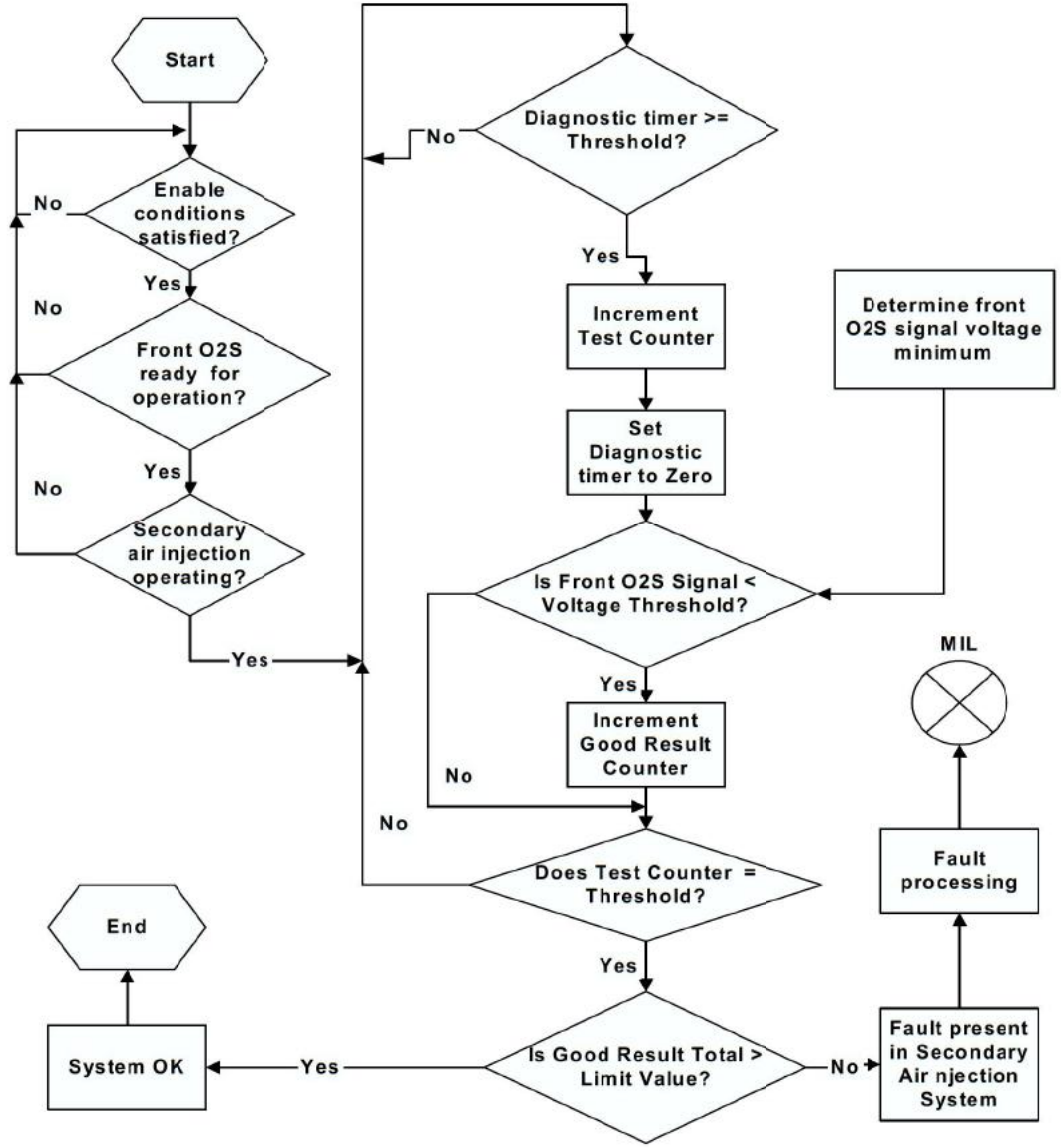
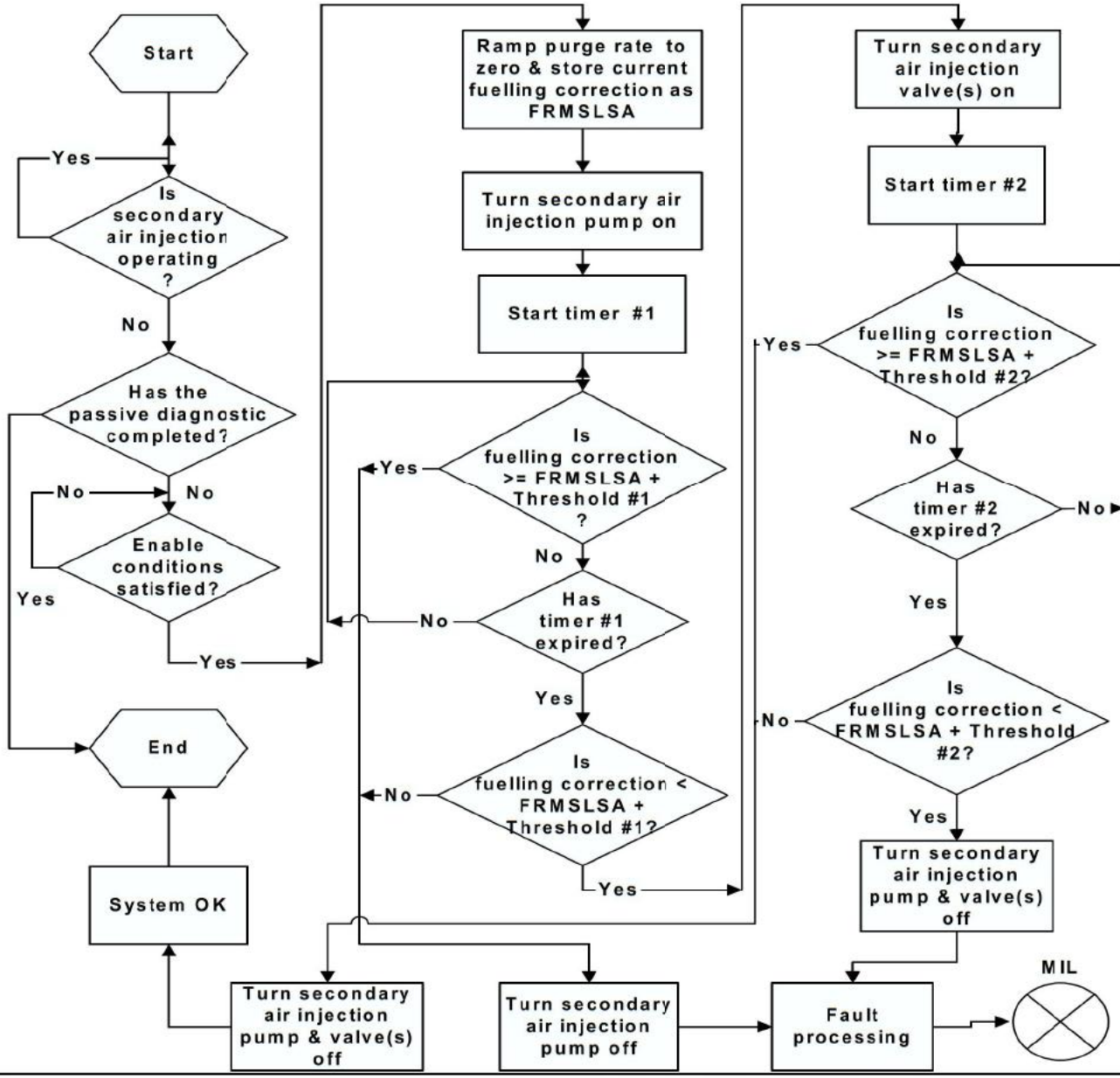
The active test is in two parts. First the current feedback correction factor is recorded and the secondary air injection pump turned on, but with the control valves shut. If the fuelling enriches by more than a threshold, then the valves are leaking or stuck open, but if after a timer has elapsed the feedback correction is below the threshold, then the system proceeds with a flow check.

