



Workshop Manual Engine Management Systems

Rolls-Royce & Bentley motor cars

Rolls-Royce Silver Spirit

Rolls-Royce Silver Spur

Rolls-Royce Corniche

Rolls-Royce Corniche II

Bentley Eight

Bentley Mulsanne

Bentley Mulsanne S

Bentley Turbo R

Bentley Continental

**1987, 1988, and 1989
model year cars**

TSD 4737

September 1989



Introduction

This manual is written specifically for skilled service personnel and it is therefore assumed that the workshop safety and repair procedures generally accepted by the motor trade are appreciated, understood, and carried out.

Information relating to any subsequent modification will be circulated by the issue of amended or additional pages.

Each chapter incorporates an issue record sheet. Reference must be made to these sheets when determining either the current issue date for a particular page, or the number of pages contained within a chapter/section.

Throughout the manual reference is made to the right-hand and left-hand side of the car, this is determined when sitting in the driver's seat.

In order to identify the two banks of engine cylinders, it should be noted that 'A' bank of cylinders is on the right-hand side and 'B' bank on the left-hand side when viewed from the driver's seat.

Service personnel at Rolls-Royce Motor Cars Limited are always prepared to answer queries or give advice on individual servicing problems. When making an enquiry it is essential that the full vehicle identification number (VIN) is quoted.

Important

When obtaining information for a particular model always refer to the appropriate Chapter and/or Section contents page.



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General information

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General information

Health risk

Engine oils

Prolonged and repeated contact with mineral oil will result in the removal of natural fats from the skin, leading to dryness, irritation, and dermatitis. In addition, used engine oil contains potentially harmful contaminants which may cause skin cancer. Adequate means of skin protection and washing facilities should be provided.

Health protection precautions

1. Avoid prolonged and repeated contact with oils, particularly used engine oils.
2. Wear protective clothing, including impervious gloves where practicable.
3. Do not put oily rags in pockets.
4. Avoid contaminating clothes, particularly underpants, with oil.
5. Overalls must be cleaned regularly. Discard unwashable clothing and oil impregnated footwear.
6. First aid treatment should be obtained immediately for open cuts and wounds.
7. Use barrier creams, applying before each work period, to help the removal of oil from the skin.
8. Wash with soap and water to ensure all oil is removed (skin cleansers and nail brushes will help). Preparations containing lanolin replace the natural skin oils which have been removed.
9. Do not use fuel, kerosine, diesel fuel, gas oil, thinners, or solvents for washing skin.
10. If skin disorders develop, obtain medical advice.
11. Where practicable, degrease components prior to handling.
12. Where there is a risk of eye contact, eye protection should be worn, for example, chemical goggles or face shields; in addition an eye-wash facility should be provided.

See also UK Health and Safety Executive Cautionary Notice SHW 397 'Effects of Mineral Oil on the Skin'.

Environmental protection precautions

It is illegal to pour used oil onto the ground, down sewers or drains, or into water courses.

The burning of used engine oil in small space heaters or boilers is not recommended unless emission control equipment is fitted. In cases of doubt check with the Local Authority.

Dispose of used oil through authorized waste disposal contractors to licensed waste disposal sites, or to the waste oil reclamation trade. If in doubt, contact the Local Authority for advice or disposal facilities.

Exhaust gases

The exhaust gases contain carbon monoxide (CO), which is odourless and invisible but very poisonous.

Operating the air conditioning system in a confined space increases the danger of these gases entering the car.

Ideally, engines should be run in the open where the exhaust gases can discharge into the atmosphere. However, when running engines within an enclosed working area, the exhaust gases must always be removed safely.

Refer to further text within this manual regarding the use of exhaust gas extraction hoses and equipment.

Fuel

Fuel may contain up to 5% of benzene as an anti-knock additive. Benzene is extremely injurious to health (being carcinogenic) therefore, all contact should be kept to an absolute minimum, particularly inhalation.

