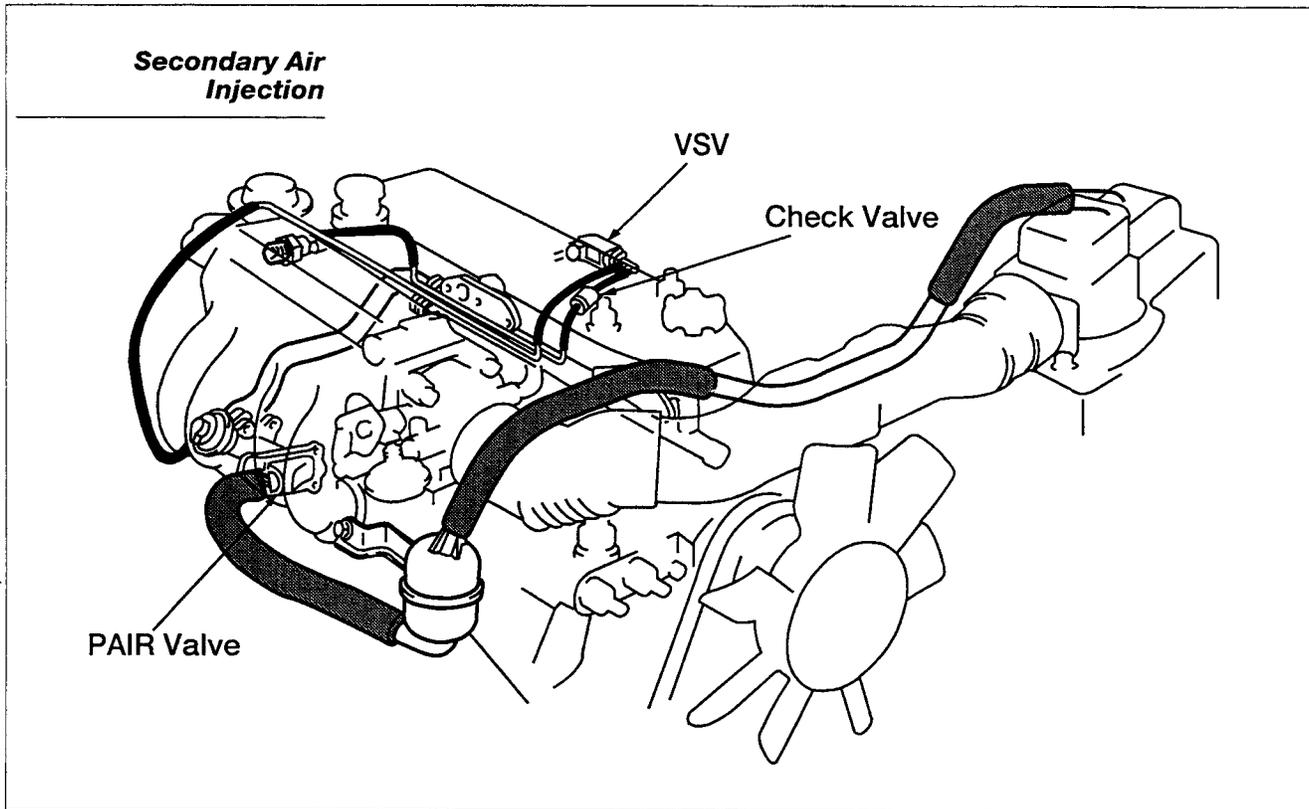


Secondary Air Injection



Pulsed Secondary Air Injection System (PAIR)