For the second part of the active diagnostic the valves are opened and if after a time limit, the feedback has not enriched the fuelling by more than a second threshold, then a problem exists with the system and if it is present again on a subsequent drive cycle, a fault is stored and the MIL illuminated.

### 4.3.2 Passive Secondary Air Injection Diagnostic Monitoring Structure



### 4.3.3 Active Secondary Air Injection Diagnostic Monitoring Structure



| Secondary Air Injection System Monitoring Operation | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Component/ System | Fault Codes | Monitoring Strategy Description | Malfunction Criteria | Threshold value | Secondary Parameter | Enable Conditions | Time Required | MIL Illumination |
| **Secondary Air Injection Pump Relay** | P0418 | circuit continuity - short to battery positive | voltage - drive on | voltage > 1/2 * Battery positive | engine speed<br>battery voltage | > 80 rpm<br>7.5V < B+ < 17V | immediately/ continuous | two driving cycles |
| | | circuit continuity - short to ground | voltage - drive off | voltage < 1/3 * Battery positive | | | | |
| | | circuit continuity - open circuit | voltage - drive off | 1/3 * Battery positive< voltage < 2/3 * Battery positive | | | | |
| **Secondary Air Injection Valve Vacuum Solenoid Drive** | P0412<br>P0414<br>P0413 | circuit continuity - short to battery positive<br>circuit continuity - short to ground<br>circuit continuity - open circuit | voltage - drive on<br>voltage - drive off<br>voltage - drive off | voltage > 1/2 * Battery positive<br>voltage < 1/3 * Battery positive<br>1/3 * B+ < voltage < 2/3 * Battery positive | engine speed<br>battery voltage | > 80 rpm<br>7.5V < B+ < 17V | immediately/ continuous | two driving cycles |
| **Secondary Air Injection System** (Passive Test)<br>Bank 1<br>Bank 2 | <br><br>P1412<br>P1415 | the front O2S voltage Minimum value is sampled over a time of 0.100 sec .If this value is greater than a threshold, then the system is ok | system is OK if:- bank 1 O2S Value<br><br>and bank 2 O2S Value | < 0.501 V (for > 55 times in 80 Samples)<br><br>< 0.399 V (for > 55 times in 80 samples) | engine speed<br>engine load<br>engine airflow<br>ECT<br>front O2S<br><br>secondary air<br>time after engine start<br>altitude factor | 520 < rpm < 2520<br>1.5 < TL ms < 4.0<br>< 55.56 g/sec<br>> 8 °C<br>ready for operation<br>for > 10.0 sec<br>operating<br>< 655 sec<br><br>> 0.711 | 14 sec/ once per driving cycle | two driving cycles |
| **Secondary Air Injection System** | | valve check:- run the secondary air | change in fuelling correction | • •0.05 | vehicle speed<br>engine state<br>secondary air | = 0 mph<br>Idle<br>not operating, but | 10.5 sec/ once per driving cycle | two driving cycles |

| Secondary Air Injection System Monitoring Operation | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Component/ System | Fault Codes | Monitoring Strategy Description | Malfunction Criteria | Threshold value | Secondary Parameter | Enable Conditions | Time Required | MIL Illumination |
| (Active Test)<br><br>Bank 1<br>Bank 2<br><br><br><br><br><br>Bank 1<br>Bank 2 | <br><br>P1413<br>P1416<br><br><br><br><br><br>P1414<br>P1417 | injection pump with the control valves shut and monitor the Fuelling Correction<br><br>flow check:- if the valve check is successful, continue running the pump, but with the valves open and monitor the Fuelling correction. | change in fuelling correction | < 0.08 | injection<br><br>fuel system status<br>passive secondary air diagnostic<br>altitude factor<br>time after engine start<br>purge status<br><br>active test counter | has operated this drive cycle<br>Closed loop<br><br>not completed<br><br><br>> 0.711<br>> 580 sec<br><br>ramped to zero & wait 3.0 sec<br>> 0 | | |

If the above table does not include details of the following enabling conditions: - IAT, ECT, vehicle speed range, and time after engine start-up then the state of these parameters has no influence upon the execution of the monitor.