Fuel has a sufficiently high vapour pressure to allow a hazardous build-up of vapour in poorly ventilated areas. Therefore, any work should be carried out in a well ventilated area.

Fuel vapour is an irritant to the eyes and lungs, and if high concentrations are inhaled it may cause nausea, headache, and depression.

Fuel liquid is an irritant to the eyes and skin and may cause dermatitis following prolonged or repeated contact.

When it becomes necessary to carry out work involving the risk of contact with fuel, particularly for prolonged periods, it is advisable to wear protective clothing including safety goggles, gloves, and aprons.

If there is contact with fuel the following emergency treatment is advised.

Ingestion (swallowing)

Do not induce vomiting. Give the patient milk to drink (if none is available water can be given). The main hazard after swallowing fuel is that some of the liquid may get into the lungs. Send the patient to hospital immediately.

Eyes

Wash with a good supply of clean water for at least 10 minutes.

Skin contact

Immediately drench the affected parts of the skin with water. Remove contaminated clothing and then wash all contaminated skin with soap and water.

Inhalation (breathing in vapour)

Move the patient into the fresh air. Keep the patient warm and at rest. If there is loss of consciousness give artificial respiration. Send the patient to hospital.

High voltage levels

Dangerously high voltage levels are present in an electronic ignition system. These levels are not only



present in individual components, but also in the wiring looms, plugs, sockets, and test connections.

Both primary and secondary circuits are subject to these high voltages.

Therefore, whenever the system is switched on do not touch any components/circuits contained within the ignition system.

Always wear thick rubber gloves and use insulated tools when working on the system with the ignition switched on.

Workshop precautions

Electrical

Always ensure that the battery master switch is turned to the OFF position or the battery is disconnected, before disconnecting or connecting any electrical components. In addition, note the following.

Never disconnect the battery or switch off the battery master switch when the engine is running.

Always ensure correct polarity when making cable connections.

It is recommended that when carrying out tests on the car wiring, a good quality multi-meter is used.

Never use generator type meters.

Do not use a test lamp on circuitry that contains electronic components, such as the ignition system.

Before using test equipment always read the manufacturer's instructions.

Do not pierce any electrical leads or looms with test probes, etc.

Do not remove the high tension lead situated between the ignition coil and distributor when the engine is running.

Ensure that no arcing takes place between electrical connections.

Do not supply more than 16 volts direct current to the ignition system.

Fire

Fuel is highly flammable, therefore great care must be exercised whenever the fuel system is opened (i.e. pipes or unions disturbed) or the fuel is removed from the system. Always ensure that 'no smoking' signs and CO₂ (carbon dioxide) fire extinguishers are placed in the vicinity of the vehicle.

Always ensure that the battery is disconnected before opening any fuel lines.

If the fuel is to be removed from the tank, ensure that it is siphoned into a suitable covered container.

Fuel

Pressure

The fuel system contains fuel that may be under high pressure. Therefore, to reduce the risk of possible injury and fire, always ensure that the system is depressurized by one of the following methods before commencing any work that necessitates opening the system.

1. Allow the pressure to fall naturally by switching off the engine and allowing the vehicle to stand for a minimum of four hours before opening the system.
2. Clean the inlet connection to the fuel filter. Wrap an

absorbent cloth around the joint and carefully slacken the pipe nut to release any pressurized fuel from the system. Tighten the pipe nut. Always dispose of the cloth carefully, in accordance with the prevailing Health and Safety regulations.

Cleanliness

It is extremely important to ensure maximum cleanliness whenever work is carried out on the system.

The main points are.

1. In order to prevent the ingress of dirt, always clean the area around a connection before dismantling a joint.
2. Having disconnected a joint (either fuel or air) always blank off any open connections as soon as possible.
3. Any components that require cleaning should be washed in white spirit and dried, using compressed air.
4. If it is necessary to use a cloth when working on the system, ensure that it is lint-free.

General

Before working on the car, always ensure that the parking brake is firmly applied, the gear range selector level is in the park position, and fuse A6 is removed from fuse panel F2 on the main fuseboard.

