p>254 mm Hg (10in Hg)</p> <p>71°C (160°F)</p> <p>150 rpm</p>
<p>Lubricating Oil System</p> <p>Oil Pressure At Low Idle (minimum Allowable) At rated Speed (Minimum Allowable)</p> <p>Regulated Pressure</p> <p>Oil Pan Capacity, Low to High Standard Oil Pan Standard Oil Pan with Block Stiffener</p> <p>Total System Capacity: Standard Oil Pan Standard Oil Pan with Block Stiffener</p> <p>Oil capacity of Standard Engine Standard Oil Pan Pan ONLY</p>	<p>69 kPa (10 psig) 207 kPa (30 psig)</p> <p>517 kPa (75 psig)</p> <p>18.9 to 22.7 Litres (20 to 24 Qt) 19.9 to 23.7 Litres (21 to 25 Qt)</p> <p>22.7 Litres (24 Qt) 23.7 Litres (25 Qt)</p> <p>22.7 Litres</p>

Specifications

Cooling System	
Coolant Capacity (Engine Only)	10.9 Litres (11.5 Qt)
Standard modulating Thermostat Range	84°C - 91°C (183°F - 196°F)
Maximum Allowable Operating Temperature	100°C (212°F)
Minimum Recommended Operating Temperature	70°C (158°F)
Minimum Recommended Pressure Cap	50 kPa (7 psi)

Air Intake System

Maximum Intake Restriction (Clean Air Filter Element)	254mm H ₂ O (10.0in H ₂ O)
Maximum Intake Restriction (Dirty Air Filter Element)	635mm H ₂ O (25.0in H ₂ O)

Exhaust System

Maximum Back Exhaust Pressure	76mm Hg (3in Hg)
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Electrical System

Recommended Battery Capacity

System Voltage	Ambient Temperature			
	-18°C (0°F)		-29°C (-20°F)	
	Cold Cranking Amperes	Reserve Capacity (Minutes) ⁽¹⁾	Cold Cranking Amperes	Reserve Capacity (Minutes)
12 VDC	1500	360	1875	360
24 VDC ⁽²⁾	750	180	900	180

1. The number of plates within a given battery size determines reserve capacity. Reserve capacity determines the length of time for which a battery at 27°C (81°F) can supply 25 amperes at 10.5 volts or greater.
2. The CCA ratings are based upon two 12 VDC batteries in series.

Batteries (Specific Gravity)

Specific Gravity at 27°C (81°F)	State of Charge
1.260 to 1.280	100%
1.230 to 1.250	75%
1.200 to 1.220	50%
1.170 to 1.190	25%
1.110 to 1.130	Discharged

FUEL RECOMMENDATIONS AND SPECIFICATIONS

Fuel Recommendations

Do not mix gasoline, alcohol, or gasohol with diesel fuel. This mixture can cause an explosion.

Due to the precise tolerances of diesel injection systems, it is extremely important that the fuel be kept clean and free of dirt or water. Dirt or water in the system can cause severe damage to both the fuel pump and the fuel injectors.

Lighter fuels can reduce fuel economy and can cause damage the fuel injection pump.

Ingersoll Rand Ltd. Recommends the use of ASTM No. 2D fuel. The use of No. 2D fuel will result in optimum engine performance.

At operating temperatures below 0°C (32°F), acceptable performance can be obtained by using blends of No. 2D and No. 1D.

The viscosity of the fuel **must** be kept above 1.3 cSt at 40°C (104°F) to provide adequate fuel system lubrication.

The following chart lists alternate fuels for the 6IRQ9AE engine.

Acceptable substitutes Fuels - 6IRQ9AE									
No. 1D Diesel (1) (2)	No. 2D Diesel	No. 1K Kerosene	Jet-A	Jet-A1	JP-5	JP-8	Jet-B	JP-4	CITE
OK	OK	OK	OK	OK	OK	OK	NOT OK	NOT OK	NOT OK

1. Any adjustment to compensate for reduced performance with a fuel system using alternate fuel is not warrantable.
2. Winter blend fuels, such as those found at commercial fuel dispensing outlets, are combinations of No. 1D and No. 2D diesel and are acceptable.