## 4.4 Evaporative Emission System Monitoring – 0.040" (1.0mm) Diameter

### 4.4.1 Description

The evaporative emission system monitoring permits the detection of leaks in the fuel evaporative emission control system with a diameter of 0.040" or larger.

For this purpose, a system pressure check is performed at idle with the vehicle stationary. Since vapour generation in the fuel tank could cause the false detection of a system leak, the first step is to close the EVAP canister purge valve and EVAP canister vent solenoid valve. Any pressure build-up is then measured, so that later results can be compensated for this fuel evaporation effect.

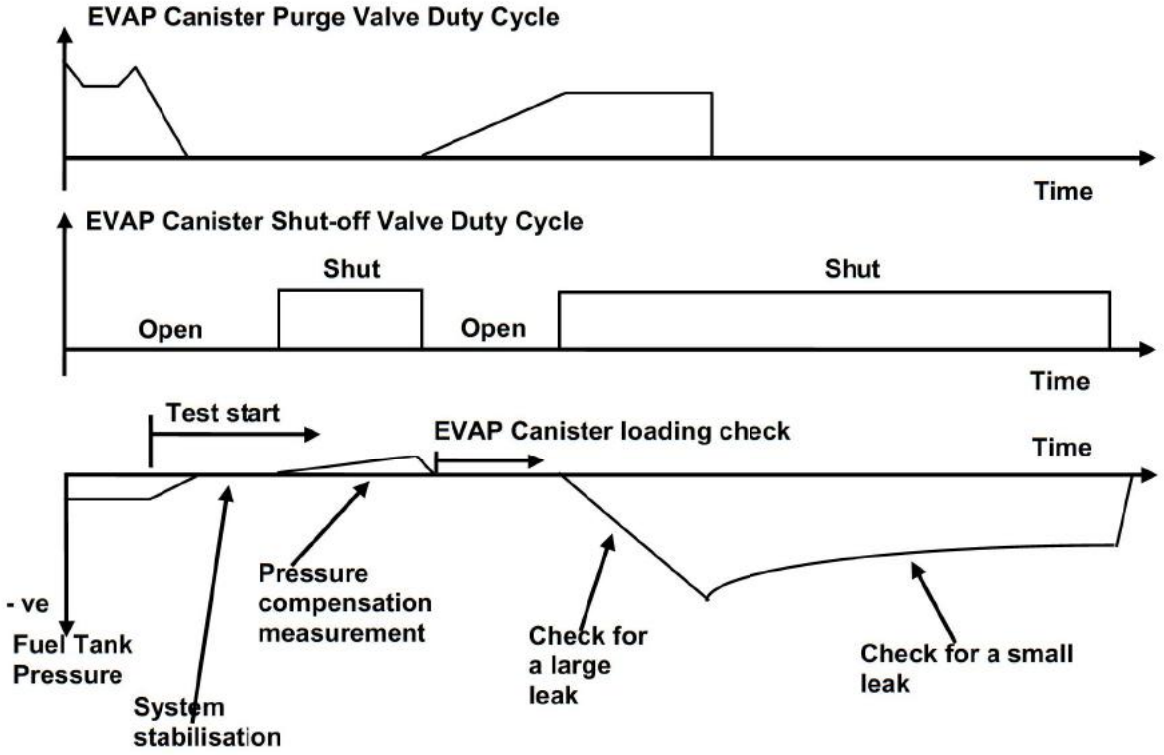
The EVAP canister purge valve is opened and the EVAP canister vent solenoid valve is closed. With this procedure a vacuum in the tank is created, which is measured by the fuel tank pressure sensor.