A number of the nuts, bolts, and setscrews used in the fuel injection system are dimensioned to the metric system, it is important therefore, that when new parts become necessary the correct replacements are obtained and fitted.

Terminology

It should be noted that not all of the components listed are fitted to any one particular model or model year of car. This section merely explains the abbreviation and operation of the specialist components used in the systems.

Air flow sensor plate

Balances the air flow entering the induction system with fuel pressure acting on the control piston.

Air flow sensor potentiometer

Monitors the quantity of air flowing into the engine.

The information is conveyed to the ECU as a measure of engine load and is one of the elements used in the calculation of ignition timing and fuelling requirements.

Air pressure transducer (APT)

The air pressure transducer monitors induction manifold pressure. It passes this information to the relevant ECU so that the necessary electrical corrections can be made to the relevant control system.

On cars fitted with one APT the unit provides instantaneous boost pressure information for the fuel injection and ignition control systems. It also supplies the information to the boost control system.

On cars fitted with two APTs one assembly is connected to the fuel injection system and the second unit is connected to the boost control system.



Air pump clutched pulley

The air injection system is de-activated whenever the coolant temperature is above 33°C (91°F) or engine speed exceeds 3000 + 100 rev/min. This is achieved by dis-engaging the air pump clutch.

Air switching valve

The air switching valve comprises a vacuum operated valve with an integral control solenoid.

At coolant temperatures below 33°C (91°F) the solenoid is energized. The resulting vacuum then applied to the diaphragm chamber opens the valve and allows injected air to pass to the exhaust manifold.

At coolant temperatures above 33°C (91°F) the solenoid is de-energized, the vacuum signal is inhibited and the injected air is re-routed to the engine air intake system.

Auxiliary air valve

Allows calibrated increases in idle circuit air flow and hence engine speed, with closed throttle plates. This provides the correct mixture strength during cold starting and warm-up periods.

Check valves

A check valve is fitted into the air injection pipe to each exhaust manifold. The valves prevent the back flow of exhaust gas.

Cold start injector

Sprays finely atomized fuel during engine cranking (cold engine) into the induction manifold. The amount and duration of cold start injector operation are dependent upon the coolant temperature.

Control piston

Cylindrical plunger type of valve that moves vertically in the fuel distributor. A precision machined edge on the piston opens the metering slits in the fuel distributor.

Coolant temperature sensor

The coolant temperature sensor is located in the thermostat housing. The internal resistance of the sensor changes with the engine coolant temperature.

To achieve the correct starting and warm-up characteristics at low operating temperatures, the ECU uses the signal it receives from the coolant temperature sensor to compute the correction factors for the ignition timing and the fuel injection system electro-hydraulic actuator.

Crankshaft reference sensor

Initiation of A1 ignition and subsequent engine firing order occurs when the front damper mounted reference pin passes the crankshaft reference sensor.

Differential pressure valves

One for each cylinder, maintains the correct pressure of fuel at the metering slits.

Dump valve

Allows compressed air to recirculate back through the

air intake. Closure of the dump valve allows induction manifold pressure (boost) to build-up during increasing engine load, to values predetermined by the boost control system.

The dump valve also acts as a relief valve if the boost pressure exceeds a preset level.

Electro-hydraulic actuator (EHA)

Mounted on the fuel distributor, the electro-hydraulic actuator replaces the warm-up regulator used on K-Jetronic systems. A positive increase in current (mA) supply to the EHA results in a corresponding increase in fuel flow and hence fuel mixture strength.

On 1989 model year cars fitted with the KE3-Jetronic fuel injection system, it is also possible to have a negative increase in the supply to the EHA which will 'lean off' the mixture.

Engine running sensor

Inhibits the supply of power to the fuel pump unless the engine is running. The only exception being one by-pass to the circuit, which allows the fuel pump to operate when the engine is being 'cranked' by the starter motor.