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LUBRICATING OIL RECOMMENDATIONS AND SPECIFICATIONS

New Engine Break-in Oils

A sulphated ash limit of 1.85 percent has been placed on all engine lubricating oils recommended for use in Ingersoll Rand. Higher ash oils can cause valve and / or piston damage and lead to excessive oil consumption.

The use of a synthetic-based oil does not justify extended oil change intervals. Extended oil change intervals can decrease engine life due to factors such as corrosion, deposits, and wear.

Special 'break-in' engine lubricating oils are **not** recommended for new or rebuilt Ingersoll Rand engines. Use the same kind of oil during the 'break-in' as used in normal operating.

Arctic Operation Engine Oil.

If an engine is operated in ambient temperatures consistently below -23°C (-9°F), and there are no provisions to keep the engine warm when **not** in operation, use a synthetic CE / SF or higher API classification engine oil with adequate low temperature properties (such as 5W-20 or 5W-30).

General Information

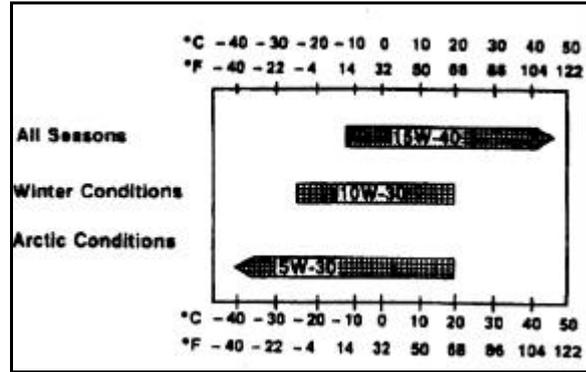
The use of quality engine lubricating oils, combined with appropriate oil drain and filter change intervals, are critical factors in maintaining engine performance and durability.

Ingersoll Rand Ltd recommends the use of a high-quality SAE 15W-40 multiviscosity heavy-duty engine oil, such as Ingersoll Rand Pro-Tec Engine Oil that meets the requirement of the American Petroleum Institute (API) performance classification CG-4 or CH-4.

NOTE: In areas where CG-4 or CH-4 lubricating oils are **not** available, CF-4 lubricating oil can be used, but the lubricating oil change interval **must** be reduced to 250 hours or 6 months.

A sulphated ash limit of 1.0 mass percentage is suggested for optimum valve and piston deposit and oil consumption control, the sulphated ash **must not** exceed 1.85 mass percent.

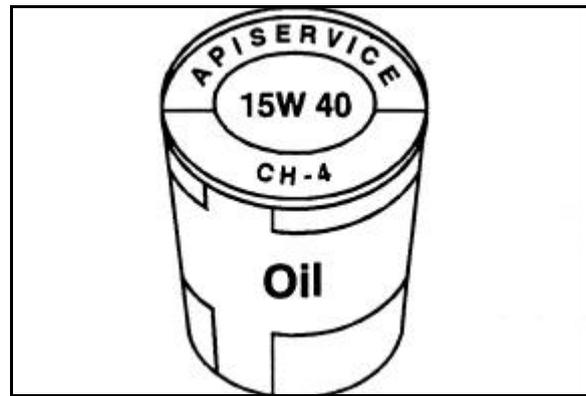
The use of low-viscosity oils, such as 10W or 10W-30, can be used to aid in starting the engine and in providing sufficient oil flow at ambient temperatures below -5°C (-23°F). However, continuous use of low-viscosity oils can decrease engine life due to wear.



The API service symbols are shown in the accompanying illustration. The upper half of the symbol displays the appropriate oil categories.

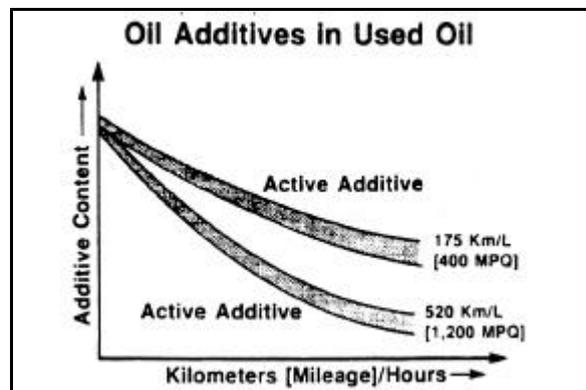
The lower half can contain a description of oil energy conserving features.