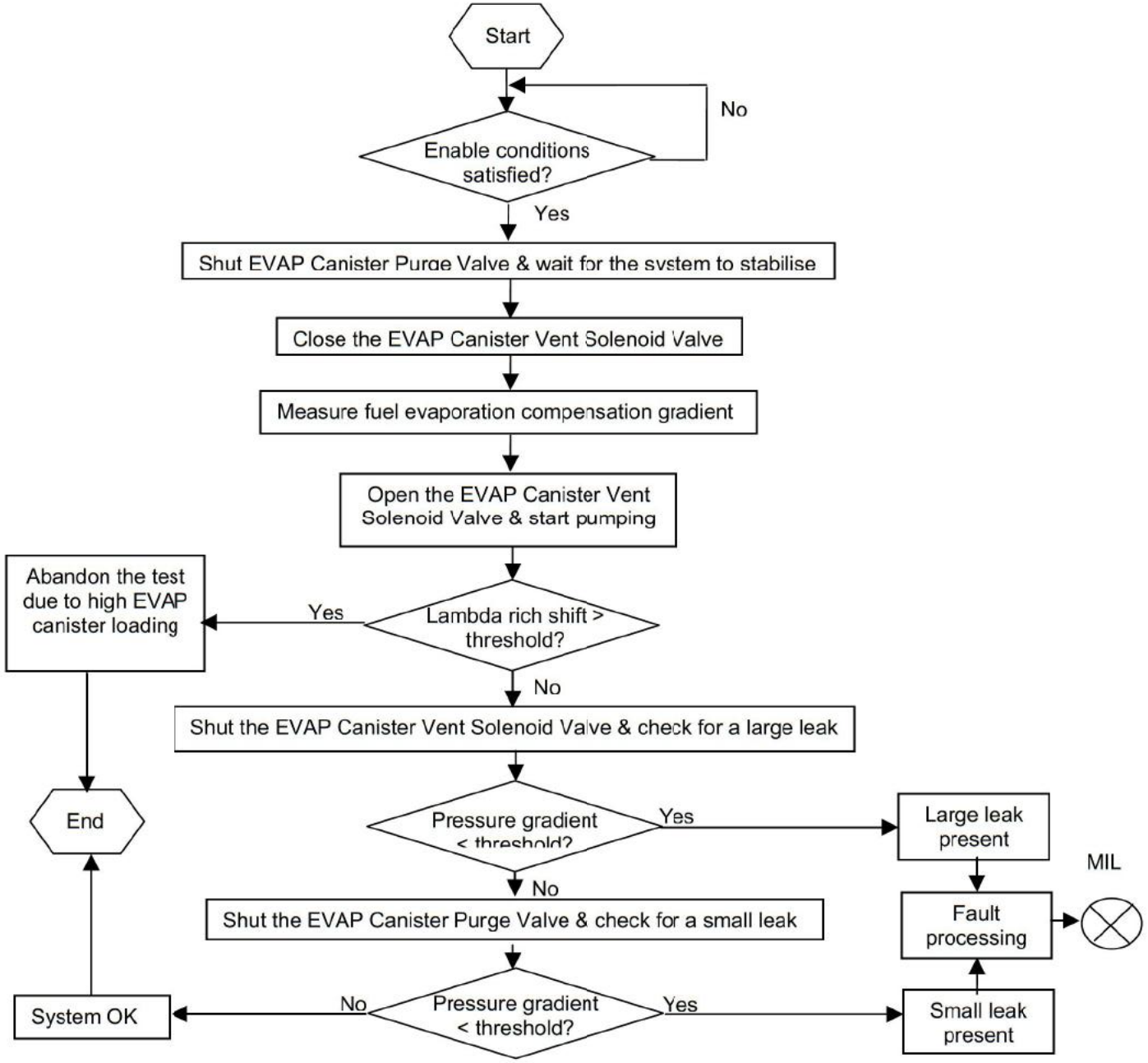
If no vacuum is detected, a large leak is assumed and the diagnosis is halted. If a large lean correction of the oxygen sensor controller is detected during the vacuum build-up, then the check is also halted, since fuel vapour is present in the system due to a high EVAP canister loading and idle instability will occur if the test is continued.

At a pre-determined vacuum the EVAP canister purge valve is closed, and the system is now considered "closed". From the gradient of the vacuum decay and the previously measured fuel vapour generation pressure rise, the presence of a leak can be inferred. The decay of the vacuum gradient also depends on the fuel level in the tank. The fuel level is roughly derived from the gradients of the vacuum build-up and vacuum decay and this information is also used when determining if a leak is present.