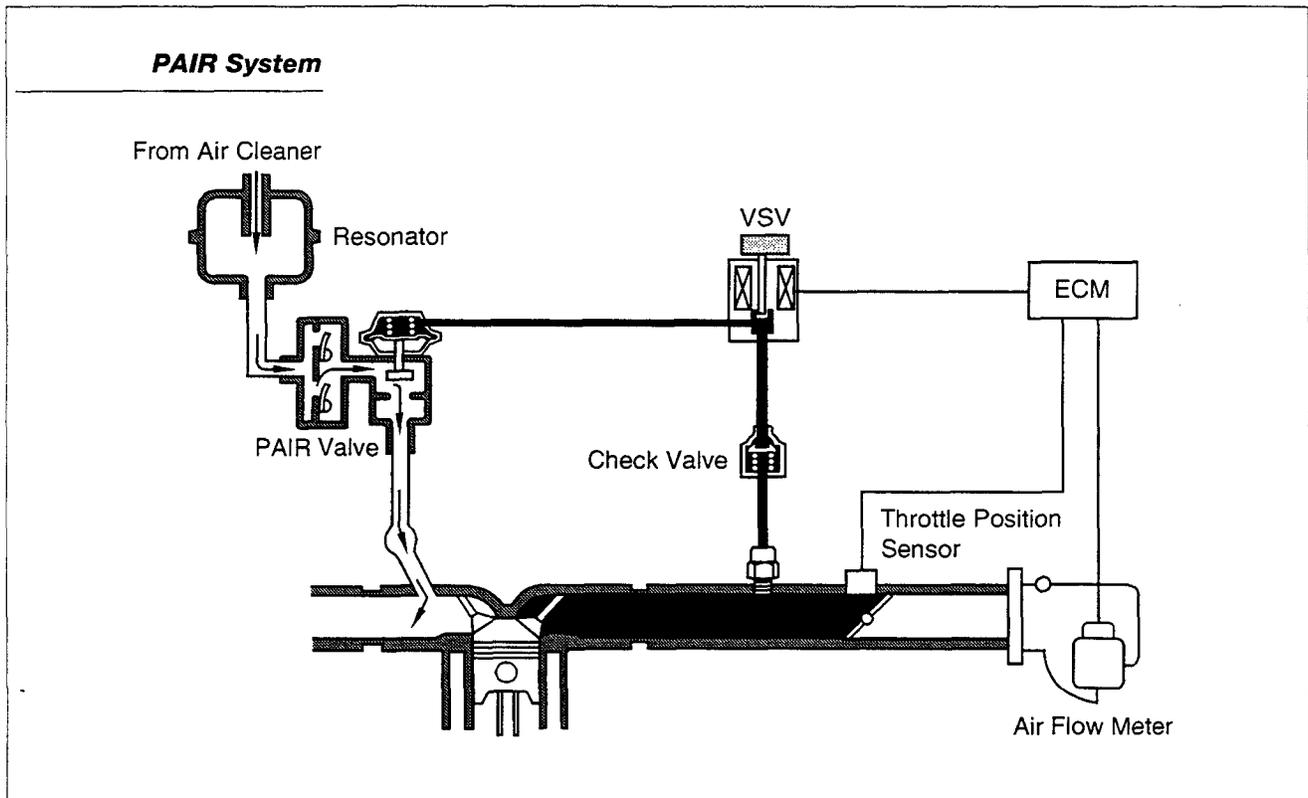
Combustion gases that enter the exhaust manifold are not completely burned and would continue to burn if not limited by the amount of oxygen in the exhaust system. To decrease the level of emissions emitted from the tailpipe, the Pulsed Secondary Air Injection (or Air Suction) system is used to introduce air into the exhaust flow, thereby allowing combustion to continue well into the exhaust system. This prolonged combustion (oxidation) period helps to lower the levels of HC and CO emissions that are forwarded to the catalytic converter. Additional air in the exhaust system also ensures that an adequate supply of oxygen is provided to the converter for catalyst oxidation.

Pulsed Secondary Air Injection (PAIR) systems do not use an air pump, but rely solely on the pressure differential that exists between atmospheric pressure and exhaust vacuum pulsation to draw air into the exhaust manifold.

System Components

Toyota PAIR system uses the following components:

- PAIR valve (with reed valves)
- Vacuum Switching Valve (VSV)
- Check valve
- Resonator
- Air passage hoses



PAIR System Operation

Exhaust pressure is high when the exhaust valve opens to allow combustion gases into the exhaust manifold. However, once the valve closes, exhaust pressure drops below atmospheric pressure to create a vacuum in the exhaust manifold. This explains why exhaust pressure rapidly pulsates above and below atmospheric pressure.

The PAIR system promotes HC and CO oxidation by adding additional oxygen into the exhaust manifold during cold engine operation and deceleration (when very specific parameters are met). These operating conditions typically produce higher levels of HC and CO emissions.

This system simply provides a controlled air passage between atmosphere and the exhaust manifold. Whenever exhaust manifold pressure drops below atmospheric pressure, fresh air from the high pressure zone (atmosphere) flows through the system and enters the exhaust manifold where it promotes emission oxidation.