The center section identifies the SAE oil viscosity grade.



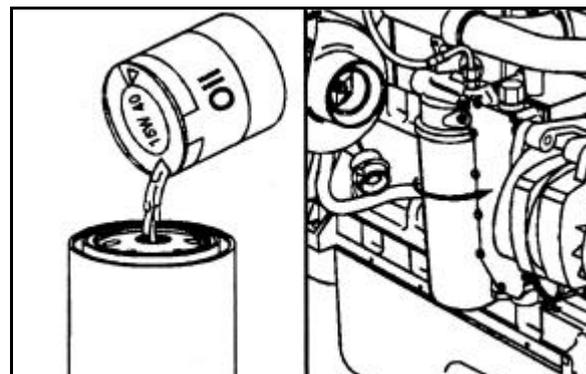
As the engine oil becomes contaminated, essential oil additives are depleted. Lubricating oils, protect the engine as long as these additives are functioning properly. Progressive contamination between oil and filter change intervals is normal. The amount of contamination will vary depending on the operation of the engine, hours on the oil, fuel consumed, and new oil added.

Extending oil and filter change intervals beyond the recommendations will decrease engine life due to factors such as corrosion, deposits and wear.

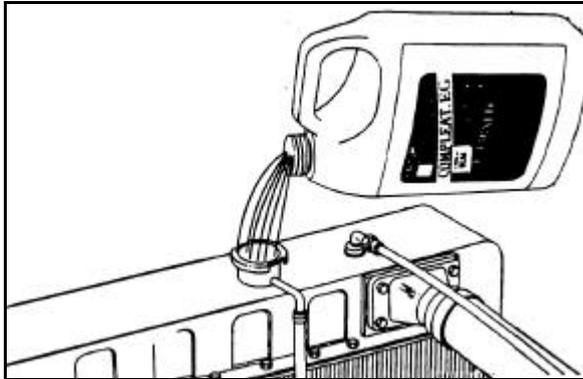


Ingersoll Rand Filter Specification

Ingersoll Rand CPN: 22177737



COOLANT RECOMMENDATIONS AND SPECIFICATIONS

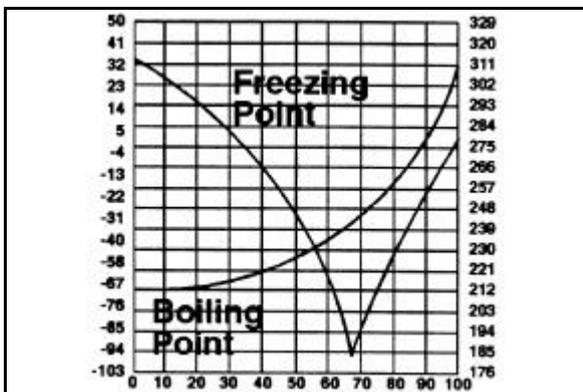


Fully Formulated Coolant / Antifreeze

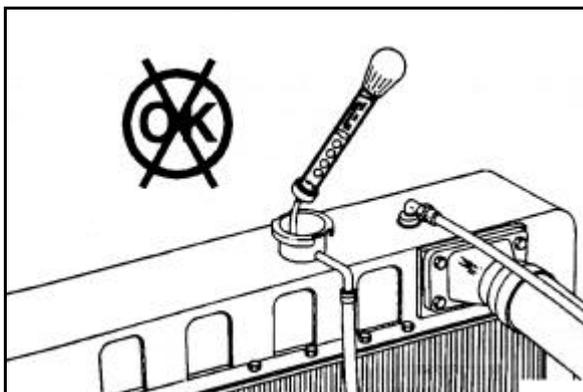
Ingersoll Rand Ltd. recommends using either a 50/50 mixture of high-quality water and fully formulated antifreeze or fully formulated coolant when filling the cooling system. The fully formulated antifreeze or coolant **must** meet TMC RP 329 or TMC RP 330 specifications.