Engine speed sensor

The signal generated by the rotation of the four segment timing wheel is sensed by the engine speed sensor. The information is then conveyed to the K-Motronic ECU for calculation of the engine speed.

Exhaust gas recirculation valve (EGR)

The operation of this valve is vacuum controlled.

A proportion of exhaust gas is recirculated from the exhaust system, through the EGR valve, into the induction manifold where it mixes with intake air.

Exhaust gas wastegate

Regulates the flow of exhaust gas to the turbocharger turbine when either boost pressure or engine detonation reach predetermined levels. The boost control system actuates wastegate control.

Four segment timing wheel

The four segment timing wheel has four equal length segments and gaps. Angular relationship of segment to gap is 54° and 36° respectively, and produces a 60:40 ratio signal for engine speed calculation.

Fuel accumulator

When the engine is stopped, the small volume of fuel held in the accumulator (under pressure from the accumulator spring) maintains pressure in the primary fuel circuit to ensure good starting response during the engine 'cranking' operation (i.e. fuel is immediately available).

Fuel cooler

The fuel cooler is located in the left-hand side of the engine compartment. It uses air conditioning system refrigerant to cool the fuel prior to its return to the tank.



Fuel distributor

Apportions the fuel equally to the injectors adjacent to each engine cylinder.

Fuel pressure regulator

Maintains a constant primary circuit fuel pressure. When the engine is stopped, the fuel pressure regulator allows the system pressure to drop rapidly to a value preset by the fuel accumulator (i.e. just below the injector valve operating pressure). It also seals the return line from the lower chambers of the differential pressure valve.

Heated oxygen sensor

Measures the oxygen content (which is directly related to the air/fuel ratio) in the exhaust gas and by means of an electrical signal transmits the information to the electronic control unit.

Idle speed actuator

The idle speed actuator contains a stepping motor, the armature of which is connected to a rotating slide. This adjusts the cross sectional area of the by-pass passage.

The duty cycle from the K-Motronic ECU produces a torque at the rotating armature which acts against a return spring.

The by-pass opening is continually adjusted to maintain the correct engine idle speed under all potential engine load conditions.

Injector

One injector is used for each engine cylinder and sprays finely atomized fuel under all running conditions into the induction system.

Intercooler

A charge air intercooler is fitted below the air cleaner assembly. It is situated in the ambient air stream behind the air dam and beneath the front bumper. The intercooler reduces compressed air temperature, this enables recovery of charge air density and maintains optimum engine power output.

KE2-Jetronic electronic control unit (ECU)

Processes input from a chain of engine mounted sensors and provides the necessary electronic fuel corrections in terms of DC mA to the electro-hydraulic actuator. This includes start, post start, warm-up, acceleration enrichment, and positive induction manifold pressure compensation.

K-Motronic digital ECU

The K-Motronic ECU is mounted in the ECU compartment in the rear right-hand corner of the engine compartment.

The K-Motronic system brings together the benefits of digital fuel injection (KE3-Jetronic) and ignition control (EZ 58F) systems into a single electronic control unit (ECU). Other features of the system include cold start and warm-up enrichment, idle speed regulation, and automatic correction of any long term

mixture strength deviations.

On cars fitted with catalytic converters the K-Motronic system also provides an 'on-board' self diagnostic facility.

The engine is equipped with several sensors that continuously monitor operating parameters such as engine speed, coolant temperature, and load. The sensors are connected to the digital ECU which is programmed with characteristic data for the following functions, mixture strength control, ignition timing, idle speed control, and purging of the evaporative emission control canister.

Knock sensors

Sense crankcase vibration and then produce an output signal which is processed by the boost electronic control unit. If knock is present the ECU signals the boost control valve to divert the compressor pressure signal more towards the wastegate than atmosphere.

'On board' self diagnostic ability

A fascia mounted warning panel illuminates to alert the driver to a number of possible engine related faults. The lamp displays the message 'Check Engine' and is illuminated when the engine is running and a failure is identified.

