GENERAL
The common rail system was designed for electronic control of injection quantity, injection timing and injection pressure to obtain optimal operational control.

Features
• Lower exhaust gas and higher output due to high pressure injection in all usage ranges.
• Reduction in noise and exhaust gas due to injection rate control.
• Improved performance due to increased flexibility in the injection timing setting.
• Independent control of injection pressure in response to engine speed and load.

Main Elements

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Vehicle Model</th>
<th>Engine Model</th>
<th>Cylinder Configuration</th>
<th>Total Displacement (cc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISUZU</td>
<td>Forward</td>
<td>6HK1</td>
<td>Straight 6</td>
<td>7,800</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6SD1</td>
<td></td>
<td>9,800</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6WG1</td>
<td></td>
<td>15,600</td>
</tr>
</tbody>
</table>
1. Outline

1.1 System Outline
This system also provides the following functions:
- A self-diagnosis and alarm function using computer to diagnose the system’s major components and alert the driver in the event of a problem.
- A fail-safe function to stop the engine, depending upon the location of the problem.
- A backup function to change the fuel regulation method, thus enabling the vehicle to continue operation.

1.2 System Configuration
Divided by function, the system can be classified according to the fuel system and the control system.

[1] Fuel System
High-pressure fuel that is generated by the supply pump is distributed to the cylinders using a rail. Electromagnetic valves in the injectors then open and close the nozzle needle valve to control the start and end of fuel injection.

[2] Control System
Based on the signals received from various sensors mounted on the engine and the vehicle, the ECU controls current timing and the duration in which the current is applied to the injectors, thus ensuring an optimal amount of fuel is injected at an optimal time.

The control system can be broadly classified according to the following electronic components: sensors, computers, and actuators.
<table>
<thead>
<tr>
<th>Date</th>
<th>Revision Contents</th>
</tr>
</thead>
</table>
| 2007. 09 | • SCV: Explanation of compact SCV added to "Suction Control Valve (SCV)". (Operation: Refer to page 1-30.)  
|        | • "Repair" section added.                                                           |
# Table of Contents

## Operation Section

1. **GENERAL DESCRIPTION**
   - 1.1 Changes In Environment Surrounding The Diesel Engine ........................................ 1-1
   - 1.2 Demands On Fuel Injection System .................................................................................. 1-2
   - 1.3 Types Of And Transitions In ECD (ELECTRONICALLY CONTROLLED DIESEL) Systems .......... 1-3
   - 1.4 Common Rail System Characteristics ............................................................................... 1-4
   - 1.5 Common Rail System And Supply Pump Transitions ....................................................... 1-5
   - 1.6 Injector Transitions ........................................................................................................ 1-5
   - 1.7 Common Rail System Configuration ............................................................................... 1-6

2. **COMMON RAIL SYSTEM OUTLINE**
   - 2.1 Layout of Main Components ........................................................................................ 1-7

3. **SUPPLY PUMP DESCRIPTION**
   - 3.1 HP0 Type ..................................................................................................................... 1-12
   - 3.2 HP2 Type ..................................................................................................................... 1-18
   - 3.3 HP3 Type ..................................................................................................................... 1-27
   - 3.4 HP4 Type ..................................................................................................................... 1-41

4. **RAIL DESCRIPTION**
   - 4.1 Rail Functions and Composition .................................................................................. 1-46
   - 4.2 Component Part Construction and Operation ................................................................. 1-46

5. **INJECTOR DESCRIPTION**
   - 5.1 General Description ..................................................................................................... 1-50
   - 5.2 Injector Construction and Features .............................................................................. 1-51
   - 5.3 Injector Operation ........................................................................................................ 1-54
   - 5.4 Injector Actuation Circuit ............................................................................................ 1-54
   - 5.5 Other Injector Component Parts .................................................................................. 1-56

6. **DESCRIPTION OF CONTROL SYSTEM COMPONENTS**
   - 6.1 Engine Control System Diagram (Reference) ................................................................. 1-59
   - 6.2 Engine ECU (Electronic Control Unit) ........................................................................ 1-60
   - 6.3 EDU (Electronic Driving Unit) ...................................................................................... 1-60
   - 6.4 Various Sensors ............................................................................................................ 1-61