Water Quality	
Calcium Magnesium (Hardness)	Maximum 170 ppm as (CaCO ₃ + MgCO ₃)
Chloride	40 ppm as(Cl)
Sulfur	100 ppm as (SO ₄)

High-quality water is important for cooling system performance. Excessive levels of calcium and magnesium contribute to scaling problems, and excessive levels of chlorides and sulphates cause cooling system corrosion.



Fully formulated antifreeze **must** be mixed with high-quality water at a 50/50 ratio (40- to 60-percent working range). A 50/50 mixture of antifreeze and water has a -36°C (-33°F) freezing point and a 110°C (230°F) boiling point. The actual lowest freezing point of ethylene glycol antifreeze is at 68 percent. Using higher concentrations of antifreeze will raise the freezing point of the solution and increase the possibility of a silicate gel problem.



A refractometer **must** be used to measure the freezing point of the coolant accurately.

Do **not** use a floating ball hydrometer. Use of a floating ball hydrometer can give an incorrect reading.

Specifications

Use a low-silicate antifreeze that meets ASTM4985 test (GM6038M specification) criteria.

Concentration

Antifreeze **must** be used in any climate for both freezing and boiling point protection. Ingersoll Rand recommends a 50 percent concentration level (40– to 60-percent range) of ethylene glycol or propylene glycol in most climates. Antifreeze at 68-percent concentration provides the maximum freeze protection and **must never** be exceeded under any condition. Antifreeze protection decreases above 68 percent.

Ethylene Glycol	Propylene Glycol
40% equals -23°C (-9°F)	40% equals -21°C (-6°F)
50% equals -37°C (-35°F)	50% equals -33°C (-27°F)
60% equals -54°C (-65°F)	60% equals -49°C (-56°F)
68% equals -71°C (-96°F)	68% equals -63°C (-81°F)

Concentration Testing

Antifreeze concentration **must** be checked using a refractometer. “Floating ball” type density testers or hydrometers are **not** accurate enough for use with heavy-duty diesel cooling systems.

Coolant Change Recommendation

The coolant **must** be drained and replaced every 2 years to eliminate build-up of harmful chemicals.

Cooling System Additives

Supplemental Coolant Additives (SCA)

Supplemental coolant additives (SCA) are recommended for all Ingersoll Rand cooling systems. Antifreeze alone does **not** provide sufficient protection for heavy-duty diesel engines.

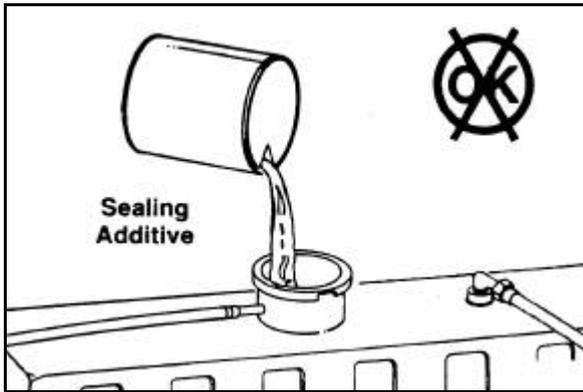
SCA Concentration

The recommended concentration level of SCA is 1.5 units for every 3.7 litres (1 gal). The SCA concentration **must never** exceed 3.0 units for every 3.7 litres (1 gal) nor fall below 1.2 units for every 3.7 litres (1 gal).

Cooling System Sealing Additives

Do **not** use sealing additives in the cooling system. The use of sealing additives will.

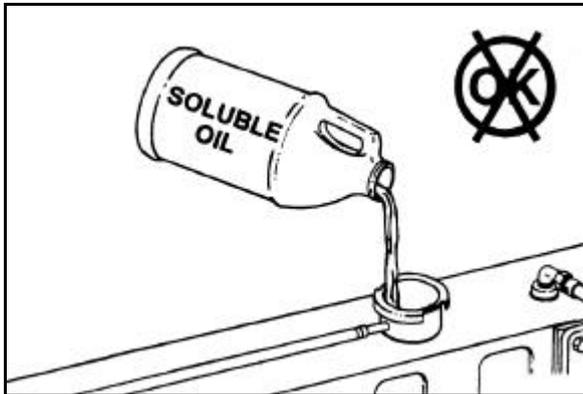
- Build up in coolant low-flow areas.
- Clog coolant filters.
- Plug the radiator and oil cooler.
- Possibly damage the water pump seal.