When the 'Check Engine' lamp is illuminated a fault message (in the form of a four digit code) is stored within the K-Motronic ECU and can be subsequently used to inform workshop personnel of the faulty components or system.

Pressure control valve

Operating from an electrical signal received from the electronic control unit, the valve varies the fuel pressure in the lower chambers of the differential pressure valves.

Pressure damper

Dampens the pressure pulses caused by the operation of the pressure control valve.

Purge control valve

This valve is connected into the purge line of the fuel evaporative emission control system. It regulates the purge flow rate depending upon engine load and mode of operation. The valve receives a duty cycle signal from the engine management system ECU.

Thermal time switch

Situated in the thermostat housing. Depending upon the temperature of the coolant, it controls the operation of the cold start injector.

Throttle position switch (TPS)

Identifies the engine operating mode (i.e. idle, part load, or full load).

Part load occurs when the switch contacts are broken between idle and full load.

Turbocharger

Increases the power and torque of the engine by utilizing energy from the exhaust gas.



Figure A2-1

Vehicle specification



| Specification | UK and all countries not listed | | Norway and Sweden | |
|------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|--------------|---------------------|--------------|
| | Naturally Aspirated | Turbocharged | Naturally Aspirated | Turbocharged |
| Engine | | | | |
| L 410 I | 87/88/89 | — | 87/88/89 | — |
| L 410 IT | — | 87/88 | — | 87/88 |
| L 410 ITI | — | 89 | — | 89 |
| Fuel injection system | | | | |
| Bosch K-Jetronic | 87/88/89 | — | 87/88/89 | — |
| Bosch KE2-Jetronic | — | 87/88 | — | 87/88 |
| Bosch KE3-Jetronic (electronically controlled by K-Motronic engine management system) | — | 89 | — | 89 |
| Fuel system | | | | |
| Recirculatory with in-tank and main pumps | 87/88 | 87/88 | 87/88 | 87/88 |
| With fuel cooler | 89 | 89 | 89 | 89 |
| Turbocharging system | | | | |
| Boost pressure control system regulating exhaust gas by-passing turbocharger via a wastegate | — | 87/88/89 | — | 87/88/89 |
| Ignition control system | | | | |
| Constant energy type. Lucas 35 DM 8 distributor conventional vacuum and centrifugal advance | 87/88/89 | — | 87/88/89 | — |
| Digital non-adjustable EZ 58F. Twin 2 x 4 cylinder distributor | — | 87/88 | — | 87/88 |
| Digital non-adjustable EZ 58F (electronically controlled by K-Motronic engine management system). Twin 2 x 4 cylinder distributor. | — | 89 | — | 89 |
| Exhaust emission control system | | | | |
| Air injection system | — | — | 89 | 89 |
| EGR system | — | — | 89 | — |
| Catalytic converter system with closed-loop | — | — | **89 | **89 |
| Fuel evaporative emission control system | | | | |
| Standard purge control system | — | — | 88/89 | — |
| Programmed purge control system | — | — | — | 89 |
| Crankcase emission control system | | | | |
| Recirculatory closed breather type | 87/88/89 | 87/88/89 | 87/88/89 | 87/88/89 |
| Air intake system | | | | |
| Filter mounted on right-hand inner wing valance | 87/88/89 | 87/88 | 87/88/89 | 87/88 |
| With charge air intercooler | — | 89 | — | 89 |
| Throttle intake | | | | |
| Rod and lever system | 87/88/89 | 87/88/89 | 87/88/89 | 87/88/89 |

* Middle East has revised ignition timing ** Remote CO tapping *** Other than Australia

† Japan has excessive exhaust temperature warning †† With mods for boost system

| Austria and Switzerland | | Middle East and Taiwan | | Australia, Canada, Japan, and USA | | Workshop Manual |
|---------------------------|-----------------|------------------------|------------------|-------------------------------------------------|----------------|---------------------------------------------------------------------------------|
| Naturally Aspirated | Turbocharged | Naturally Aspirated | Turbocharged | Naturally Aspirated | Turbocharged | |
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