7. **CONTROL SYSTEM**
   - 7.1 Fuel Injection Control .................................................................................................. 1-66
   - 7.2 E-EGR System (Electric-Exhaust Gas Recirculation) .................................................... 1-76
   - 7.3 Electronically Controlled Throttle (Not Made By DENSO) ........................................... 1-78
   - 7.4 Exhaust Gas Control System ......................................................................................... 1-79
   - 7.5 DPF System (Diesel Particulate Filter) ......................................................................... 1-80
   - 7.6 DPNR SYSTEM (DIESEL PARTICULATE NOx REDUCTION) ...................................... 1-82
## Table of Contents

### 8. DIAGNOSIS
- 8.1 Outline Of The Diagnostic Function ................................................. 1-83
- 8.2 Diagnosis Inspection Using DST-1 ...................................................... 1-83
- 8.3 Diagnosis Inspection Using The MIL (Malfunction Indicator Light) ........ 1-84
- 8.4 Throttle Body Function Inspection ...................................................... 1-86

### 9. END OF VOLUME MATERIALS
- 9.1 Particulate Matter (PM) ........................................................................ 1-87
- 9.2 Common Rail Type Fuel Injection System Development History And The World’s Manufacturers .................................................................................................................. 1-87
- 9.3 Higher Injection Pressure, Optimized Injection Rates, Higher Injection Timing Control Precision, Higher Injection Quantity Control Precision .......................................................... 1-88
- 9.4 Image Of Combustion Chamber Interior .................................................. 1-90

### Repair Section

#### 1. DIESEL ENGINE MALFUNCTIONS AND DIAGNOSTIC METHODS (BASIC KNOWLEDGE)
- 1.1 Combustion State and Malfunction Cause .............................................. 2-91
- 1.2 Troubleshooting ...................................................................................... 2-92

#### 2. DIAGNOSIS OVERVIEW
- 2.1 Diagnostic Work Flow ............................................................................ 2-93
- 2.2 Inquiries .................................................................................................. 2-94
- 2.3 Non-Reoccurring Malfunctions ............................................................... 2-96

#### 3. DTC READING (FOR TOYOTA VEHICLES)
- 3.1 DST-2 .................................................................................................... 2-98
- 3.2 DTC Check (Code Reading via DST-2) ................................................... 2-98
- 3.3 DTC Memory Erasure (via DST-2) .......................................................... 2-98

#### 4. TROUBLESHOOTING BY SYSTEM
- 4.1 Intake System Diagnosis ....................................................................... 2-99
- 4.2 Fuel System Diagnosis ......................................................................... 2-99
- 4.3 Basics of Electrical/Electronic Circuit Checks ....................................... 2-102

#### 5. TROUBLESHOOTING
- 5.1 Troubleshooting According to Malfunction Symptom (for TOYOTA Vehicles) ......................................................................................... 2-107
- 5.2 Other Malfunction Symptoms ................................................................ 2-122

#### 6. DIAGNOSIS CODES (DTC)
- 6.1 DTC Chart (Example) ............................................................................ 2-124
1. GENERAL DESCRIPTION

1.1 Changes In Environment Surrounding The Diesel Engine

- Throughout the world, there is a desperate need to improve vehicle fuel economy for the purposes of preventing global warming and reducing exhaust gas emissions that affect human health. Diesel engine vehicles are highly acclaimed in Europe, due to the good fuel economy that diesel fuel offers. On the other hand, the "nitrogen oxides (NOx)" and "particulate matter (PM)" contained in the exhaust gas must be greatly reduced to meet exhaust gas regulations, and technology is being actively developed for the sake of improved fuel economy and reduced exhaust gases.

(1) Demands on Diesel Vehicles

- Reduce exhaust gases (NOx, PM, carbon monoxide (CO), hydrocarbon (HC) and smoke).
- Improve fuel economy.
- Reduce noise.
- Improve power output and driving performance.

(2) Transition of Exhaust Gas Regulations (Example of Large Vehicle Diesel Regulations)

- The EURO IV regulations take effect in Europe from 2005, and the 2004 MY regulations take effect in North America from 2004. Furthermore, the EURO V regulations will take effect in Europe from 2008, and the 2007 MY regulations will take effect in North America from 2007. Through these measures, PM and NOx emissions are being reduced in stages.

![Graph showing PM and NOx emissions](Q000989E)