### 4.4.2 Monitoring Structure

Typical fuel tank pressure characteristic during the diagnostic test





| Evaporative Emission System Monitoring – 0.040" (1.0mm) Diameter | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Component/ System | Fault Codes | Monitoring Strategy Description | Malfunction Criteria | Threshold value | Secondary Parameter | Enable Conditions | Time Required | MIL Illumination |
| **Evaporative Emission Canister Purge Valve** | P0443 | Circuit continuity - short to battery positive | voltage - drive on | voltage > 1/ 2 * Battery positive | engine speed<br>battery voltage | > 80 rpm<br>7.5V < Battery positive < 17V | immediately/ continuous | two driving cycles |
| | P0445 | Circuit continuity - short to ground | voltage - drive off | voltage < 1/3 * Battery positive | | | | |
| | P0444 | circuit continuity - open circuit | voltage - drive off | 1/3 * B+ < voltage < 2/3 * Battery positive | | | | |
| | P0440 | Functional check – valve open or Leaking | fuel tank pressure during pressure compensation measurement for the EVAP Purge system check | < - 1.464 hPa | see evaporative emission system purge check | | up to 24.5 sec/once per driving cycle | two driving cycles |
| | | | fuel tank pressure at the end of the large system leak test | < - 15.62 hPa | | | up to 36.5 sec/once per driving cycle | |
| **Evaporative Emission Purge System** | P0455 | vacuum check uses the EVAP canister vent solenoid valve & the fuel tank pressure sensor | large system leak (e.g. missing filler cap) | vacuum build up gradient < 0.305 hPa/sec | EVAP canister purge vapour factor<br>fuel tank pressure<br>lambda control<br>engine state<br>battery voltage<br>vehicle speed<br>altitude factor<br>intake air temperature<br>engine load<br>fuel tank level | < 5.0<br>• -15.13 hPa<br>active<br>idle<br>• 11.0V<br>Zero<br>• 0.73<br>• -12.0 °C<br>• 2.80 msec<br>not empty | up to 36.5 sec/once per driving cycle | two driving cycles |
| | P0442 | | small system leak (• 1mm) | vacuum decay grad. - (pressure comp. grad. * comp. factor) > Threshold | | | up to 41.5 sec/once per driving cycle | |

| Evaporative Emission System Monitoring – 0.040" (1.0mm) Diameter | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Component/ System | Fault Codes | Monitoring Strategy Description | Malfunction Criteria | Threshold value | Secondary Parameter | Enable Conditions | Time Required | MIL Illumination |
| | | | | | engine air flow rate<br>ECT at engine start<br><br>time after engine start<br>transfer gears | • 40.0 kg/hr<br>-12.0 °C < start temp. < 65.25 °C<br>> 960 sec<br><br>high range | | |
| **Evaporative Emission Canister Vent Solenoid Valve** | P0449 | circuit continuity - short to battery positive | voltage - drive on | voltage > 1/2 * Battery positive | engine speed<br>battery voltage | > 80 rpm<br>7.5V < Battery positive < 17V | immediately/ continuous | two driving cycles |
| | P0448 | circuit continuity - short to ground | voltage - drive off | voltage < 1/3 * Battery positive | | | | |
| | P0447 | circuit continuity - open circuit | voltage - drive off | 1/3* Battery positive < voltage < 2/3* Battery positive | | | | |
| | P0446 | functional check for a blocked EVAP canister vent solenoid valve | fuel tank pressure too low during large system leak test | tank pressure < - 1.464 hPa | see evaporative emission purge system check | | up to 36.5 sec/once per driving cycle | |
| | | | fuel tank pressure too low during stabilisation phase of EVAP system check | tank pressure < - 14.64 hPa | | | 20 sec/ once per driving cycle | |
| **Fuel Tank Pressure Sensor** | P0452<br>P0453 | fuel tank pressure signal high/low | fuel tank pressure (min)<br>fuel tank pressure (max) | < -28.30 hPa<br>> 29.52 hPa | transfer gears | high range | 5.0 sec/ continuous | two driving cycles |
| | P0451 | sensor functional check | filtered pressure reading | ••15.13 hPa | transfer gears<br>engine state<br>ECT at engine start | high range<br>idle<br>••35.25 °C | 5.0 sec/ once per driving cycle | two driving cycles |