Cooling System Soluble Oils

Do **not** use soluble oils in the cooling system. The use of soluble oils will.

- Allow cylinder pitting
- Corrode brass and copper
- Damage heat transfer surfaces
- Damage seals and hoses.



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Engine Component Torque Values

Torque Table

Component	Wrench Size	Torque Value		
		N•m	ft- lb	In- lb
Aftercooler Mounting	10 mm	24	18	
Aftercooler Water Hose Clamp	8 mm	5		41
Alternator Link (Delco 10-15 SI)	13 mm	24	18	
Alternator Link (Delco 20-27 SI)	3/4 in	43	32	
Alternator Mtg. Bolt 10-15SI	15 mm	43	32	
Alternator Mtg. 27 SI	18 mm	77	57	
Alternator Support (Upper)	10 mm	24	18	
Belt Tensioner Flat Bracket	Allen 5 mm	24	18	
Belt Tensioner Mounting	15 mm	43	32	
Crankshaft Damper And Pulley	15 mm	137	101	
Crossover Clamp	5/16 in	5		44
Tee-Bolt-Type Clamp	11 mm	8		71
Exhaust Outlet Pipe, V-Band Clamp	7/16 in	8		71
Fan Bracket Mounting	10 mm	24	18	
Fan Pulley	10 mm	24	18	
Fan Pulley	13 mm	43	32	
Fuel Filter	75 to 85 mm	Install as specified by filter manufacturer		
Fuel Filter Adapter Nut	24 mm	32	24	
Lubricating Oil Filter	75 to 85 mm	3/4 of a turn after contact		
Lubricating Oil Cooler Assembly	10 mm	24	18	
Lubricating Oil Pan Drain Plug	17 mm	80	59	
Lubricating Oil Pan Heater Plug	27 mm	80	59	
Starter Mounting	10 mm	43	32	
Thermostat Housing	10 mm	24	18	
Water Inlet Connection	15 mm	43	32	
Water Pump Mounting	13 mm	24	18	
Rocker Lever (Valve) Cover	15 mm	12		106
Water-In-Fuel Sensor	19 mm		Hand-tighten	

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SERVICE PARTS LIST

IR CPN	DESCRIPTION
15900525	THERMOSTAT
15901945	PRESSURE SWITCH
15902430	INJECTOR
22113039	FAN BELT
22177711	FUEL FILTER
22177737	OIL FILTER ENG
36841138	TEMPERATURE SENDER
36868156	WATER FILTER
36870608	OIL PRESSURE SENDER
36896892	PRESSURE REGULATOR
89288971	AIR FILTER MAIN
89288989	AIR FILTER SAFETY
89311716	PROTEC ENGINE OIL

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WARRANTY

Ingersoll-Rand, through its distributor, warrants that each item of equipment manufactured by it and delivered hereunder to the initial user will be free of defects in material and workmanship for a period of three (3) months from initial operation or six (6) months from the date of shipment to the initial user, whichever occurs first.

With respect to the following types of equipment, the warranty period enumerated below will apply in lieu of the foregoing warranty period.

- A. **Aftercoolers** - The earlier of nine (9) months from date of shipment to or six (6) months from initial operation by initial user.
- B. **Portable Compressors, Portable Generator Sets - 9 Kva through to 550 Kva, Portable Light Towers and Air Dryers** - The earlier of twelve (12) months from shipment to or the accumulation of 2,000 hours of operation by the initial user.
2.5 Kva Through to 8 Kva - The earlier of twelve (12) months from shipment to or the accumulation of 2,000 hours of operation by the initial user.