PAIR Valve

The PAIR system should only operate when needed; thus, a PAIR valve is used to control system air flow. It is simply a vacuum control diaphragm valve, similar to an EGR valve, that is opened to allow secondary air flow and closed to prohibit flow. The PAIR valve assembly also contains reed valves that prevent exhaust gases from entering system and possibly damaging it, when exhaust pressure exceeds atmospheric pressure.

EMISSION SUB SYSTEMS - Secondary Air Injection

ECM Controlled VSV

An ECM controlled VSV is located in-line with the vacuum signal to the PAIR valve. It is a normally closed VSV that is switched on by the ECM during conditions when emission production is high and fresh air is needed to promote emission oxidation. A resonator is located at the air intake and is used to baffle air pulsation that normally occurs during system operation.

PAIR System Operating Strategy

PAIR operating strategy varies between different engine applications; therefore, refer to the Repair Manual for exact system operating parameters. An example of a typical program strategy (Truck with 22R-E engine) allows secondary air flow during the following conditions:

- **Cold engine operation**; when coolant temperature is below 86° F and engine speed is below 3600 rpm
- **Deceleration**; when either of the following conditions are met:
 - coolant temperature above 140°F, IDL on, and vehicle speed above 2 mph
 - coolant temperature above 140°F, IDL on, vehicle speed below 2 mph, and engine speed above 2,500 rpm

Effects of PAIR System on Emissions and Driveability

In most cases, an inoperative PAIR system will have little effect on vehicle driveability; however, higher levels of emissions may result during periods when secondary air should be supplied (cold engine operation and deceleration). This is due to the lack of oxygen needed to prolong combustion in the exhaust manifold and assist the in catalyst oxidation.

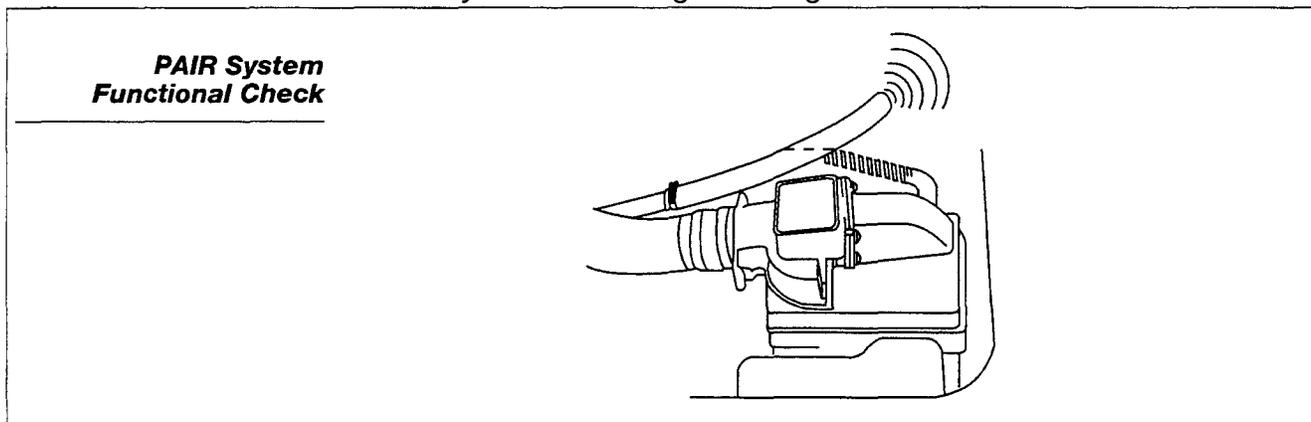
PAIR System Tests

A visual check of the PAIR system hoses and components may quickly identify problems that prevent secondary air flow. Check the air control and passage hoses for leaks, kinks, cracks, or damage and replace as necessary. Exhaust residue in the air induction system would indicate damaged reed valves.

A functional check of the PAIR system can be performed as follows:

- Disconnect the PAIR system air intake hose from the air cleaner
- Start the engine cold and allow it to idle. Confirm that a pulsating noise is heard from the PAIR air intake hose

Note: *This confirms secondary air flow during cold engine idle*



EMISSION SUB SYSTEMS - Secondary Air Injection

- Allow the engine to reach operating temp. and let it idle. Confirm that no pulsating noise is heard from the PAIR air intake hose

Note: This confirms no secondary air flow during hot engine idle

- Next, race the engine and then snap the throttle closed. Confirm that a pulsating noise is initially heard from the PAIR air intake hose, then stops after a few seconds.

Note: This confirms secondary air flow during deceleration until engine speed falls below a certain level.