Ingersoll-Rand will provide a new part or repaired part, at its sole discretion, in place of any part which is found to be defective in material or workmanship during the period described above. Labor cost to replace the part is the responsibility of the initial user.
- C. **Portable Compressor Air Ends** - The earlier of twenty-four (24) months from shipment to or the accumulation of 4,000 hours of operation by the initial user. For Air Ends, the warranty against defects will include replacement of the complete Air End, provided the original Air End is returned assembled and all original seals are intact
- C. **Portable Compressor Airend Limited Extended Warranty** - The earlier of sixty (60) months from shipment to or the accumulation of 10,000 hours of operation by the initial user. This extended warranty is limited to defects in design or defective material or workmanship in rotors, housings, bearings and gears and provided all the following conditions are met:
 1. The original air end is returned assembled and all original seals are intact.
 2. Continued use of genuine Ingersoll-Rand parts, fluids, oil and filters.
 3. Maintenance is performed at prescribed intervals by authorized and properly trained service engineers.
- D. **Generator Alternator - 9 Kva through to 550 Kva**, The earlier of twenty-four (24) months from shipment to or the accumulation of 4,000 hours of operation by the initial user.
2.5 Kva Through to 8 Kva - The earlier of twelve (12) months from shipment to or the accumulation of 2,000 hours of operation by the initial user.
- E. **Portable Light Tower Alternator** - The earlier of twelve (12) months from shipment to or the accumulation of 2,000 hours of operation by the initial user. Light Source model only, the earlier of twenty-four (24) months from shipment to or the accumulation of 4,000 hours of operation by the initial user.
- F. **Ingersoll-Rand Engines** - The earlier of twenty-four (24) months from shipment to or the accumulation of 4,000 hours of operation by the initial user.
- G. **Ingersoll-Rand Platinum Drive Train Limited Extended Warranty** - Platinum drive train refers to the Ingersoll-Rand Engine and Airend combination. The earlier of sixty (60) months from shipment to, or the accumulation of 10,000 hours of operation by the initial user. The starter, alternator, fuel injection system and all electrical components are

excluded from this extended warranty. The air end seal and drive coupling are included in the warranty but air end drive belts are excluded. This limited extended warranty is automatically available when meeting the following conditions are met:

1. The original air end is returned assembled and unopened.
2. Continued use of genuine Ingersoll-Rand parts, fluids, oil and filters.
3. Maintenance is performed at prescribed intervals by authorized and properly trained service engineers.

Ingersoll-Rand shall be provided with such information as it requires to confirm that these conditions have been complied with.

H 1. Construction Tools, (Portable Power range only) – Twelve (12) months from shipment to initial user. Ingersoll-Rand will provide a new part or repaired part, at its sole discretion, in place of any part which is found to be defective in material or workmanship during the period described above. Labor cost to replace the part is the responsibility of the initial user.

2. Construction Tools Limited Extended Warranty, (Portable Power range only). Thirty-six (36) months from shipment to initial user. This extended warranty is automatically available only when the tool is registered with Ingersoll-Rand by completing and submitting the Warranty Registration form. Ingersoll-Rand will provide a new part or repaired part, at its sole discretion, in place of any part which is found to be defective in material or workmanship during the period described above. Labor cost to replace the part is the responsibility of the initial user.

I Spare Parts– Six (6) months from date of shipment to the initial user.

Ingersoll-Rand will provide a new part or repaired part, at its sole discretion, in place of any part that is found to be defective in material and workmanship during the period described above. Such parts will be repaired or replaced without charge to the initial user during normal working hours at the place of business of an Ingersoll-Rand distributor authorized to sell the type of equipment involved or other establishment authorized by Ingersoll-Rand. User must present proof of purchase at the time of exercising warranty. The above warranties do not apply to failures occurring as a result of abuse; misuse, negligent repairs, corrosion, erosion and normal wear and tear, alterations or modifications made to the product without express written consent of Ingersoll-Rand; or failure to follow the recommended operating practices and maintenance procedures as provided in the product's operating and maintenance publications.

Accessories or equipment furnished by Ingersoll-Rand, but manufactured by others, including, but not limited to, engines, tires, batteries, engine electrical equipment, hydraulic transmissions, carriers, shall carry only the manufacturer's warranty, which Ingersoll-Rand can lawfully assign to the initial user.

THE ABOVE WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED, (EXCEPT THAT OF TITLE), AND THERE ARE NO WARRANTIES OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE.