ELECTRONIC ENGINE CONTROLS - V8 S/C 5.0 L PETROL

SPECIFICATIONS

TORQUE SPECIFICATIONS

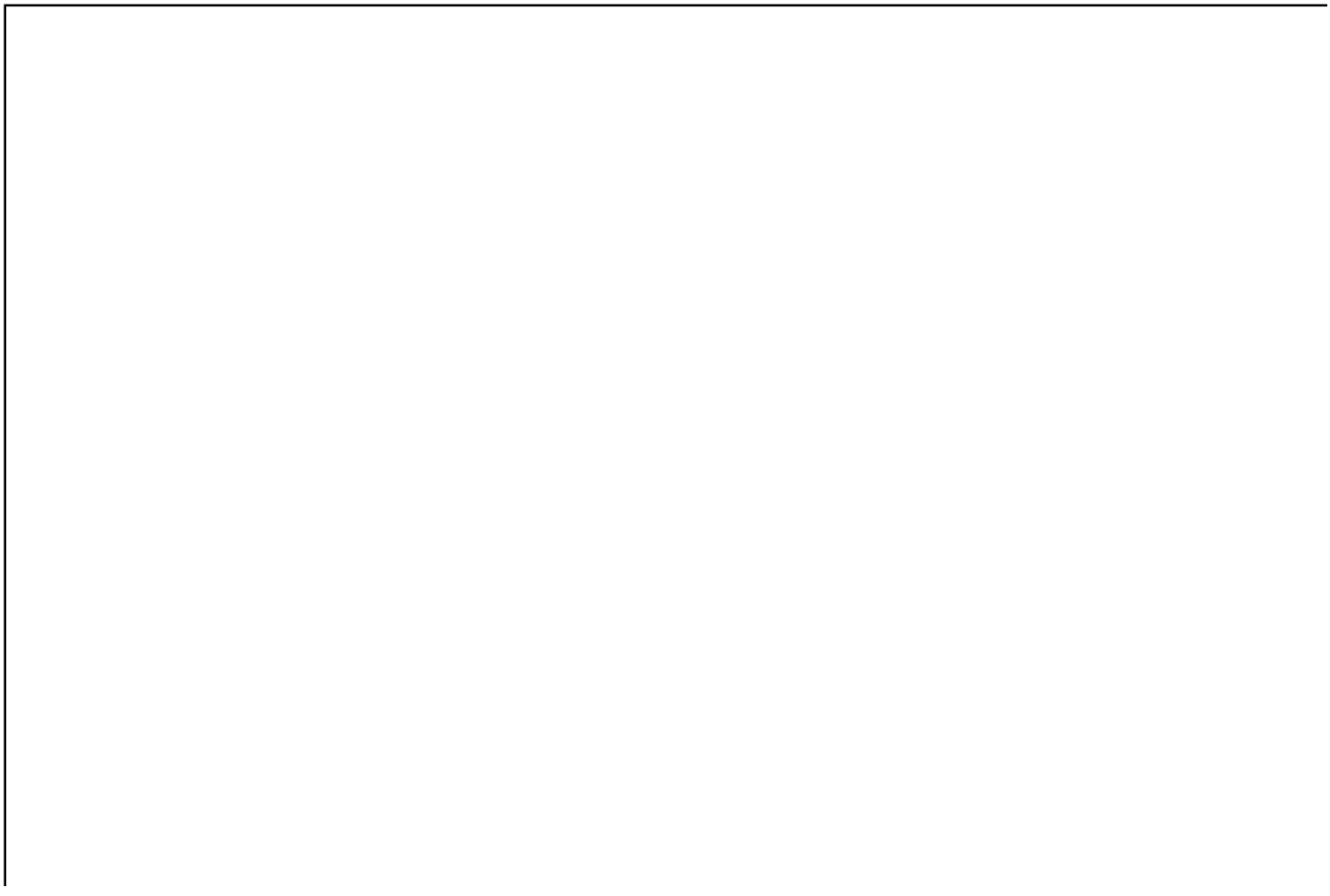
NOTE: **All Variants.**

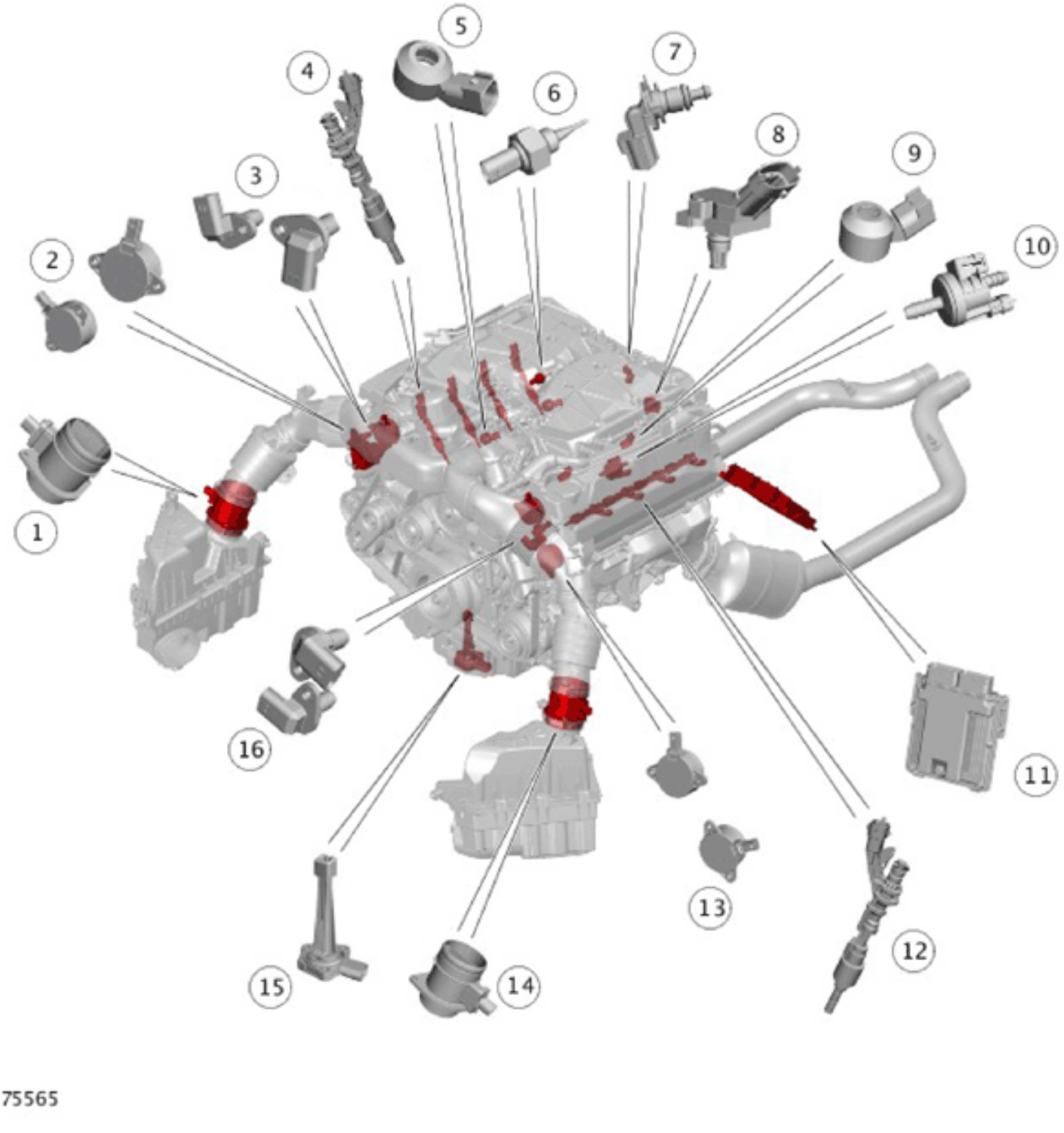
DESCRIPTION	NM	LB-FT	LB-IN
Camshaft position (CMP) sensor(s) retaining bolt	7	Â	62
Crankshaft position (CKP) sensor retaining bolt	10	Â	89
Heated oxygen sensor(s) (HO2S)	48	Â	425
Catalyst monitor sensor(s)	48	Â	425
Knock sensor(s) (KS) retaining bolt	20	Â	177
Fuel rail pressure (FRP) sensor	38	Â	336
Manifold absolute pressure and temperature (MAPT) sensor	5	-	44
Mass air flow (MAF) sensor	3.5	-	31
Engine oil level sensor retaining bolts	12	Â	106
Variable valve timing (VVT) oil control solenoid(s) retaining bolt	10	Â	89
Engine control module (ECM) retaining bolt	7	-	62
Engine control module (ECM) retaining nut	7	-	62
ECM retaining bracket bolt	7	-	62

DESCRIPTION AND OPERATION

COMPONENT LOCATION

ELECTRONIC ENGINE CONTROLS - SHEET 1 OF 4

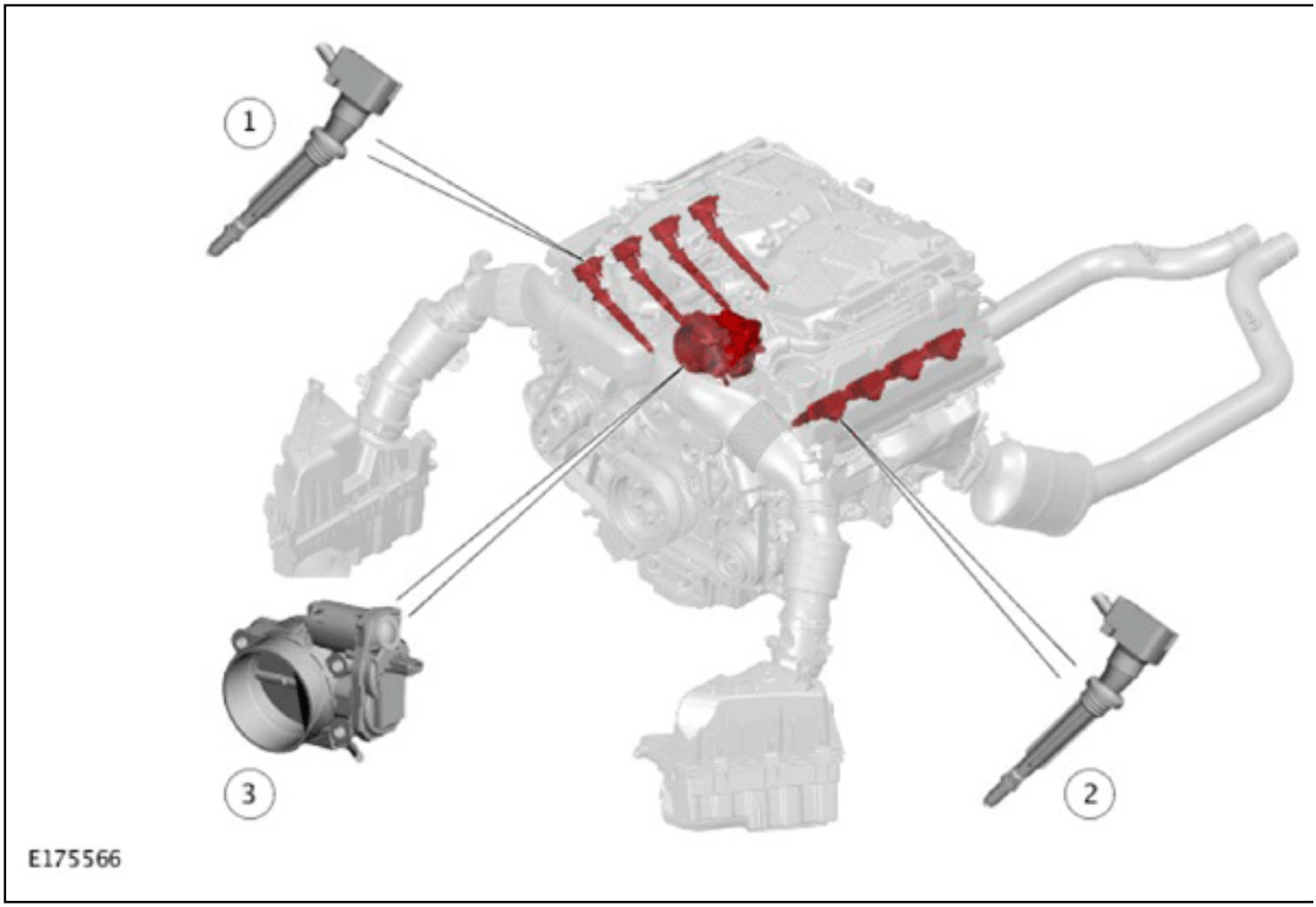




ITEM	DESCRIPTION
1	Right Mass Air Flow and Temperature (MAFT) sensor
2	Variable Camshaft Timing (VCT) actuator - Bank 2 (2 off)
3	Camshaft Position sensor (CMP) - Bank 2 (2 off)
4	Fuel Injector - Bank 2 (4 off)
5	Knock Sensor - Bank 2 (2 off)
6	Charge air cooler temperature sensor
7	Engine Coolant Temperature sensor (ECT)
8	Manifold Absolute Pressure and Temperature sensor (MAPT)
9	Knock Sensor - Bank 1 (2 off)
10	Purge valve
11	Engine Control Module (ECM)
12	Fuel Injector - Bank 1 (4 off)
13	Variable Camshaft Timing (VCT) actuator - Bank 1 (2 off)

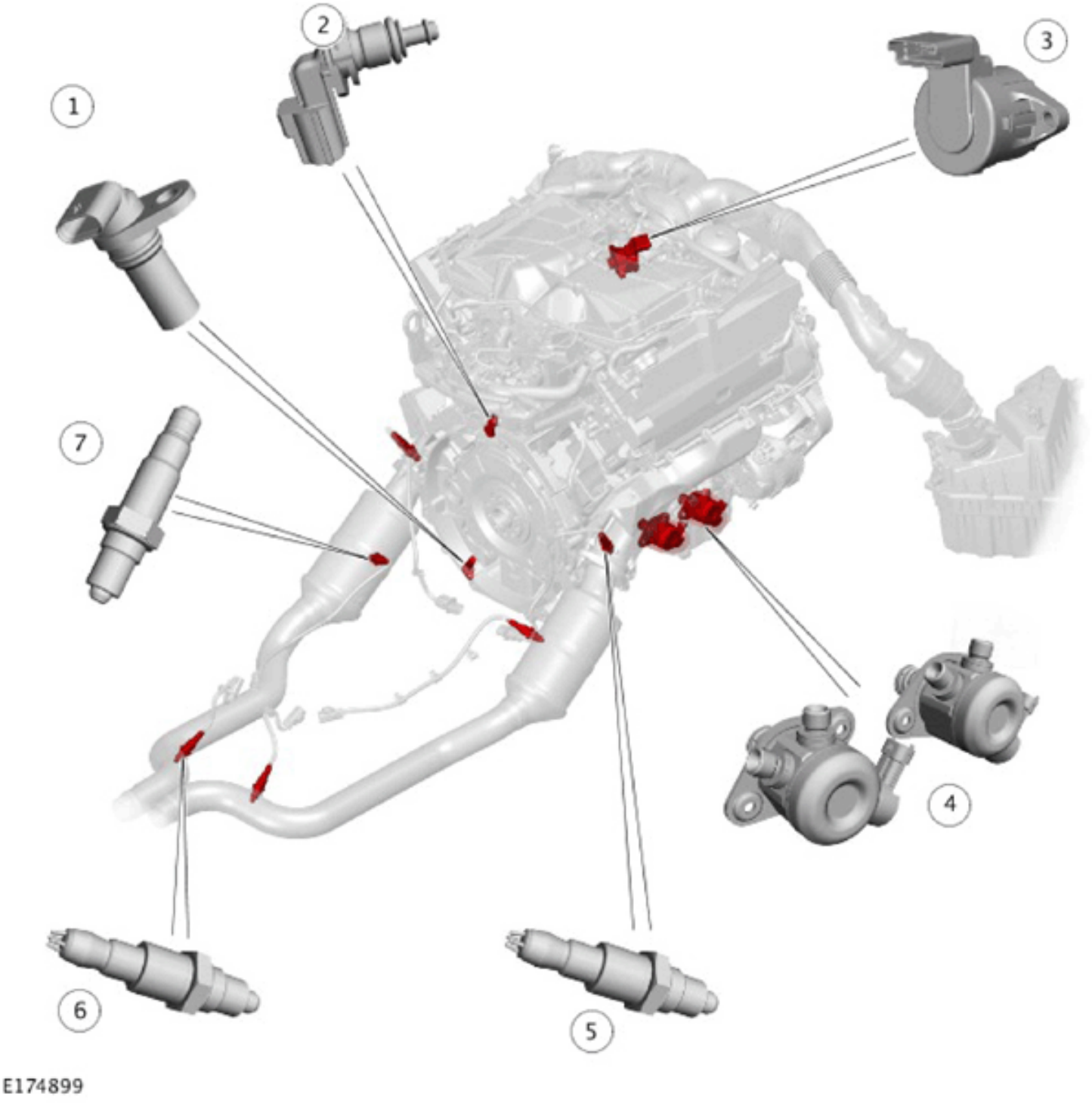
ITEM	DESCRIPTION
14	Left Mass Air Flow and Temperature (MAFT) sensor
15	Oil level and temperature sensor
16	Camshaft Position sensor (CMP) - Bank 1 (2 off)

ELECTRONIC ENGINE CONTROLS - SHEET 2 OF 4



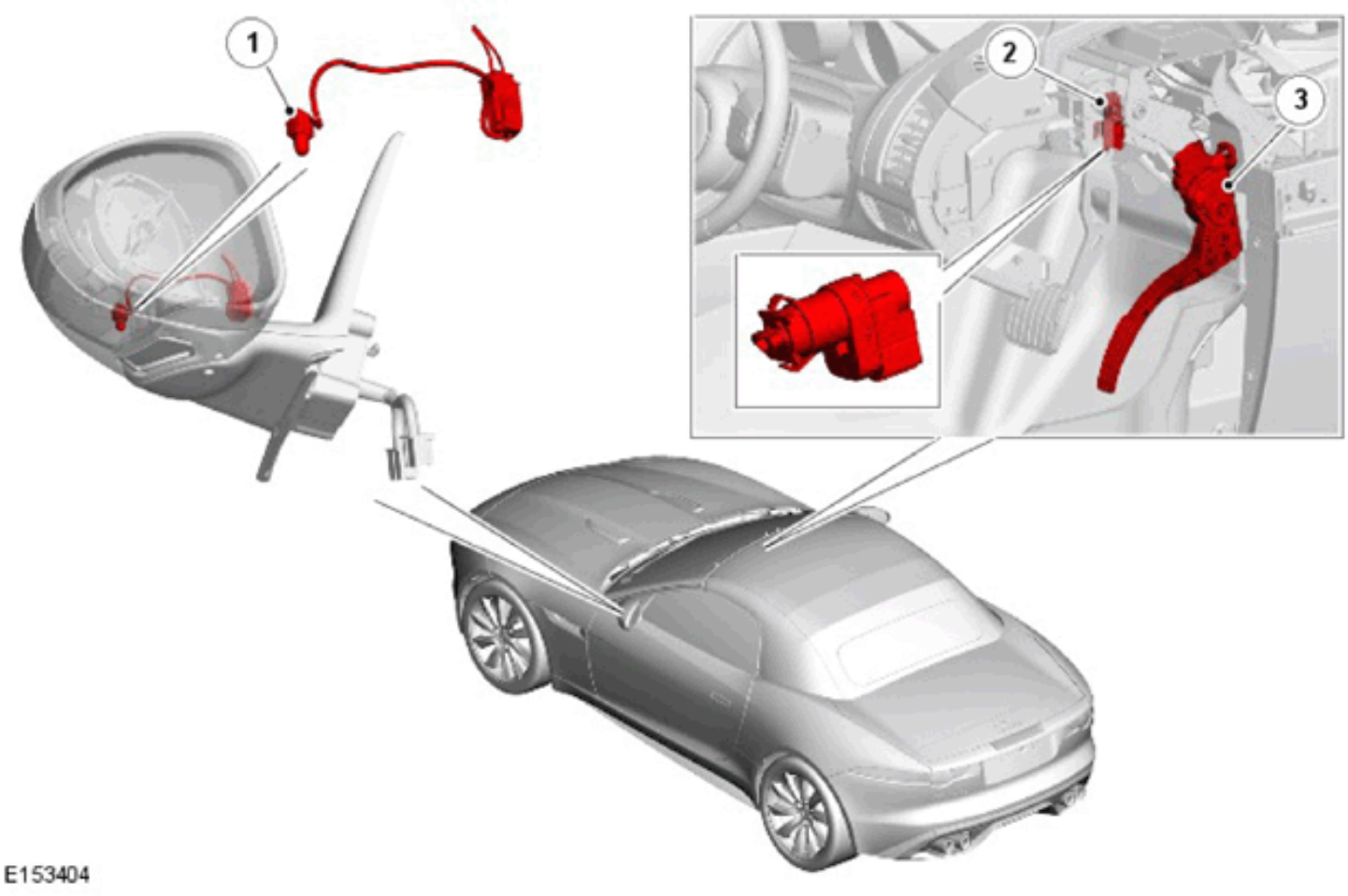
ITEM	DESCRIPTION
1	Ignition Coil - Bank 2 (4 off)
2	Electric throttle
3	Ignition Coil - Bank 1 (4 off)
4	Electric thermostat

ELECTRONIC ENGINE CONTROLS - SHEET 3 OF 4



ITEM	DESCRIPTION
1	Crankshaft Position sensor (CKP)
2	Engine Coolant Temperature sensor (ECT)
3	Bypass valve
4	High Pressure Fuel pump (2 off)
5	Heated Oxygen sensor (HO2S) - Pre-Catalyst (2 off)
6	Heated Oxygen sensor (HO2S) - Post-Catalyst (2 off)
7	Heated Oxygen sensor (HO2S) - Mid-Catalyst (2 off)

ELECTRONIC ENGINE CONTROLS - SHEET 4 OF 4



ITEM	DESCRIPTION
1	Ambient Air Temperature (AAT) sensor
2	Brake Pedal switch
3	Accelerator Pedal Position (APP) sensor

OVERVIEW

The electronic engine control system operates the engine to generate the output demanded by the APP (Accelerator Pedal Position) sensor and loads imposed by other system

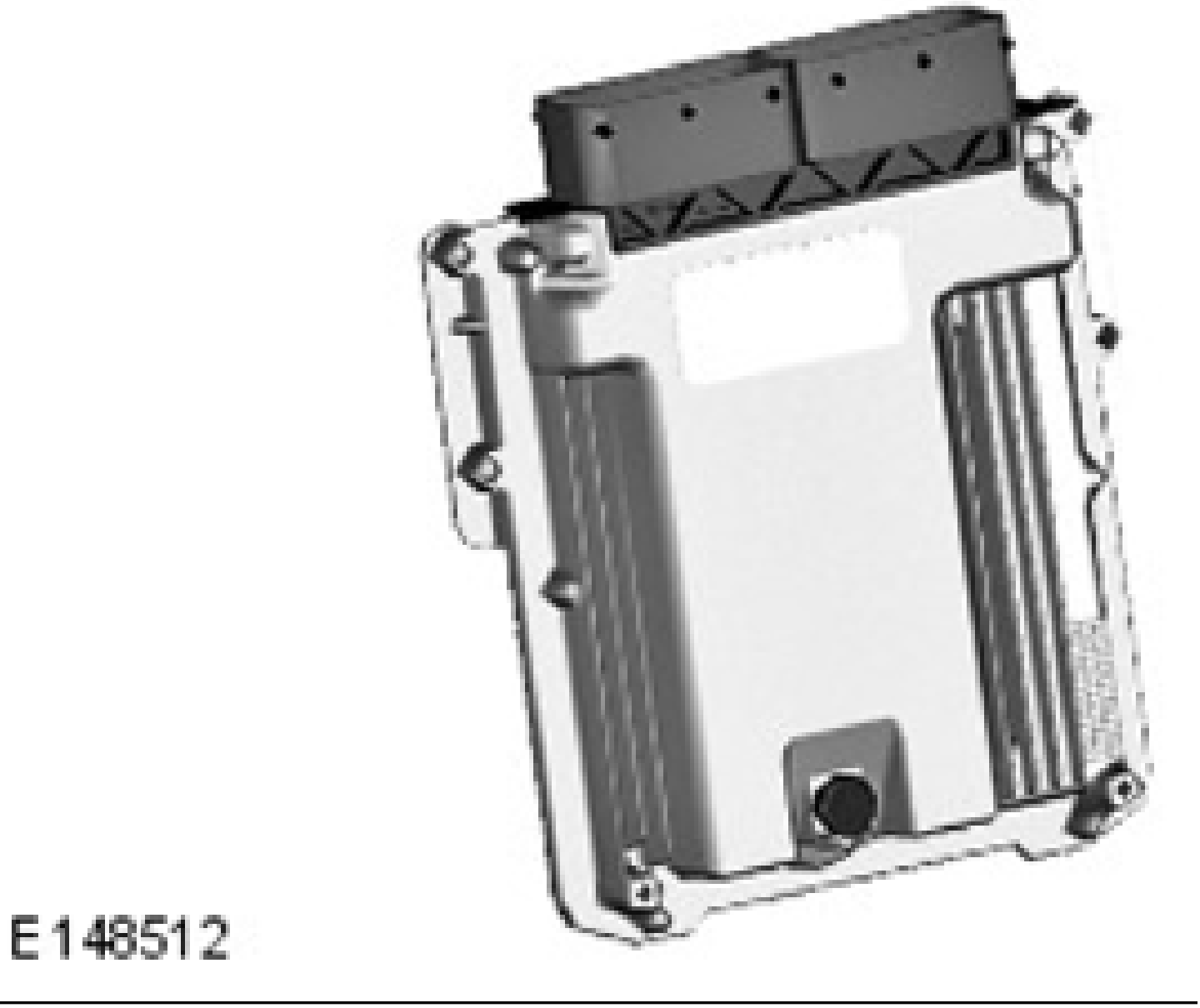
The electronic engine control system has an ECM (Engine Control Module) that uses a torque-based strategy to evaluate inputs from sensors and other systems, and then proc outputs to engine actuators to produce the required torque.

The electronic engine control system controls the following:

- Charge Air
- Fueling
- Ignition Timing
- Valve Timing
- Cylinder Knock
- Idle Speed
- Engine Cooling Fan
- Evaporative Emissions
- OBD (On-Board Diagnostic)
- Immobilization System Interface
- Speed Control

DESCRIPTION

ENGINE CONTROL MODULE



The ECM is installed in the rear left corner of the engine compartment.

The ECM has the capability of adapting its fuel and ignition control outputs in response to several sensor inputs.

The ECM receives inputs from the following:

- CKP (Crankshaft Position) sensor
- CMP (Camshaft Position) sensors (4 off)
- ECT (Engine Coolant Temperature) sensor (2 off)
- Knock sensors (2 off)
- MAFT (Mass Air Flow and Temperature sensors (2 off)
- MAPT (Manifold Absolute Pressure and Temperature) sensor
- TPS (Throttle Position Sensor)
- Heated Oxygen sensor (HO2S) sensors (4 off)
- APP (Accelerator Pedal Position) sensor
- AAT (Ambient Air Temperature) sensor
- FRPT (Fuel Rail Pressure and Temperature) sensor

  For additional information, refer to: **Fuel Charging and Controls** (Description and Operation).

- Engine Cooling Fan

  For additional information, refer to: **Supercharger Cooling** (Description and Operation).

- Brake Pedal Switch

For additional information, refer to: **Anti-Lock Control - Stability Assist** (Description and Operation).

- Speed Control Switch

  For additional information, refer to: **Speed Control - V8 S/C 5.0L Petrol** (Description and Operation).

- Oil Level and Temperature Sensor

  For additional information, refer to: **Engine** (Description and Operation).

- LP (Low Pressure) Fuel Sensor

  For additional information, refer to: **Fuel Tank and Lines** (Description and Operation).

- FPDM (Fuel Pump Driver Module)

  For additional information, refer to: **Fuel Tank and Lines** (Description and Operation).

- TCS (Transmission Control Switch)

  For additional information, refer to: **Intake Air Distribution and Filtering** (Description and Operation).

- Supercharger Bypass Valve Position Sensor

  For additional information, refer to: **Intake Air Distribution and Filtering** (Description and Operation).

- Charge air cooler temperature sensor

  For additional information, refer to: **Intake Air Distribution and Filtering** (Description and Operation).

- Brake Vacuum Sensor (if fitted)

  For additional information, refer to: **Anti-Lock Control - Stability Assist** (Description and Operation).

The ECM provides outputs to the following:

- Electric Throttle
- Relay
- Heater Elements of the HO2S (heated oxygen sensor) (2 off)
- Fuel Injectors (8 off)

  For additional information, refer to: **Fuel Charging and Controls** (Description and Operation).

- Active Exhaust Solenoid Valve

  For additional information, refer to: **Exhaust System** (Description and Operation).

- Ignition Coils (8 off)

  For additional information, refer to: **Engine Ignition** (Description and Operation).

- VCT (Variable Camshaft Timing) actuators (4 off)

  For additional information, refer to: **Engine** (Description and Operation).

- Evaporative emissions purge valve

  For additional information, refer to: **Evaporative Emissions** (Description and Operation).

- Engine Starter Motor Relay

  For additional information, refer to: **Starting System** (Description and Operation).

- Engine Cooling Fan

  For additional information, refer to: **Supercharger Cooling** (Description and Operation).

- Charge Air Coolant Pump Relay

  For additional information, refer to: **Supercharger Cooling** (Diagnosis and Testing).

- HP (High Pressure) Fuel Pump (2 off)

  For additional information, refer to: **Fuel Charging and Controls** (Description and Operation).

- FPDM (Fuel Pump Driver Module)

  For additional information, refer to: **Fuel Tank and Lines** (Description and Operation).

- DMTL (Diagnostic Module Tank Leakage)

  For additional information, refer to: **Fuel Tank and Lines** (Description and Operation).

- Supercharger Bypass Valve Actuator

For additional information, refer to: **Intake Air Distribution and Filtering** (Description and Operation).

- Inlet Manifold Tuning Valve

  For additional information, refer to: **Intake Air Distribution and Filtering** (Description and Operation).

CRANKSHAFT POSITION (CKP) SENSOR

The CKP sensor is an inductive sensor that allows the ECM to determine the angular position of the crankshaft and the engine speed.

The CKP sensor is installed in the rear left side of the oil pan, in line with the engine drive plate. The sensor is secured with a single screw and sealed with an O-ring. A three electrical connector provides the interface with the engine harness.

The head of the CKP sensor faces a reluctor ring pressed into the outer circumference of the engine drive plate. The reluctor ring has 60 teeth, with 2 teeth missing. There are teeth at 6Â° intervals, with two teeth removed to provide a reference point with a centerline that is 21Â° BTDC (Before Top Dead Center) on cylinder 1 of bank 2.

If the CKP sensor fails, the ECM:

- Uses signals from the CKP sensors to determine the angular position of the crankshaft and the engine speed
- Adopts a limp home mode where engine speed is limited to a maximum of 3000 rev/min.

With a failed CKP sensor, engine starts will require a long crank time while the ECM determines the angular position of the crankshaft using the CMP sensors.

CAMSHAFT POSITION (CMP) SENSORS

The CMP sensors are MRE (Magneto Resistive Element) sensors that allow the ECM to determine the angular position of the camshafts. MRE sensors produce a digital outp which allows the ECM to detect speeds down to zero.

Four CMP sensors are installed in the front upper timing covers, one for each camshaft.

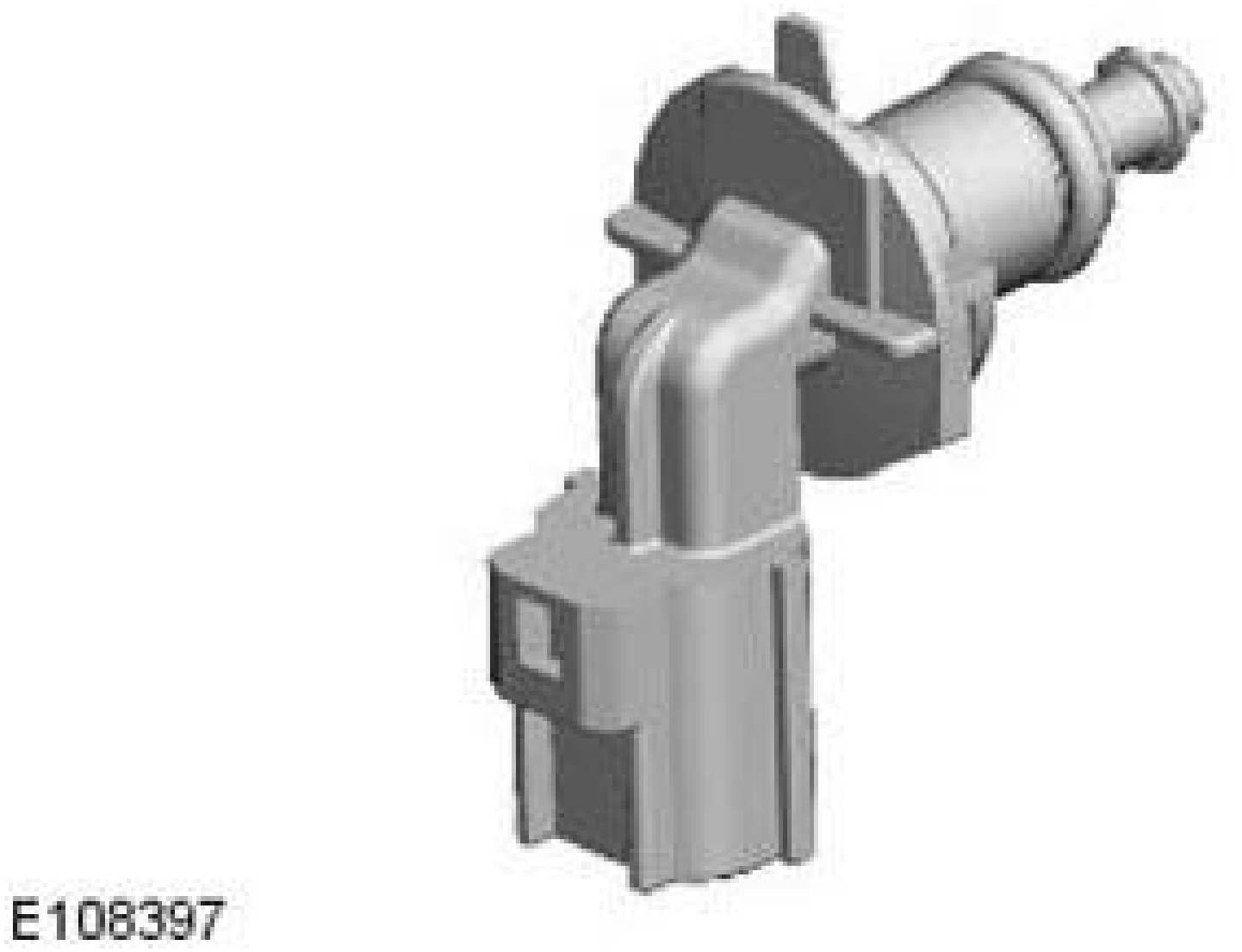
Each CMP sensor is secured with a single screw and sealed with an O-ring. On each CMP sensor, a three pin electrical connector provides the interface with the engine harne

The head of each CMP sensor faces a sensor wheel attached to the front of the related VCT unit.

If an exhaust CMP sensor fails, the ECM disables the VCT of both exhaust camshafts.

If an intake CMP sensor fails, the ECM disables the VCT of both intake camshafts. This can result in the engine being slow, or failing, to start.

ENGINE COOLANT TEMPERATURE (ECT) SENSORS



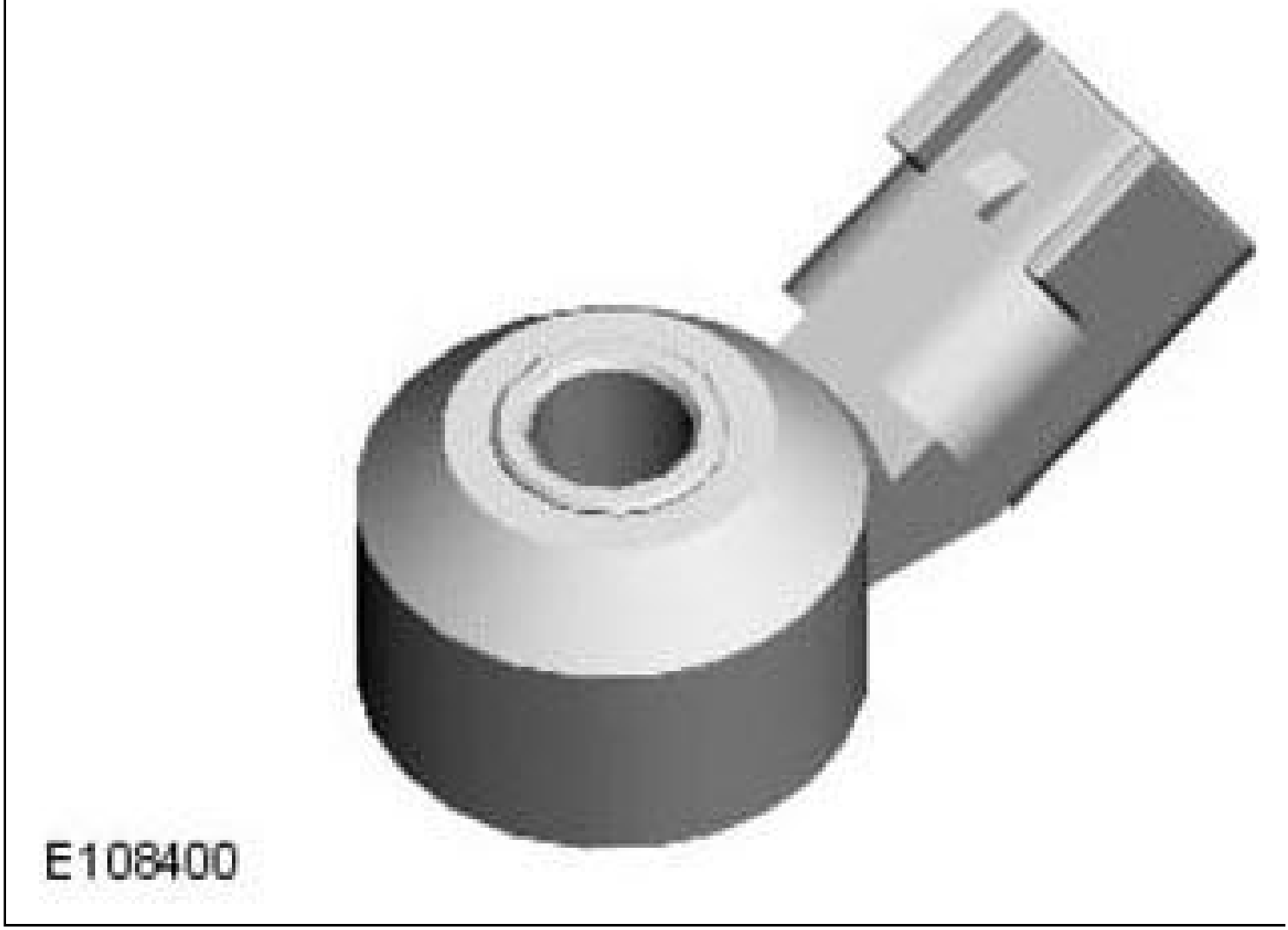
The ECT sensor is NTC (Negative Temperature Coefficient) thermistor that allows the ECM to monitor the engine coolant temperature.

The sensor is secured with a twist-lock and latch mechanism, and is sealed with an O-ring. A two pin electrical connector provides the interface between the sensor and the er harness.

If there is an ECT fault, the ECM adopts an estimated coolant temperature. On the second consecutive trip with an ECT fault, the ECM illuminates the MIL (Malfunction Ind Lamp).

ECT is installed in the heater manifold, at the rear of the Bank 1 cylinder head. The input from this sensor is used in calibration tables and by other systems.

KNOCK SENSORS



The knock sensors are piezo-ceramic sensors that allow the ECM to employ active knock control and prevent engine damage from pre-ignition or detonation.

Two knock sensors are installed on the inboard side of each cylinder head. Each knock sensor is secured with a single screw. On each knock sensor, a two pin electrical conne provides the interface with the engine harness.

The ECM compares the signals from the knock sensors with mapped values stored in memory to determine when detonation occurs on individual cylinders. When detonation detected, the ECM retards the ignition timing on that cylinder for a number of engine cycles, and then gradually returns it to the original setting.

The ECM cancels closed loop control of the ignition system if the signal received from a knock sensor becomes implausible. In these circumstances the ECM defaults to base mapping for the ignition timing. This ensures the engine will not become damaged if low quality fuel is used. The MIL will not illuminate, although the driver may notice tha engine 'pinks' in some driving conditions and displays a drop in performance and smoothness.

The ECM calculates the default value if a sensor fails on either bank of cylinders.

MANIFOLD ABSOLUTE PRESSURE AND TEMPERATURE (MAPT) SENSOR

The MAPT sensor allows the ECM to calculate the air charge density immediately before it enters the cylinders. This is used to adjust the ignition timing relative to the boost pressure, and to monitor the performance of the charge air coolers.

The MAPT sensor is installed in the left charge air cooler outlet. The sensor is secured with a single screw and sealed with an O-ring. A four pin electrical connector provides interface with the engine harness.

MASS AIR FLOW AND TEMPERATURE (MAFT) SENSOR

The MAFT sensors allow the ECM to measure the mass flow and the temperature of the air flow into the engine. The mass air flow is measured with a hot film element in the sensor. The temperature of the air flow is measured with a NTC thermistor in the sensor. The mass air flow is used to determine the fuel quantity to be injected in order to ma the target air/fuel mixture required for correct operation of the engine and the catalytic converters.

There are two MAFT sensors installed, one in each air cleaner outlet duct. Each MAFT sensor is integral with the intake duct. On each MAFT sensor, a five pin electrical cor provides the interface with the engine harness.

If the hot film element signal fails, the ECM invokes a software backup strategy to calculate the mass air flow from other inputs. Closed loop fuel control, closed loop idle sp control and evaporative emissions control are suspended. The engine will suffer from poor starting, poor throttle response and, if the failure occurs while driving, the engine s may dip and surging may occur before recovering.

If the NTC thermistor signal fails the ECM adopts a default value of 25 Â°C (77 Â°F) for the intake air temperature.

THROTTLE POSITION SENSOR

The TPS allow the ECM to determine the position and angular rate of change of the throttle blade.

There are two TPS located in the electric throttle. See below for details of the electric throttle.

If a TPS fails, the ECM:

- Adopts a limp home mode where engine speed is limited to a maximum of approximately 2000 rev/min.
- Discontinues evaporative emissions control.
- Discontinues closed loop control of engine idle speed.

With a failed TPS, the engine will suffer from poor running and throttle response.

CHARGE AIR COOLER TEMPERATURE SENSOR

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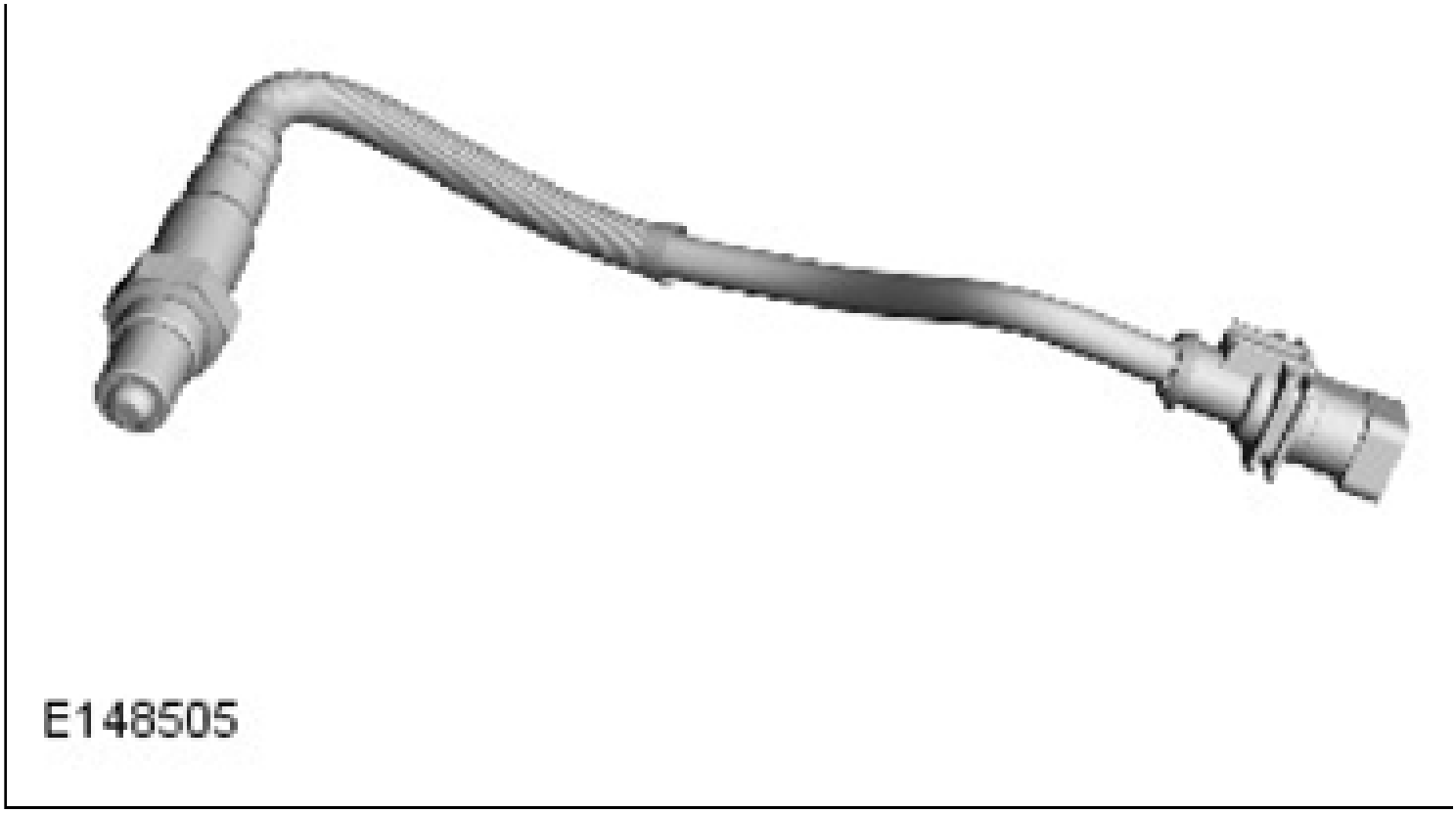
The charge air cooler temperature sensor is installed in the supercharger top cover. A two pin electrical connector provides the interface between the sensor and the engine ha
The sensor contains an NTC thermistor with supply and return connections to the ECM.

The ECM supplies the sensor with a 5V reference voltage and translates the return voltage into a temperature. The ECM uses the input:

- To monitor operation of the charge air coolant pump.
- For air mass calculations used in control of the supercharger bypass valve, as part of the charge air strategy that co-ordinates operation of the electric throttle and the by
  valve, and predicts the air mass delivered to the cylinders.

If the charge air temperature sensor fails, the ECM substitutes the input with a modelled temperature. Failure of the sensor is unlikely to be noticeable to the driver.

HEATED OXYGEN SENSORS



The HO2S allow the ECM to measure the oxygen content of the exhaust gases, for closed loop control of the fuel and air mixture and for catalytic converter monitoring.

A pre-catalyst HO2S is installed in the outlet of each exhaust manifold, which enables independent control of the fuel and air mixture for each cylinder bank. A mid catalyst H is installed in a central position on the side of each catalytic converter and a post catalyst HO2S is installed in each catalytic converter outlet pipe in the exhaust system; these the performance of the catalytic converter to be optimized and monitored.

HO2S need to operate at high temperatures in order to function correctly. To achieve the high temperatures required, the sensors are fitted with heater elements that are contro a PWM signal from the ECM. The heater elements are operated after each engine start, once it has been calculated that there is no moisture in the exhaust (between 0 and 10 r delay), and also during low load conditions when the temperature of the exhaust gases is insufficient to maintain the required sensor temperature. The time period for operatio the heater elements is determined by the temperature of the post catalyst HO2S. The PWM duty cycle is carefully controlled to prevent thermal shock to cold sensors. A non-functioning heater delays the sensors readiness for closed loop control and increases emissions.

The pre catalyst HO2S produce a constant voltage, with a variable current that is proportional to the lambda ratio. The mid and post catalyst HO2S produce an output voltage dependant on the ratio of the exhaust gas oxygen to the ambient oxygen.

The HO2S age with mileage, increasing their response time to switch from rich to lean and lean to rich. This increase in response time influences the ECM closed loop contro leads to progressively increased emissions. Measuring the period of rich to lean and lean to rich switching monitors the response rate of the pre catalyst sensors.

Diagnosis of electrical faults is continually monitored in pre, mid and post catalyst sensors. This is achieved by checking the signal against maximum and minimum threshold open and short circuit conditions.

If a HO2S fails:

- The ECM defaults to open loop fueling for the related cylinder bank.
- The CO (Carbon Monoxide) and emissions content of the exhaust gases may increase.
- The exhaust may smell of rotten eggs (hydrogen sulphide H2S).

With a failed HO2S, the engine will suffer from reduced refinement and performance.

ACCELERATOR PEDAL POSITION (APP) SENSOR

The APP sensor allows the ECM to determine the driver requests for vehicle speed, acceleration and deceleration. The ECM uses this information, together with information the ABS (Anti-Lock Brake System) control module and the TCM (Transmission Control Module), to determine the setting of the electric throttle.

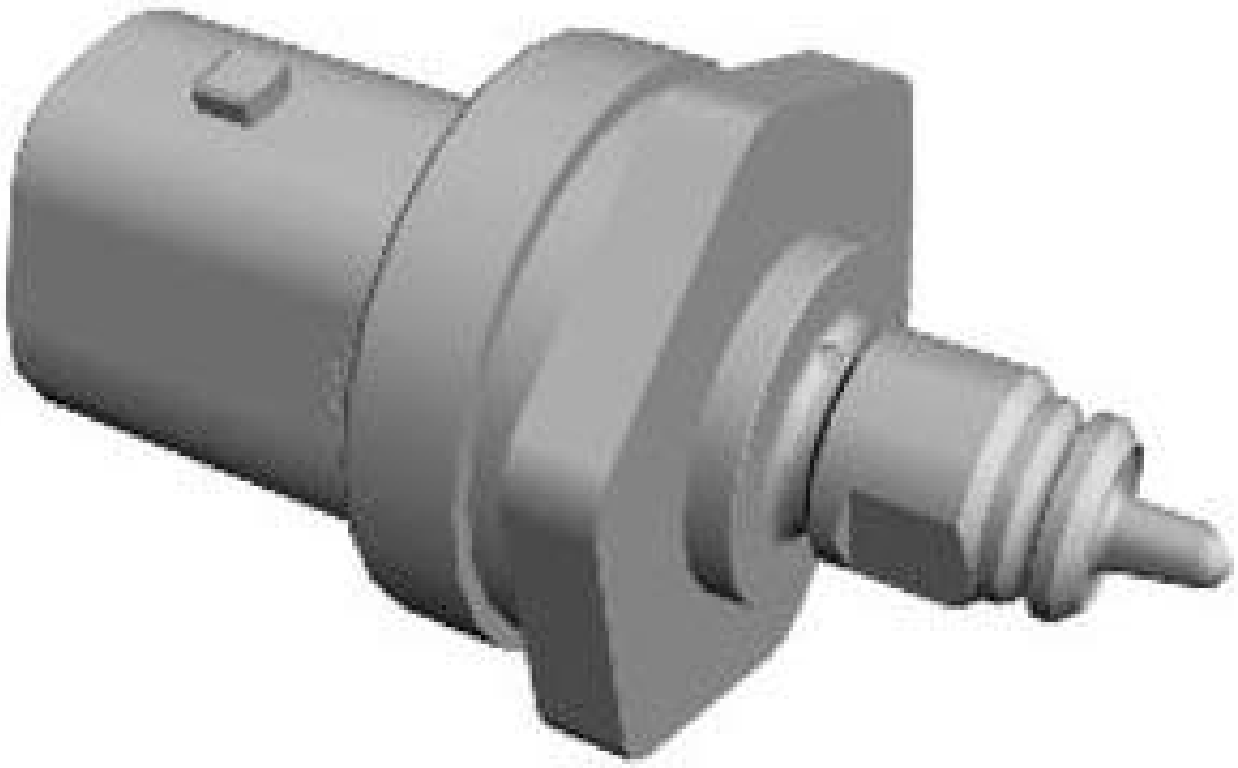
Three screws attach the APP sensor and integrated accelerator pedal to a bracket on the lower instrument panel. A six pin electrical connector provides the interface with the harness.

The APP sensor is a twin track potentiometer. Each track receives an independent power supply from the ECM and returns an independent analog signal to the ECM. Both sig contain the same positional information, but the signal from track 2 is half the voltage of the signal from track 1 at all positions.

If both signals have a fault, the ECM adopts a limp home mode, which limits the engine speed to 2000 rev/min maximum.

The ECM constantly checks the range and plausibility of the two signals and stores a fault code if it detects a fault.

FUEL RAIL PRESSURE AND TEMPERATURE (FRPT) SENSOR



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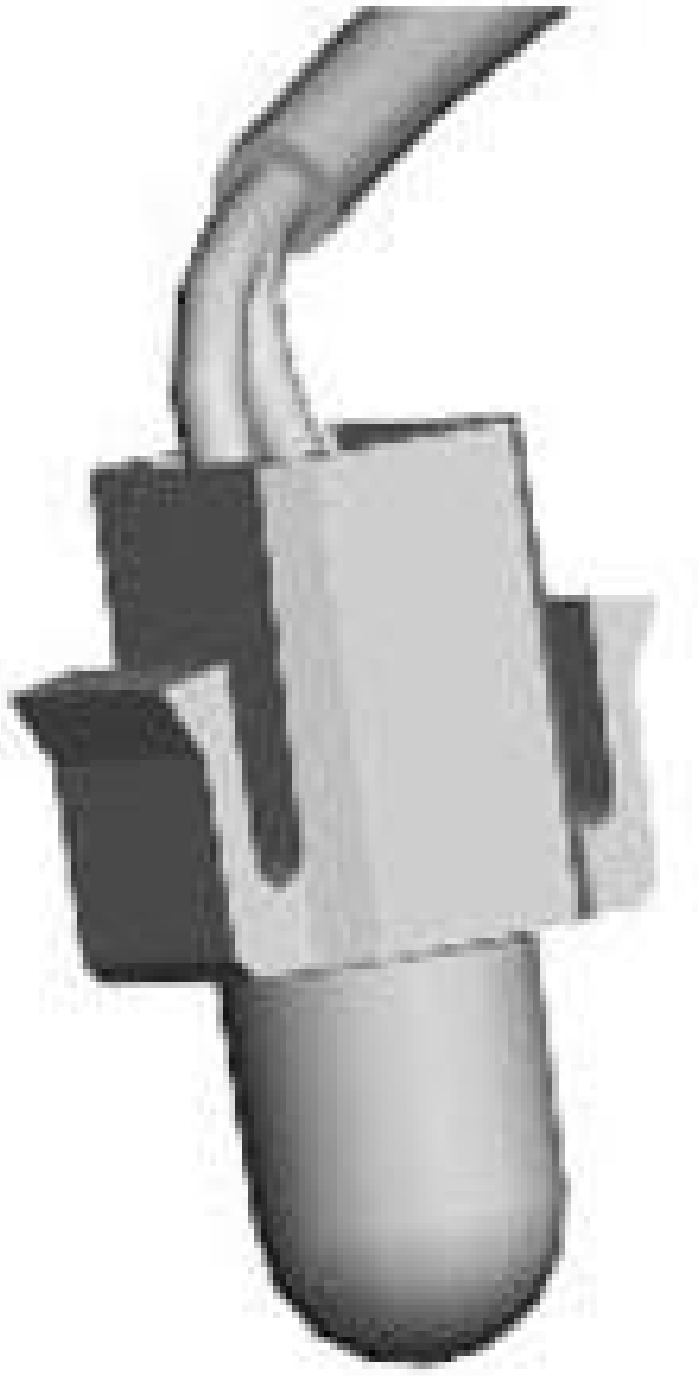
The FRPT sensor provides the ECM with a continuous signal of fuel rail pressure via hardwired connection. The FRPT sensor is installed in the rear of the Bank 1 fuel rail. T FRPT sensor is screwed into a threaded boss in the fuel rail.

The FRPT sensor contains a steel diaphragm fitted with strain gages, which are incorporated into a Wheatstone bridge. The output from the Wheatstone bridge is processed b ECM to determine a pressure value. The FRPT sensor contains an NTC (Negative Temperature Coefficient) sensor which allows the ECM to determine the fuel temperature.

AMBIENT AIR TEMPERATURE (AAT) SENSOR



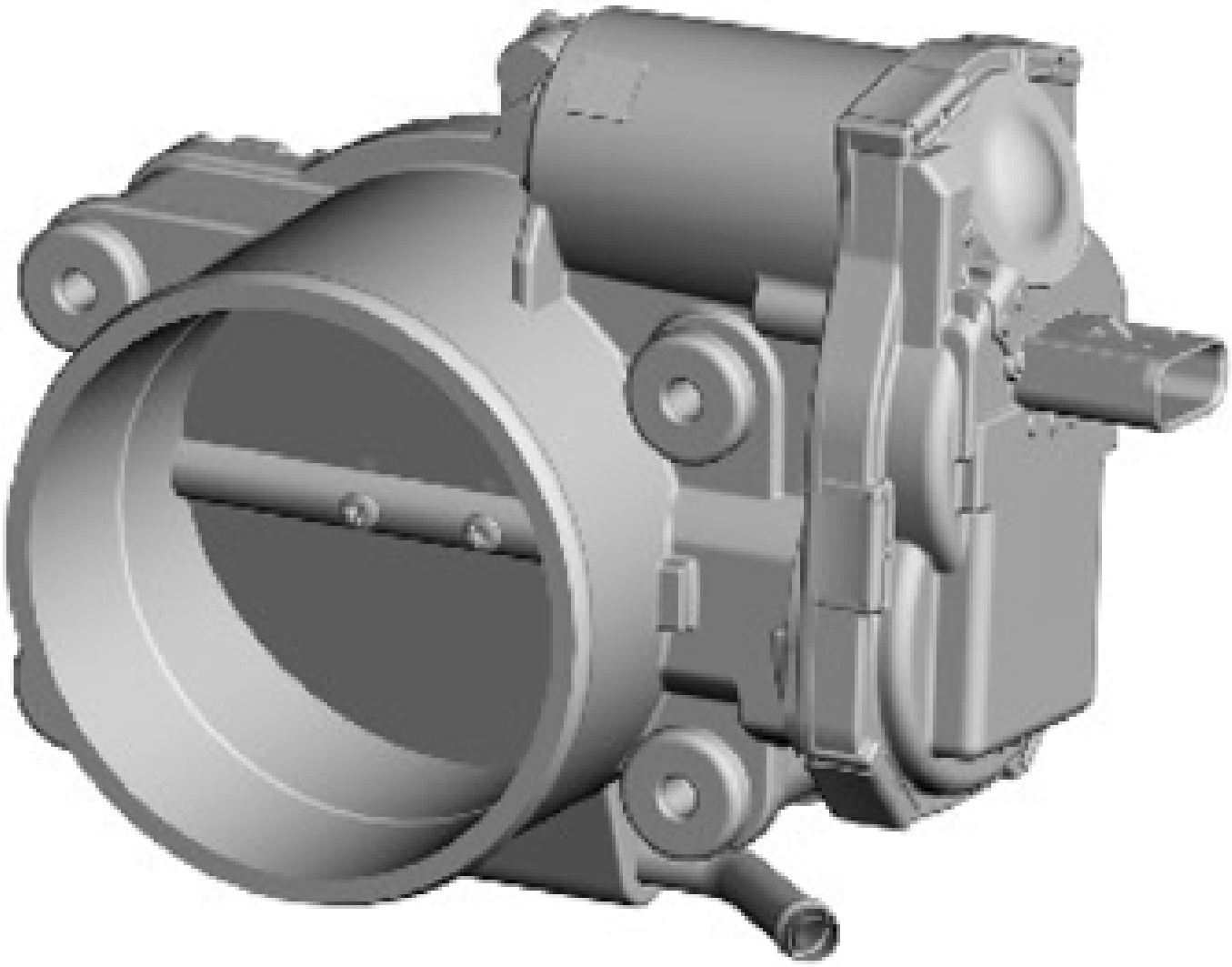
The AAT sensor is a NTC thermistor that allows the ECM to monitor the temperature of the air around the vehicle. The ECM uses the AAT sensor input for a number of func including engine cooling fan control. The ECM also transmits the ambient air temperature on the HS (high speed) CAN bus for use by other control modules.

The AAT sensor is installed in the left exterior mirror, with the bulb of the sensor positioned over a hole in the bottom of the mirror casing.

The ECM supplies the sensor with a 5 V reference voltage and a ground, and translates the return signal voltage into a temperature.

If there is a fault with the AAT sensor, the ECM calculates the AAT from the temperature inputs of the MAFT sensors. If the AAT sensor and the temperature inputs of the M sensors are all faulty, the ECM adopts a default ambient temperature of 25 Â°C (77 Â°F).

ELECTRIC THROTTLE



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The ECM uses the electric throttle to help regulate engine torque.

The electric throttle is installed between the t-piece duct of the intake air distribution and filtering system, and the inlet of the supercharger. For additional information, refer t
Intake Air Distribution and Filtering (Description and Operation).

The throttle plate is operated by an electric DC (Direct Current) motor integrated into the throttle body. The ECM uses a PWM (Pulse Width Modulation) signal to control the
motor. The ECM compares the APP sensor inputs against an electronic request or value to determine the required position of the throttle plate. The ECM and electric throttle
required to:

- Monitor requests for speed control operation.
- Automatically operate the electric throttle for accurate speed control.
- Perform all DSC (dynamic stability control) engine interventions.
- Monitor and carry out maximum engine speed and road speed cut outs.

- Provide different engine maps for the ride and handling optimization system.

A software strategy within the ECM calibrates the position of the throttle plate at the beginning of each ignition cycle. When the ignition is turned on, the ECM performs a se and calibration routine by fully closing the throttle plate and then opening it again. This tests the default position springs and allows the ECM to learn the fully closed positior

OPERATION

ENGINE CONTROL MODULE RELAY

The ECM relay is used to initiate the power up and power down routines within the ECM.

The ECM relay is installed in the EJB (Engine Junction Box).

When the ignition is turned on, battery voltage is applied to the ignition sense input from the CJB (Central Junction Box). The ECM then starts its power up routines and ener the ECM relay.

When the ignition is turned off, the ECM maintains its powered up state while it conducts the power down routines. This can be for:

- Up to 20 minutes in extreme cases, when the DMTL system is running (NAS markets)
- Up to 5 minutes when cooling fans are required.

On completion of the power down routines the ECM de-energizes the ECM relay.

ECM ADAPTIONS

The ECM has the ability to adapt the input values it uses to control certain outputs. This capability maintains engine refinement and ensures the engine emissions remain with legislated limits. The components which have adaptions associated with them are:

- The APP
- The HO2S
- The MAFT Sensor
- The CKP Sensor
- Electric Throttle
- Knock Sensors

HEATED OXYGEN AND MASS AIR FLOW AND TEMPERATURE SENSORS

There are several adaptive maps associated with the fueling strategy. Within the fueling strategy the ECM calculates short-term adaptions and long term adaptions. The ECM monitor the deterioration of the HO2S (heated oxygen sensor)'s over a period of time. It will also monitor the current correction associated with the sensors.

The ECM will store a fault code in circumstances where an adaption is forced to exceed its operating parameters. Simultaneously, the ECM will record the engine speed, engi and intake air temperature.

CRANKSHAFT POSITION SENSOR

The characteristics of the signal supplied by the CKP sensor are learned by the ECM. This enables the ECM to set an adaption and support the engine misfire.

Due to a small variation between different drive plates and different CKP sensors, the adaption must be reset if either component is renewed, or removed and refitted. It is als necessary to reset the drive plate adaption if the ECM is renewed or replaced. The ECM supports four drive plate adaptions for the CKP sensor. Each adaption relates to a spe engine speed range. The engine speed ranges are detailed in the information below:

ADAPTION	ENGINE SPEED REV/MIN
1	1800 - 3000
2	3001 - 3800
3	3801 - 4600
4	4601 - 5400

MISFIRE DETECTION

Legislation requires that the ECM must be able to detect the presence of an engine misfire. It must be able to detect misfires at two separate levels. The first level is an amoun misfire that could lead to the legislated emissions limit being exceeded by a given amount. The second level is a misfire rate that causes degradation in catalytic converter eff

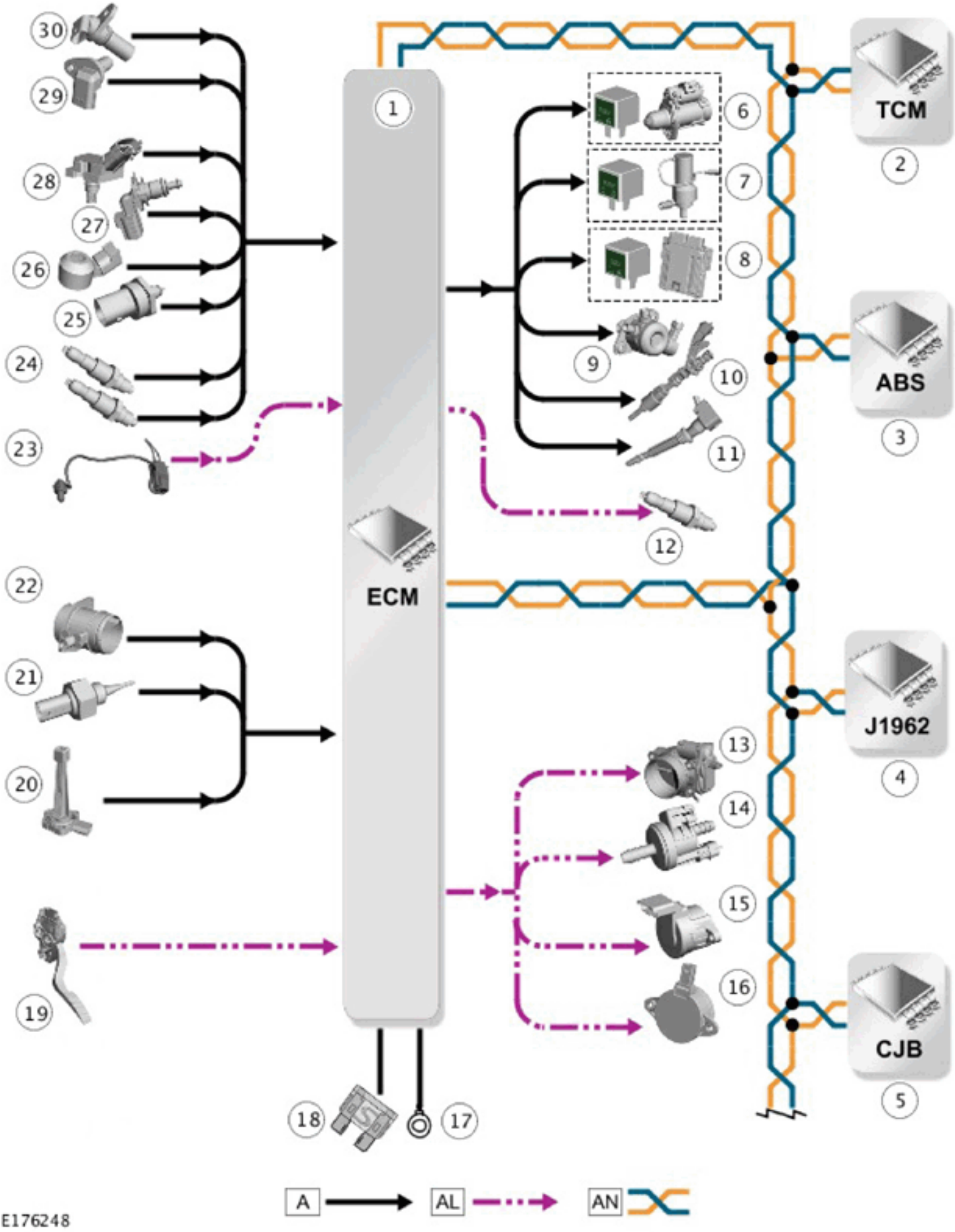
The ECM monitors the number of misfire occurrences within two engine revolution ranges. If the ECM determines a misfire failure within either of these two ranges, over tw consecutive journeys, it will record a fault code and details of the engine speed, engine load and engine coolant temperature. In addition, if the second level of misfire occurs, trip, the ECM flashes the MIL while the fault is occurring.

The signal from the CKP sensor indicates how fast the poles on the drive plate are passing the sensor tip. A sine wave is generated each time a pole passes the sensor tip. The can detect variations in drive plate speed by monitoring the sine wave signal supplied by the crankshaft position sensor. By assessing this signal, the ECM can detect the pres an engine misfire. The ECM will evaluate the signal against a number of factors and will decide whether to record the occurrence or ignore it. The ECM can assign a misfire judgement to an individual cylinder, which can be viewed on Jaguar approved diagnostic equipment

DIAGNOSTICS

The ECM stores each fault as a DTC (Diagnostic Trouble Code). The DTC and associated environmental and freeze frame data can be read using Jaguar approved diagnostic equipment, which can also read real time data from each sensor, the adaption values currently being employed and the current fueling, ignition and idle speed settings.

INPUT AND OUTPUT CONTROL DIAGRAM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A = HARDWIRED; AL = PWM (PULSE WIDTH MODULATION); AN = HS (HIGH SPEED) CAN (CONTROLLER AREA NETWORK) POWERTRAIN SYST BUS.

ITEM	DESCRIPTION
1	Engine Control Module (ECM)
2	Transmission Control Module (TCM)
3	Anti-lock Brake System control module (ABS)
4	Diagnostic Connector (J1962)
5	Central Junction Box (CJB)
6	Starter motor relay
7	Charge air coolant pump relay
8	Engine Control Module (ECM) Relay
9	High Pressure Fuel pump (2 off)
10	Fuel Injector (6 off)
11	Ignition Coil (6 off)
12	Heated Oxygen Sensor (HO2S) - Pre-Catalyst (2 off)
13	Electric throttle
14	Purge Valve
15	Bypass Valve
16	Variable Camshaft Timing (VCT) actuators (4 off)
17	Ground
18	Power supply
19	Accelerator Pedal Position (APP) sensor
20	Electric thermostat
21	Oil level and temperature sensor
22	Charge air temperature sensor
23	Mass Air Flow and Temperature sensor (MAFT) (2 off)
24	Ambient Air Temperature sensor (AAT)
25	Heated Oxygen Sensor (HO2S) - mid-catalyst (2 off) and Heated Oxygen Sensor (HO2S) - post-catalyst (2 off)
26	Fuel Rail Pressure and Temperature sensor (FRPT)
27	Knock sensor (2 off)
28	Engine Coolant Temperature sensor (ECT)
29	Manifold Absolute Pressure and Temperature sensor (MAPT)
30	Camshaft Position sensor (CMP) (4 off)
31	Crankshaft Position sensor (CKP)

DIAGNOSIS AND TESTING

PRINCIPLES OF OPERATION

For a detailed description of the Electronic Engine Controls, refer to the relevant Description and Operation section in the service information. Refer to: **Electronic Engine C** (Description and Operation).

INSPECTION AND VERIFICATION

WARNING:

- **Wait at least 30 seconds after stopping the engine before commencing any repair to the high pressure fuel system. Failure to fo this instruction may result in personal injury.**
- **Place the vehicle in a well ventilated, quarantined area and arrange 'No Smoking'/'Fuel Fumes' signs around the vehicle. Failure follow this instruction may result in personal injury.**
- **Before working on the fuel system, ground the vehicle to earth and maintain the ground connection until the work is complete. Failure to follow this instruction may result in personal injury.**
- **Do not perform any repairs to the high pressure fuel system whilst the engine is running. The fuel pressure can be extremely h Failure to follow this instruction may result in personal injury.**
- **Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable vapours are always present and may ignite. Failure to follow this instruction may result in personal injury.**
- **After making repairs, the fuel system must be checked visually for leaks. Failure to follow this instruction may result in persona injury.**
- **If taken internally do not induce vomiting, seek immediate medical attention. Failure to follow these instructions may result in personal injury.**
- **If fuel is taken internally, do not induce vomiting. Seek immediate medical attention. Failure to follow this instruction may result personal injury.**
- **If fuel contacts the eyes, flush the eyes with cold water or eyewash solution and seek medical attention. Failure to follow this instruction may result in personal injury.**
- **Wash hands thoroughly after handling fuel, as prolonged contact may cause irritation. Should irritation develop, seek medical attention. Failure to follow this instruction may result in personal injury.**
- **This procedure involves fuel handling. Be prepared for fuel spillage at all times and always observe fuel handling precautions. Failure to follow this instruction may result in personal injury.**

CAUTION:

- **Before disconnecting any part of the fuel system, it is imperative that all dust, dirt and debris is removed from around compone to prevent ingress of foreign matter. Failure to follow this instruction may result in damage to the vehicle.**

- **It is essential that absolute cleanliness is observed when working with fuel system components. Always install blanking plugs open orifices or lines. Failure to follow this instruction may result in damage to the vehicle.**
- **Diagnosis by substitution from a donor vehicle is NOT acceptable. Substitution of control modules does not guarantee confirm of a fault, and may also cause additional faults in the vehicle being tested and/or the donor vehicle.**

NOTE:

- **If a control module or a component is suspect and the vehicle remains under manufacturer warranty, refer to the Warranty Poli Procedures manual, or determine if any prior approval programme is in operation, prior to the installation of a new module/component.**
- **When performing voltage or resistance tests, always use a digital multimeter accurate to three decimal places, and with an up-t date calibration certificate. When testing resistance always take the resistance of the digital multimeter leads into account.**
- **Check and rectify basic faults before beginning diagnostic routines involving pinpoint tests.**

Visual Inspection

1. Verify the customer concern
2. Visually inspect for obvious signs of damage and system integrity

MECHANICAL	ELECTRICAL
• Engine oil level • Cooling system coolant level • Fuel level • Fuel contamination • Fuel leaks • Accessory drive belt • Vacuum hoses • Fuel injectors • High pressure fuel pumps • Fuel metering valve • Turbine bypass control actuator	• Fuses • Wiring harnesses and connectors • Powertrain control module • Transmission control module • Crankshaft position sensor • Accelerator pedal position sensor • Camshaft position sensors • Engine coolant temperature sensor • Knock sensors • Mass air flow and temperature sensor • Low fuel pressure sensor • Ambient air temperature sensor • Radiator outlet temperature sensor • Fuel rail pressure sensor • Charge air pressure sensor • Oil level and temperature sensor • Heated oxygen sensors • Ignition coils • Electric throttle • Fuel pump module • Variable camshaft timing actuators • Purge valve

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart, alternatively check for Diagnostic Trouble Codes (DTCs) and refer to the DTC
5. Check DDW for open campaigns. Refer to the corresponding bulletins and SSMs which may be valid for the specific customer complaint and carry out the recommend as required

SYMPTOM CHART

SYMPTOM	POSSIBLE CAUSES	ACTION

SYMPTOM	POSSIBLE CAUSES	ACTION
The engine does not crank	• Battery/charging system fault • Engine system fault • Transmission fault • Transmission control switch not set to Park or Neutral • Smart key not present/recognised • Starter relay fault • Starter motor ground circuit open circuit, high resistance • Starter motor solenoid circuit short circuit to ground, open circuit, high resistance • Starter motor circuit short circuit to ground, open circuit, high resistance • Engine seized	• Refer to the relevant section of the service information and check the battery and charging system. Rectify as necessary • Using the Jaguar Land Rover approved diagnostic equipment, check the powertrain control module for related DTCs and refer to the relevant DTC index • Using the Jaguar Land Rover approved diagnostic equipment, check the transmission control module for related DTCs and refer to the relevant DTC index • Set the transmission control switch to Park or Neutral and retest • Check that the smart key is present and recognised • Check the operation of the starter relay. Rectify as necessary • Refer to the applicable SYSTEM WIRING DIAGRAM(S) and check the starter motor ground circuit for open circuit, high resistance. Repair the wiring harness as necessary • Refer to the applicable SYSTEM WIRING DIAGRAM(S) and check the starter motor solenoid power circuit for short circuit to ground, open circuit, high resistance. Repair the wiring harness or install a new starter motor solenoid as necessary • Refer to the applicable SYSTEM WIRING DIAGRAM(S) and check the starter motor power circuit for short circuit to ground, open circuit, high resistance. Repair the wiring harness or install a new starter motor as necessary • Check that the engine turns freely
Engine cranks but does not start	• Positive crankcase ventilation system blocked/leaking • Ignition system fault • Fuel system fault • Engine system fault	• Check the integrity of the positive crankcase ventilation system. Rectify as necessary • Refer to the relevant section of the service information and check the ignition system. Rectify as necessary • Refer to the relevant section of the service information and check the fuel system. Rectify as necessary • Using the Jaguar Land Rover approved diagnostic equipment, check the powertrain control module for related DTCs and refer to the relevant DTC index
Engine cranks and fires, but will not start	• Evaporative emissions system fault • Ignition system fault • Fuel system fault • Engine system fault	• Refer to the relevant section of the service information and check the evaporative emissions system. Rectify as necessary • Refer to the relevant section of the service information and check the ignition system. Rectify as necessary • Refer to the relevant section of the service information and check the fuel system. Rectify as necessary • Using the Jaguar Land Rover approved diagnostic equipment, check the powertrain control module for related DTCs and refer to the relevant DTC index

SYMPTOM	POSSIBLE CAUSES	ACTION
Engine difficult to start (cold engine)	• Battery/charging system fault • Engine system fault • Fuel system fault • Evaporative emissions system fault	• Refer to the relevant section of the service information and check the battery and charging system. Rectify as necessary • Using the Jaguar Land Rover approved diagnostic equipment, check the powertrain control module for related DTCs and refer to the relevant DTC index • Refer to the relevant section of the service information and check the fuel system. Rectify as necessary • Refer to the relevant section of the service information and check the evaporative emissions system. Rectify as necessary
Engine difficult to start (warm/hot engine)	• Injector(s) leaking • Engine system fault • Evaporative emissions system fault • Fuel system fault • Ignition system fault	• Check the injectors for leaks. Rectify as necessary • Using the Jaguar Land Rover approved diagnostic equipment, check the powertrain control module for related DTCs and refer to the relevant DTC index • Refer to the relevant section of the service information and check the evaporative emissions system. Rectify as necessary • Refer to the relevant section of the service information and check the fuel system. Rectify as necessary • Refer to the relevant section of the service information and check the ignition system. Rectify as necessary
Engine difficult to start after hot soak (vehicle standing, engine off, after engine has reached operating temperature)	• Injector(s) leaking • Engine system fault • Evaporative emissions system fault • Fuel system fault • Ignition system fault	• Check the injectors for leaks. Rectify as necessary • Using the Jaguar Land Rover approved diagnostic equipment, check the powertrain control module for related DTCs and refer to the relevant DTC index • Refer to the relevant section of the service information and check the evaporative emissions system. Rectify as necessary • Refer to the relevant section of the service information and check the fuel system. Rectify as necessary • Refer to the relevant section of the service information and check the ignition system. Rectify as necessary
Engine cranks too slowly	• Battery/charging system fault • Starter motor ground circuit open circuit, high resistance • Starter motor power circuit open circuit, high resistance • Starter motor internal failure • Engine oil grade incorrect	• Refer to the relevant section of the service information and check the battery and charging system. Rectify as necessary • Refer to the applicable SYSTEM WIRING DIAGRAM(S) and check the starter motor ground circuit for open circuit, high resistance. Repair the wiring harness as necessary • Refer to the applicable SYSTEM WIRING DIAGRAM(S) and check the starter motor power circuit for open circuit, high resistance. Repair the wiring harness as necessary • Check the operation of the starter motor. Rectify as necessary • Check the engine oil grade. Rectify as necessary
Engine cranks too fast	• Timing chain failure • Low engine compression	• Check the integrity of the timing chain. Rectify as necessary • Refer to the relevant section of the service information and test the engine cylinder compressions. Rectify as necessary

SYMPTOM	POSSIBLE CAUSES	ACTION
Engine stalls soon after start	• Positive crankcase ventilation system blocked/leaking • Engine system fault • Ignition system fault • Intake pipe restricted/blocked • Air filter element restricted/blocked • Intake pipe disconnected/damaged after the air cleaner • Fuel system fault	• Check the integrity of the positive crankcase ventilation system. Rectify as necessary • Using the Jaguar Land Rover approved diagnostic equipment, check the powertrain control module for related DTCs and refer to the relevant DTC index • Refer to the relevant section of the service information and check the ignition system. Rectify as necessary • Check the intake pipe for restrictions and blockages. Rectify as necessary • Install a new air filter element as necessary • Check the intake system for correct installation and damage. Rectify as necessary • Refer to the relevant section of the service information and check the fuel system. Rectify as necessary
Engine stalls on overrun	• Engine system fault	• Using the Jaguar Land Rover approved diagnostic equipment, check the powertrain control module for related DTCs and refer to the relevant DTC index
Engine stalls at steady speed	• Engine system fault	• Using the Jaguar Land Rover approved diagnostic equipment, check the powertrain control module for related DTCs and refer to the relevant DTC index
Engine stalls with speed control enabled	• Engine system fault	• Using the Jaguar Land Rover approved diagnostic equipment, check the powertrain control module for related DTCs and refer to the relevant DTC index
Engine stalls when manoeuvring	• Engine system fault • Excessive additional engine loads (power steering, air conditioning, etc) • Transmission fault	• Using the Jaguar Land Rover approved diagnostic equipment, check the powertrain control module for related DTCs and refer to the relevant DTC index • Check for excessive loads being placed on the engine by the power steering, air conditioning, etc • Using the Jaguar Land Rover approved diagnostic equipment, check the transmission control module for related DTCs and refer to the relevant DTC index
Engine hesitates/poor acceleration	• Fuel system fault • Injector(s) leaking • Intake pipe disconnected/damaged after the air cleaner • Engine system fault • Accelerator pedal movement restricted (carpet, mats, etc) • Ignition system fault • Transmission fault	• Refer to the relevant section of the service information and check the fuel system. Rectify as necessary • Check the injectors for leaks. Rectify as necessary • Check the intake system for correct installation and damage. Rectify as necessary • Using the Jaguar Land Rover approved diagnostic equipment, check the powertrain control module for related DTCs and refer to the relevant DTC index • Check that the accelerator pedal is free from restriction. Rectify as necessary • Refer to the relevant section of the service information and check the ignition system. Rectify as necessary • Using the Jaguar Land Rover approved diagnostic equipment, check the transmission control module for related DTCs and refer to the relevant DTC index

SYMPTOM	POSSIBLE CAUSES	ACTION
Engine backfires	• Fuel system fault • Intake pipe disconnected/damaged after the air cleaner • Engine system fault • Ignition system fault • Variable camshaft timing system stuck active	• Refer to the relevant section of the service information and check the fuel system. Rectify as necessary • Check the intake system for correct installation and damage. Rectify as necessary • Using the Jaguar Land Rover approved diagnostic equipment, check the powertrain control module for related DTCs and refer to the relevant DTC index • Refer to the relevant section of the service information and check the ignition system. Rectify as necessary • Check the operation of the variable camshaft timing system. Rectify as necessary
Engine surges	• Fuel system fault • Engine system fault • Ignition system fault	• Refer to the relevant section of the service information and check the fuel system. Rectify as necessary • Using the Jaguar Land Rover approved diagnostic equipment, check the powertrain control module for related DTCs and refer to the relevant DTC index • Refer to the relevant section of the service information and check the ignition system. Rectify as necessary
Engine detonates/knocks	• Engine system fault • Fuel system fault • Intake pipe disconnected/damaged after the air cleaner • Variable camshaft timing system stuck active	• Using the Jaguar Land Rover approved diagnostic equipment, check the powertrain control module for related DTCs and refer to the relevant DTC index • Refer to the relevant section of the service information and check the fuel system. Rectify as necessary • Check the intake system for correct installation and damage. Rectify as necessary • Check the operation of the variable camshaft timing system. Rectify as necessary
No throttle response	• Engine system fault	• Using the Jaguar Land Rover approved diagnostic equipment, check the powertrain control module for related DTCs and refer to the relevant DTC index
Speed control inhibited/disabled	• Engine system fault	• Using the Jaguar Land Rover approved diagnostic equipment, check the powertrain control module for related DTCs and refer to the relevant DTC index
Throttle response poor	• Engine system fault • Positive crankcase ventilation system blocked/leaking • Transmission fault • Dynamic stability control event • Intake pipe disconnected/damaged after the air cleaner	• Using the Jaguar Land Rover approved diagnostic equipment, check the powertrain control module for related DTCs and refer to the relevant DTC index • Check the integrity of the positive crankcase ventilation system. Rectify as necessary • Using the Jaguar Land Rover approved diagnostic equipment, check the transmission control module for related DTCs and refer to the relevant DTC index • No fault - Accelerator pedal response may be temporarily reduced or inhibited when the dynamic stability control is active • Check the intake system for correct installation and damage. Rectify as necessary
Malfunction indicator lamp illuminated or engine warning message displayed	• Engine system fault	• Using the Jaguar Land Rover approved diagnostic equipment, check the powertrain control module for related DTCs and refer to the relevant DTC index

PINPOINT TEST A: MISFIRE PINPOINT TEST

A1: CHECK FOR MISFIRE COUNTS

Check the Powertrain control module (PCM) for related engine system DTCs and refer to relevant DTC index. If DTCs relating to any subsystem are present then these be addressed before continuing with this pinpoint test e.g. Ignition system (including crank shaft sensor), Fuelling system (includes fuel system too lean/rich)

1. Using the Jaguar Land Rover Approved Diagnostic Equipment, run the **Powertrain - Misfire - Cylinder Identification** application

Can a **persistent** misfire be confirmed

Yes : Proceed to next step

No : If the misfire is not present, ensure conditions required to replicate the misfire are understood and repeat the test

Consider the following:

DTC snapshot information: Engine temperature, Engine speed, Vehicle speed, Time since the engine was started Driving conditions when the misfire occurred

A2: VISUAL CHECK

1. Inspect the wiring harness for the ignition coils and fuel injectors. Ensure that the electrical connector pins are not backed out or corroded and the electrical conn latch correctly

Have any wiring harness or electrical connector faults been identified?

Yes : Rectify the fault as required

Repeat test step 1 (CHECK FOR MISFIRE COUNTS)

No : Proceed to next step

A3: SWAP IGNITION COIL CYLINDER TO CYLINDER

1. Swap the ignition coil from the affected cylinder(s) with a coil from a known good cylinder (do not remove the spark plug)
2. Repeat test step 1 (CHECK FOR MISFIRE COUNTS)

Has the misfire changed cylinder position?

Yes : Check and install a new ignition coil as required

Repeat test step 1 (CHECK FOR MISFIRE COUNTS)

No : Proceed to next step

A4: SWAP SPARK PLUG CYLINDER TO CYLINDER

1. Swap the spark plug(s) from the affected cylinder(s) with a spark plug from a known good cylinder
2. Repeat test step 1 (CHECK FOR MISFIRE COUNTS)

Has the misfire changed cylinder position?

Yes : Check and install new spark plug(s) as required

Repeat test step 1 (CHECK FOR MISFIRE COUNTS)

No : Proceed to next step

A5: ELECTRICAL CHECKS (OSCILLOSCOPE REQUIRED)

1. Using an oscilloscope check the actuation signal from the Powertrain Control Module (PCM) to the ignition coil
2. Compare the affected cylinder actuation signal for plausibility against known good cylinder actuation signals

Is the actuation signal for the affected cylinder plausible?

Yes : Proceed to next step

No : Refer to the applicable SYSTEM WIRING DIAGRAM(S) and check the affected cylinder ignition coil circuit for short circuit to ground, short circuit to po open circuit, high resistance

Inspect the electrical connectors for signs of water ingress and pins for damage and/or corrosion

A6: CHECK FUEL TRIMS

1. Using the Jaguar Land Rover Approved Diagnostic Equipment, run the **Powertrain - Adaptive Fuel Trim Display** application
2. Check the short term and long term fuel trims

Does the application show the values within tolerance?

Yes : Proceed to next step

No : Using the Jaguar Land Rover Approved smoke machine, check the air intake system and vacuum hoses for leakage, blockage and mechanical integrity

Check and install new air intake or vacuum system components only as required

Repeat test step 1 (CHECK FOR MISFIRE COUNTS)

A7: CHECK MASS AIR FLOW SENSOR

1. Using the Jaguar Land Rover Approved Diagnostic Equipment, check datalogger signal 0x0504 - Air Flow Sensor Bank 1
2. Using the Jaguar Land Rover Approved Diagnostic Equipment, check datalogger signal 0x0505 - Air Flow Sensor Bank 2
3. Compare the sensor values at idle and part load

Are the sensor values comparable between bank 1 and bank 2

Yes : Proceed to step 9 (SWAP FUEL INJECTORS CYLINDER TO CYLINDER)

No : Proceed to next step

A8: SWAP MASS AIR FLOW SENSOR

1. Swap mass air flow sensors bank to bank
2. Using the Jaguar Land Rover Approved Diagnostic Equipment, check datalogger signal 0x0504 - Air Flow Rate From Mass Air Flow Sensor Bank 1
3. Using the Jaguar Land Rover Approved Diagnostic Equipment, check datalogger signal 0x0505 - Air Flow Rate From Mass Air Flow Sensor Bank 2
4. Compare the sensor values at idle and part load

Are the sensor values comparable between bank 1 and bank 2

Yes : Proceed to next step

No : Refer to the applicable SYSTEM WIRING DIAGRAM(S) and check the mass air flow sensor circuit for short circuit to ground, short circuit to power, open high resistance

Inspect connectors for signs of water ingress and pins for damage and/or corrosion

Check for restricted air flow

Check and install a new mass air flow sensor component only as required

Repeat test step 1 (CHECK FOR MISFIRE COUNTS)

A9: SWAP FUEL INJECTORS CYLINDER TO CYLINDER

1. Swap the fuel injector(s) from the affected cylinder(s) with a fuel injector from a known good cylinder
2. Repeat test step 1 (CHECK FOR MISFIRE COUNTS)

Has the misfire changed cylinder position?

Yes : Check and install new fuel injector(s)

Only the fuel injector for the corresponding DTC cylinder referenced should be replaced

Repeat test step 1 (CHECK FOR MISFIRE COUNTS)

No : Proceed to next step

A10: CARRY OUT ENGINE COMPRESSION TEST

1. Where available, using the Jaguar Land Rover Approved Diagnostic Equipment, run the **Inline Diagnostic Unit 2 relative compression test** application, availab the following vehicles:

- **AJ126 and AJ133:** L405, L494, X152, X260, L319 MY14>, X250 MY13>, X351 MY13>
- For vehicles not covered by the diagnostic tool compression test, refer to TOPIx section 303-00 Cylinder Compression Test

Were the compression test values within limits?

Yes : proceed to next step

No : Carry out a cylinder leakage test to identify the area of compression loss e.g. cylinder or valve issue

A11: OTHER POSSIBLE CAUSES

NOTE: **The items on the following list are less likely to have set the DTC (s) but should be considered as other possibilities to be chec**

1. Other possible causes:

- Crankshaft position sensor incorrect installation
- Reluctor ring mechanical damage at the flywheel
- Crank case ventilation system blockage or leakage

Were any of the above issues identified?

Yes : Rectify the fault as required

Repeat test step 1 (CHECK FOR MISFIRE COUNTS)

No : Reconfirm the customer issue, ensure conditions required to replicate the misfire are understood and repeat the test

DTC INDEX

For a list of Diagnostic Trouble Codes (DTCs) that could be logged on this vehicle, please refer to: **Diagnostic Trouble Code (DTC) Index - V8 S/C 5.0L Petrol, DTC: En Control Module (ECM)** (Description and Operation).

DIAGNOSIS AND TESTING

DIAGNOSIS OF BOSCH HEATED OXYGEN SENSORS (HO2S)

A full description of oxygen sensor monitoring, can be found in the service information Documents Tab/Diagnostics Section/OBD II System Information

CAUTION: **Diagnosis by substitution from a donor vehicle is NOT acceptable. Substitution of control modules does not guarantee confirmation fault and may also cause additional faults in the vehicle being checked and/or the donor vehicle**

NOTE:

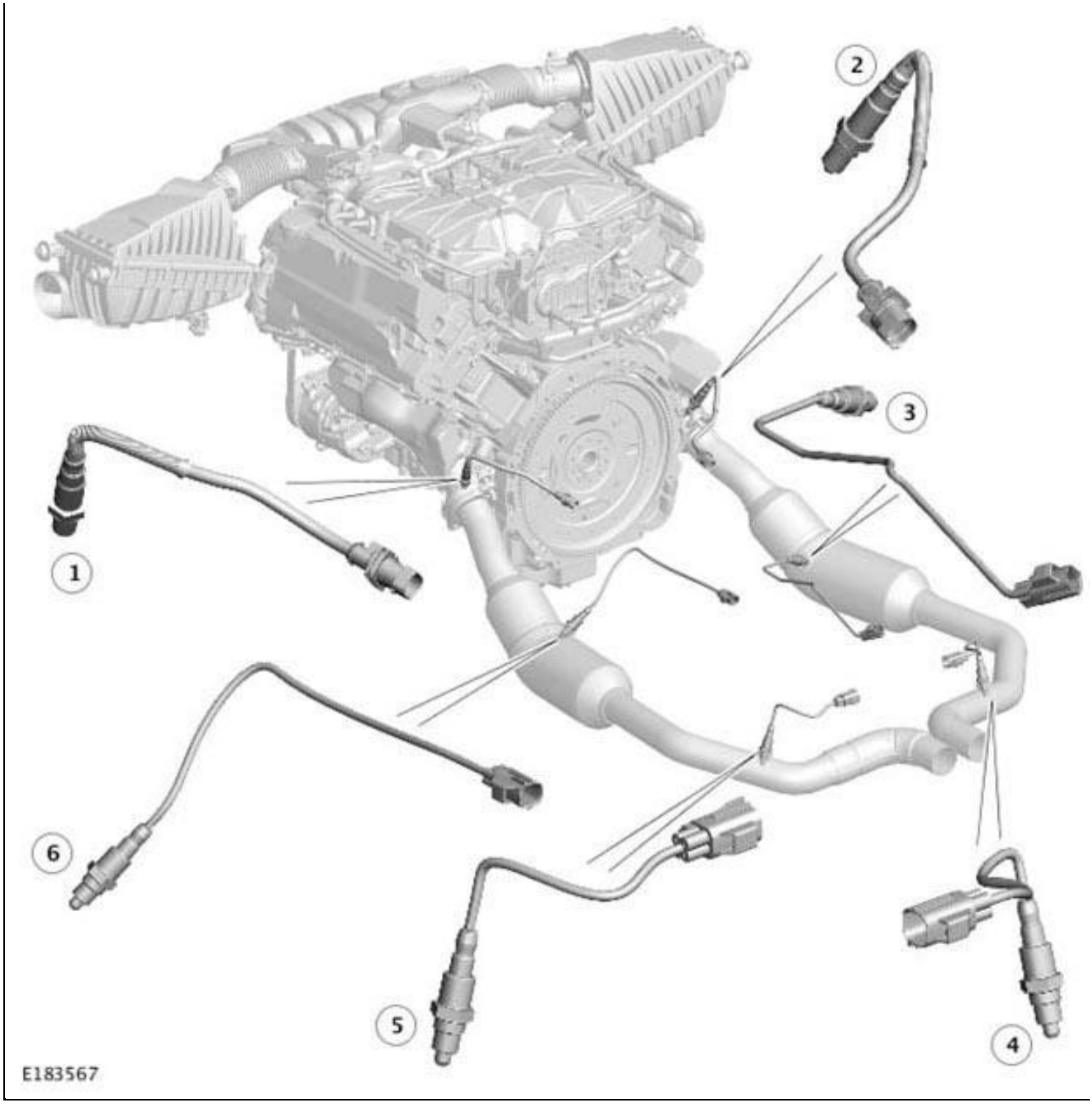
- **Check and rectify basic faults before beginning diagnostic routines involving pinpoint tests**
- **Generic scan tools may not read the codes listed, or may read only 5-digit codes. Match the 5 digits from the scan tool to the fi digits of the 7-digit code listed to identify the fault (the last 2 digits give extra information read by the manufacturer-approved diagnostic system).**
- **When performing voltage or resistance tests, always use a digital multimeter accurate to three decimal places, and with an up-t date calibration certificate. When testing resistance always take the resistance of the digital multimeter leads into account.**
- **Inspect connectors for signs of water ingress, and pins for damage and/or corrosion.**
- **If DTCs are recorded and, after performing the pinpoint tests, a fault is not present, an intermittent concern may be the cause. Always check for loose connections and corroded terminals.**
- **Check DDW for open campaigns. Refer to the corresponding bulletins and SSMs which may be valid for the specific customer complaint and carry out the recommendations as required.**

The purpose of this document is to aid in the correct diagnosis of Bosch Heated Oxygen Sensors (HO2S) and to prevent unnecessary installation of new parts. It may be deem after diagnosis that a particular sensor has failed, in this case it would be expected that only the failed sensor is replaced and **NOT** a complete vehicle set.

PRINCIPLE OF OPERATION

For a detailed description of electronic engine controls, refer to the relevant description and operation section of the service information.

Heated Oxygen Sensor (HO2S) location



ITEM	DESCRIPTION
1	Heated Oxygen Sensor (HO2S) - Pre catalyst - Bank 2 sensor 1
2	Heated Oxygen Sensor (HO2S) - Pre catalyst - Bank 1 sensor 1
3	Heated Oxygen Sensor (HO2S) - Mid catalyst - Bank 1 sensor 2
4	Heated Oxygen Sensor (HO2S) - Post catalyst - Bank 1 sensor 3
5	Heated Oxygen Sensor (HO2S) - Post catalyst - Bank 2 sensor 3
6	Heated Oxygen Sensor (HO2S) - Mid catalyst - Bank 2 sensor 2

INSPECTION AND VERIFICATION

Visual Inspection

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

MECHANICAL	ELECTRICAL

MECHANICAL	ELECTRICAL
• Heated Oxygen Sensor (HO2S) incorrect installation • Heated Oxygen Sensor (HO2S) contamination by incorrect fuel or oil • Heated Oxygen Sensor (HO2S) degraded • Exhaust system leakage • Exhaust system restriction • Air intake system leakage • Mass air flow sensor contamination • Incorrect fuel pressure • Pipe detached or union leakage between intake manifold and cylinder head	• Connector is disconnected, connector pin is backed out, connector pin co • Fuses • Wiring harness • Electrical connector(s)

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. **Using the approved diagnostic tool, check for Diagnostic Trouble Codes (DTCs).**
5. Refer to the DTC help text in Section 100-00 for diagnostic help specific to the logged DTC(s).

HEATED OXYGEN SENSOR (HO2S) ACTIVATION REQUIREMENTS

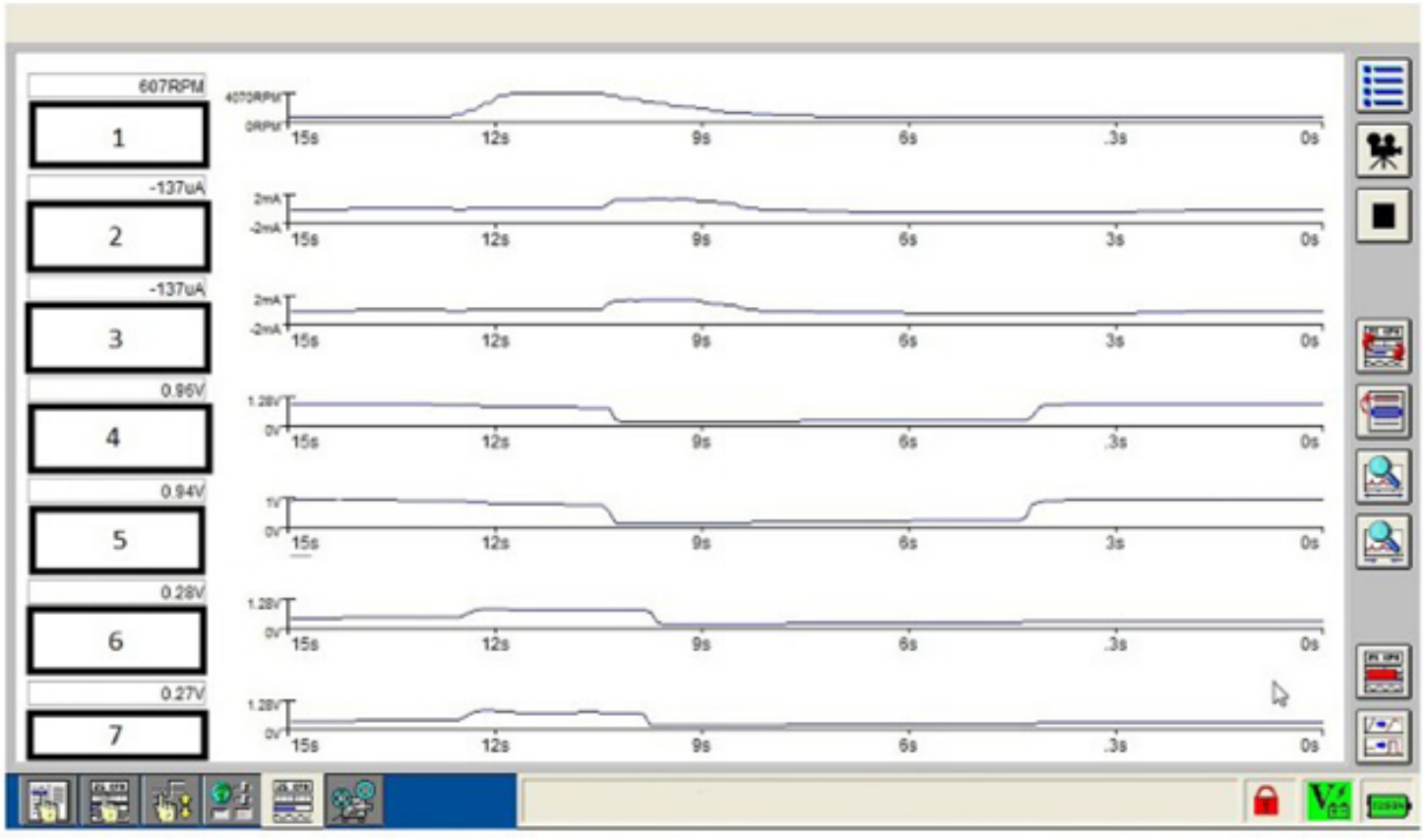
NOTE: **If the sensor has not become active, then DTCs will not be logged.**

The drive cycle required to activate all of the Heated Oxygen Sensor (HO2S) can vary greatly in time. This is dependent on all of the sensors reaching 'dew point' during prev drive cycles. 'Dew point' is where the moisture content in the exhaust has evaporated and can no longer damage the Heated Oxygen Sensor (HO2S). The closer a Heated Oxy Sensor (HO2S) is to the engine, the faster it will achieve 'dew point'. Once a Heated Oxygen Sensor (HO2S) has reached 'dew point' the Heated Oxygen Sensor (HO2S) heati activated and shortly afterwards the Heated Oxygen Sensor (HO2S) will be functional. **Once functional the Heated Oxygen Sensor (HO2S) diagnostics become active an report any error states with a DTC.**

VIEWING OPERATION OF HEATED OXYGEN SENSOR (HO2S)

Using Datalogger view the output signals for all Heated Oxygen Sensors (HO2S) and confirm correct operation. As each Heated Oxygen Sensor (HO2S) becomes active the signal can be seen reacting to changes in engine speed/load.

NOTE: **Heated Oxygen Sensors (HO2S) will become functional at different times, depending on their location within the exhaust system and previous drive cycles. See 'Drive Cycle' section below for further information.**



ITEM	DESCRIPTION
1	Engine speed
2	Oxygen Sensor Current Bank 1 sensor 1
3	Oxygen Sensor Current Bank 2 sensor 1

ITEM	DESCRIPTION
4	Oxygen Sensor Output Voltage Bank 1 - sensor 2
5	Oxygen Sensor Output Voltage Bank 2 - sensor 2
6	Oxygen Sensor Output Voltage Bank 1 - sensor 3
7	Oxygen Sensor Output Voltage Bank 2 - sensor 3

HEATED OXYGEN SENSOR DATALOGGER SIGNALS

PID	DESCRIPTION	ACTION
BANK 1		
Datalogger signal for Heated Oxygen Sensor (HO2S) - Pre catalyst - Bank 1 sensor 1		
0x03A1	Oxygen Sensor (O2S) Heater Duty Cycle Bank 1 Sensor 1	Using the manufacturer approved diagnostic system check datalogger signal. The signal is a duty cycle displayed in % varying between limits
0xF434	Oxygen Sensor Current Bank 1 sensor 1	Using the manufacturer approved diagnostic system check datalogger signal. The signal is displayed in mA varying between limits
Datalogger signal for Heated Oxygen Sensor (HO2S) - Mid catalyst - Bank 1 sensor 2		
0x03A2	Oxygen Sensor (O2S) Heater Duty Cycle Bank 1 Sensor 2	Using the manufacturer approved diagnostic system check datalogger signal. The signal is a pulse width modulated signal digital output operating between 0 and 1
0xF415	Oxygen Sensor Output Voltage Bank 1 - sensor 2	Using the manufacturer approved diagnostic system check datalogger signal. The signal is displayed in volts varying between limits
Datalogger signal for Heated Oxygen Sensor (HO2S) - Post catalyst - Bank 1 sensor 3		
0x03A3	Oxygen sensor heater duty cycle - Bank 1 sensor 3	Using the manufacturer approved diagnostic system check datalogger signal. The signal is a pulse width modulated signal digital output operating between 0 and 1
0xF416	Oxygen Sensor Output Voltage Bank 1 - sensor 3	Using the manufacturer approved diagnostic system check datalogger signal. The signal is displayed in volts varying between limits
BANK 2		
Datalogger signal for Heated Oxygen Sensor (HO2S) - Pre catalyst - Bank 2 sensor 1		
0x03A4	Oxygen Sensor (O2S) Heater Duty Cycle Bank 2 Sensor 1	Using the manufacturer approved diagnostic system check datalogger signal. The signal is a duty cycle displayed in % varying between limits
0xF438	Oxygen Sensor Current Bank 2 sensor 1	Using the manufacturer approved diagnostic system check datalogger signal. The signal is displayed in mA varying between limits
Datalogger signal for Heated Oxygen Sensor (HO2S) - Mid catalyst - Bank 2 sensor 2		
0x03A5	Oxygen Sensor (O2S) Heater Duty Cycle Bank 2 Sensor 2	Using the manufacturer approved diagnostic system check datalogger signal. The signal is a pulse width modulated signal digital output operating between 0 and 1
0xF419	Oxygen Sensor Output Voltage Bank 2 - sensor 2	Using the manufacturer approved diagnostic system check datalogger signal. The signal is displayed in volts varying between limits
Heated Oxygen Sensor (HO2S) - Post catalyst - Bank 2 sensor 3		
0x03A6	Oxygen sensor heater duty cycle - Bank 2 sensor 3	Using the manufacturer approved diagnostic system check datalogger signal. The signal is a pulse width modulated signal digital output operating between 0 and 1
0xF41A	Oxygen Sensor Output Voltage Bank 2 - sensor 3	Using the manufacturer approved diagnostic system check datalogger signal. The signal is displayed in volts varying between limits

DRIVE CYCLE

Pre catalyst and Mid catalyst sensors

Drive the vehicle until the engine is fully warm (greater than +80 Â°C). The drive cycle should include driving the vehicle in a steady throttle condition at a road speed of 30 above for a duration of at least 2 minutes. (Once functional the oxygen sensor output signal can be seen reacting to changes in engine speed/load or if the sensor is faulty a D will be raised).

Post catalyst sensors

Post catalyst sensor monitoring can take over 30 minutes of driving to become active if the 'dew point' has not been achieved in previous drive cycles or an EMS ECU battery has occurred. The Drive cycle should consist of a constant speed and load allowing sufficient heat to build up in the exhaust system.

PINPOINT TEST A: ELECTRONIC ENGINE CONTROLS PINPOINT TEST

A1: PERFORMANCE CHECK OF HEATED OXYGEN SENSOR(S) (HO2S)

NOTE:

- **Refer to the Heated Oxygen Sensor (HO2S) location section for information on Heated Oxygen Sensor (HO2S) locations**
- **Oxygen sensors will become functional at different times, depending on their location within the exhaust system and the previous drive cycles**

1. Refer to the **Heated Oxygen Sensor (HO2S) Activation Requirements** and **Drive Cycle** sections for information on Heated Oxygen Sensor (HO2S) activation requirements and drive cycles

NOTE: **Pre catalyst oxygen sensor - Signal displayed in mA - Signal changes either side of 0mA as fueling changes from lean to r**

2. Using the manufacturer approved diagnostic system check datalogger signal Oxygen Sensor Current Bank 1 - sensor 1 (low res)
3. Using the manufacturer approved diagnostic system check datalogger signal Oxygen Sensor Current Bank 2 - sensor 1 (low res)

NOTE: **Mid and post catalyst oxygen sensor - Signal displayed in Volts - Signal changes between 0 and 1 volt as fueling switches lean to rich**

4. Using the manufacturer approved diagnostic system check datalogger signal Oxygen Sensor Output Voltage Bank 1 - sensor 3
5. Using the manufacturer approved diagnostic system check datalogger signal Oxygen Sensor Output Voltage Bank 1 - sensor 2
6. Using the manufacturer approved diagnostic system check datalogger signal Oxygen Sensor Output Voltage Bank 2 - sensor 2
7. Using the manufacturer approved diagnostic system check datalogger signal Oxygen Sensor Output Voltage Bank 2 - sensor 3
8. View the output signals for each Heated Oxygen Sensor (HO2S). Once active each sensor can be seen reacting to changes in engine speed/load

Observe the oxygen sensor signal responsible for the DTC. Is the sensor functioning correctly?

Yes : No failure is found. Clear DTCs and perform road test to confirm no fault is present. Refer to the Heated Oxygen Sensor (HO2S) Activation Requirements Drive Cycle sections for information on Heated Oxygen Sensor (HO2S) activation requirements and drive cycles

No : Proceed to the next step

A2: ELECTRICAL CHECK OF HEATED OXYGEN SENSOR(S) (HO2S) HEATER POWER SUPPLY

NOTE:
- **Refer to the Heated Oxygen Sensor (HO2S) location section for information on Heated Oxygen Sensor (HO2S) locations**
- **Carry out the following electrical checks ONLY on the sensor(s) with the related DTC(s) logged**

1. Refer to the applicable SYSTEM WIRING DIAGRAM(S) and check the heater power supply
2. Switch ignition OFF
3. Disconnect Heated Oxygen Sensor (HO2S) (with the related DTC(s) logged)
4. Switch ignition ON
5. **Pre catalyst oxygen sensor** . Measure the voltage between pin 4 and battery ground
6. **Mid and post catalyst oxygen sensor** . Measure the voltage between pin 1 and battery ground

Is the measured voltage between 11 and 14 volts?

Yes : Proceed to the next step

No : Check for fuse failure

Check connectors for signs of water ingress, and pins for damage and/or corrosion

Check for vehicle harness failure - Wiring integrity short circuit to ground, short circuit to power, open circuit, high resistance

A3: ELECTRICAL CHECK OF HEATED OXYGEN SENSOR(S) (HO2S) HEATER RESISTANCE

NOTE:
- **Refer to the Heated Oxygen Sensor (HO2S) location section for information on Heated Oxygen Sensor (HO2S) locations**
- **Carry out the following electrical checks ONLY on the sensor(s) with the related DTC(s) logged**
- **Remove multimeter internal resistance value from measurement**

1. Refer to the applicable SYSTEM WIRING DIAGRAM(S) and check the heater resistance
2. Switch ignition OFF
3. Ensure the Heated Oxygen Sensor (HO2S) connector is disconnected
4. **Pre catalyst oxygen sensor** . Measure the resistance of the sensor between pin 4 and pin 3
5. **Mid and post catalyst oxygen sensor** . Measure the resistance of the sensor between pin 1 and pin 2

Is the measured resistance between 1 and 15 Ohms?

Yes : Check connectors for signs of water ingress, and pins for damage and/or corrosion

Check for vehicle harness failure - Wiring integrity short circuit to ground, short circuit to power, open circuit, high resistance

No : Install a new Heated Oxygen Sensor (HO2S) component

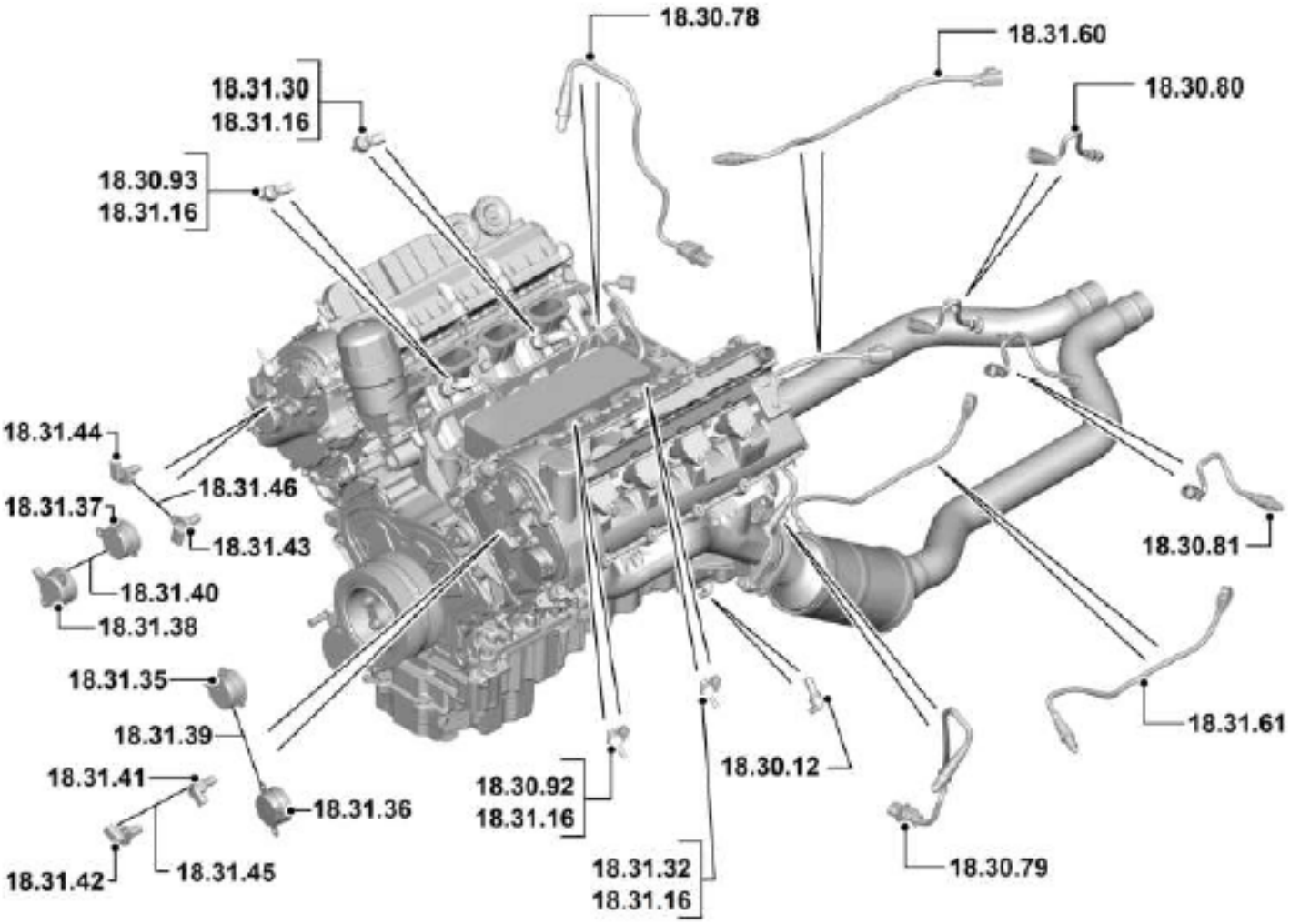
DTC INDEX

For a list of Diagnostic Trouble Codes (DTCs) that could be logged on this vehicle, please refer to

REMOVAL AND INSTALLATION

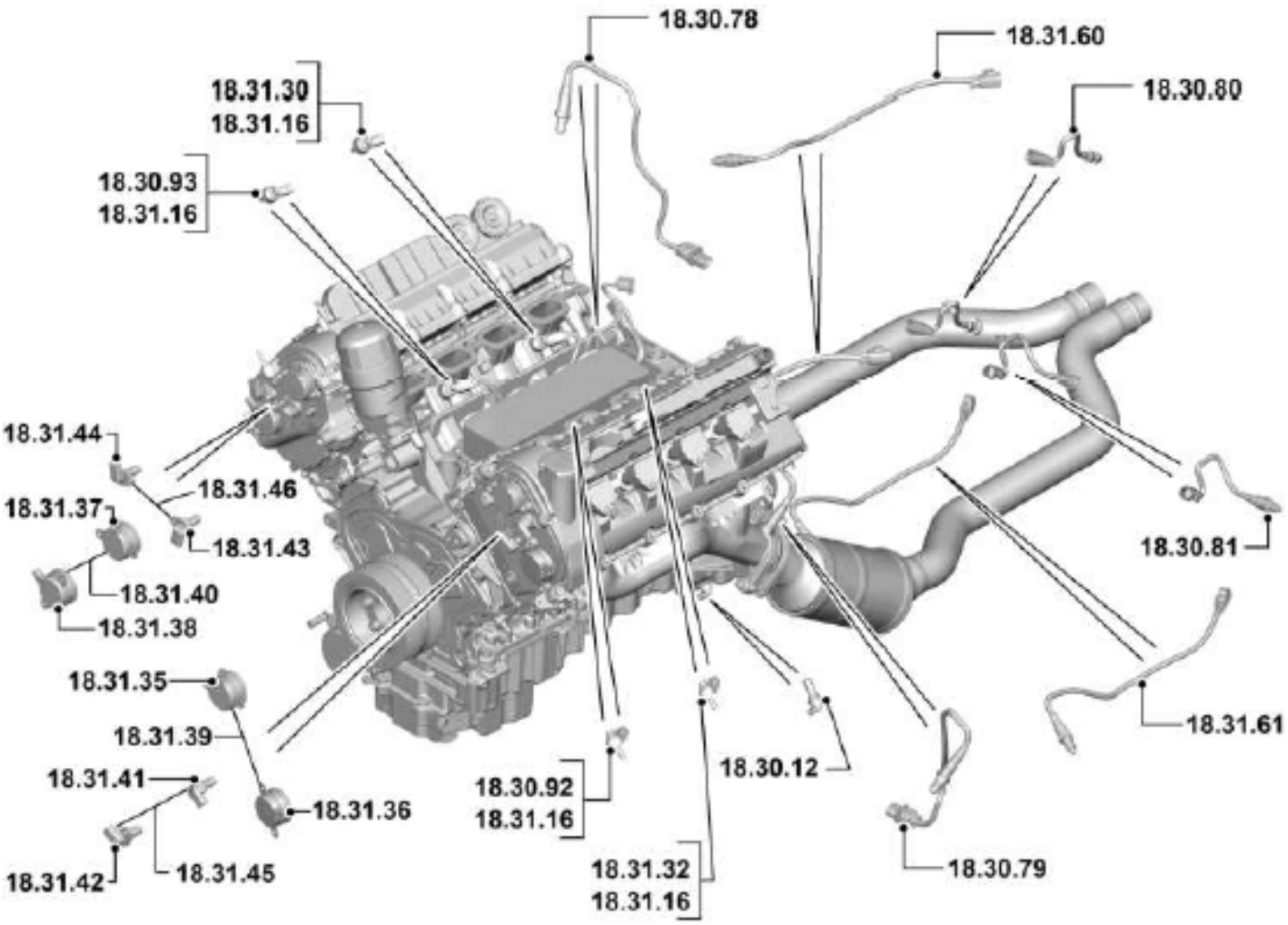
CAMSHAFT POSITION (CMP) SENSOR LH (G1917124) (2016)

18.31.11	ENGINE (CAMSHAFT) POSITION SENSOR - 'A' BANK RENEW	3000 CC, AJ V6 (AJ126)	1.3



JRT1218

18.31.41	ENGINE (INTAKE CAMSHAFT) POSITION SENSOR - B BANK - RENEW	ALL DERIVATIVES	1.3



REMOVAL

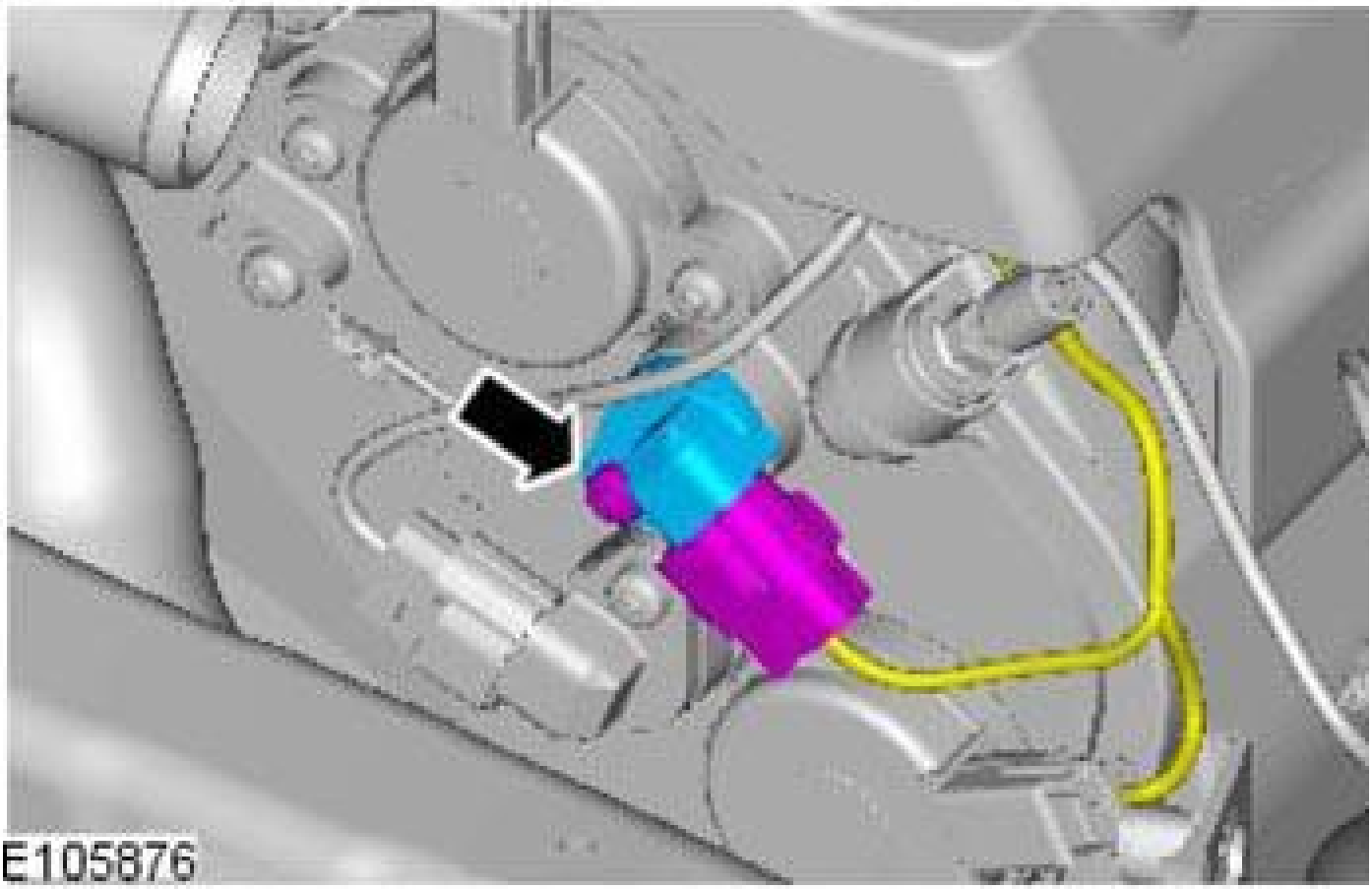
NOTE: **Removal steps in this procedure may contain installation details.**

1. WARNING: **Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.**

   Raise and support the vehicle.

2. Refer to: Thermostat Housing (Removal and Installation).

3. **NOTE:** **Lubricate the O-ring seal with clean engine oil.**



Torque Specification: **7 Nm**

INSTALLATION

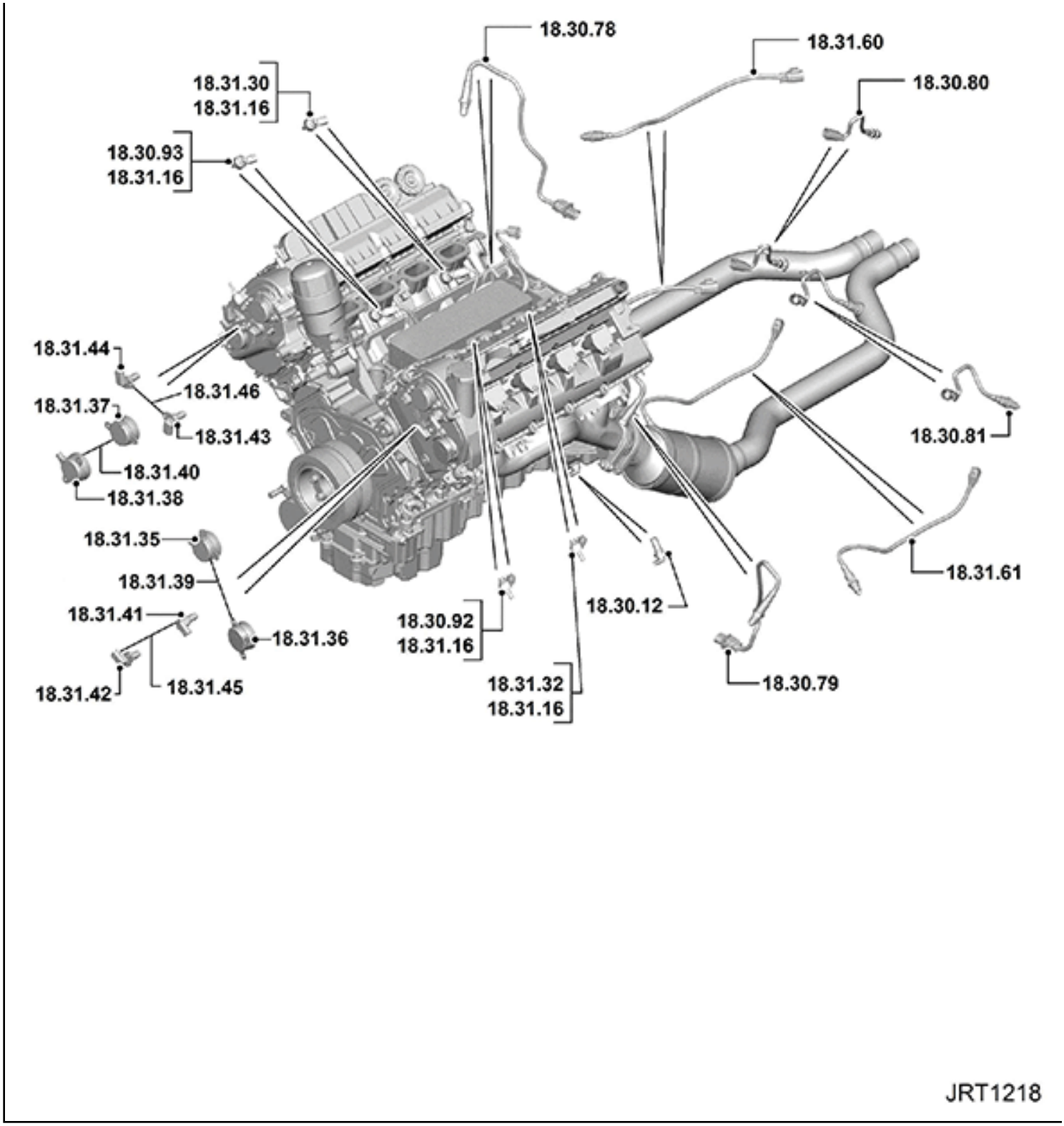
1. **CAUTION:**
   - **Make sure that the mating faces are clean and free of foreign material.**
   - **Make sure that the sensor tip is clean and free of foreign material.**

NOTE: **Lubricate the O-ring seal with clean engine oil.**

To install, reverse the removal procedure.

LEFT CAMSHAFT POSITION SENSOR

18.31.41	ENGINE (INTAKE CAMSHAFT) POSITION SENSOR - B BANK - RENEW	All Derivatives	1.3	USED WITHINS	+



REMOVAL

WARNING: **Be prepared to collect escaping coolant.**

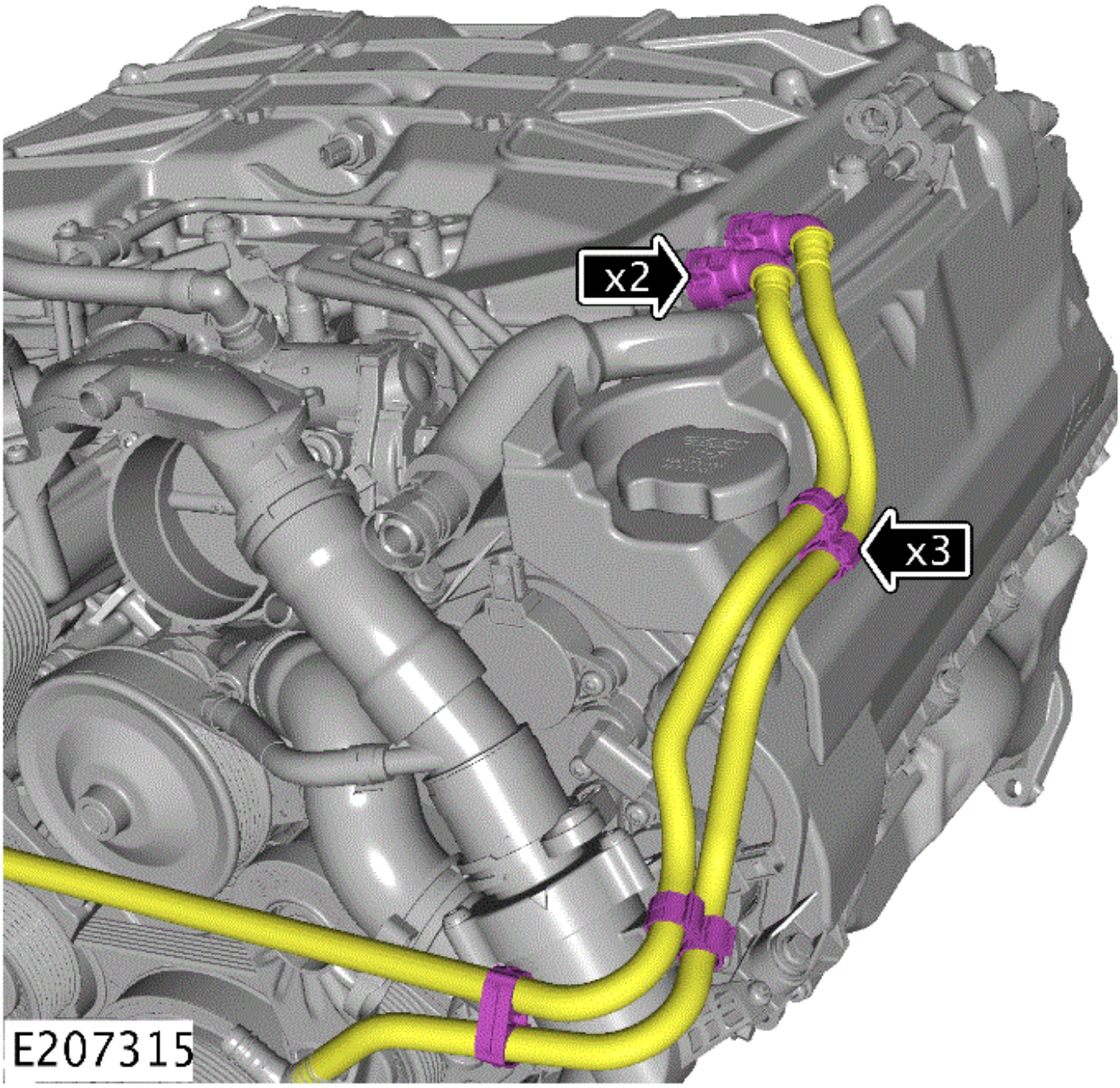
NOTE:

- **This procedure contains some variation in the illustrations depending on the vehicle specification, but the essential informatio always correct.**
- **This procedure contains illustrations showing certain components removed to provide extra clarity.**

1. Raise and support the vehicle on a suitable 2 post lift. Refer to: **Jacking & Lifting** (Description and Operation).
2. Remove the hood. Refer to: **Hood (G1580216)** (Removal and Installation).
3. Remove the engine cover. Refer to: **Engine Cover (G1580231)** (Removal and Installation).
4. Partially drain the cooling system. Refer to: **Cooling System Partial Draining And Vacuum Filling (G1816921)** (General Procedures).

5. Remove the left air cleaner outlet intermediate pipe. Refer to: **Air Cleaner Outlet Intermediate Pipe LH (G1581640)** (Removal and Installation).

6.

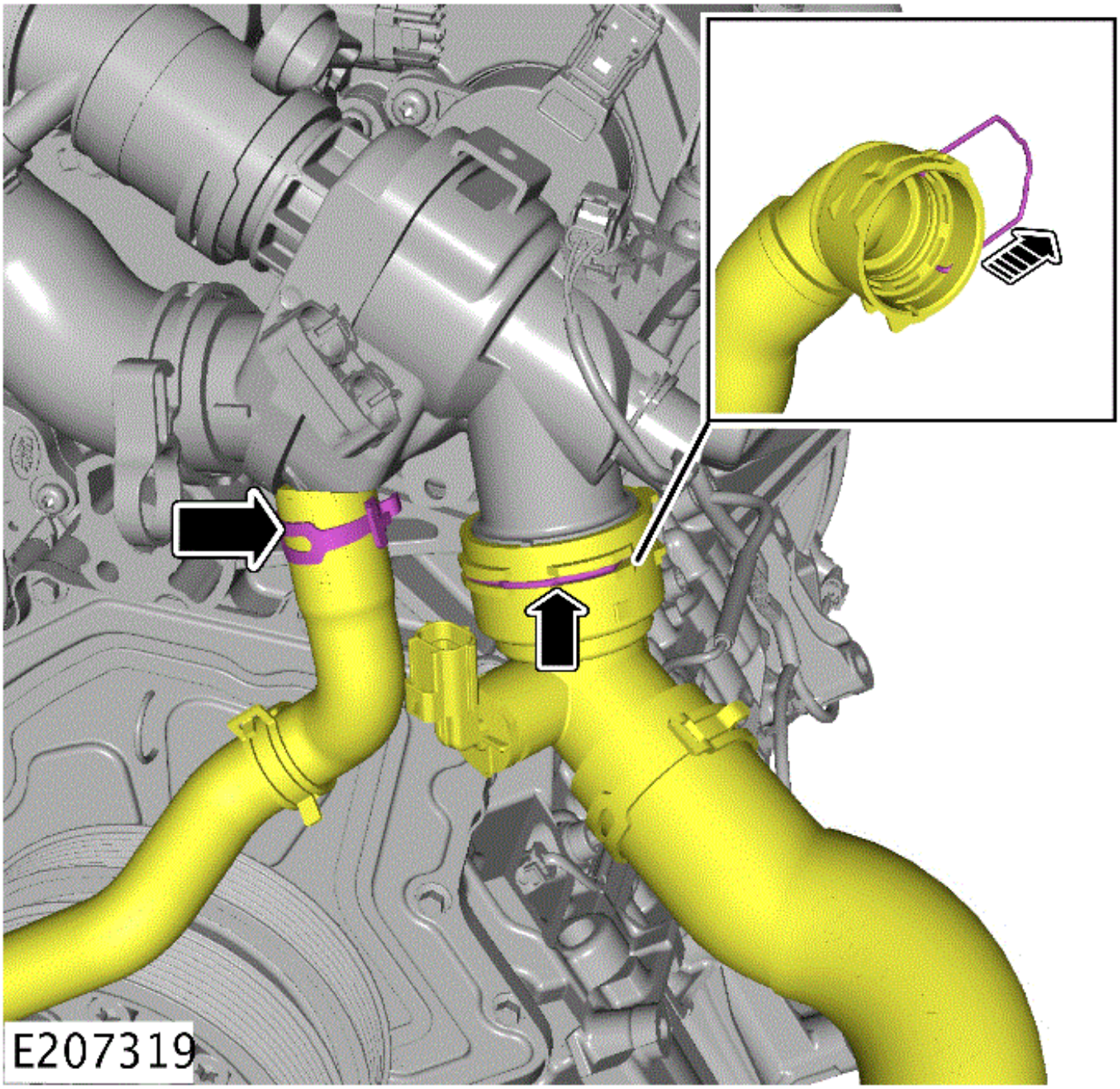


- Disconnect the 2 left supercharger coolant pipes.
- Release the 3 retaining clips.

7. G00567704

- Disconnect the Engine Coolant Temperature (ECT) sensor electrical connector.
- Release the 2 retaining clips.

8.



- Release the 2 retaining clips.
- Reposition the 2 thermostat coolant hoses away from the thermostat.

9. G00567705

- Release the 2 coolant hose retaining clips.
- Remove the thermostat retaining bolt.
- Remove the thermostat.

10. G00567706

- Disconnect the 2 Camshaft Position (CMP) sensor electrical connectors.
- Remove the 2 CMP retaining bolts.
- Remove the 2 CMP Sensors.

INSTALLATION

1.

- Install the 2 Camshaft Position (CMP) Sensors.

- Install the 2 CMP retaining bolts.

  Torque Specification: 10 Nm

- Connect the 2 CMP sensor electrical connectors.

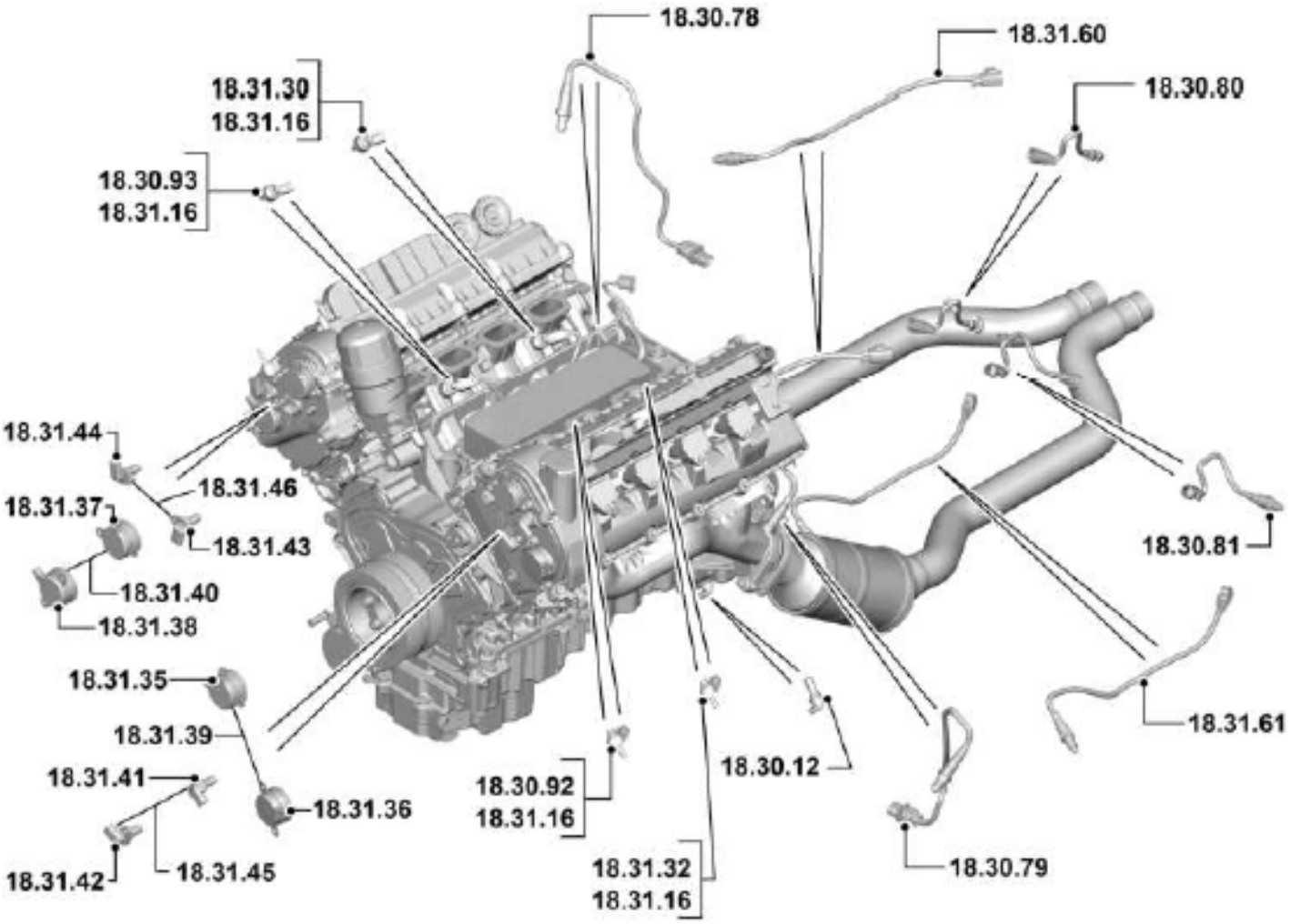
2.
   - Install the thermostat.
   - Install the thermostat retaining bolt.

     Torque Specification: 10 Nm

   - Secure the 2 coolant hose retaining clips.
3. Secure the 2 thermostat coolant hose retaining clips.
4.
   - Connect the Engine Coolant Temperature (ECT) sensor electrical connector.
   - Secure the 2 retaining clips.
5.
   - Connect the 2 left supercharger coolant pipes.
   - Secure the 3 retaining clips.
6. Install the left air cleaner outlet intermediate pipe. Refer to: **Air Cleaner Outlet Intermediate Pipe LH (G1581640)** (Removal and Installation).
7. Vacuum fill the cooling system. Refer to: **Cooling System Partial Draining And Vacuum Filling (G1816921)** (General Procedures).
8. Install the engine cover. Refer to: **Engine Cover (G1580231)** (Removal and Installation).
9. Install the hood. Refer to: **Hood (G1580216)** (Removal and Installation).

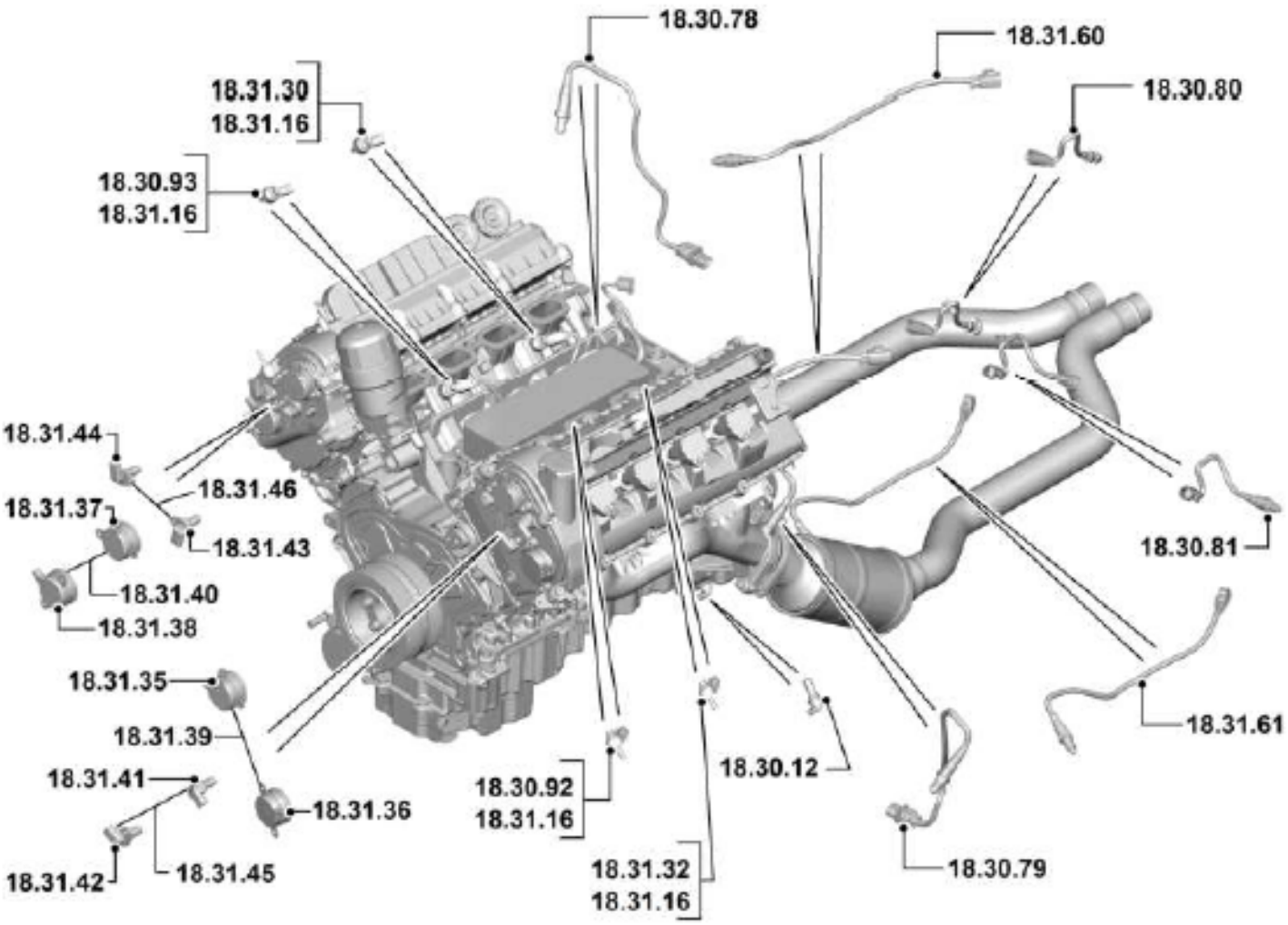
CAMSHAFT POSITION (CMP) SENSOR RH (G1917125) (2016)

18.31.41	ENGINE (INTAKE CAMSHAFT) POSITION SENSOR - B BANK - RENEW	ALL DERIVATIVES	1.3



JRT1218

18.31.42	ENGINE (EXHAUST CAMSHAFT) POSITION SENSOR - B BANK - RENEW	ALL DERIVATIVES	1.3



REMOVAL

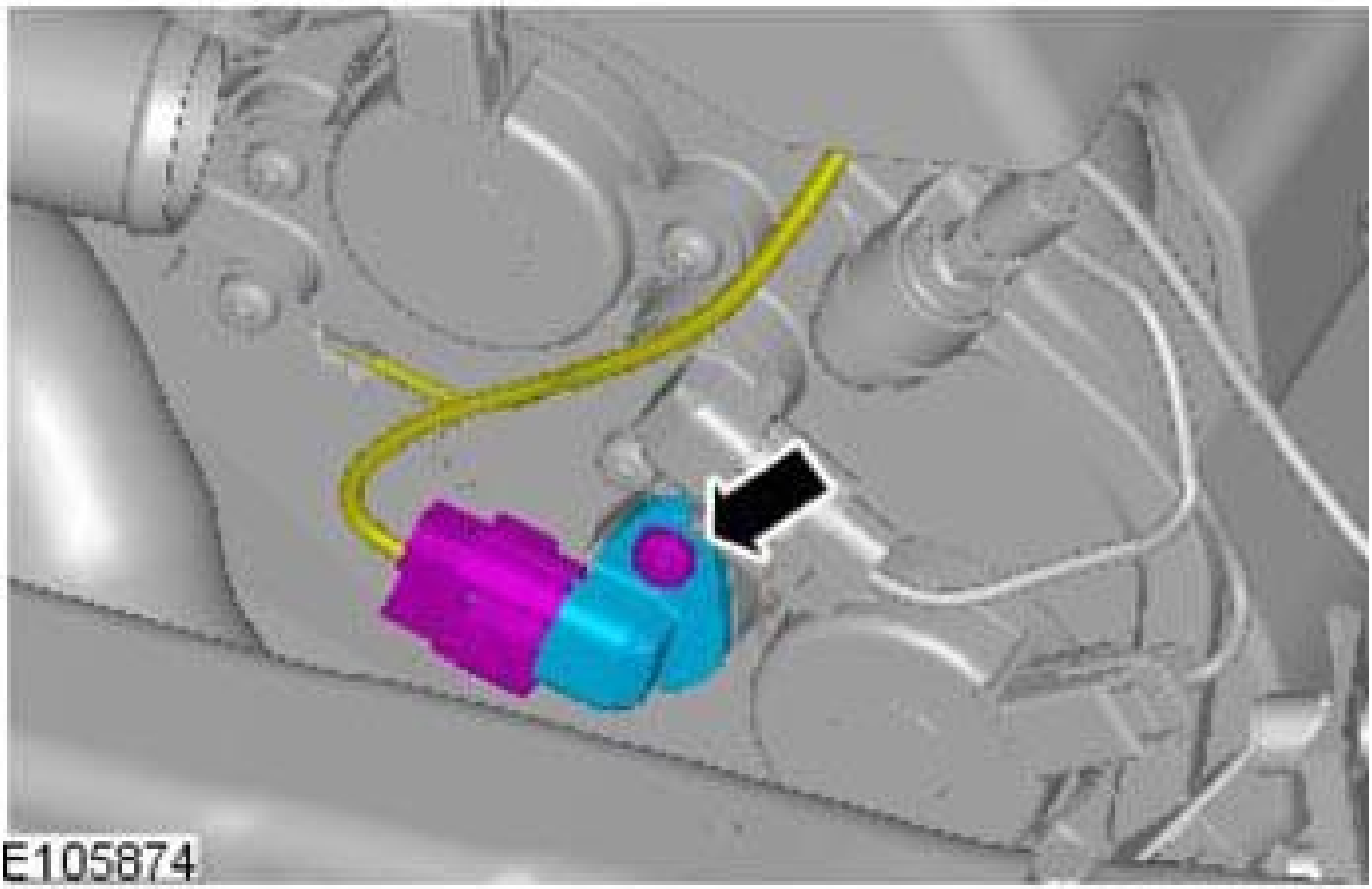
NOTE: **Removal steps in this procedure may contain installation details.**

1. WARNING: **Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.**

   Raise and support the vehicle.

2. Refer to: **Thermostat Housing** (Removal and Installation).

3.



Torque Specification: **7 Nm**

INSTALLATION

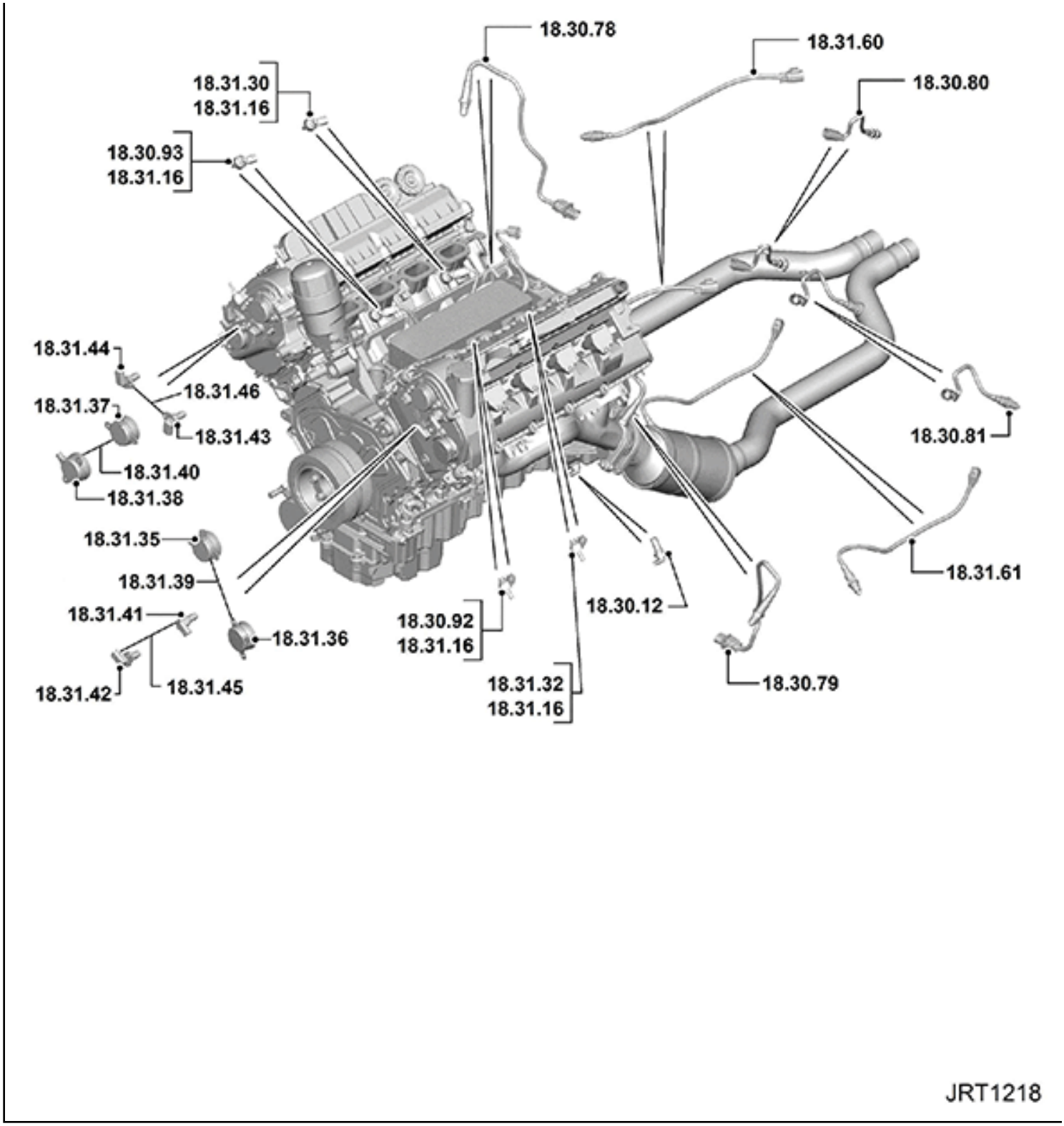
1. **CAUTION:**
   - **Make sure that the mating faces are clean and free of foreign material.**
   - **Make sure that the sensor tip is clean and free of foreign material.**

   NOTE: **Lubricate the O-ring seal with clean engine oil.**

   To install, reverse the removal procedure.

RIGHT CAMSHAFT POSITION SENSOR (G1917125)

18.31.42	ENGINE (EXHAUST CAMSHAFT) POSITION SENSOR - B BANK - RENEW	All Derivatives	1.3	USED WITHINS	+



REMOVAL

WARNING: **Be prepared to collect escaping coolant.**

NOTE:

- **This procedure contains some variation in the illustrations depending on the vehicle specification, but the essential informatio always correct.**
- **This procedure contains illustrations showing certain components removed to provide extra clarity.**

1. Raise and support the vehicle on a suitable 2 post lift. Refer to: **Jacking & Lifting** (Description and Operation).
2. Remove the hood. Refer to: **Hood (G1580216)** (Removal and Installation).
3. Remove the engine cover. Refer to: **Engine Cover (G1580231)** (Removal and Installation).
4. Partially drain the cooling system. Refer to: **Cooling System Partial Draining And Vacuum Filling (G1816921)** (General Procedures).

5. Remove the right air cleaner outlet intermediate pipe. Refer to: **Air Cleaner Outlet Intermediate Pipe RH (G1581641)** (Removal and Installation).
6. G00567679

   - Disconnect the 2 right supercharger coolant hoses.
   - Release the 2 retaining clips.
7. Release the coolant hose.

   G00567680
8. G00567681

   - Disconnect the 2 Camshaft Position (CMP) sensor electrical connectors.
   - Remove the 2 CMP retaining bolts.
   - Remove the 2 CMP sensors.

INSTALLATION

1.
   - Install the 2 Camshaft Position (CMP) sensors.
   - Install the 2 CMP retaining bolts.

     Torque Specification: 10 Nm
   - Connect the 2 CMP sensor electrical connectors.
2. Secure the coolant hose.
3.
   - Connect the 2 right supercharger coolant hoses.
   - Secure the 2 retaining clips.
4. Install the right air cleaner outlet intermediate pipe. Refer to: **Air Cleaner Outlet Intermediate Pipe RH (G1581641)** (Removal and Installation).
5. Vacuum fill the cooling system. Refer to: **Cooling System Partial Draining And Vacuum Filling (G1816921)** (General Procedures).
6. Install the engine cover. Refer to: **Engine Cover (G1580231)** (Removal and Installation).
7. Install the hood. Refer to: **Hood (G1580216)** (Removal and Installation).

CRANKSHAFT POSITION (CKP) SENSOR (G1917126) (2016)

18.30.10	COOLANT TEMPERATURE SENSOR - RENEW	ALL DERIVATIVES	1.7

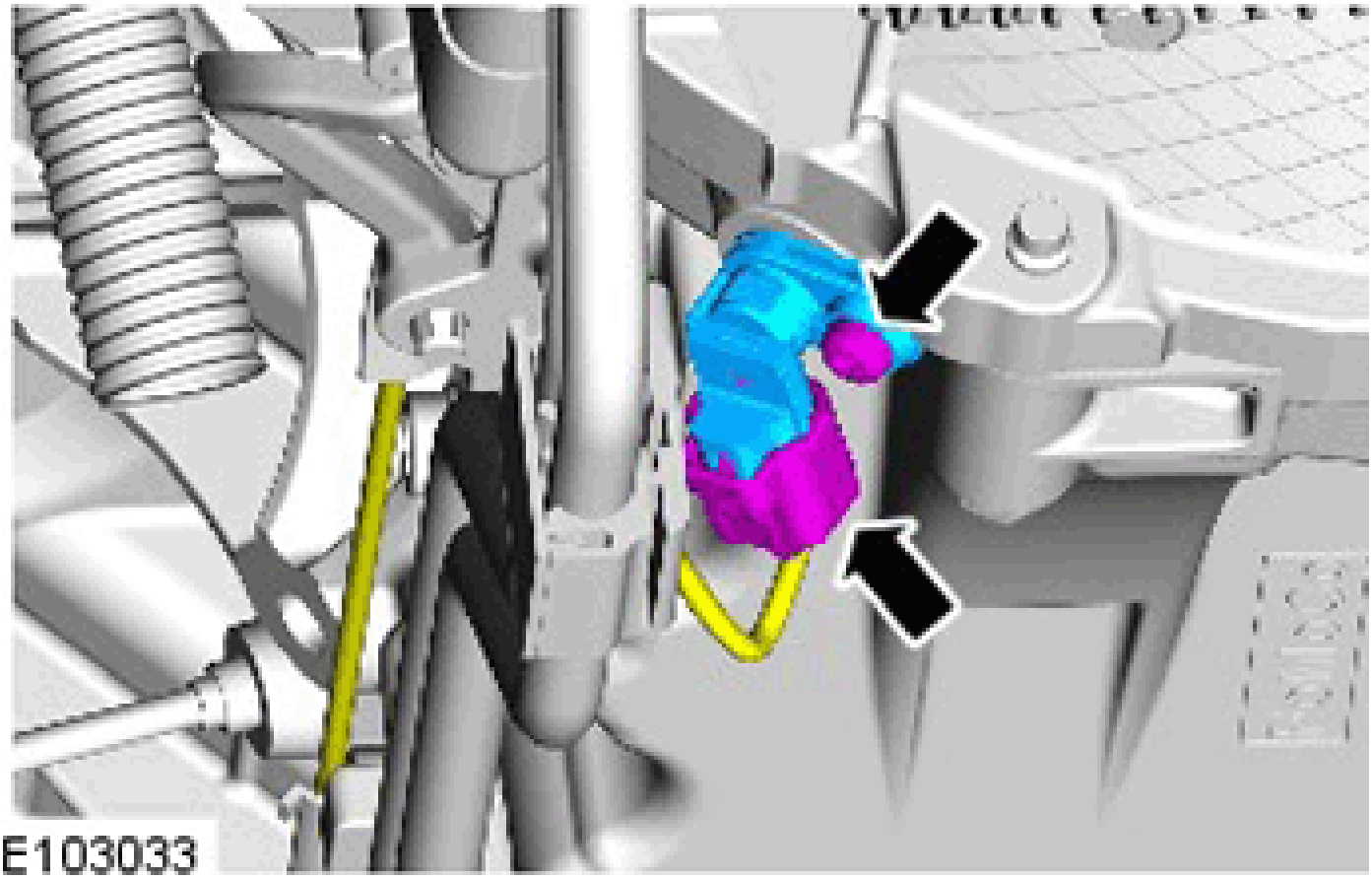
18.30.12	CRANKSHAFT POSITION SENSOR - RENEW	ALL DERIVATIVES	0.2

REMOVAL

NOTE: **Removal steps in this procedure may contain installation details.**

1. WARNING: **Make sure to support the vehicle with axle stands.**

   Raise and support the vehicle.
2. Refer to: **Air Deflector** (Removal and Installation).
3. **NOTE:** **Clean the components general area prior to dismantling.**



- *Torque Specification:* **10 Nm**

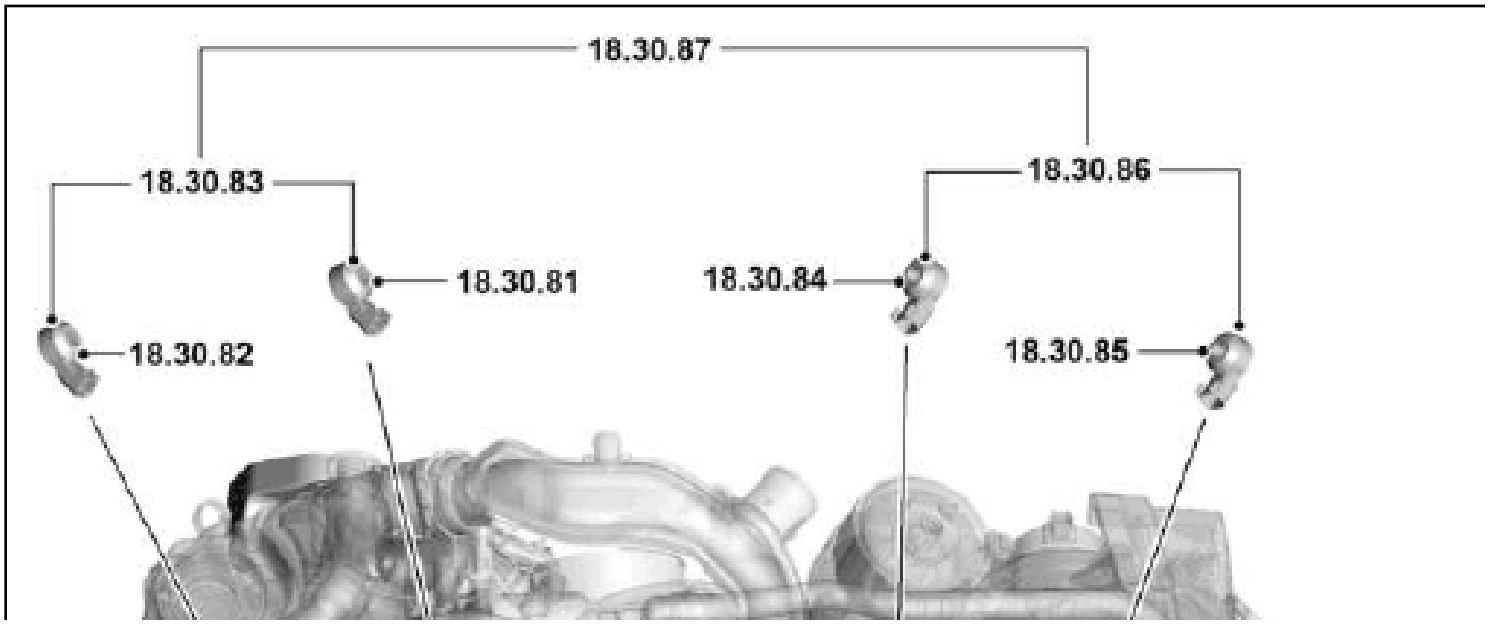
INSTALLATION

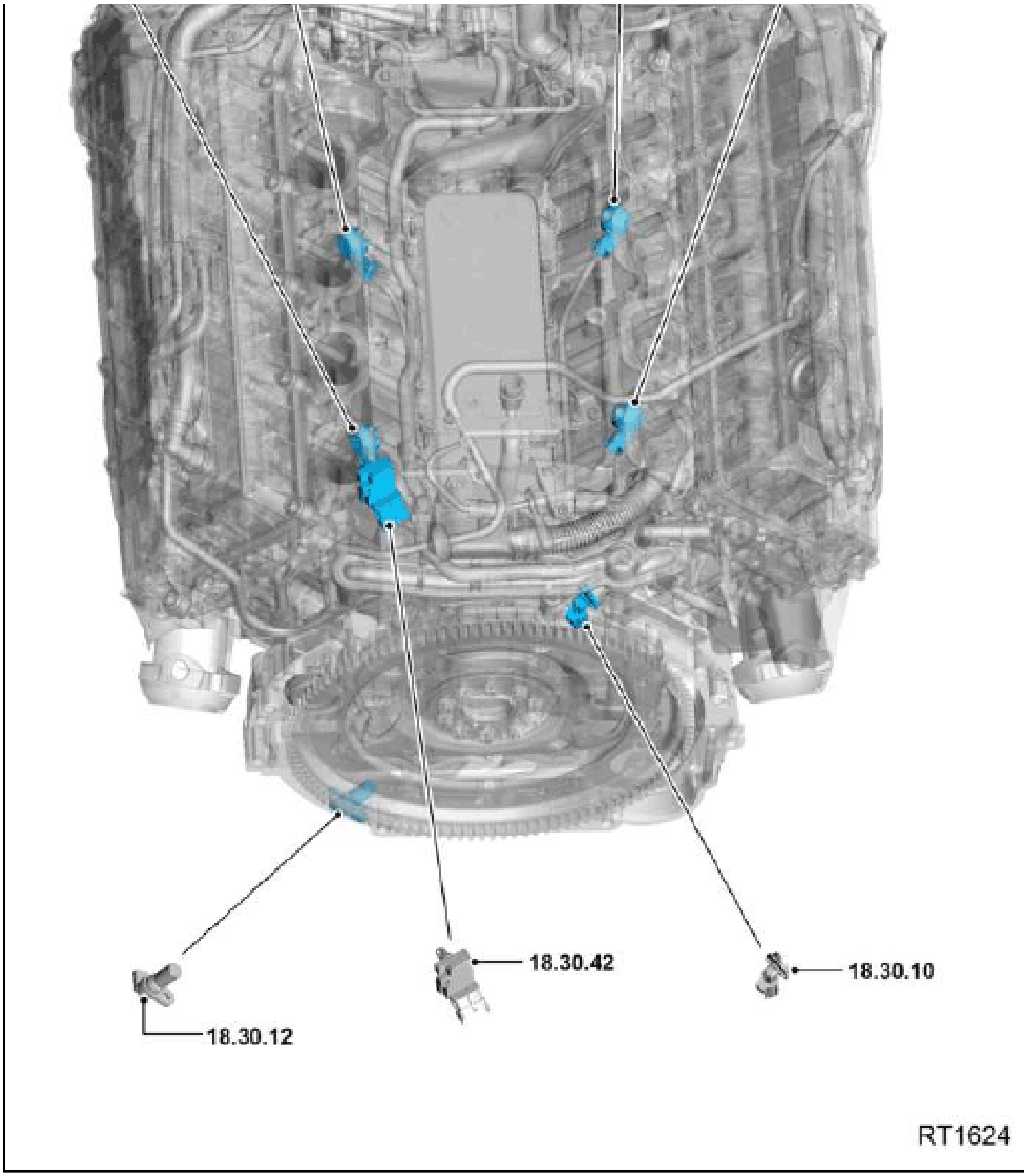
1. **CAUTION:**
   - **Make sure that the mating faces are clean and free of foreign material.**
   - **Make sure that the component is clean, free of foreign material and lubricant.**

To install, reverse the removal procedure.

ENGINE COOLANT TEMPERATURE (ECT) SENSOR (G1917127)

18.30.10	COOLANT TEMPERATURE SENSOR - RENEW	ALL DERIVATIVES	1.7





REMOVAL

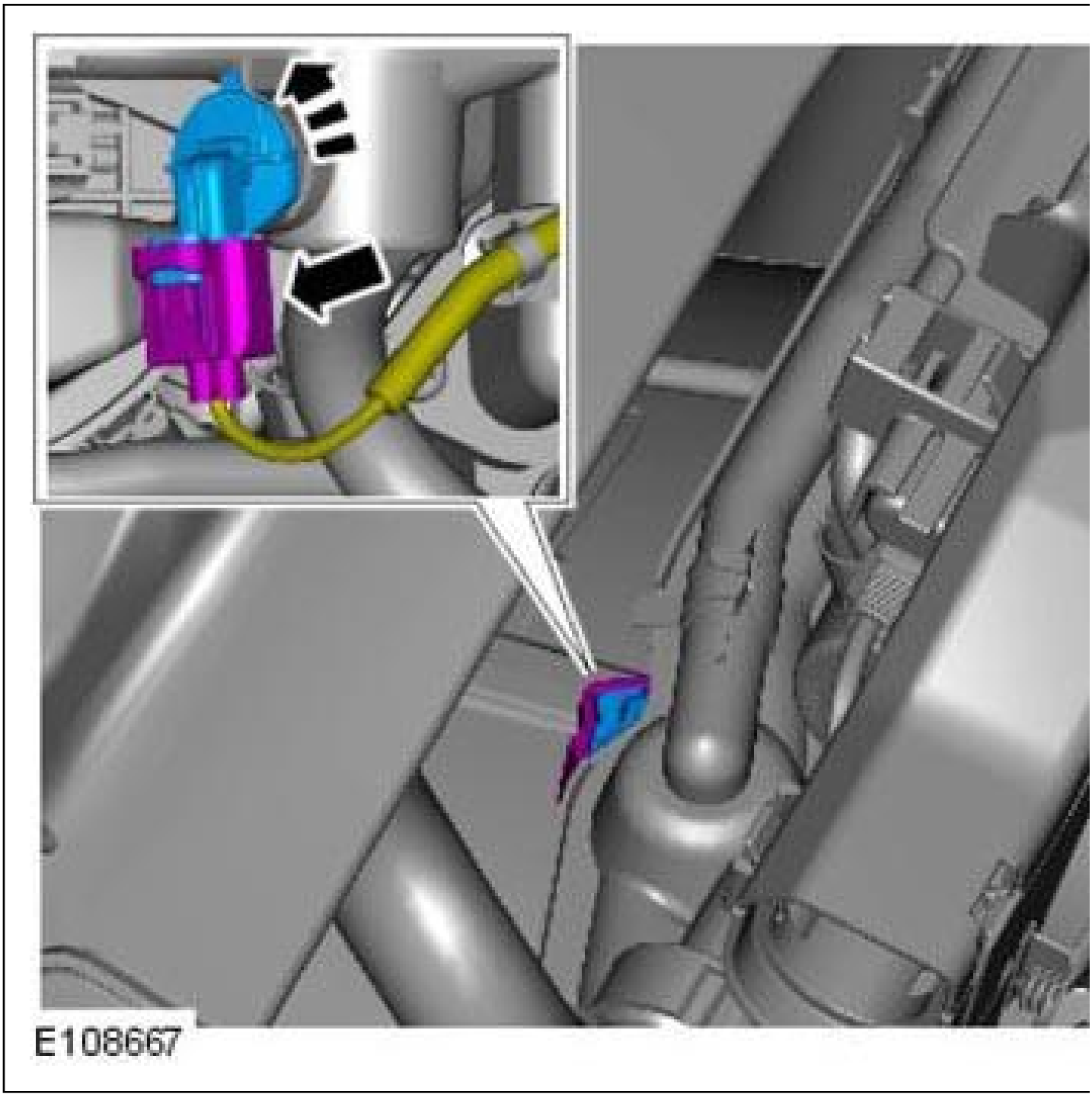
NOTE:

- **Removal steps in this procedure may contain installation details.**
- **Some variation in the illustrations may occur, but the essential information is always correct.**

1. Raise and support the vehicle.

WARNING: **Make sure to support the vehicle with axle stands.**

2. Refer to: **Engine Cover** (Removal and Installation).
3. Refer to: **Cooling System Partial Draining and Vacuum Filling** (General Procedures).
4. Refer to: **Secondary Bulkhead Panel LH** (Removal and Installation).
5. **NOTE:** **Some variation in the illustrations may occur, but the essential information is always correct.**

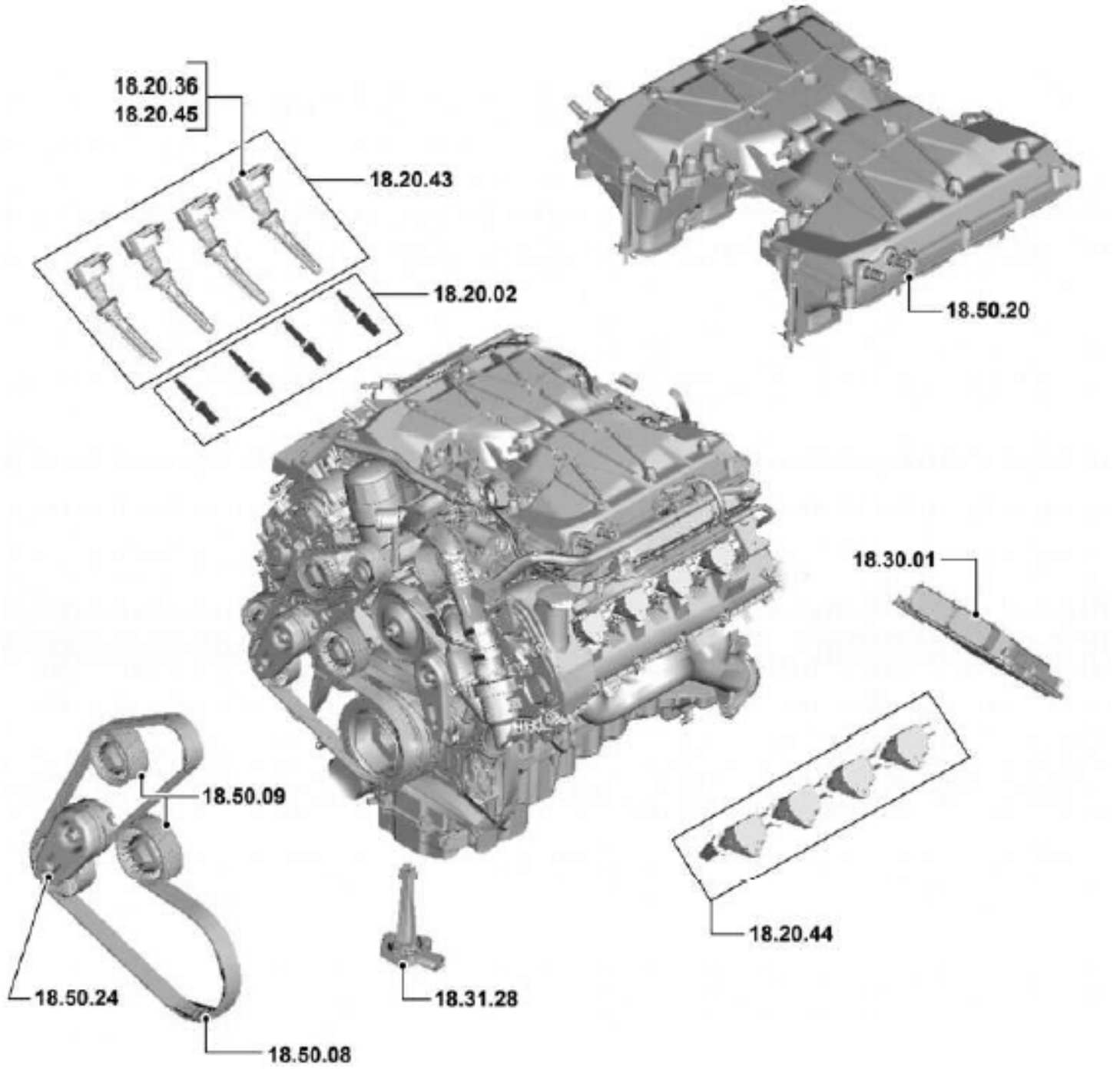


INSTALLATION

1. To install, reverse the removal procedure.

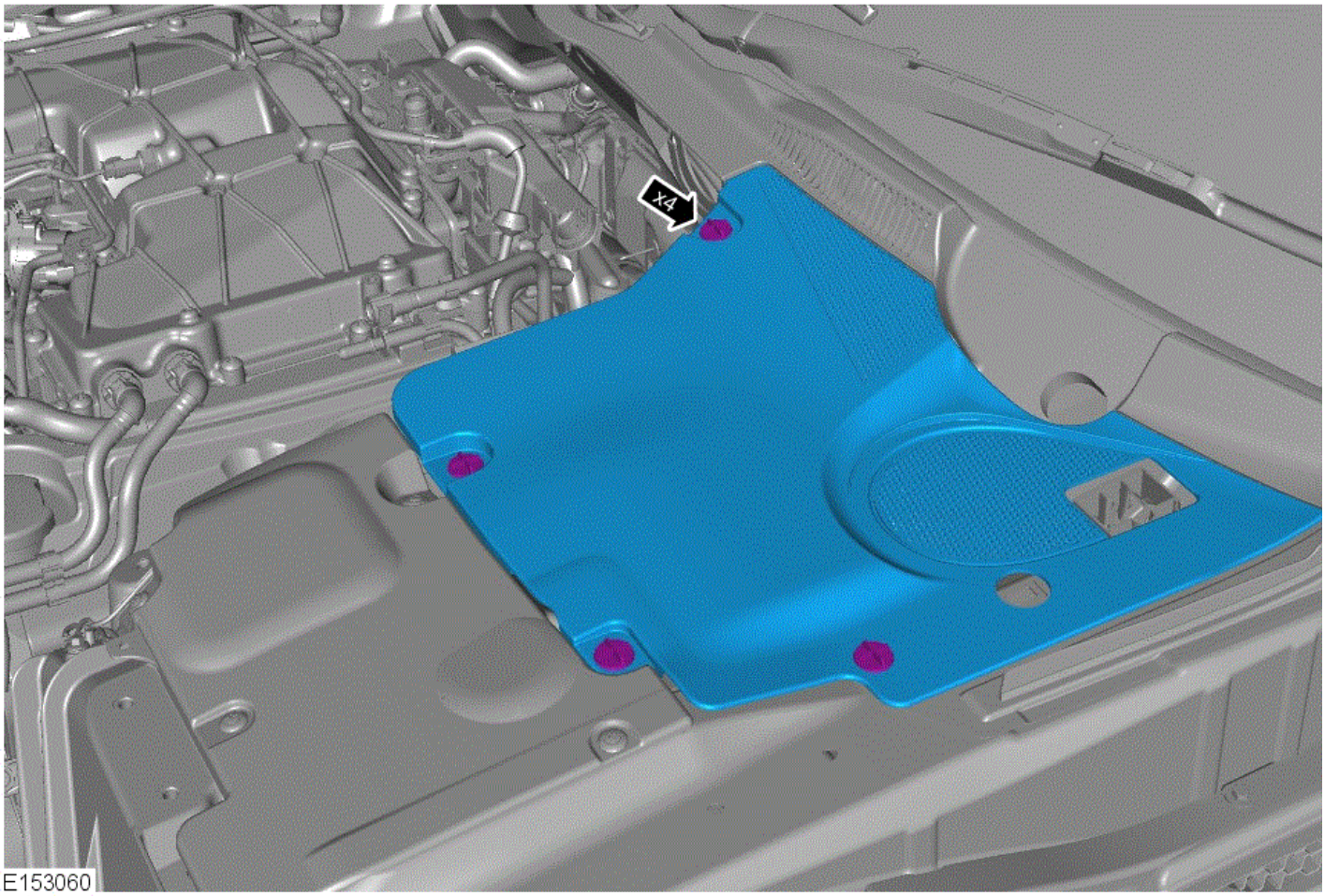
ENGINE CONTROL MODULE (G1580388)

18.30.01	Control Module - Combined Ignition And Injection - Renew	All Derivatives	0.4	USED WITHINS	+

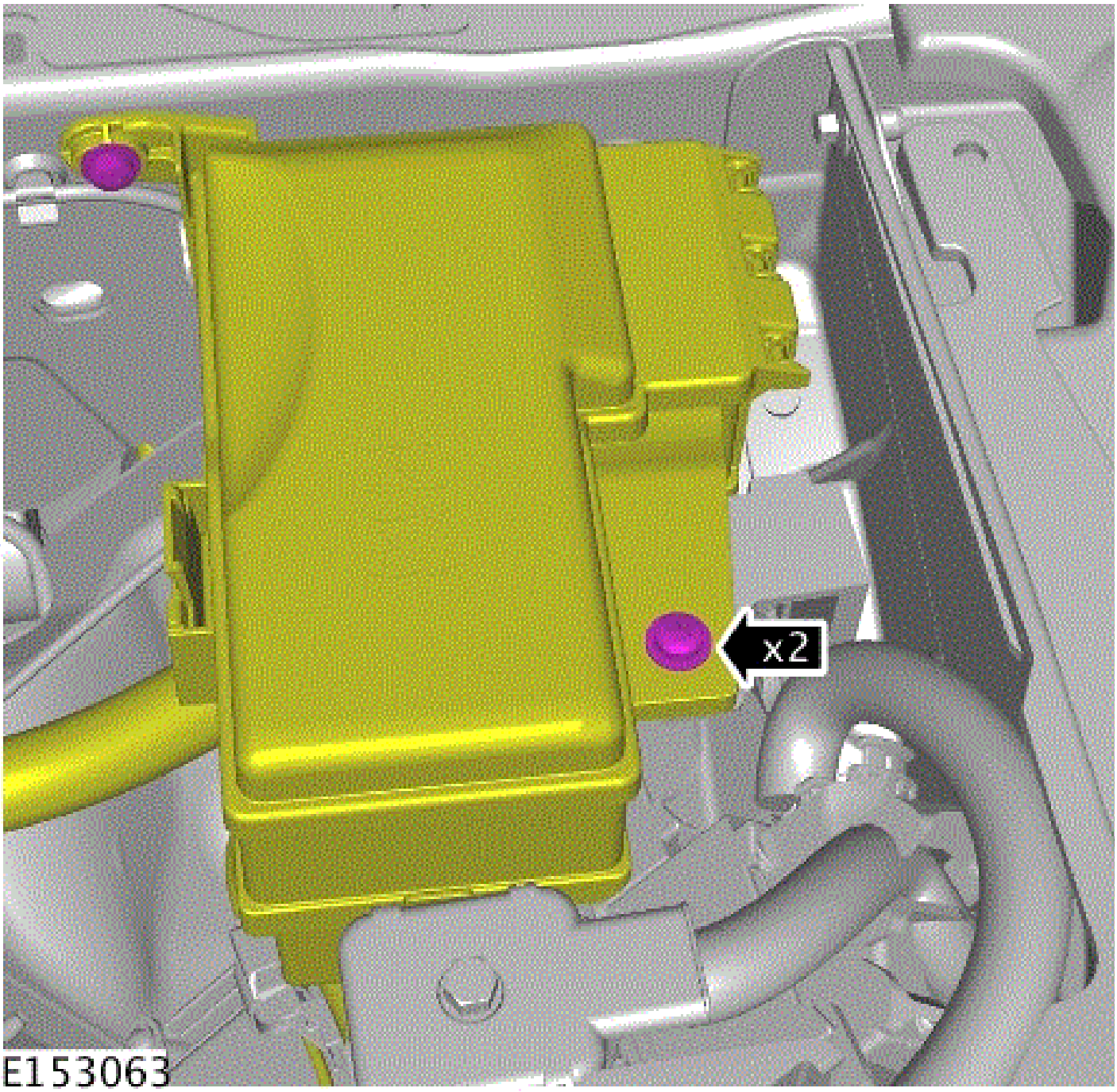


REMOVAL

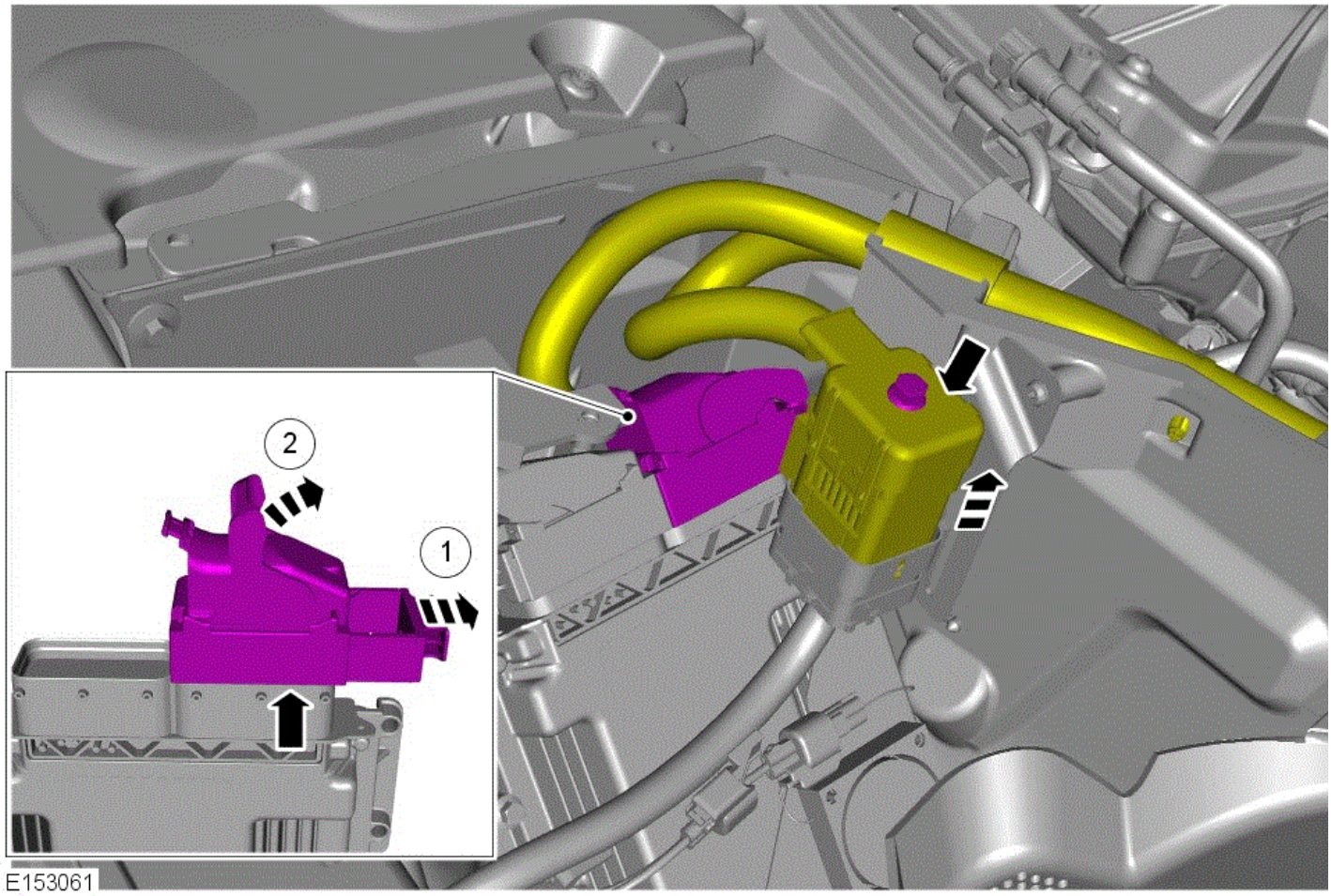
1. Refer to: **Battery Disconnect And Connect (G1920963)** (General Procedures).
2.



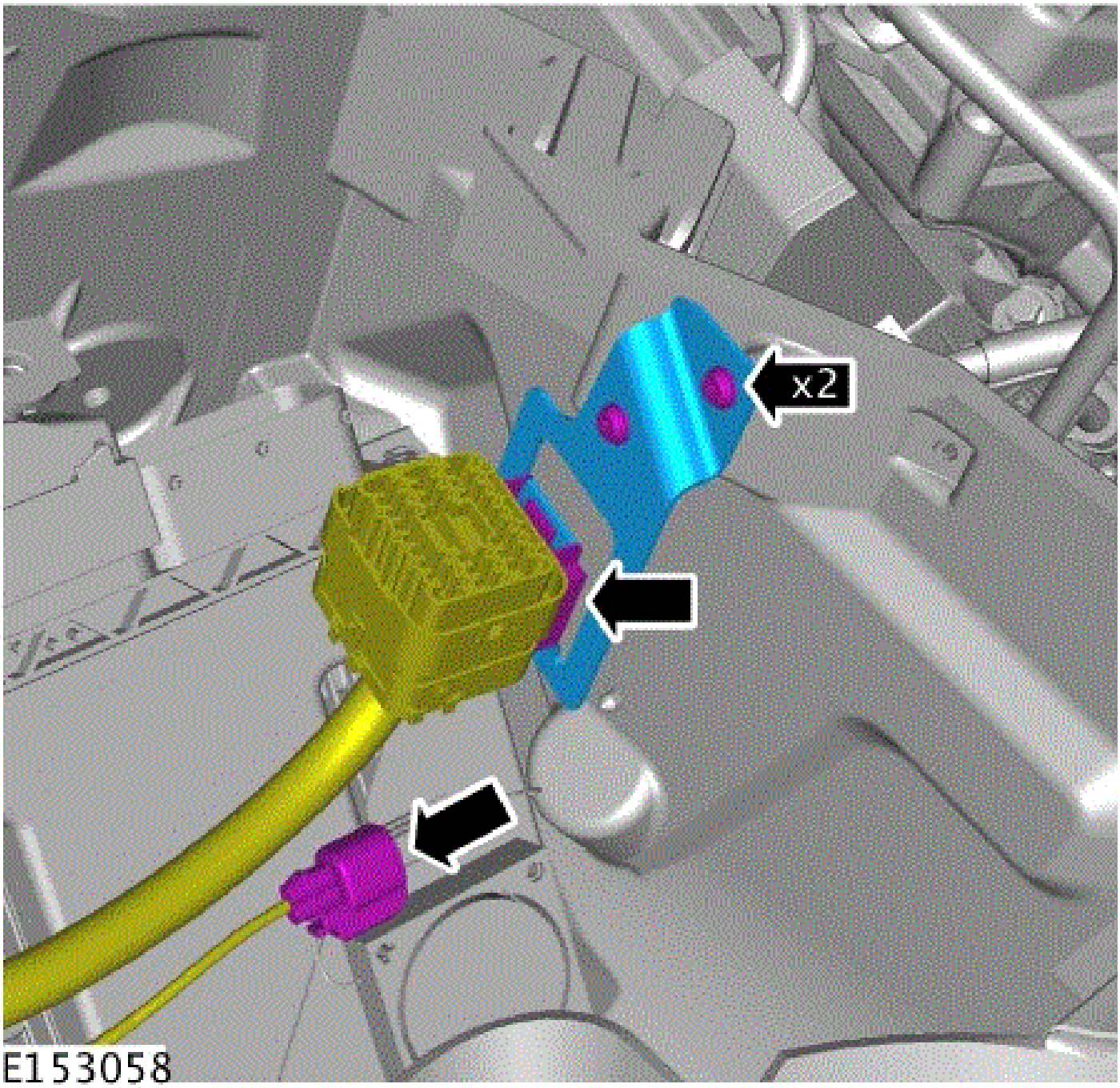
3. **Torque Specification: 10 Nm**



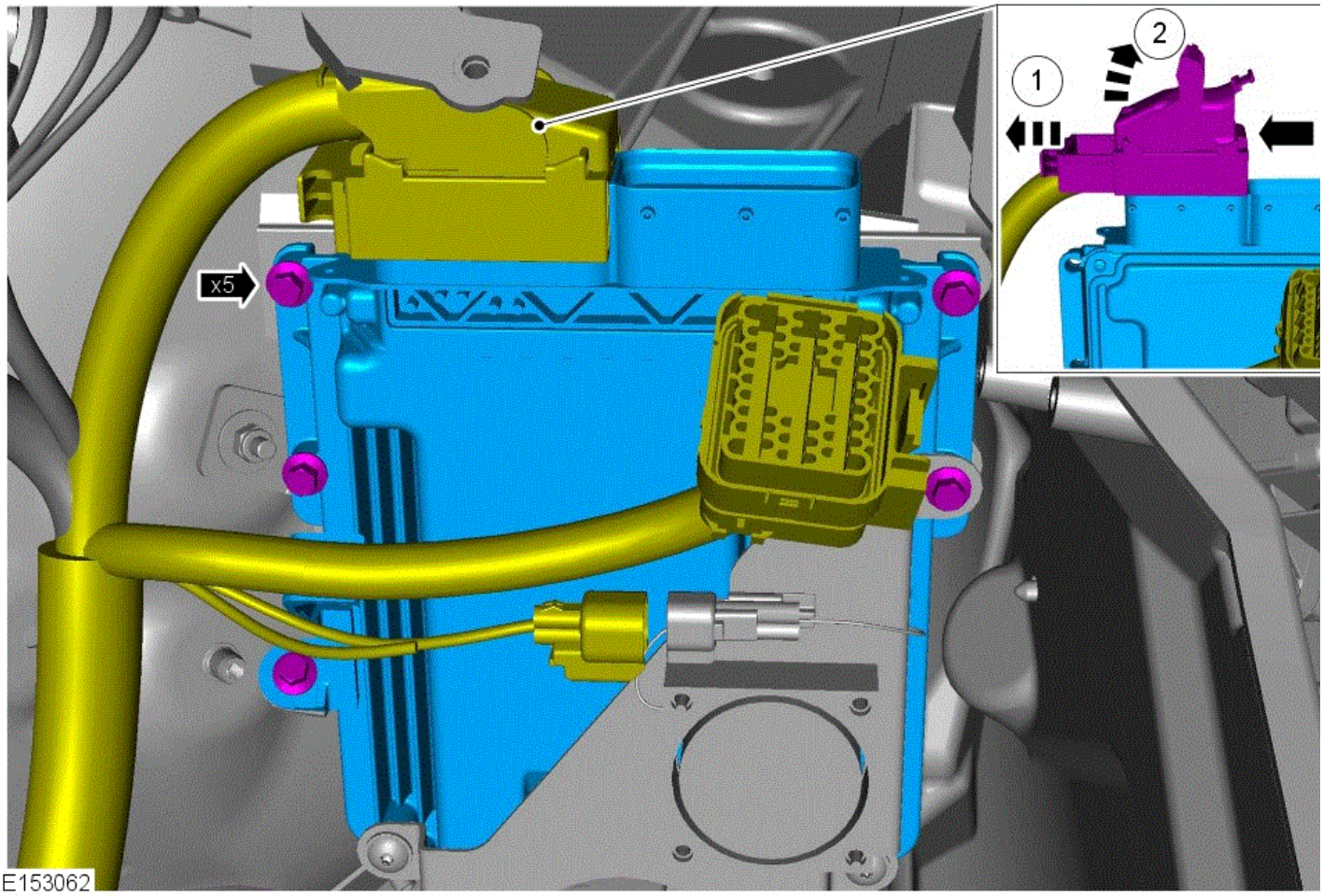
4. **Torque Specification: 10 Nm**



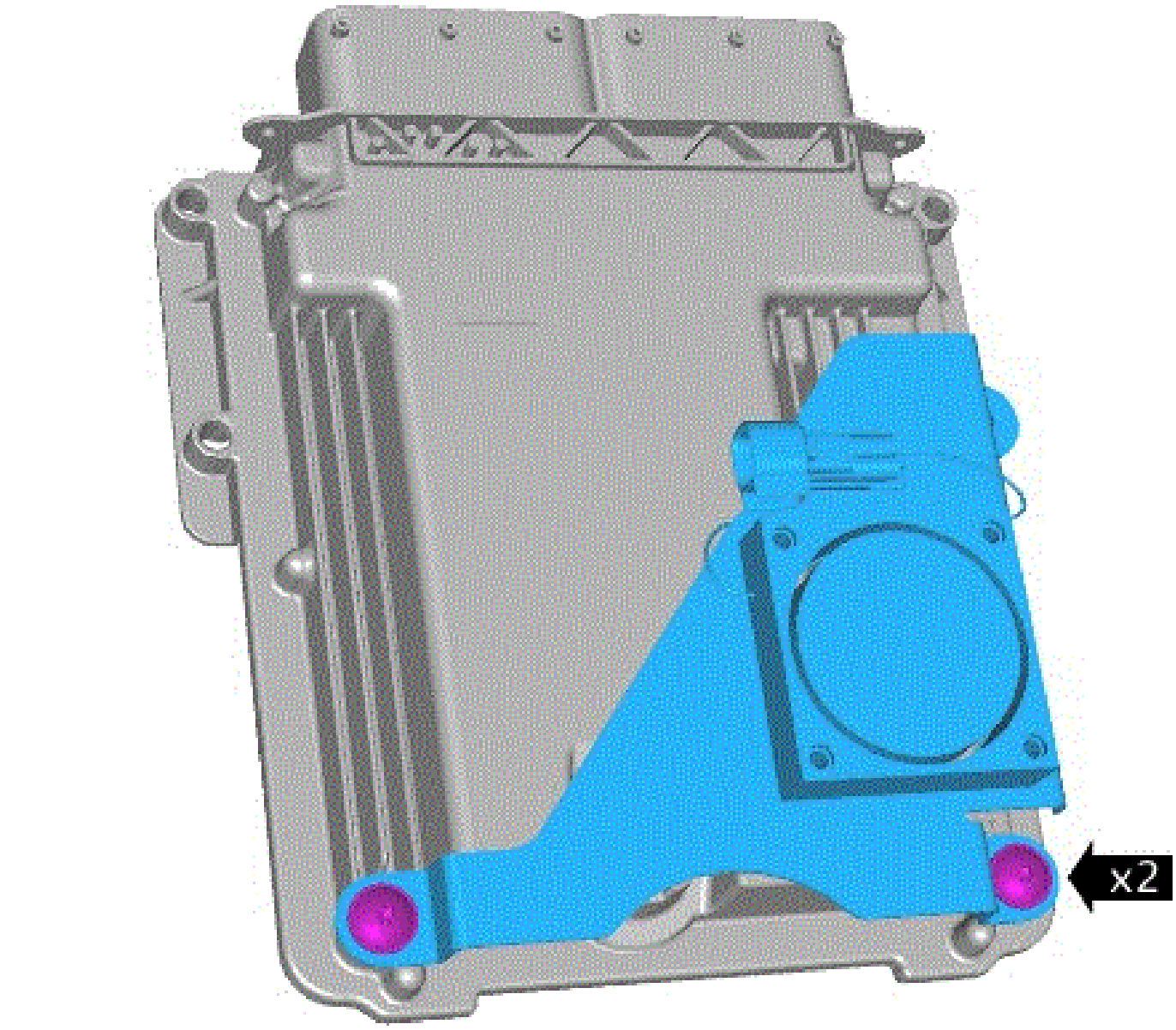
5. **Torque Specification: 6 Nm**



6. **Torque Specification: 9 Nm**



7. **Torque Specification: 7 Nm**

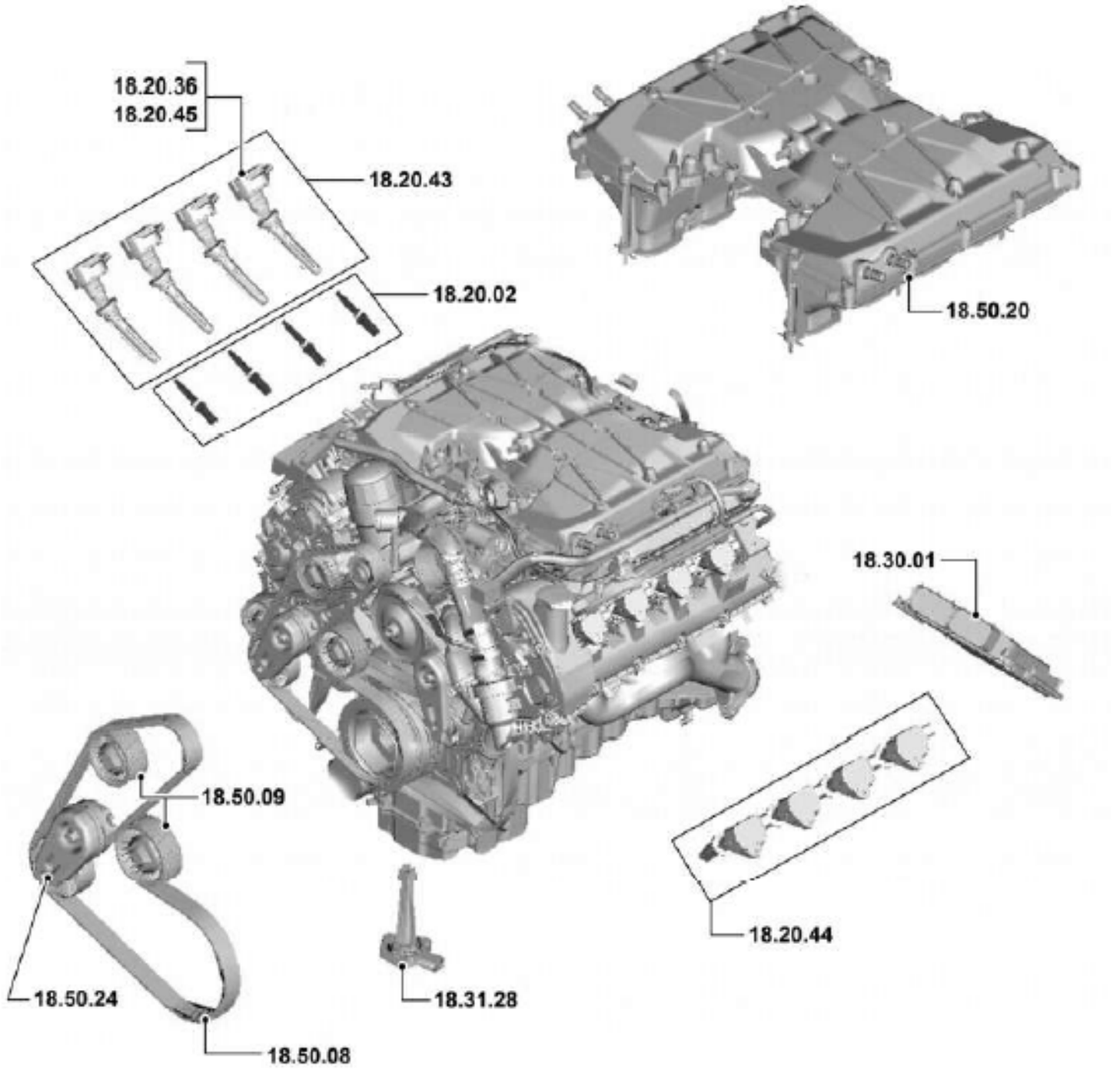


INSTALLATIOIN

1. To install, reverse the removal procedure.
2. Configure the engine control module (ECM) using the diagnostic tool.

ENGINE OIL LEVEL SENSOR (G1917108)

18.31.28	Engine Oil Level Sensor - Renew	All Derivatives	0.7	USED WITHEN	+



STEP	PART NAME	QUANTITY
Installation Step 1	Oil level gauge O-ring seal	1

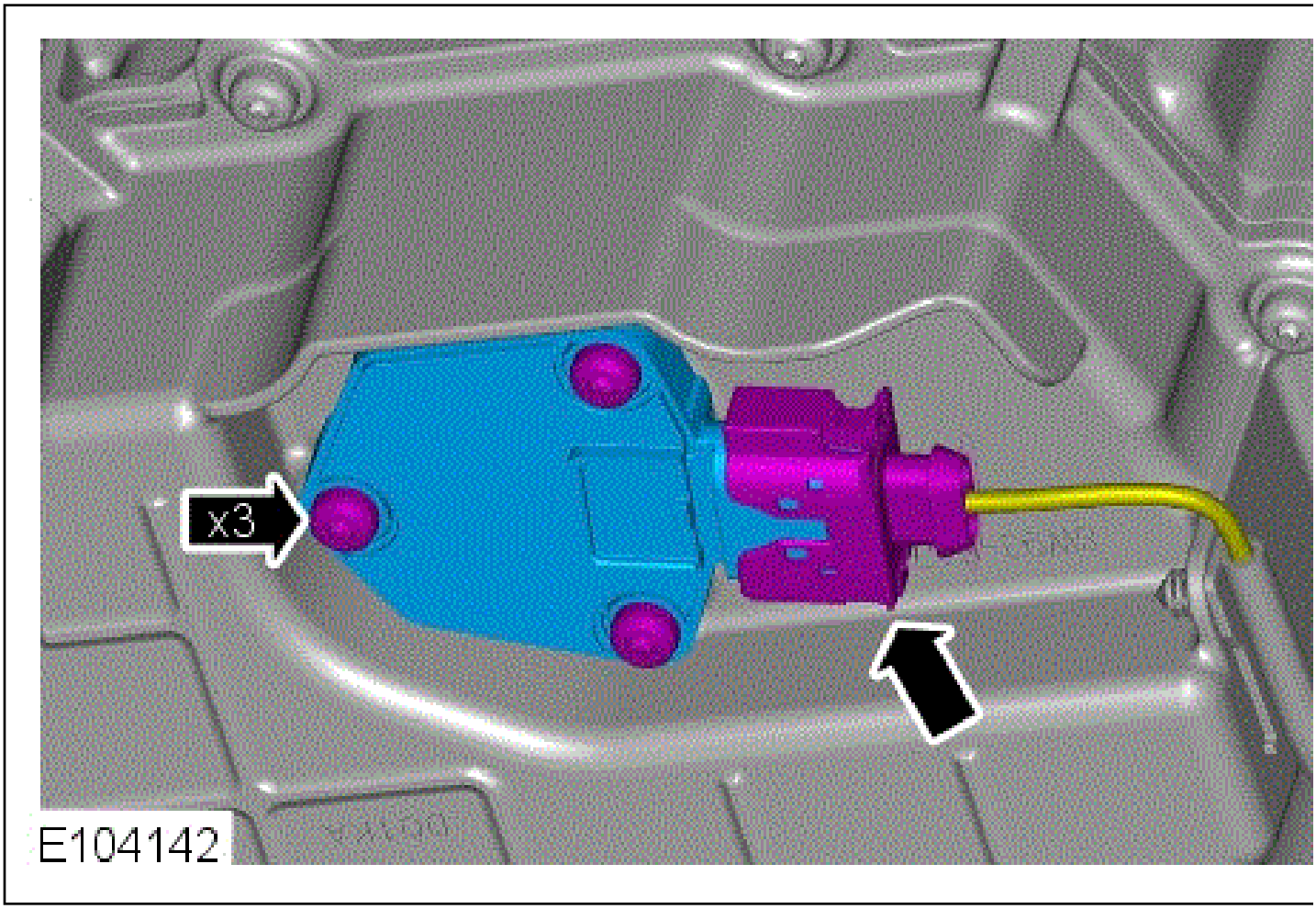
REMOVAL

WARNING: **Be prepared to collect escaping engine oil.**

NOTE:

- **This procedure contains some variation in the illustrations depending on the vehicle specification, but the essential inforr is always correct.**
- **This procedure contains illustrations showing certain components removed to provide extra clarity.**
- **Before the disconnection or removal of any components, make sure the area around joint faces and connections are clean. Plu open connections to prevent contamination.**

1. Raise and support the vehicle on a suitable 2 post lift. Refer to: **Lifting** (Description and Operation).
2. Drain the engine oil. Refer to: **ENGINE OIL DRAINING AND FILLING (G1586896)** (General Procedures).
3. **NOTE:** **Discard the O-ring seal.**



- Disconnect the engine oil level sensor electrical connector.
- Remove the 3 retaining bolts.
- Remove the engine oil level sensor.

INSTALLATION

1. **CAUTION:** **Install a new O-ring seal.**
   - Install the engine oil level sensor.

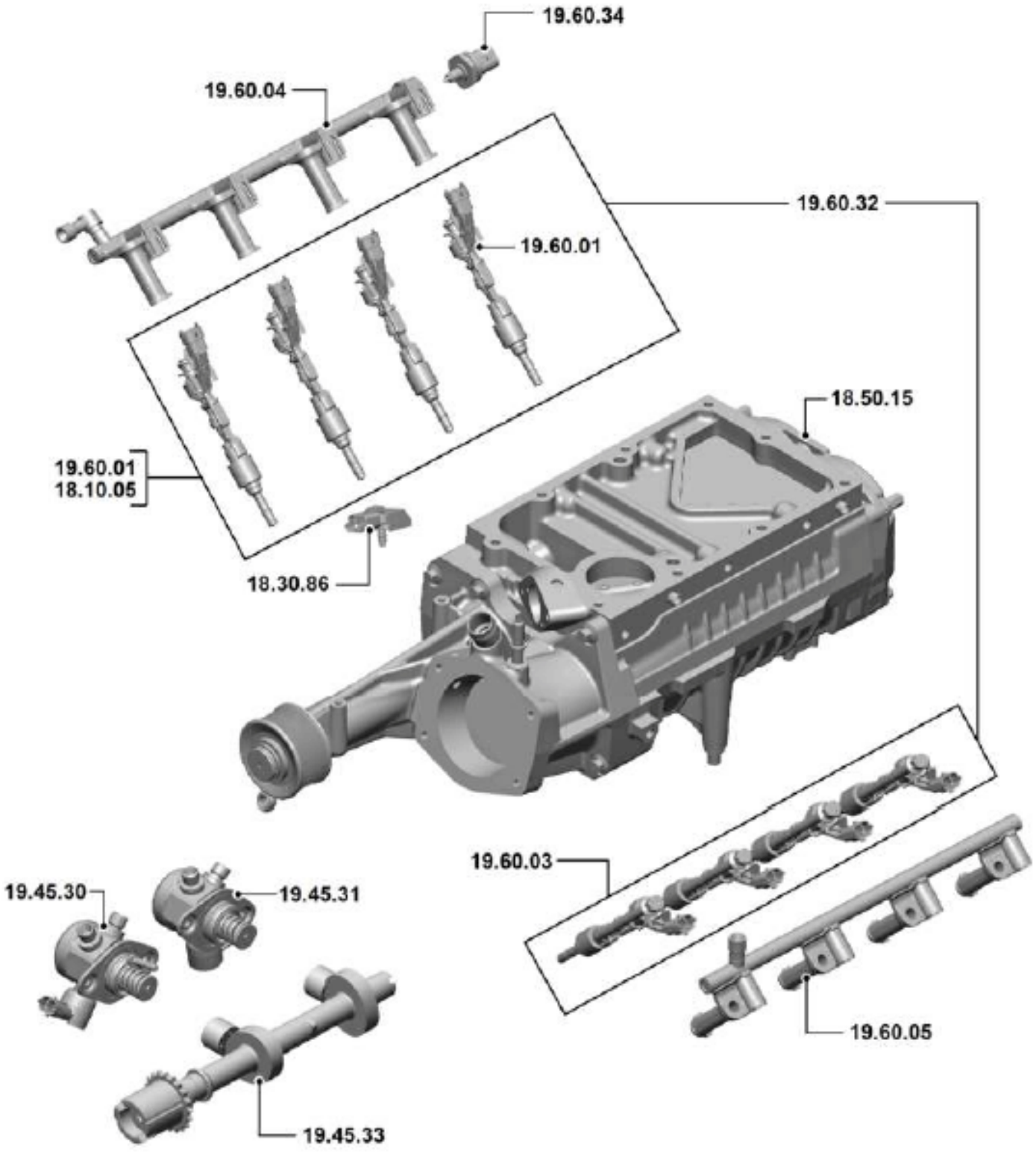
     Renew Part: Oil level gauge O-ring seal Quantity: 1.
   - Install the 3 retaining bolts.

     Torque Specification: 12 Nm
   - ?Connect the engine oil level sensor electrical connector.
2. Fill the engine oil. Refer to: **ENGINE OIL DRAINING AND FILLING (G1586896)** (General Procedures).
3. Check and if necessary top up the engine oil.
4. Start and run the engine.

FUEL RAIL PRESSURE (FRP) SENSOR (G1917131)

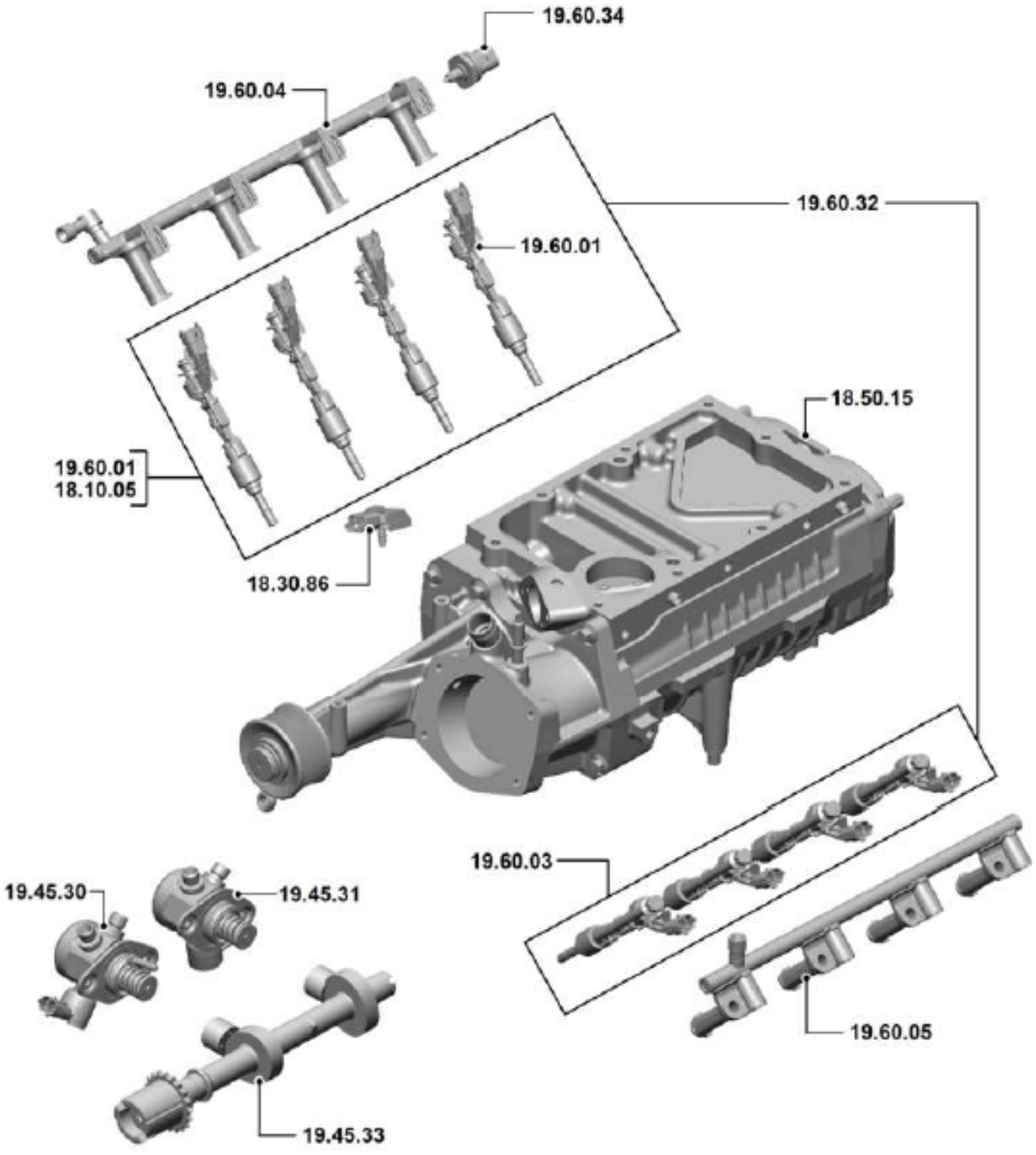
19.60.34	FUEL DIVERTER RAIL AND FUEL INJECTION PRESSURE SENSOR	3000 CC, AJ V6 (AJ126)	1.6

	ASSEMBLY - RENEW		


19.60.34
19.60.04
19.60.32
19.60.01
18.50.15
19.60.01
18.10.05
18.30.86
19.60.03
19.45.30
19.45.31
19.60.05
19.45.33

JRT1216A

19.60.34	FUEL DIVERTER RAIL AND FUEL INJECTION PRESSURE SENSOR ASSEMBLY - RENEW	5000 CC, AJ V8	1.6

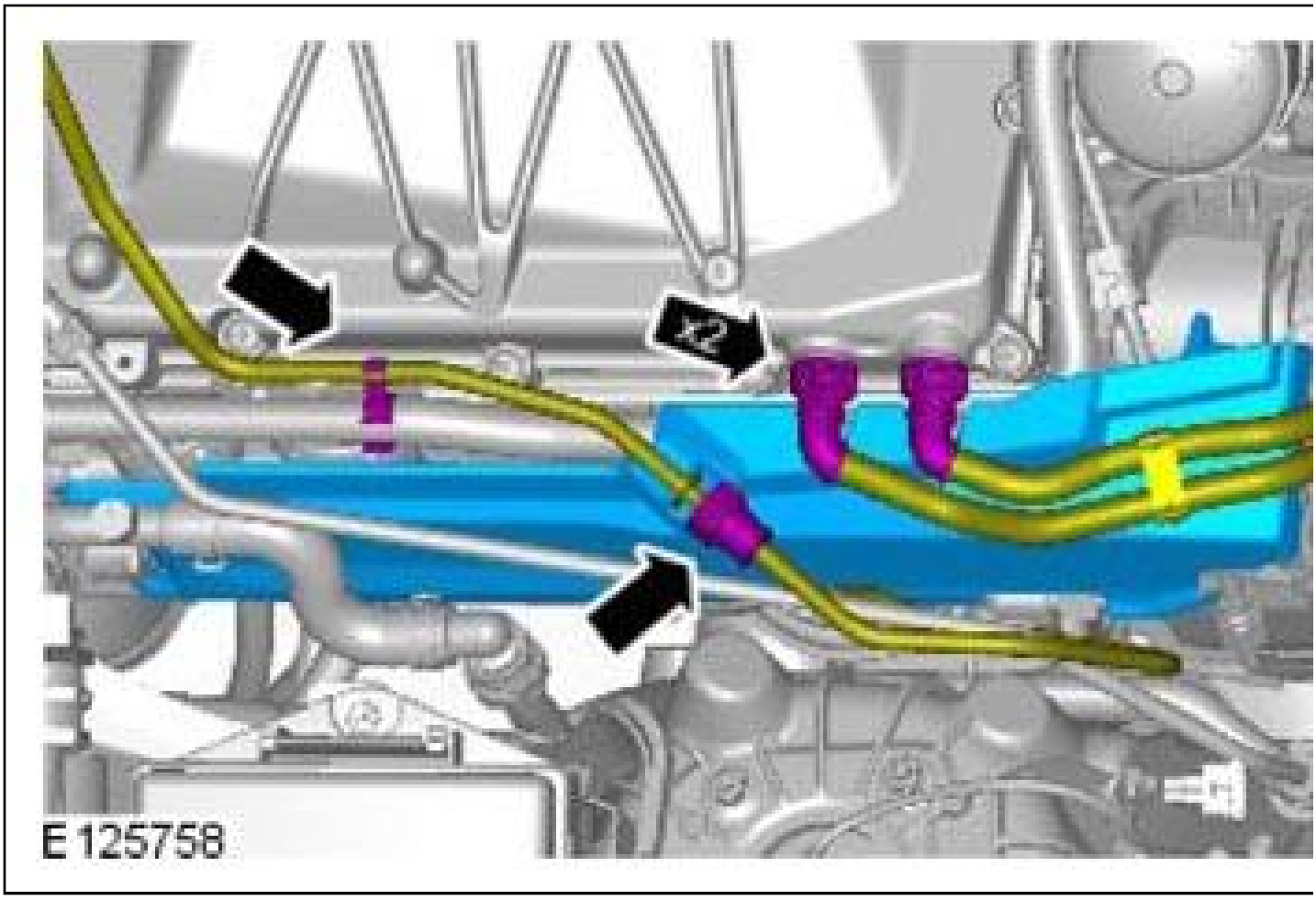

19.60.34
19.60.04
19.60.32
19.60.01
18.50.15
19.60.01
18.10.05
18.30.86
19.60.03
19.45.30
19.45.31
19.60.05
19.45.33

JRT1216A

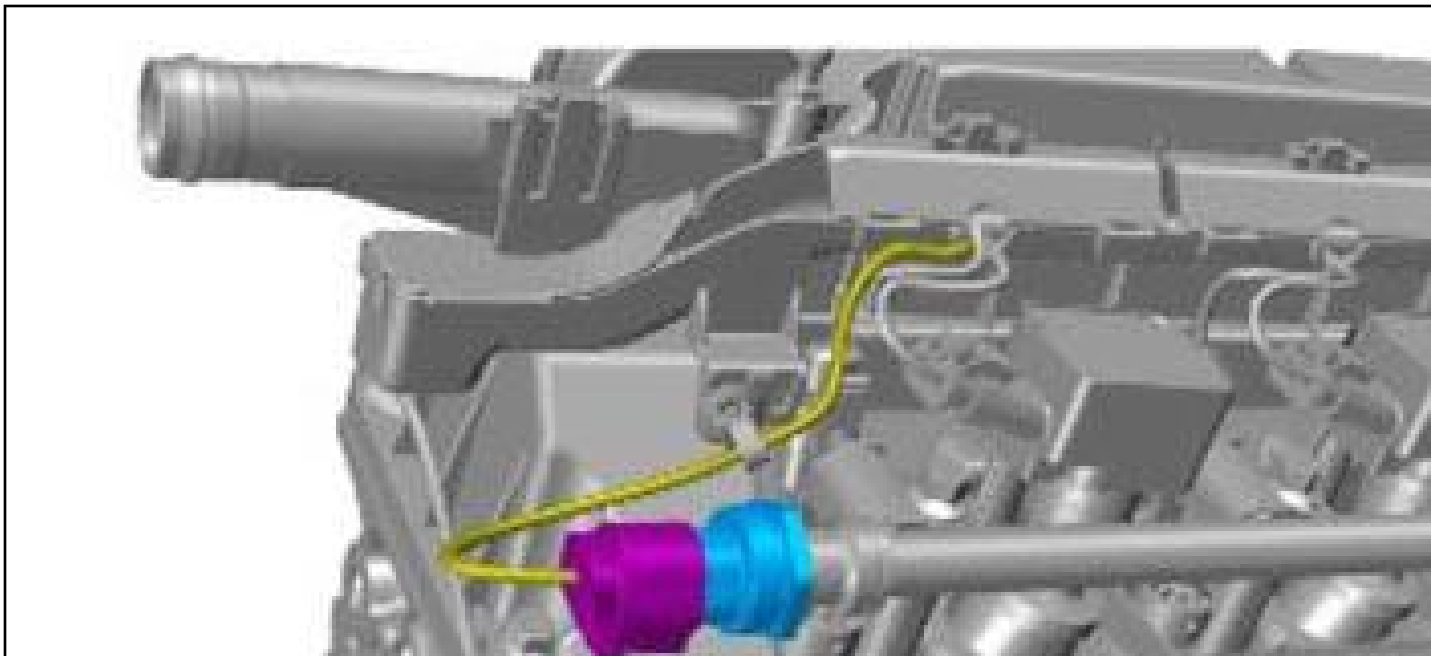
REMOVAL

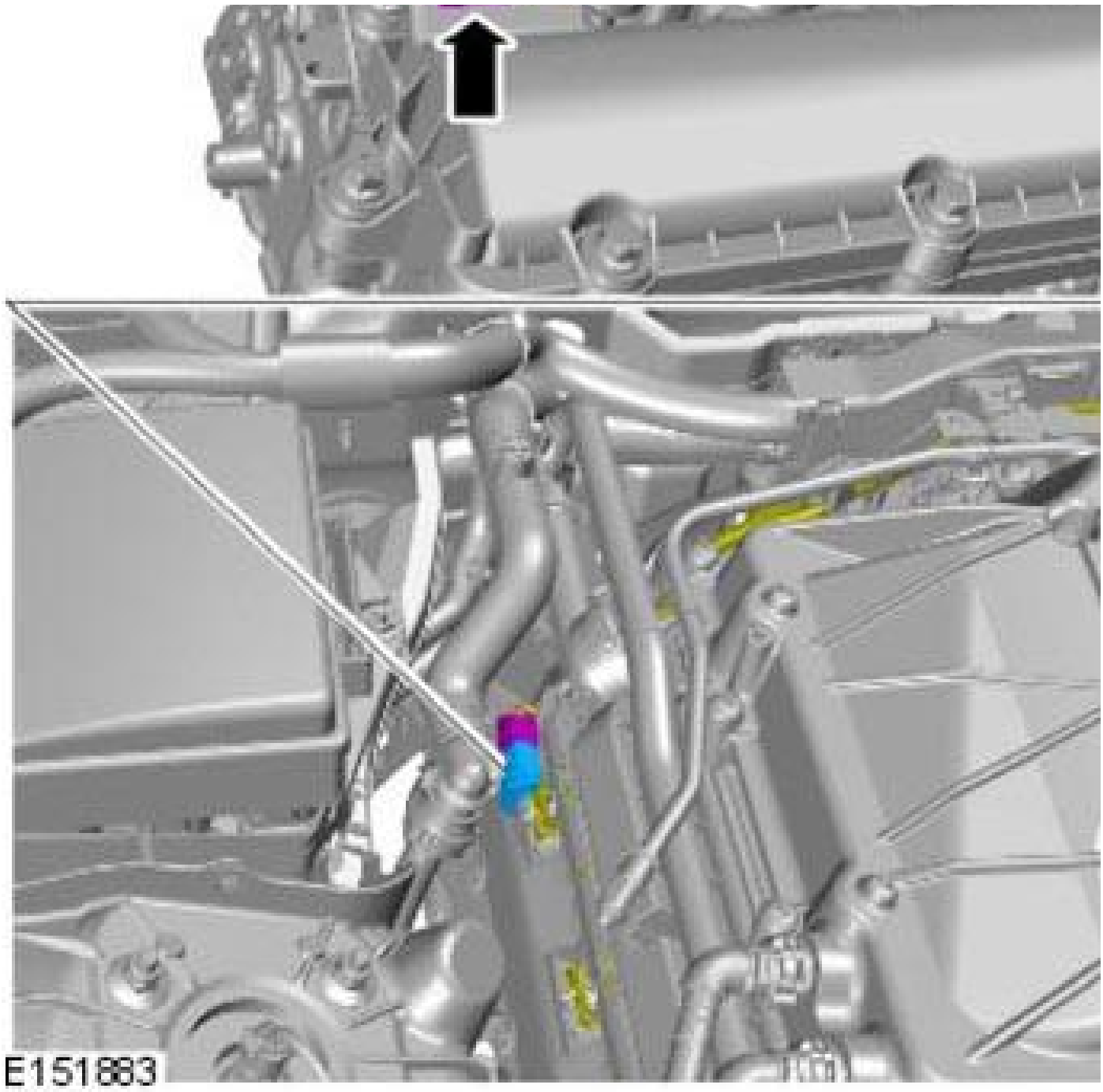
NOTE: **Removal steps in this procedure may contain installation details.**

1. Refer to: **Petrol and Petrol-Ethanol Fuel Systems Health and Safety Precautions** (Description and Operation).
2. Refer to: **Battery Disconnect and Connect** (General Procedures).
3. Refer to: **Engine Cover** (Removal and Installation).
4. Refer to: **Secondary Bulkhead Panel RH** (Removal and Installation).
5. Refer to: **Fuel System Pressure Release** (General Procedures).
6. **CAUTION:** **Cap the coolant pipe ends immediately to minimize coolant loss.**



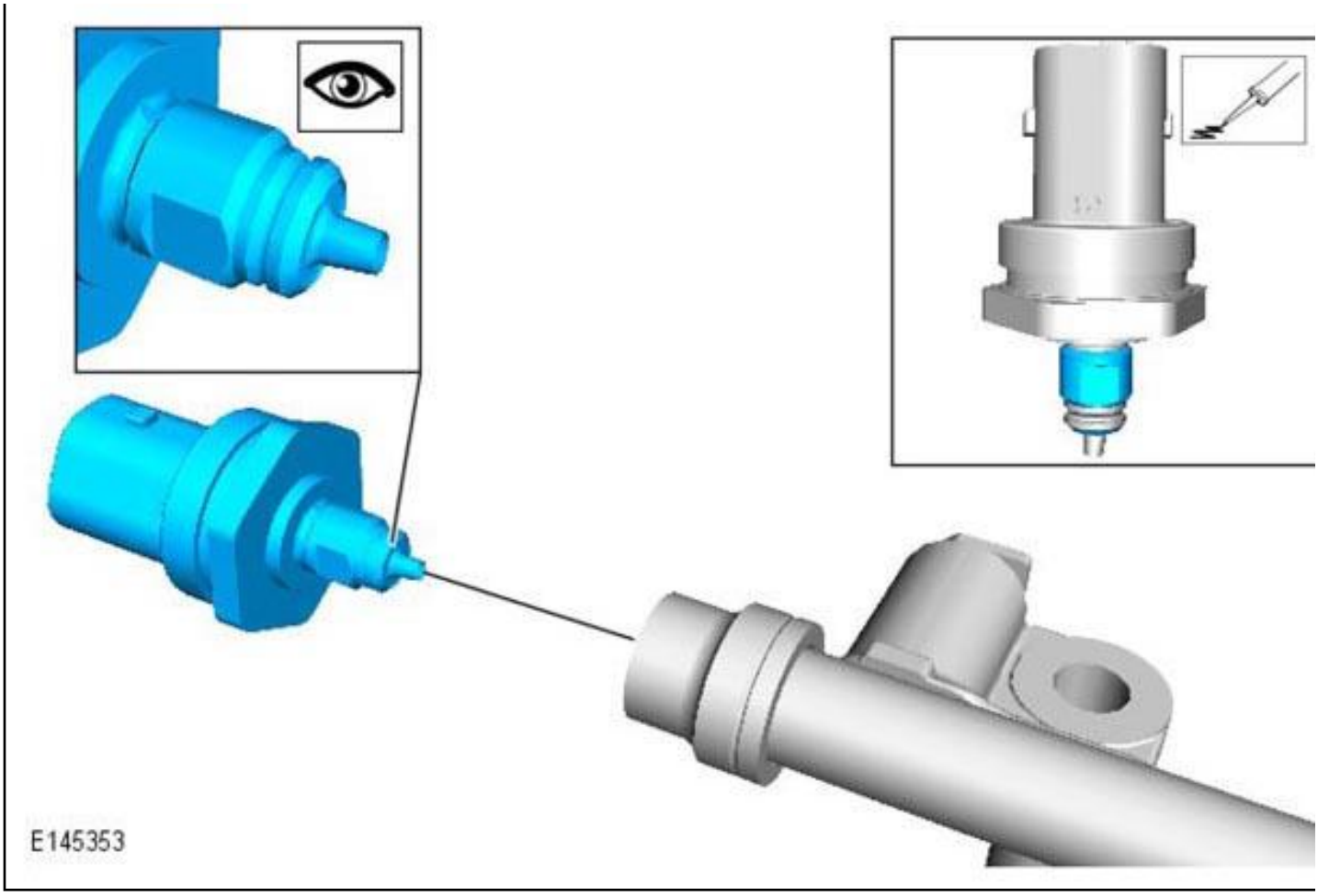
7.





8. **CAUTION:** **Be prepared to collect escaping fluids.**

   NOTE: **During lubrication, keep the component vertically as shown.**



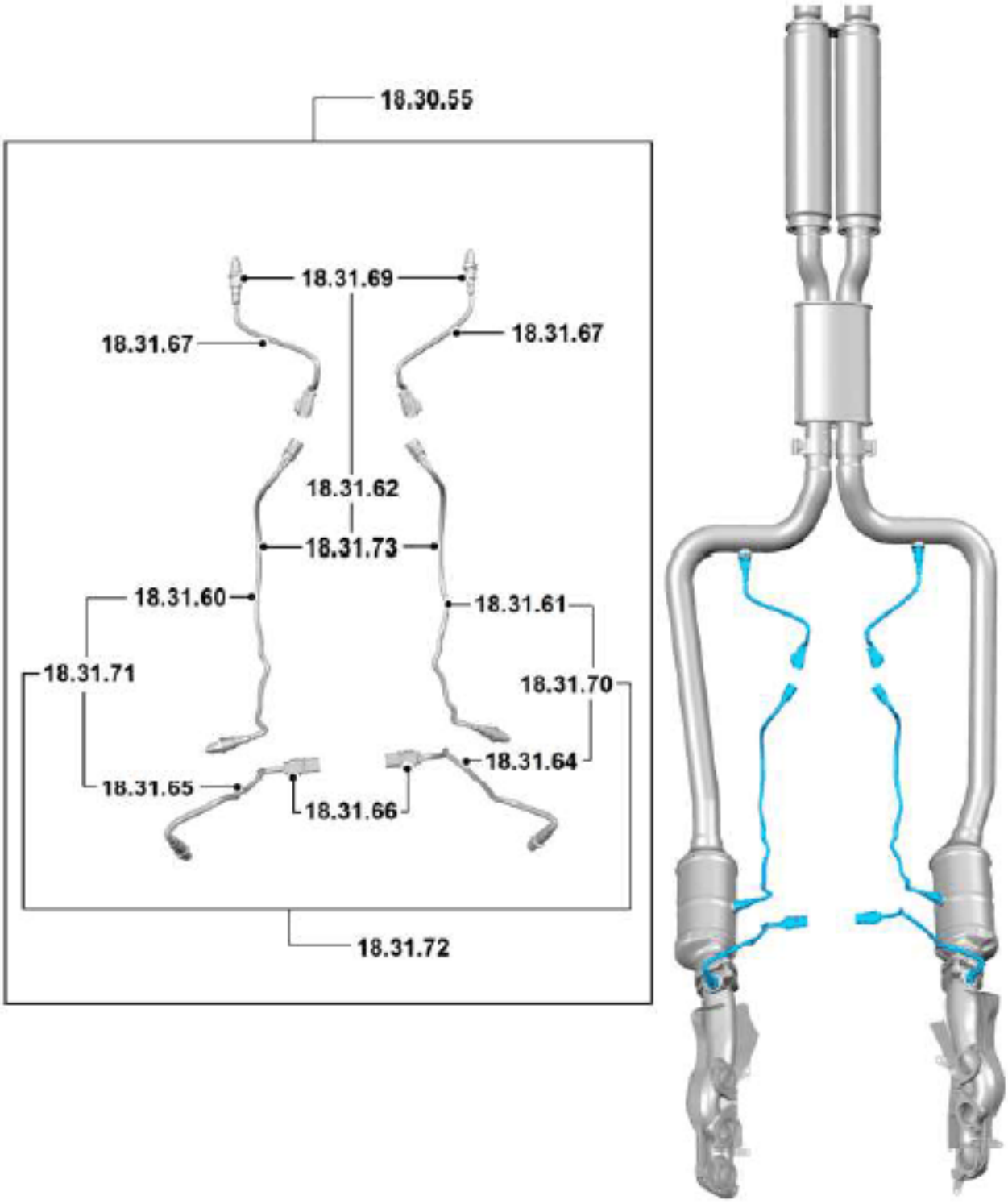
Torque Specification: **38 Nm**

INSTALLATION

1. To install, reverse the removal procedure.
2. Check and top-up the coolant if required.

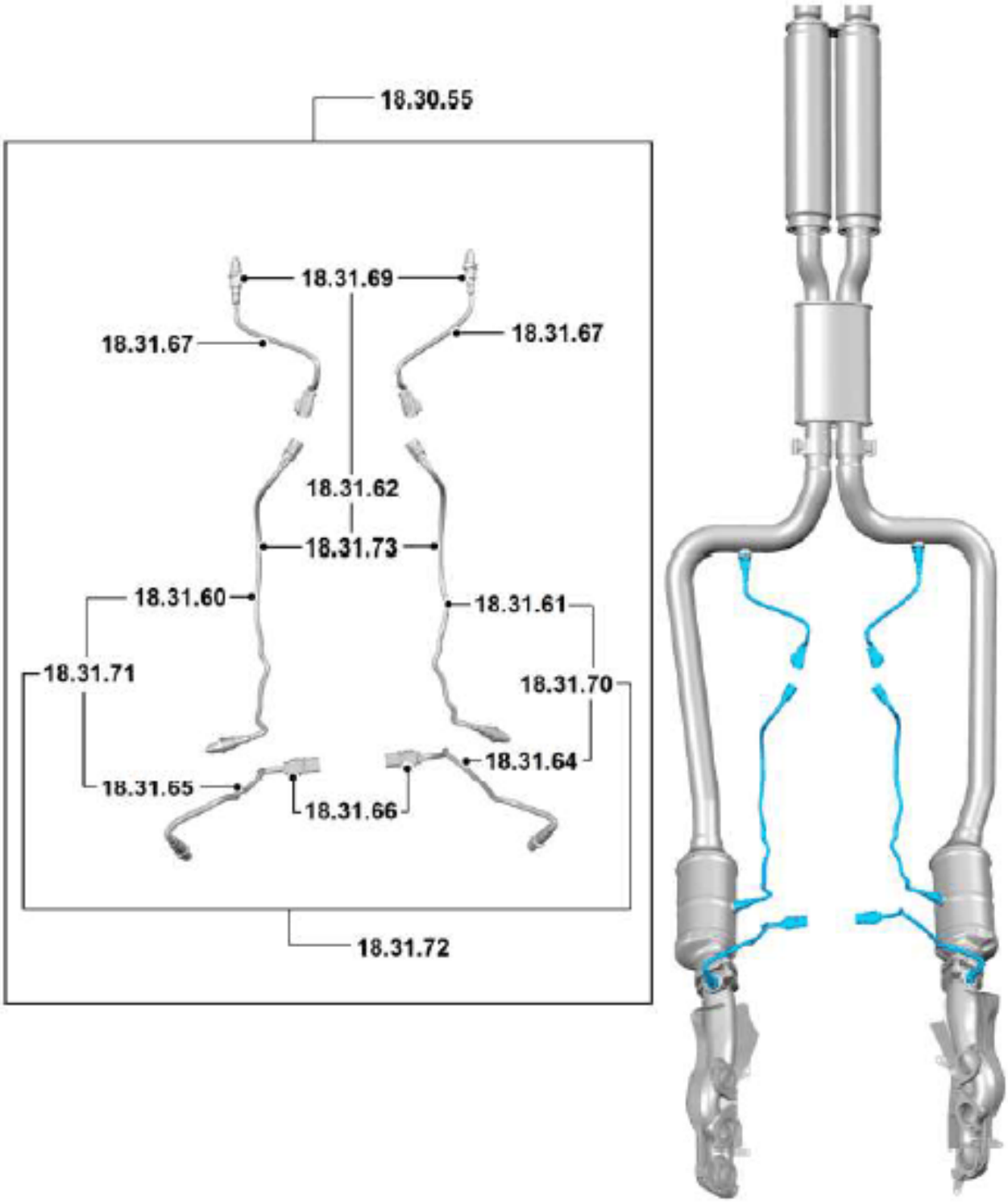
HEATED OXYGEN SENSOR (HO2S) LH (G1917132)

18.31.64	HEATED OXYGEN SENSOR (HO2S) - PRE CATALYST - LEFT BANK/EACH - RENEW	3000 CC, AJ V6 (AJ126)	1.3


18.30.55
18.31.69
18.31.67
18.31.67
18.31.62
18.31.73
18.31.60
18.31.61
18.31.71
18.31.70
18.31.64
18.31.65
18.31.66
18.31.72

JRT1558

18.31.64	HEATED OXYGEN SENSOR (HO2S) - PRE CATALYST - LEFT BANK/EACH - RENEW	5000 CC, AJ V8	1.3


18.30.55
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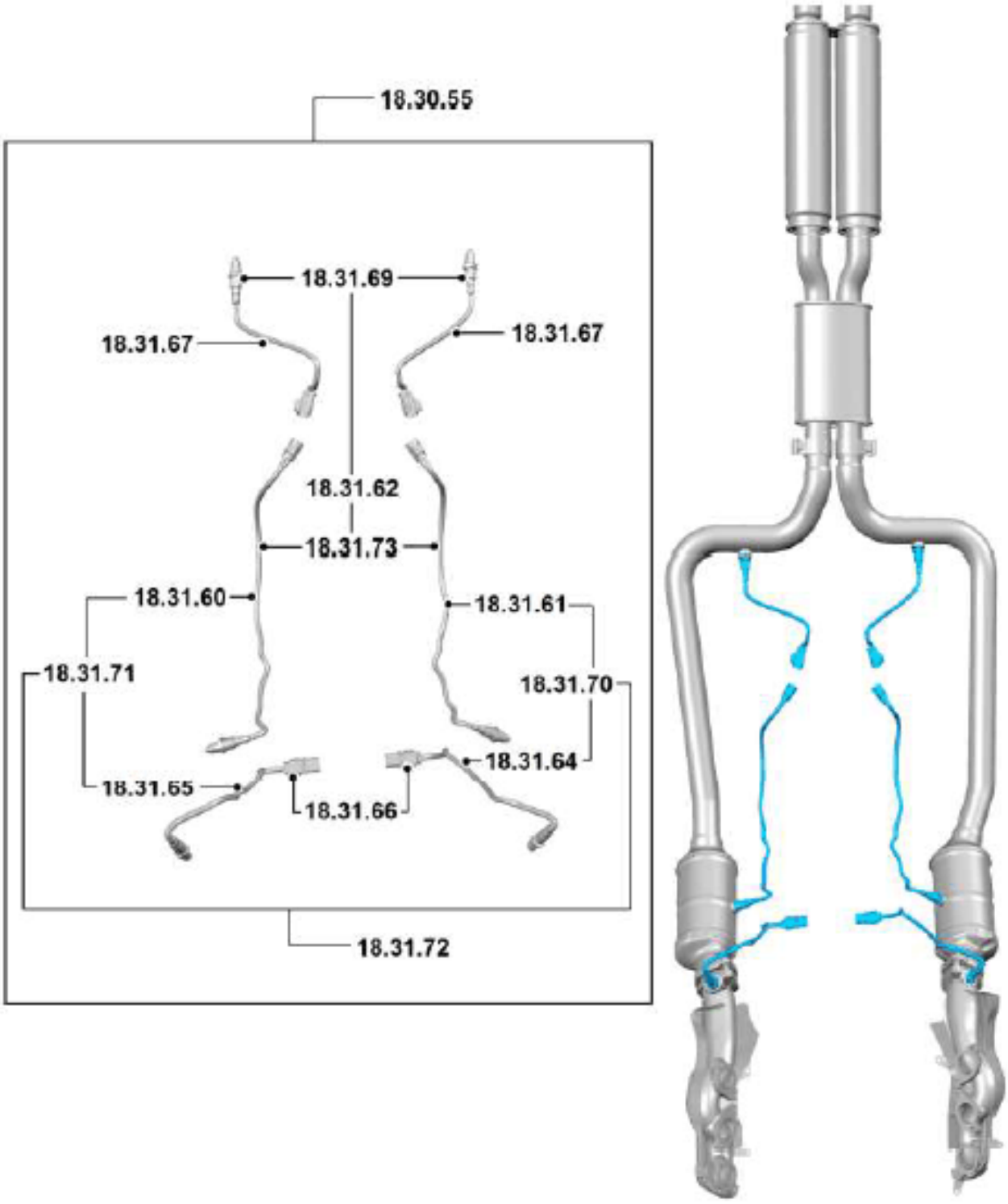
18.31.67
18.31.62
18.31.73
18.31.60
18.31.61
18.31.71
18.31.70
18.31.64
18.31.65
18.31.66
18.31.72

JRT1558

18.31.64	HEATED OXYGEN SENSOR (HO2S) - PRE CATALYST - LEFT BANK/EACH - RENEW	5000 CC, AJ V8, 2WD	1.2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18.31.67
18.31.67
18.31.62
18.31.73
18.31.60
18.31.61
18.31.71
18.31.70
18.31.64
18.31.65
18.31.66
18.31.72

JRT1558

SPECIAL TOOL(S)

	**310-121** Wrench, H02S

REMOVAL

WARNING: **Observe due care when working near a hot exhaust system.**

NOTE:

- **Removal steps in this procedure may contain installation details.**
- **Some components shown removed for clarity.**

1. Disconnect the battery ground cable

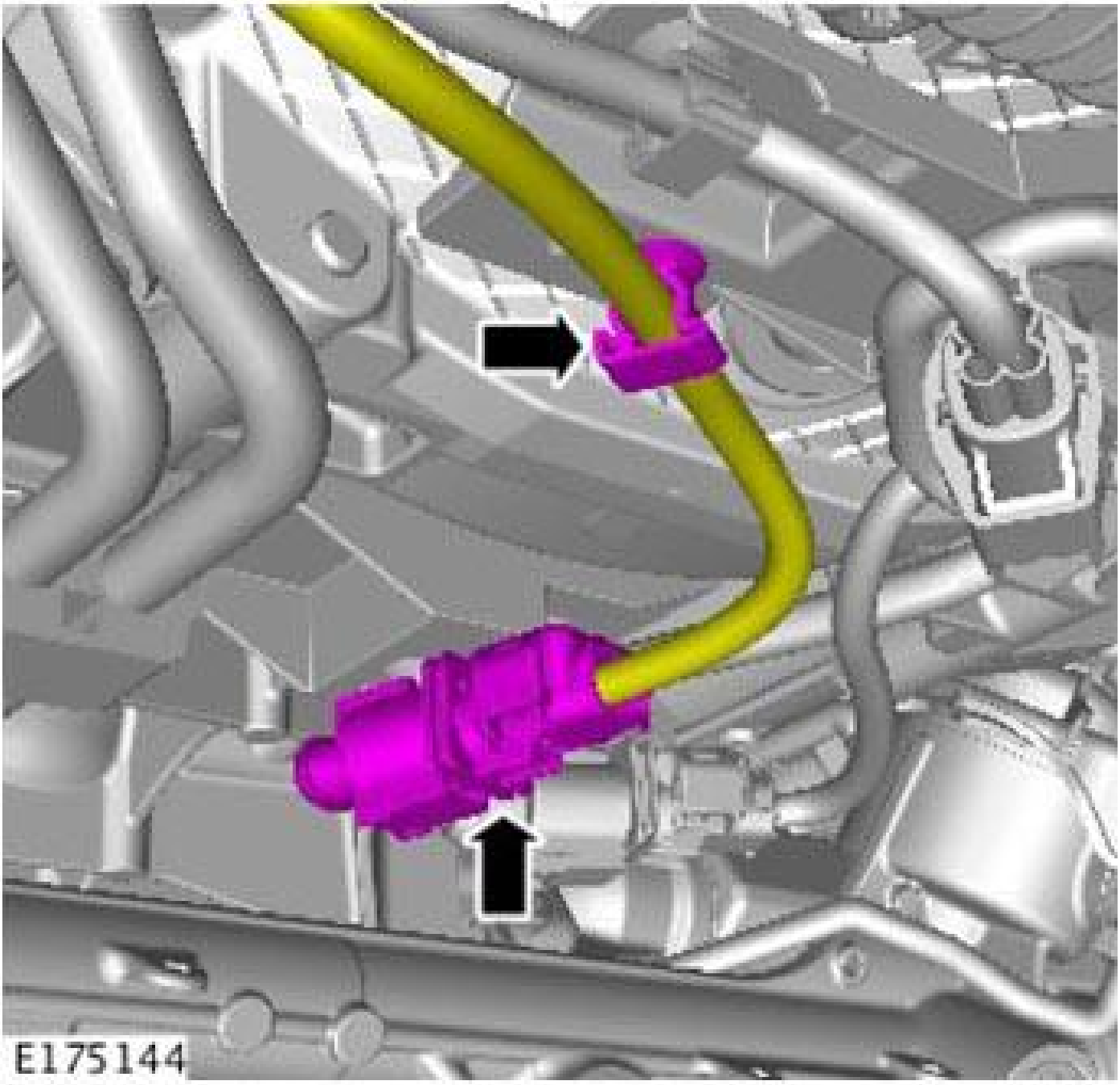
   Refer to: **Battery Disconnect and Connect** (General Procedures).

2. Raise and support the vehicle.

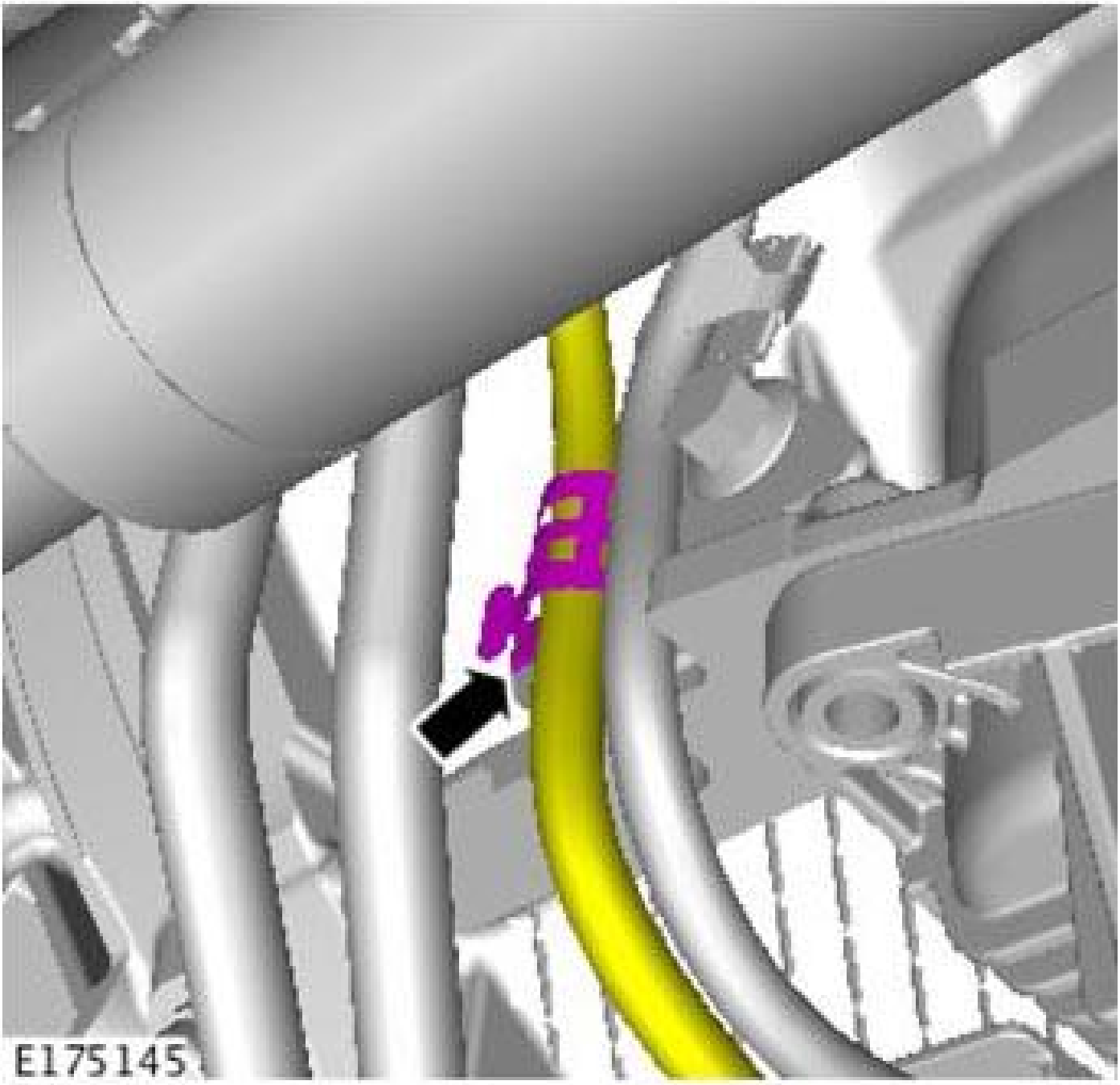
   WARNING: **Make sure to support the vehicle with axle stands.**

3. Refer to: **Air Deflector** (Removal and Installation).

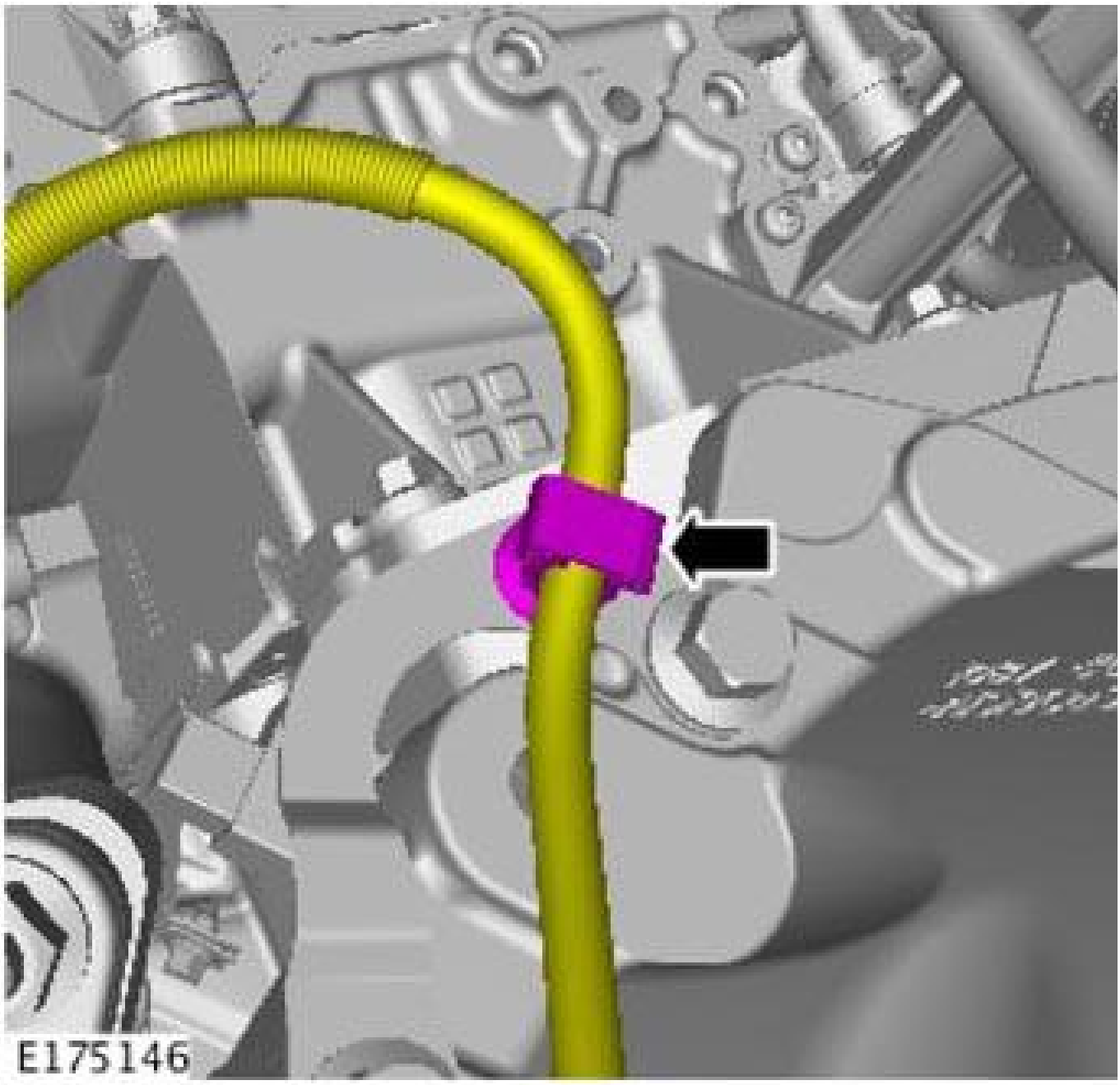
4.



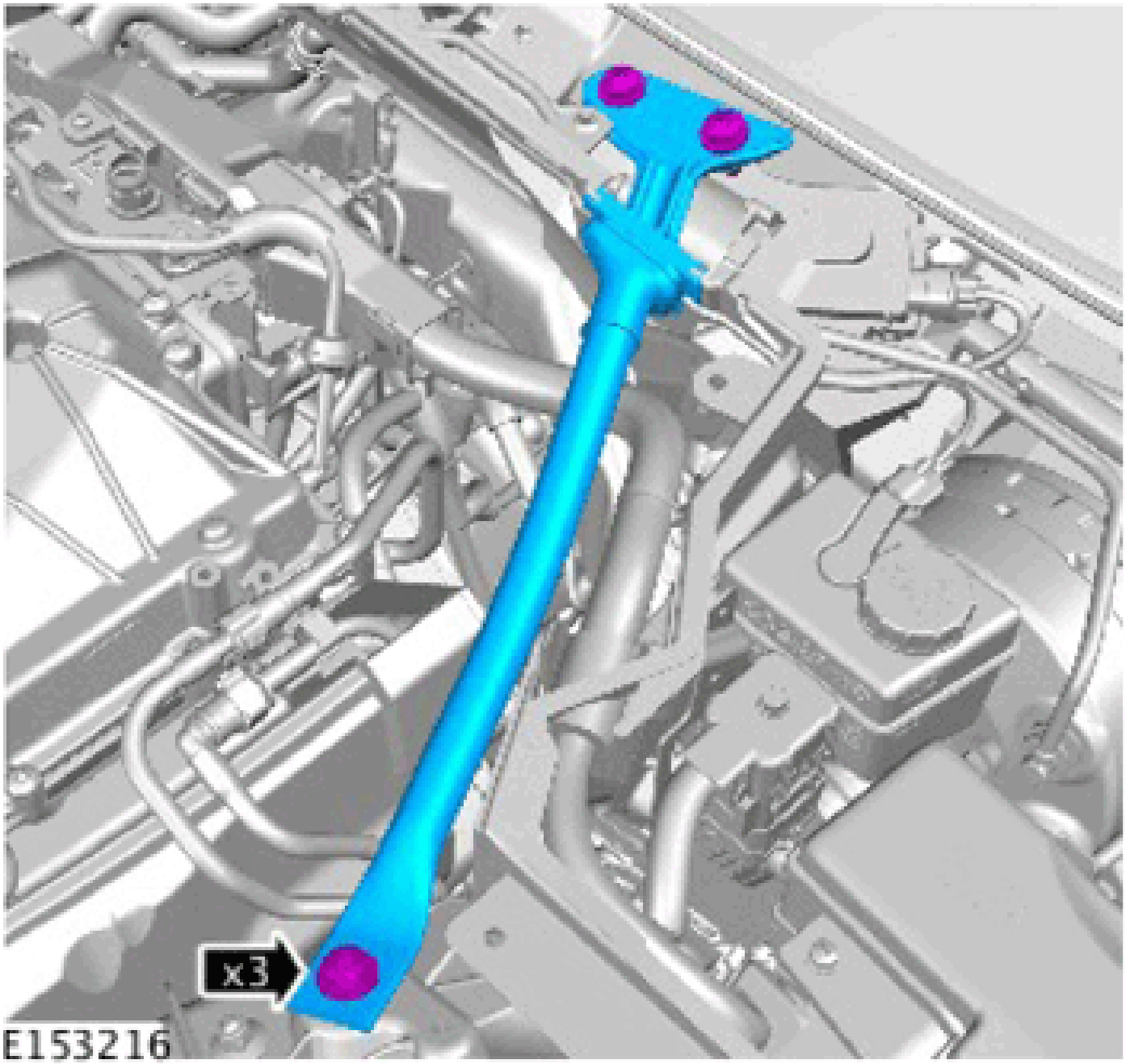
5.



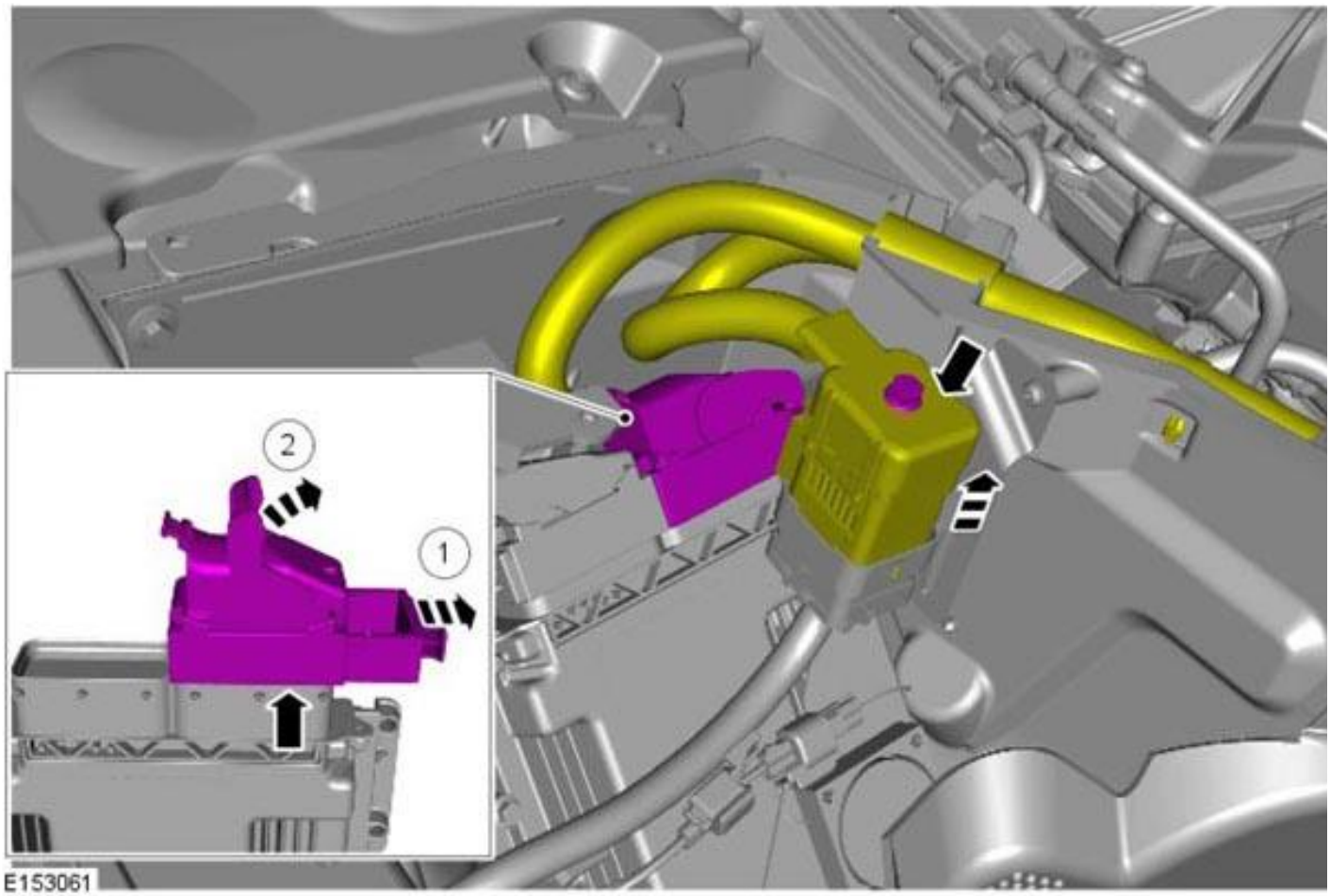
6.



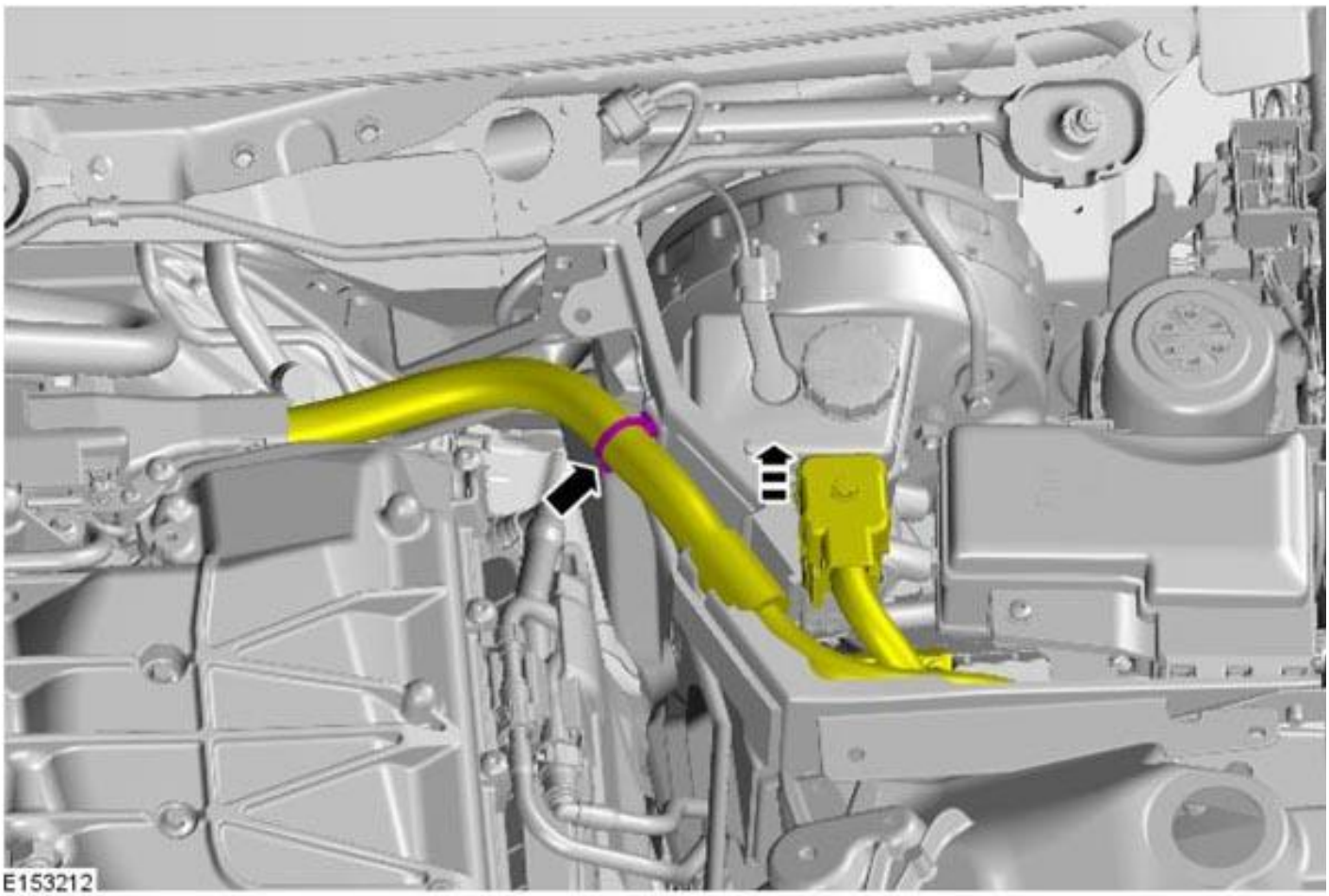
7. Refer to: **Engine Cover** (Removal and Installation).
8. Refer to: **Cowl Panel** (Removal and Installation).
9. *Torque Specification:* **55 Nm**



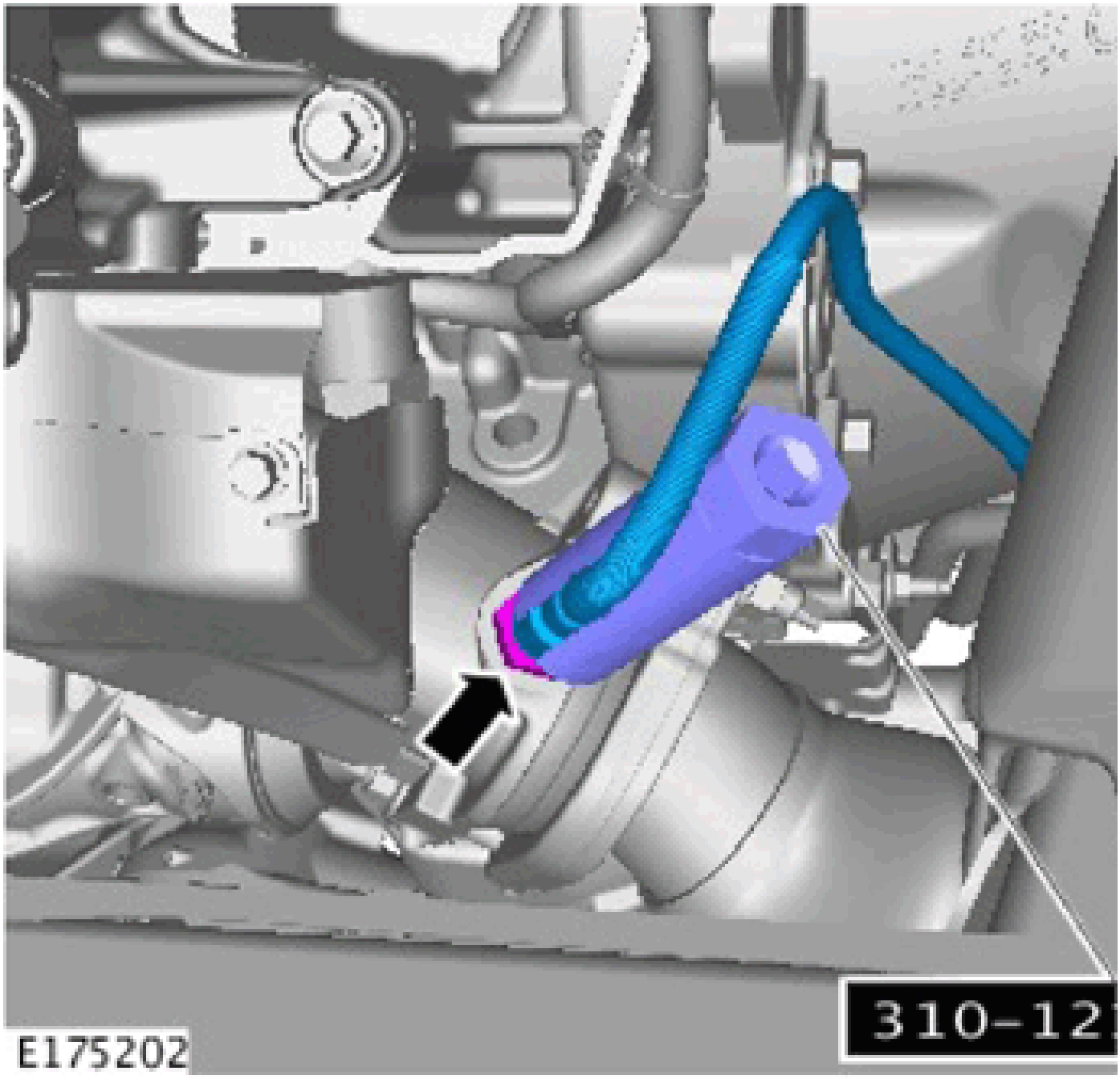
10. *Torque Specification:* **6 Nm**



11.



12. **CAUTION:** **Make sure that the area around the component is clean and free of foreign material.**

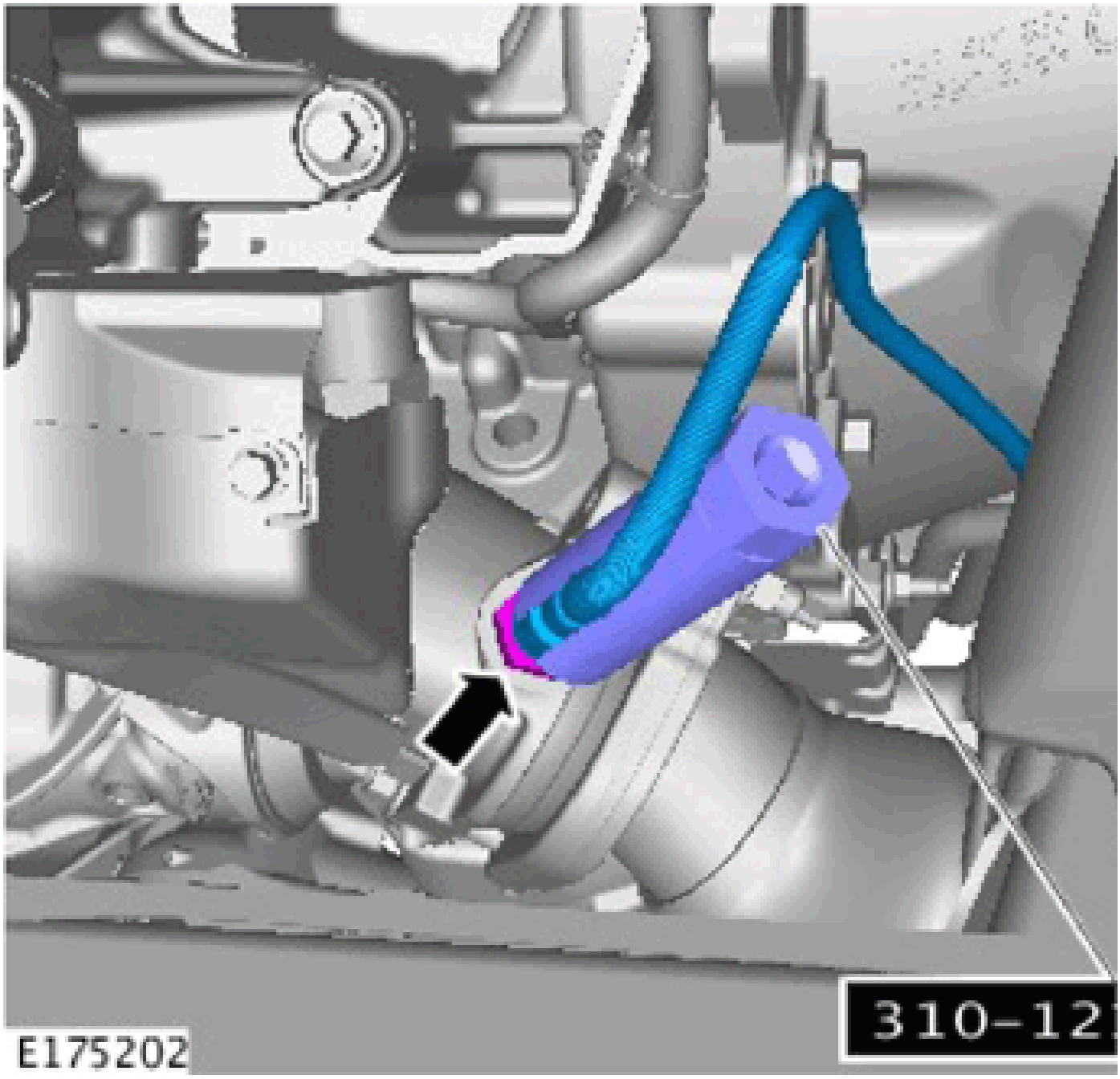


Special Tool(s): 310-121

INSTALLATION

1. **CAUTION:**
   - **Make sure that the mating faces are clean and free of corrosion and foreign material.**
   - **Make sure the anti-seize compound does not contact the HO2S tip.**
   - **If accidentally dropped or knocked install a new sensor.**

NOTE: **If the original sensor is to be installed, apply lubricant meeting specification ESE-M12A4-A to the thread of the sensor.**



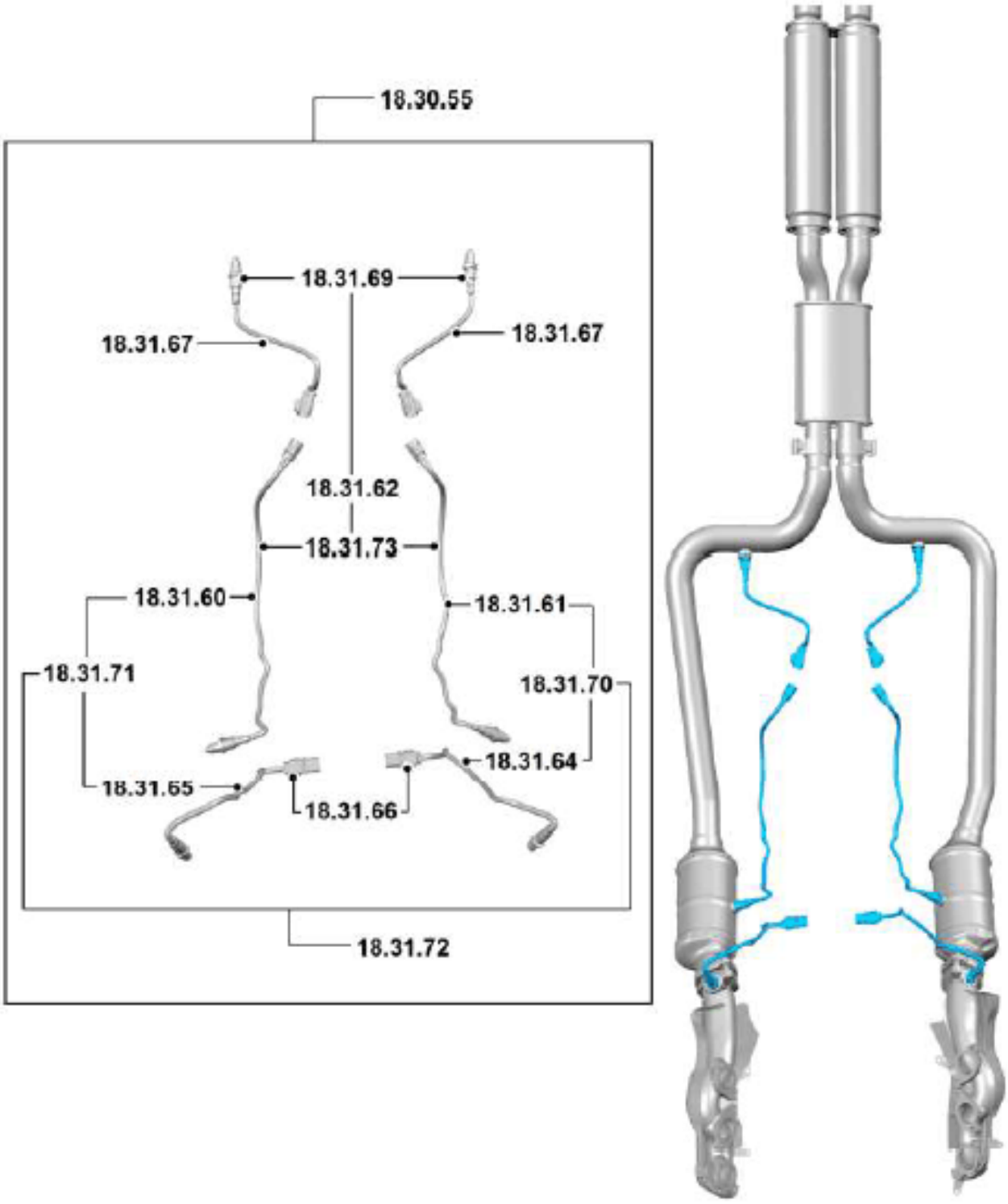
To install, reverse the removal procedure.

Special Tool(s): 310-121

Torque Specification: **45 Nm**

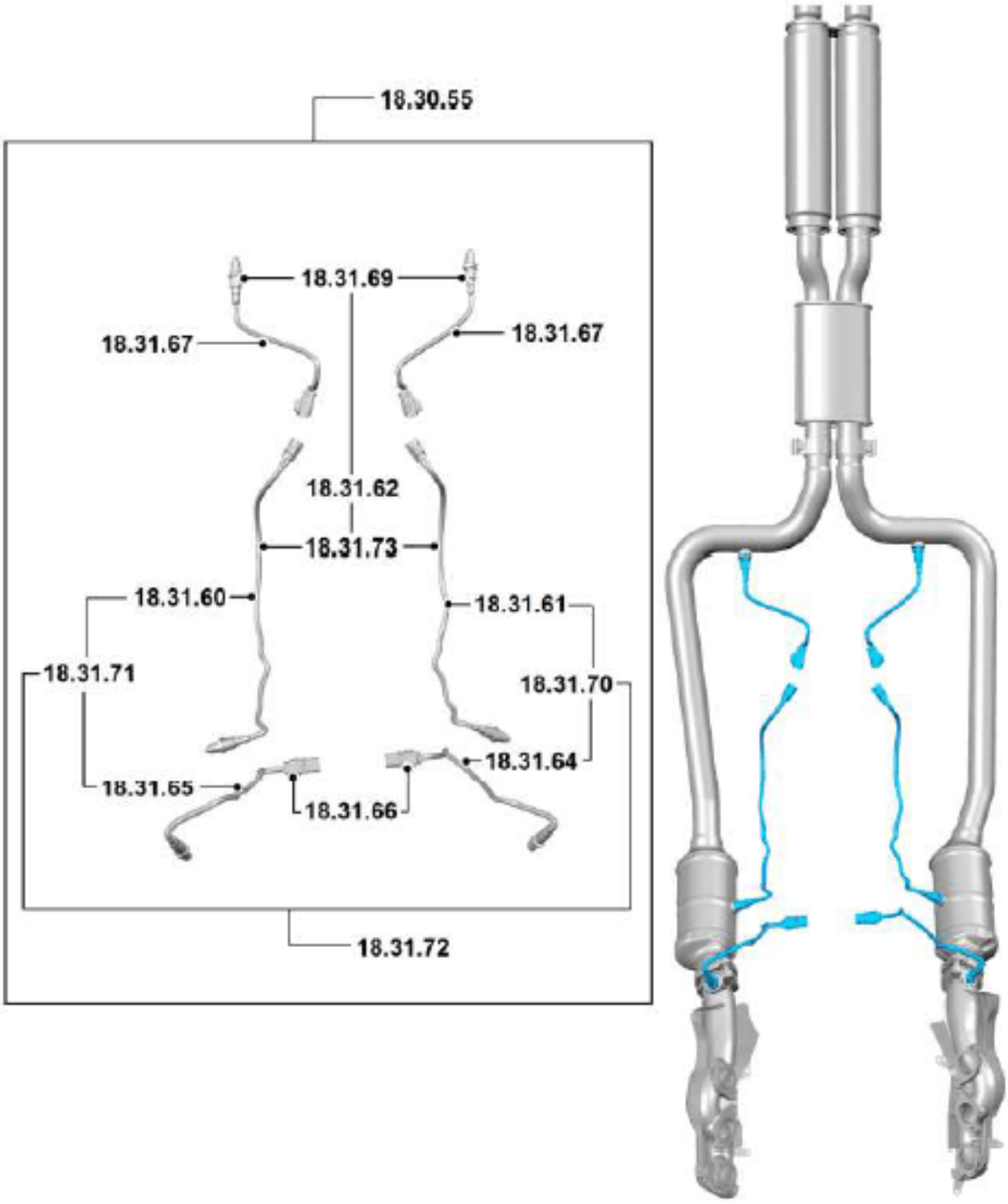
HEATED OXYGEN SENSOR (HO2S) RH (G1917133)

18.31.65	HEATED OXYGEN SENSOR (HO2S) - PRE CATALYST - RIGHT BANK - RENEW	3000 CC, AJ V6 (AJ126)	1.3


18.30.55
18.31.69
18.31.67
18.31.67
18.31.62
18.31.73
18.31.60
18.31.61
18.31.71
18.31.70
18.31.64
18.31.65
18.31.66
18.31.72

JRT1558

18.31.65	HEATED OXYGEN SENSOR (HO2S) - PRE CATALYST - RIGHT BANK - RENEW	5000 CC, AJ V8	1.3


18.30.55
18.31.69
18.31.67
18.31.67
18.31.62
18.31.73
18.31.60
18.31.61
18.31.71
18.31.70
18.31.64
18.31.65
18.31.66
18.31.72

JRT1558

SPECIAL TOOL(S)

NOTES:

	**310-121** Wrench, H02S

REMOVAL

WARNING: **Observe due care when working near a hot exhaust system.**

NOTE:

- **Removal steps in this procedure may contain installation details.**
- **Some components shown removed for clarity.**

1. Disconnect the battery ground cable

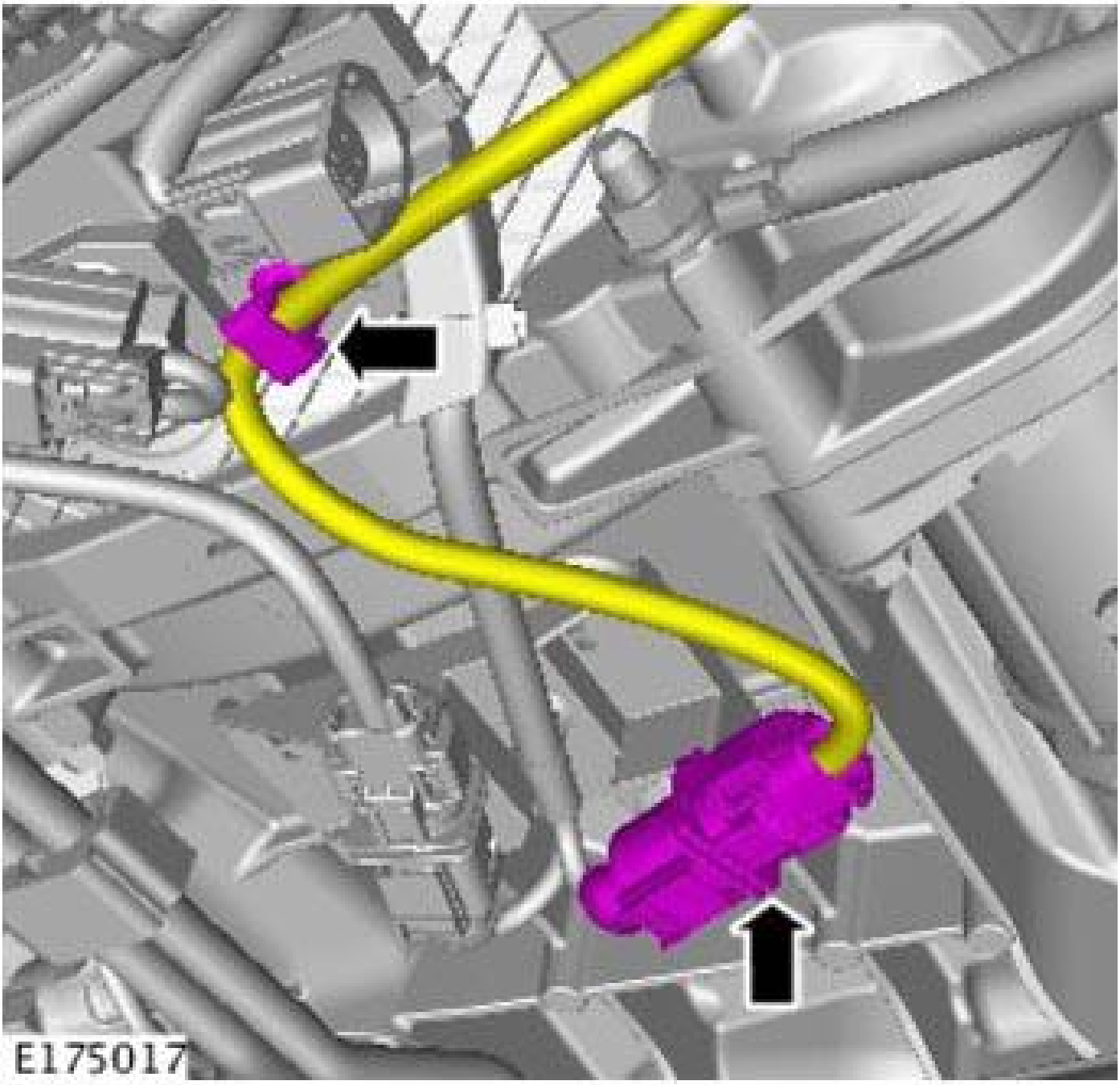
   Refer to: **Battery Disconnect and Connect** (General Procedures).

2. **WARNING:** **Make sure to support the vehicle with axle stands.**

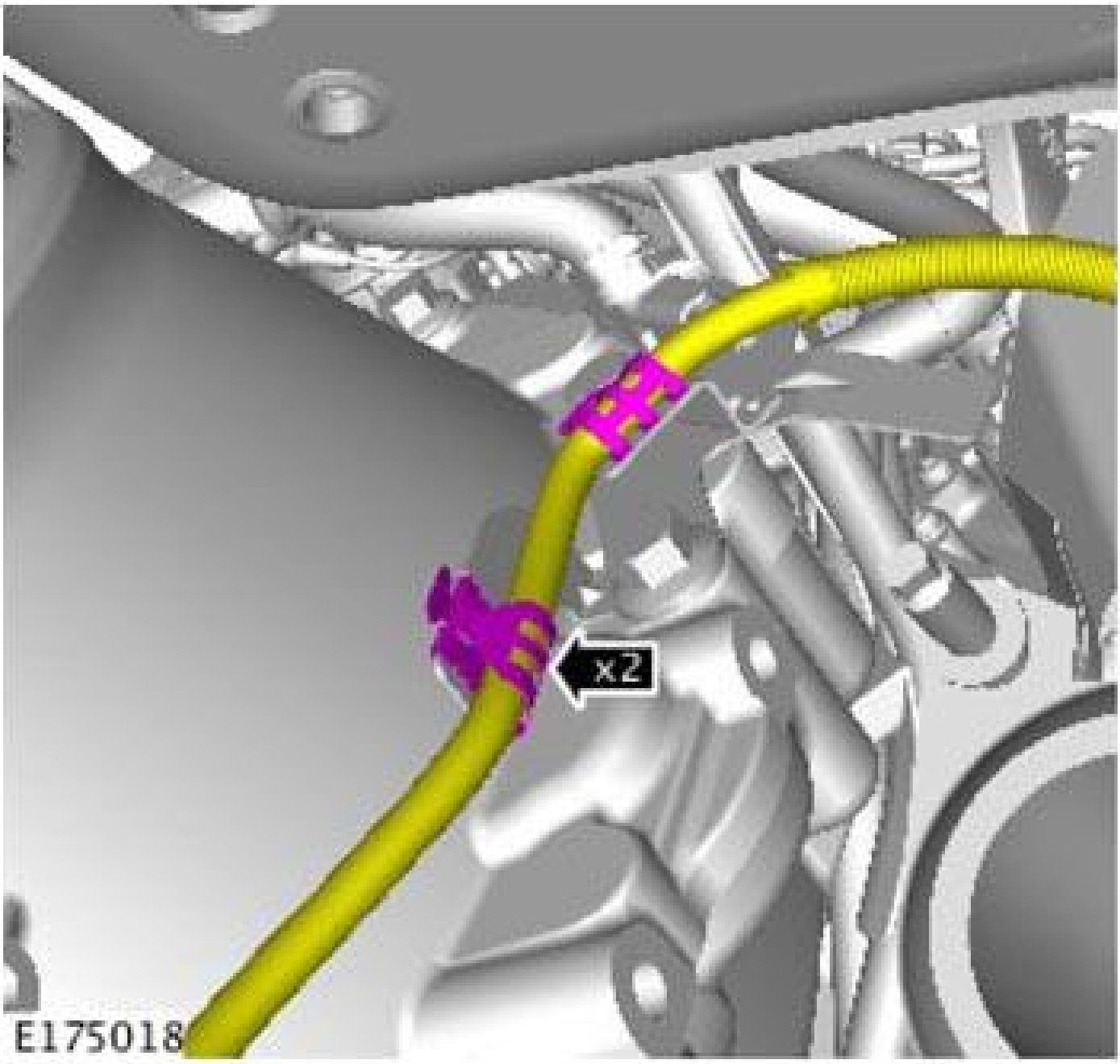
   Raise and support the vehicle.

3. Refer to: **Air Deflector** (Removal and Installation).

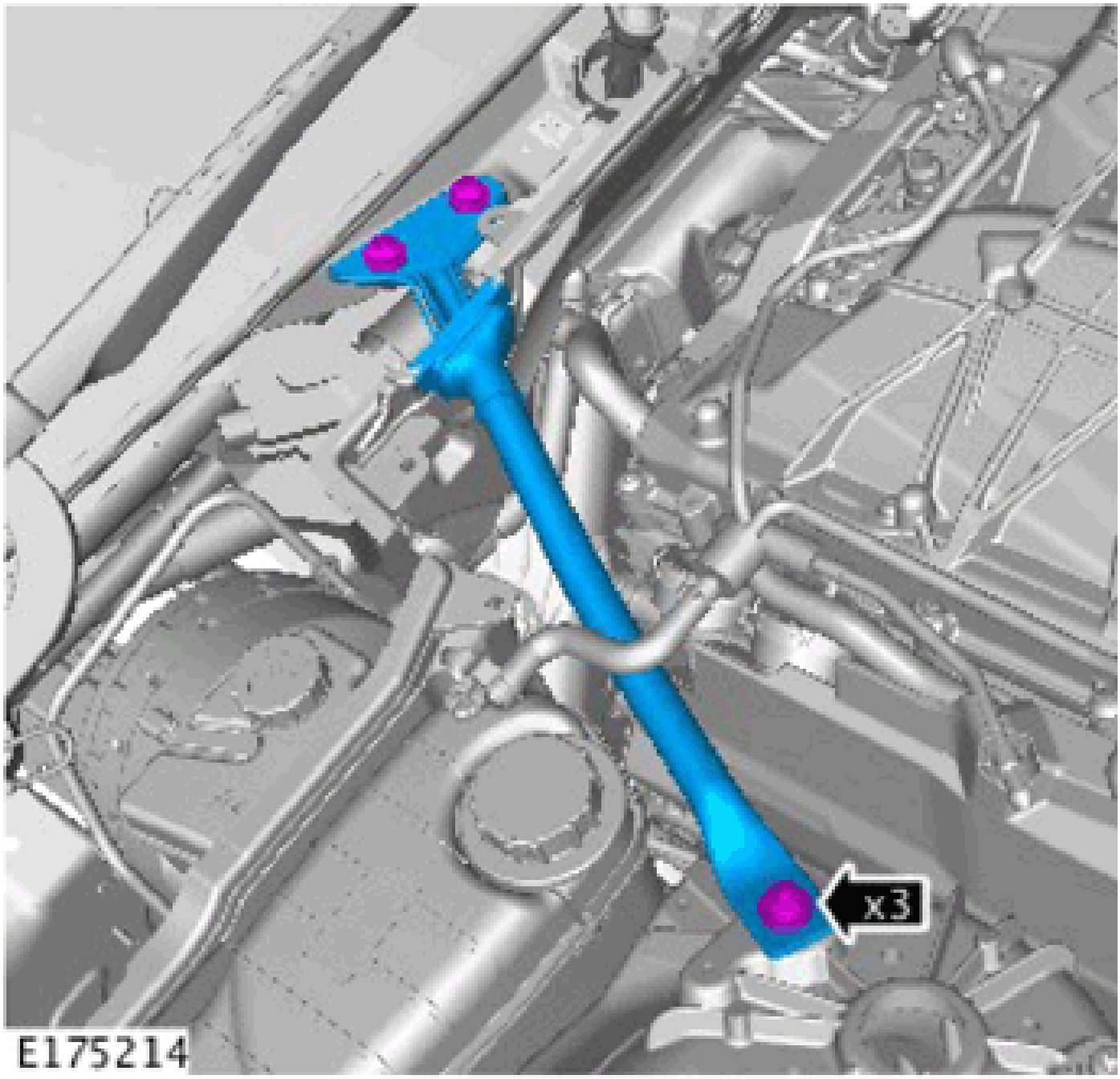
4.



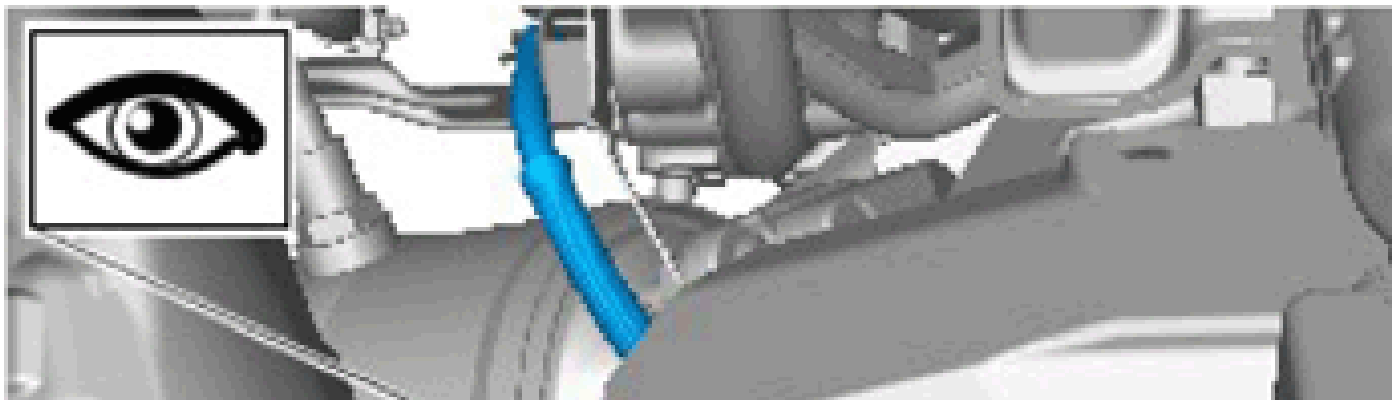
5.

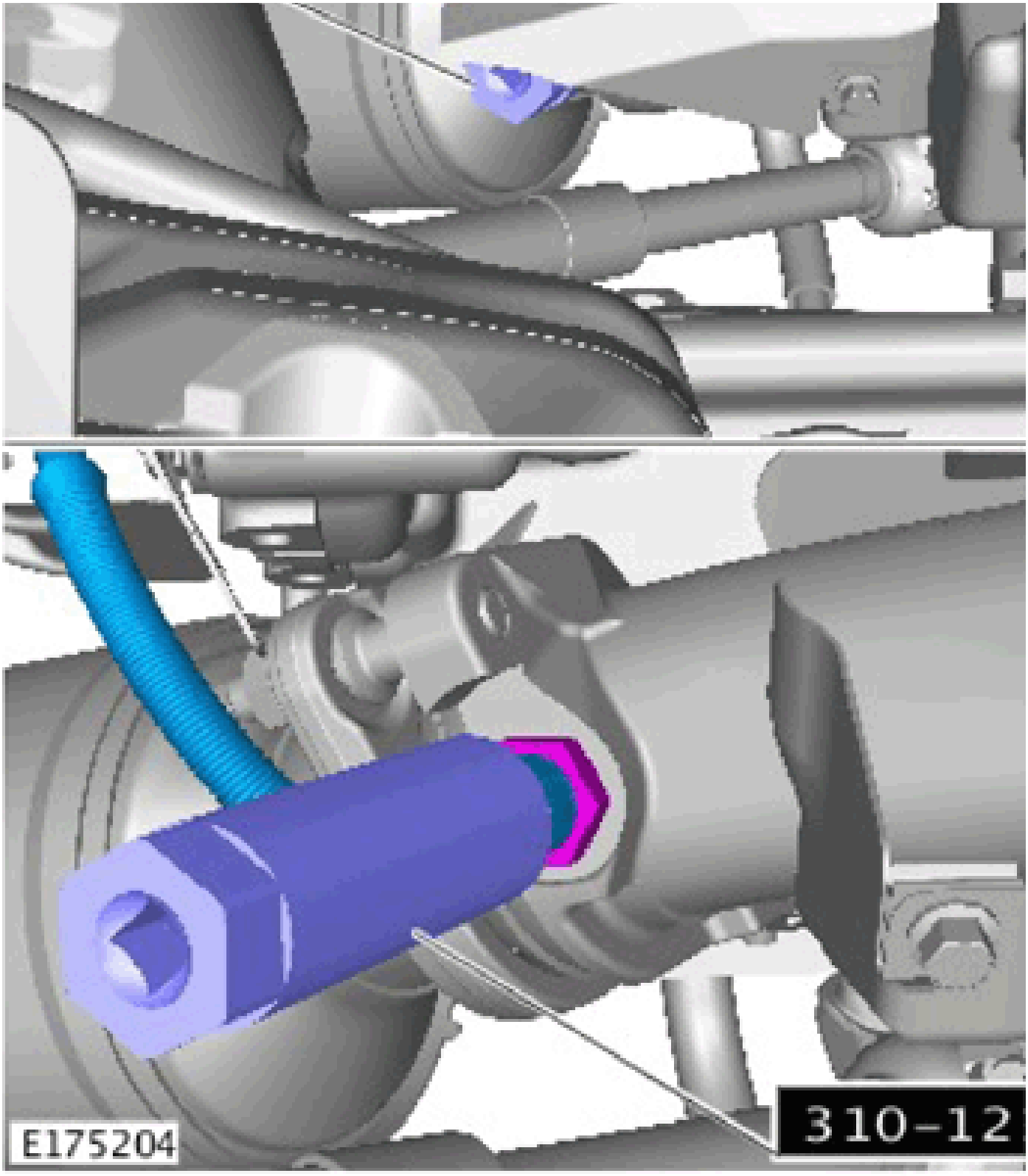


6. Refer to: **Engine Cover** (Removal and Installation).
7. Refer to: **Cowl Panel** (Removal and Installation).
8. *Torque Specification:* **55 Nm**



9. **CAUTION: Make sure that the area around the component is clean and free of foreign material.**



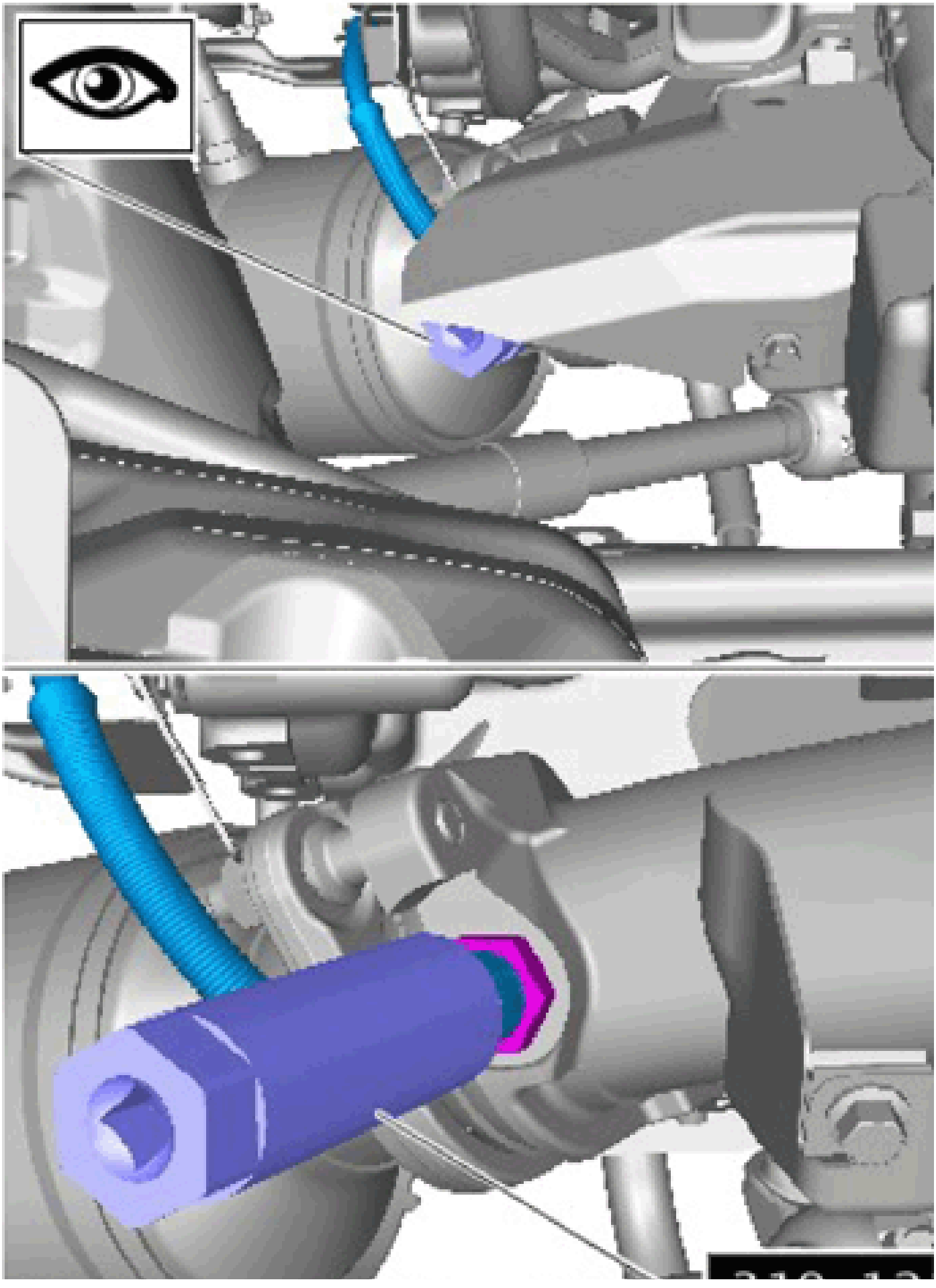


Special Tool(s): 310-121

INSTALLATION

1. **CAUTION:**
   - **Make sure that the mating faces are clean and free of corrosion and foreign material.**
   - **Make sure the anti-seize compound does not contact the HO2S tip.**
   - **If accidentally dropped or knocked install a new sensor.**

NOTE: **If the original sensor is to be installed, apply lubricant meeting specification ESE-M12A4-A to the thread of the sensor.**



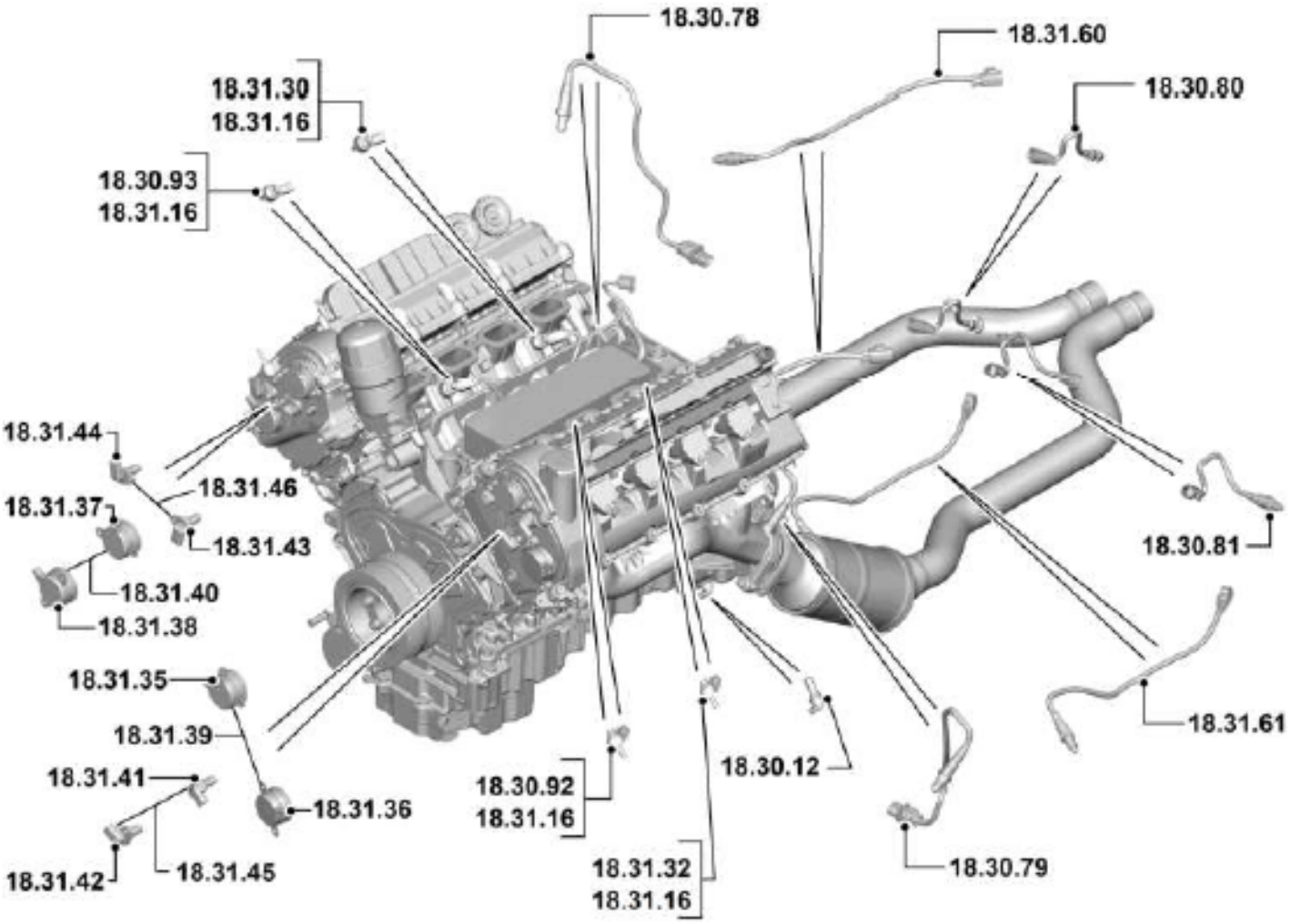
To install, reverse the removal procedure.

Special Tool(s): 310-121

Torque Specification: **45 Nm**

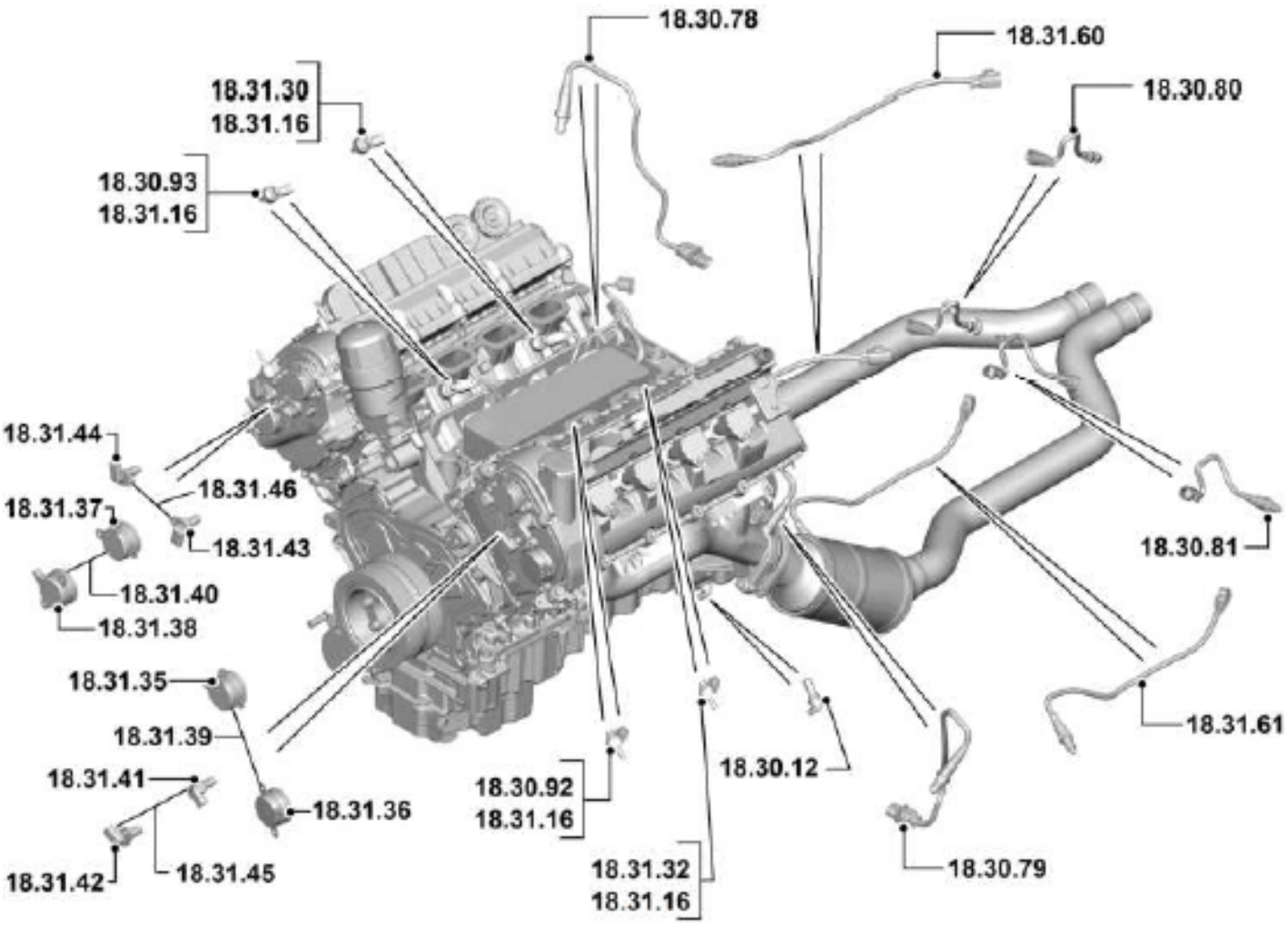
KNOCK SENSOR (KS) LH (G1917129)

18.30.92	ENGINE KNOCK SENSOR - LEFT HAND - RENEW	3000 CC, AJ V6 (AJ126)	2.9



JRT1218

18.30.92	ENGINE KNOCK SENSOR - LEFT HAND - RENEW	5000 CC, AJ V8	3



REMOVAL

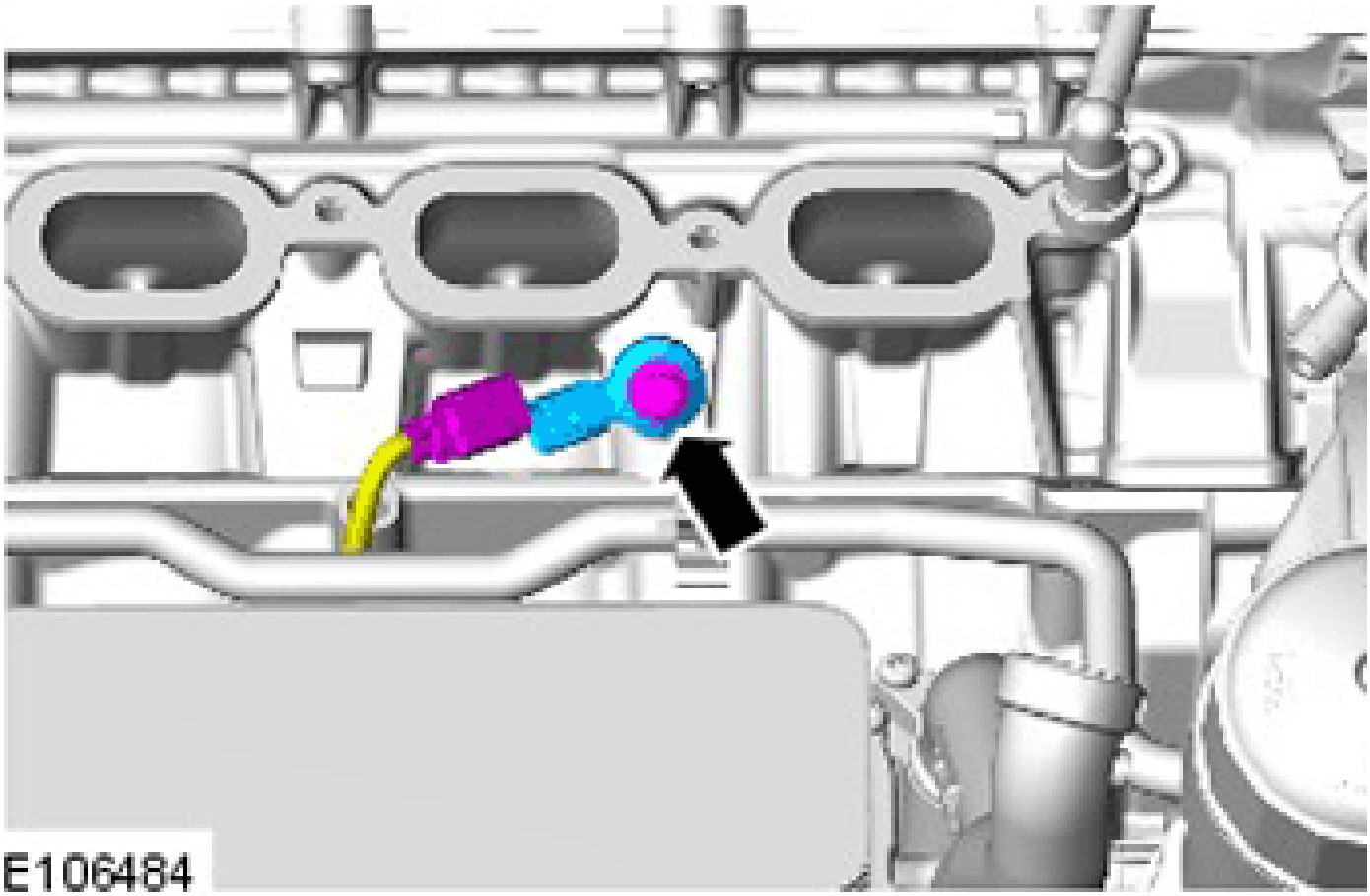
NOTE: **Removal steps in this procedure may contain installation details.**

1. Raise and support the vehicle.

   WARNING: **Make sure to support the vehicle with axle stands.**

2. Refer to: **Supercharger** (Removal and Installation). Refer to: **Supercharger** (Removal and Installation).

3. *Torque Specification:* **20 Nm**

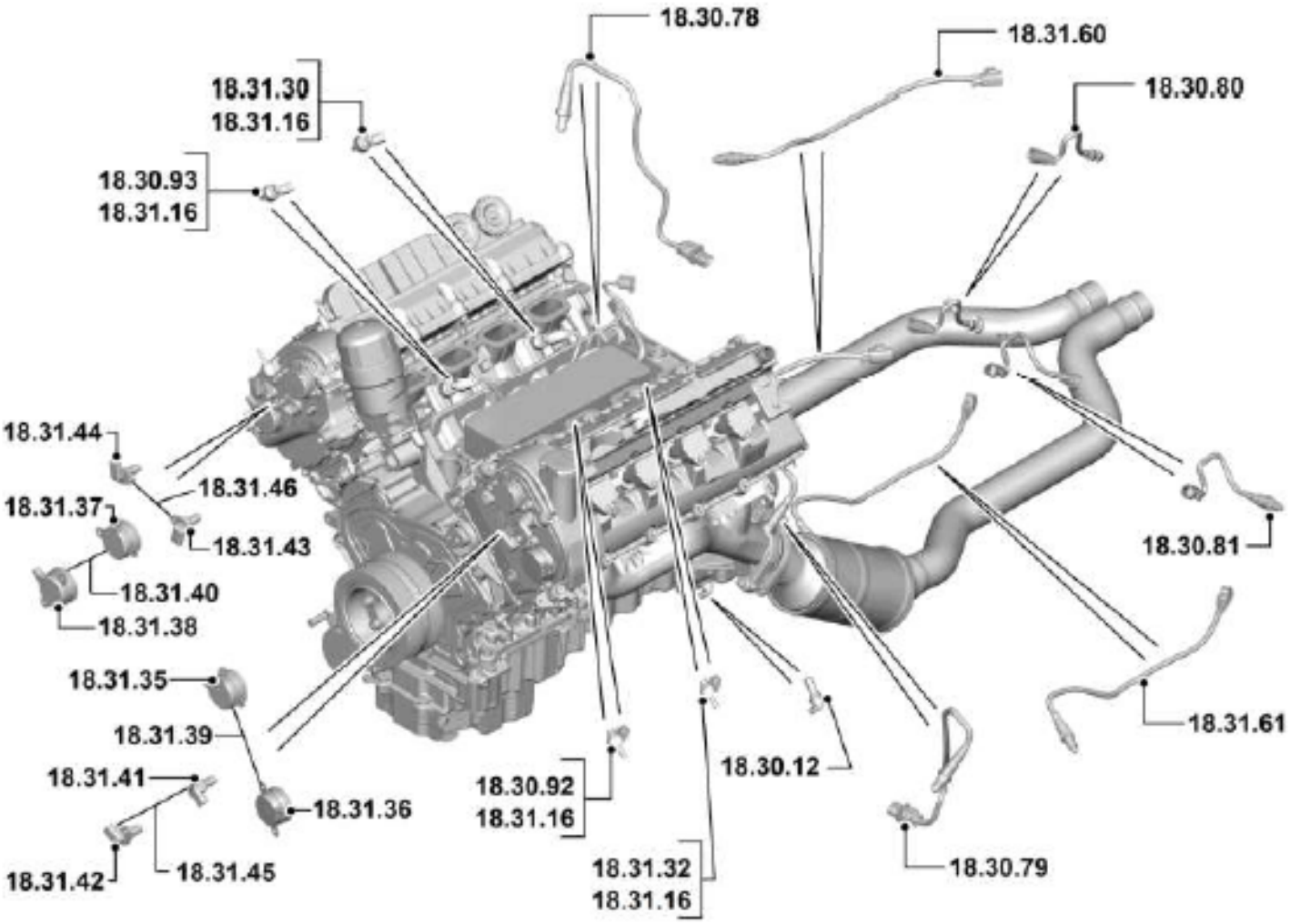


INSTALLATION

1. To install, reverse the removal procedure.

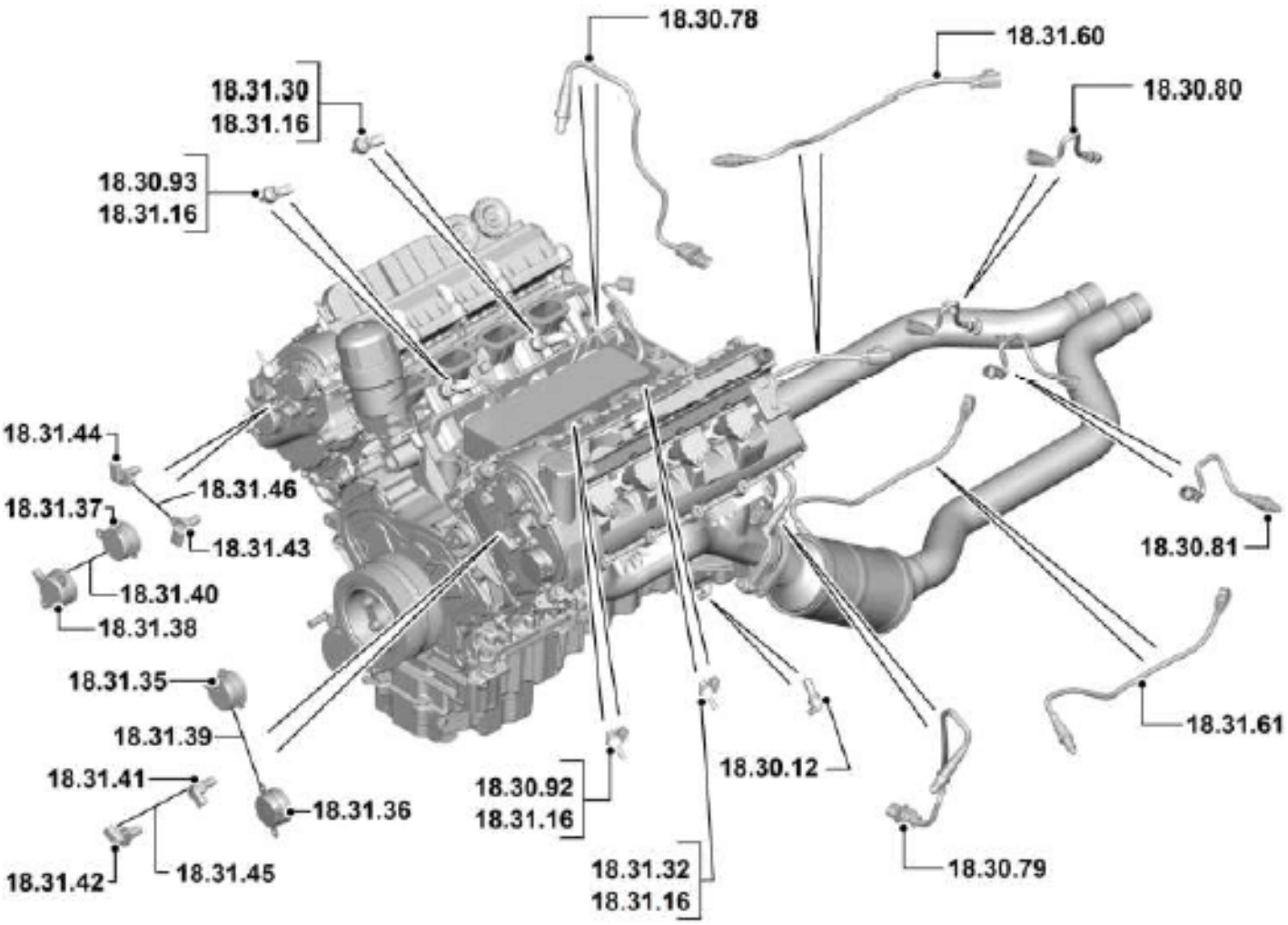
KNOCK SENSOR (KS) RH (G1917130)

18.30.93	ENGINE KNOCK SENSOR - RIGHT HAND - RENEW	3000 CC, AJ V6 (AJ126)	2.9



JRT1218

18.30.93	ENGINE KNOCK SENSOR - RIGHT HAND - RENEW	5000 CC, AJ V8	3



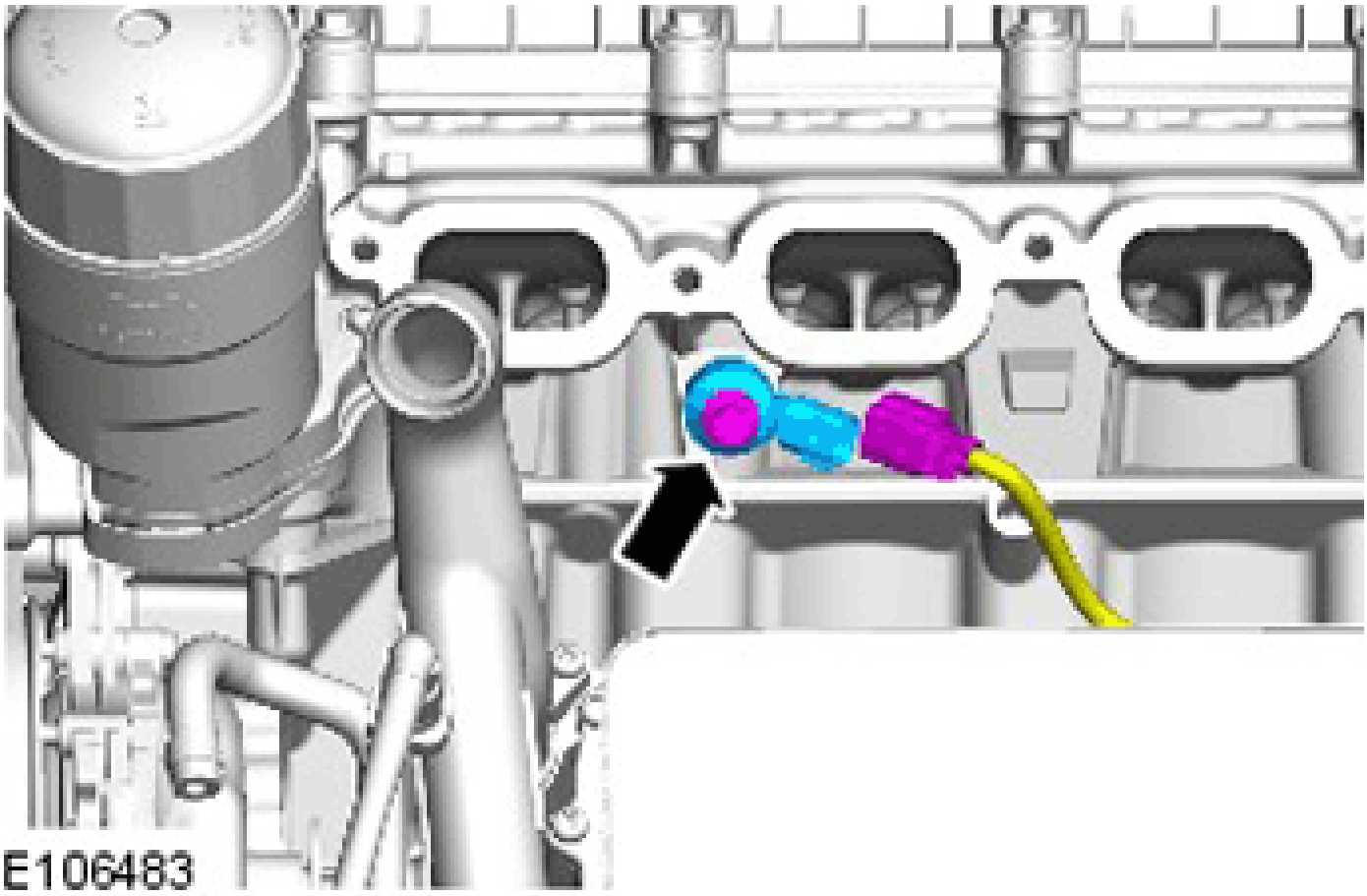
REMOVAL

NOTE: **Removal steps in this procedure may contain installation details.**

1. Raise and support the vehicle.

   WARNING: **Make sure to support the vehicle with axle stands.**

2. Refer to: **Supercharger** (Removal and Installation). Refer to: **Supercharger** (Removal and Installation).
3. *Torque Specification:* **20 Nm**



INSTALLATION

1. To install, reverse the removal procedure.

LEFT MID CATALYST HEATED OXYGEN SENSOR (HO2S) (G1917134)

SPECIAL TOOL(S)

	**310-121** Wrench, H02S

REMOVAL

WARNING: **Observe due care when working near a hot exhaust system.**

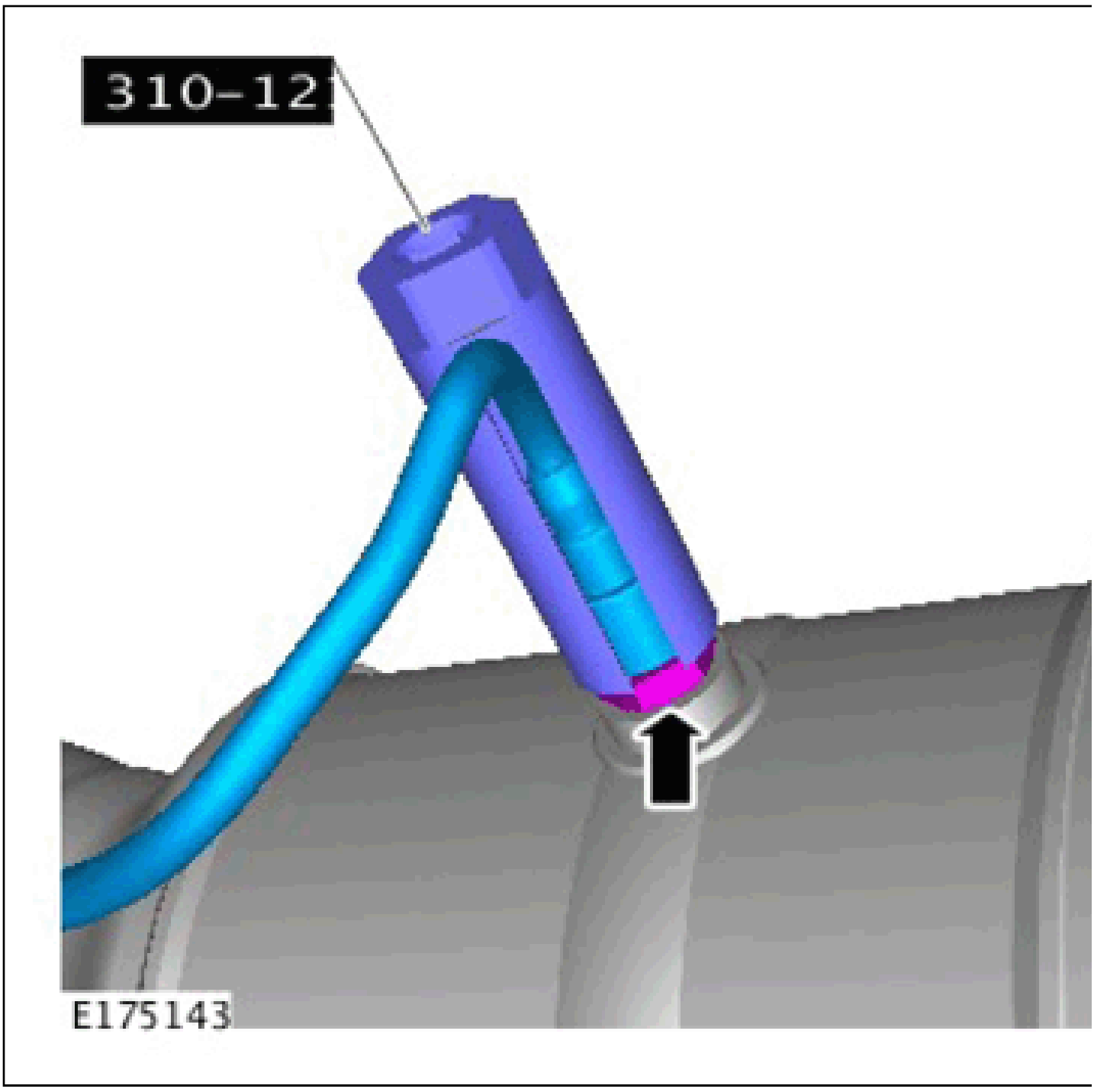
NOTE: **Removal steps in this procedure may contain installation details.**

1. **WARNING:** **Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.**

   Raise and support the vehicle.

2. Refer to: **Catalytic Converter LH** (Removal and Installation).

   Refer to: **Catalytic Converter LH** (Removal and Installation).

3. 

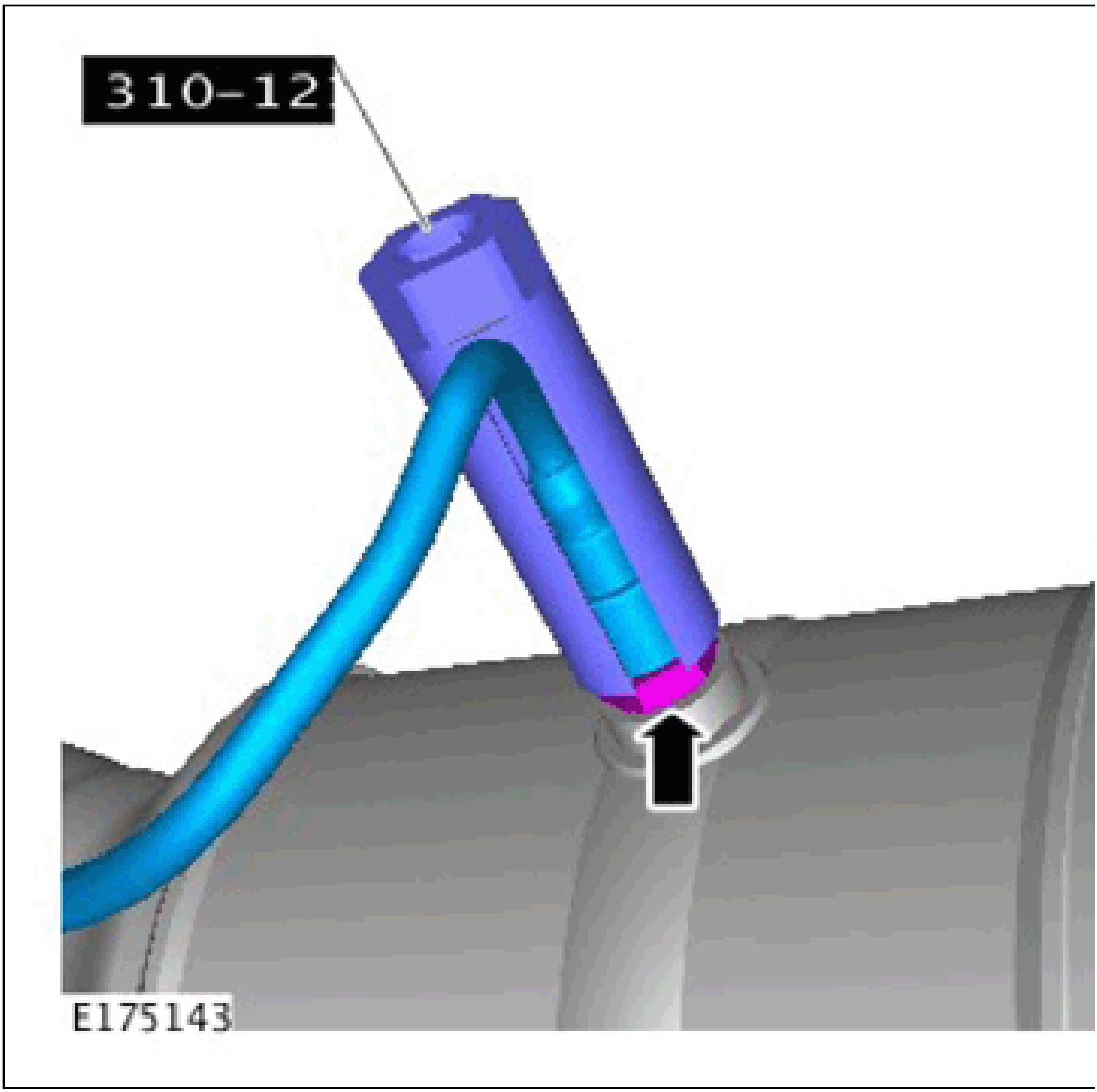
   Special Tool(s): 310-121

INSTALLATION

1. **CAUTION:**
   - **Make sure that the mating faces are clean and free of corrosion and foreign material.**
   - **Make sure the anti-seize compound does not contact the HO2S tip.**

- **If accidentally dropped or knocked install a new sensor.**

NOTE: **If the original sensor is to be installed, apply lubricant meeting specification ESE-M12A4-A to the thread of the sensor.**



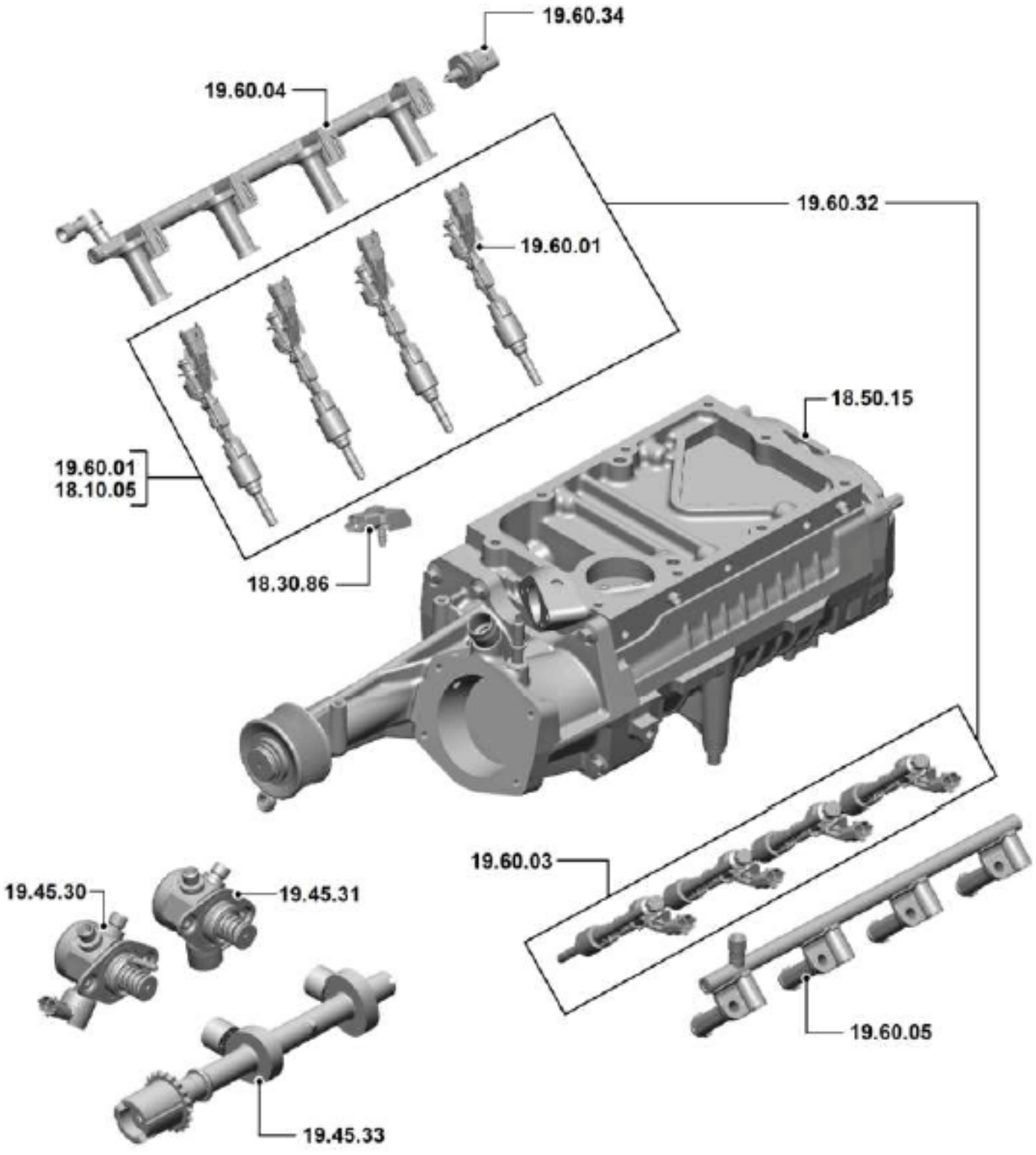
To install, reverse the removal procedure.

Special Tool(s): 310-121

Torque Specification: **48 Nm**

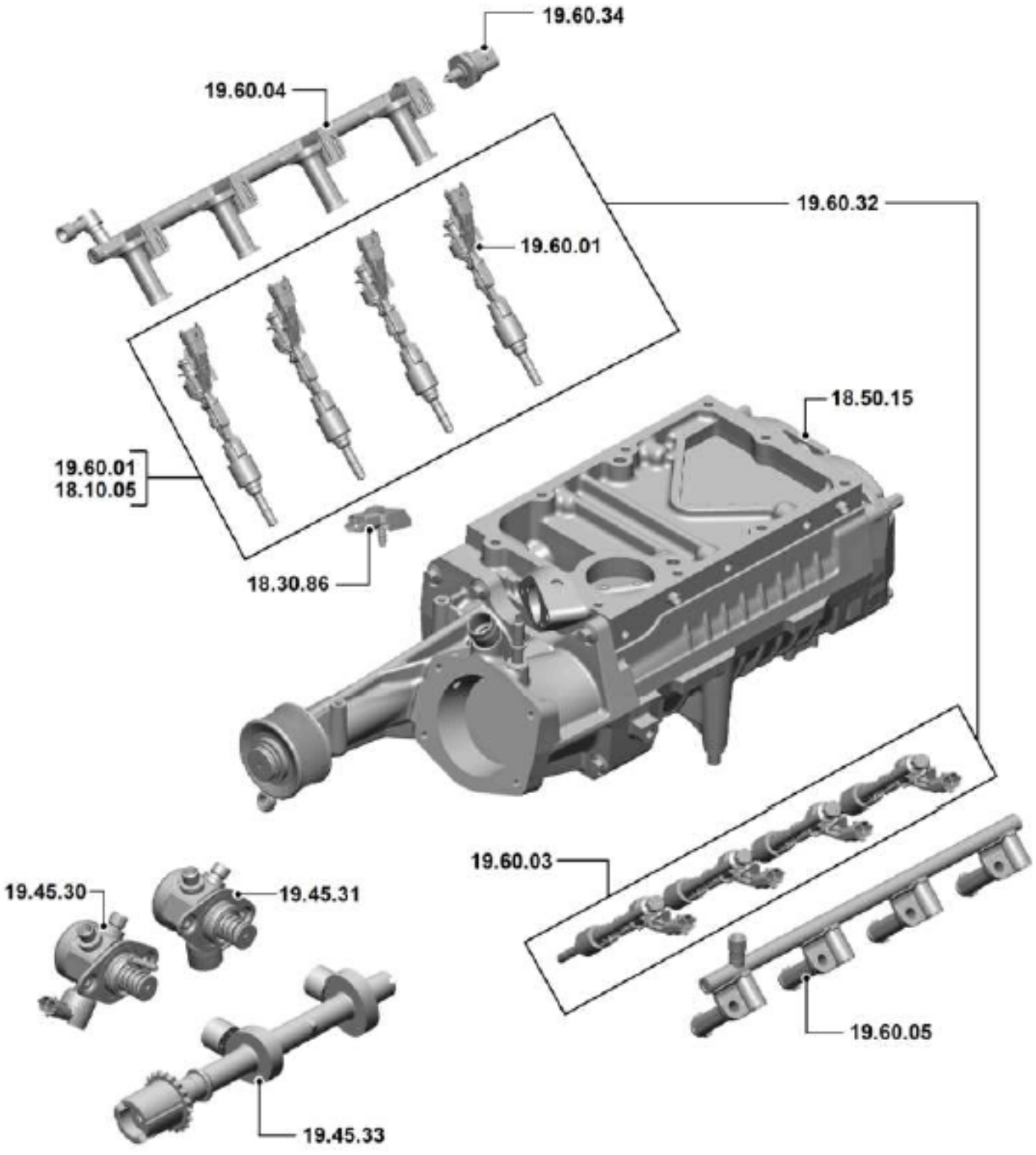
MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR (G1917137)

18.30.86	MANIFOLD ABSOLUTE PRESSURE SENSOR - VEHICLE SET - RENEW	3000 CC, AJ V6 (AJ126)	0.4


19.60.34
19.60.04
19.60.32
19.60.01
18.50.15
19.60.01
18.10.05
18.30.86
19.60.03
19.45.30
19.45.31
19.60.05
19.45.33

JRT1216A

18.30.86	MANIFOLD ABSOLUTE PRESSURE SENSOR - VEHICLE SET - RENEW	5000 CC, AJ V8	0.4


19.60.34
19.60.04
19.60.32
19.60.01
18.50.15
19.60.01
18.10.05
18.30.86
19.60.03
19.45.30
19.45.31
19.60.05
19.45.33

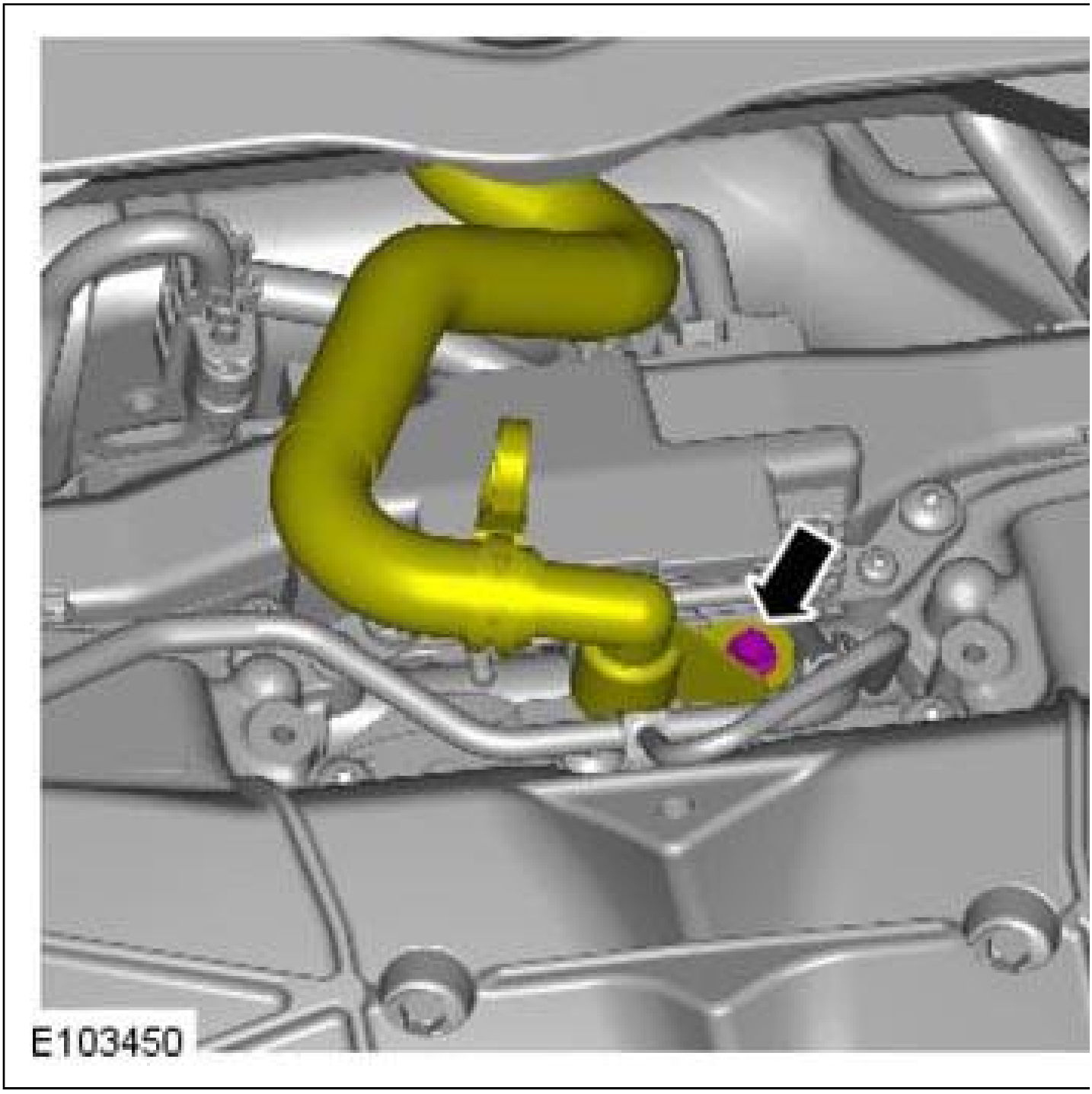
JRT1216A

REMOVAL

NOTE:

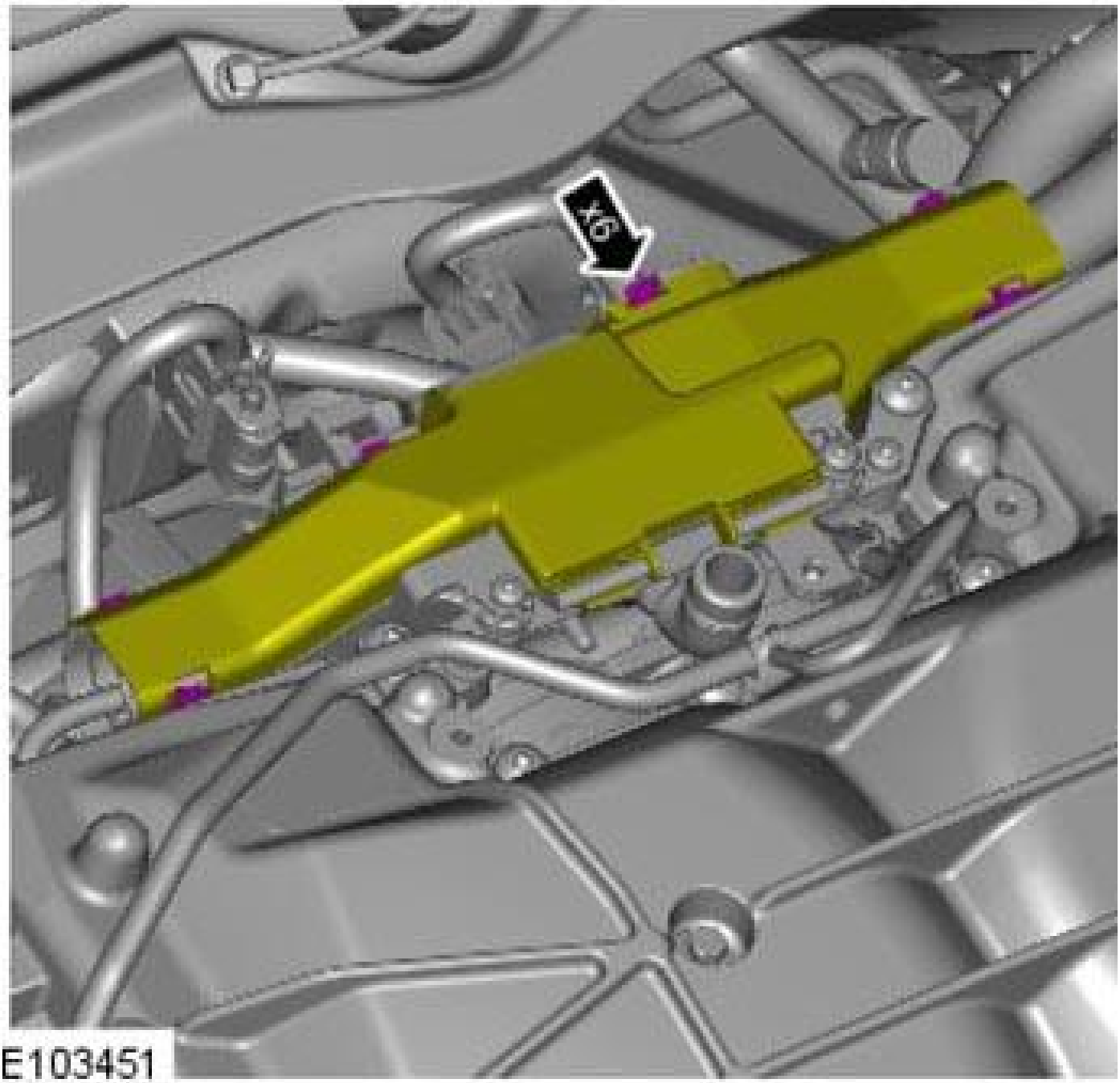
- **Removal steps in this procedure may contain installation details.**
- **Some variation in the illustrations may occur, but the essential information is always correct.**

1. Refer to: **Engine Cover** (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. **CAUTION: Be prepared to collect escaping coolant.**

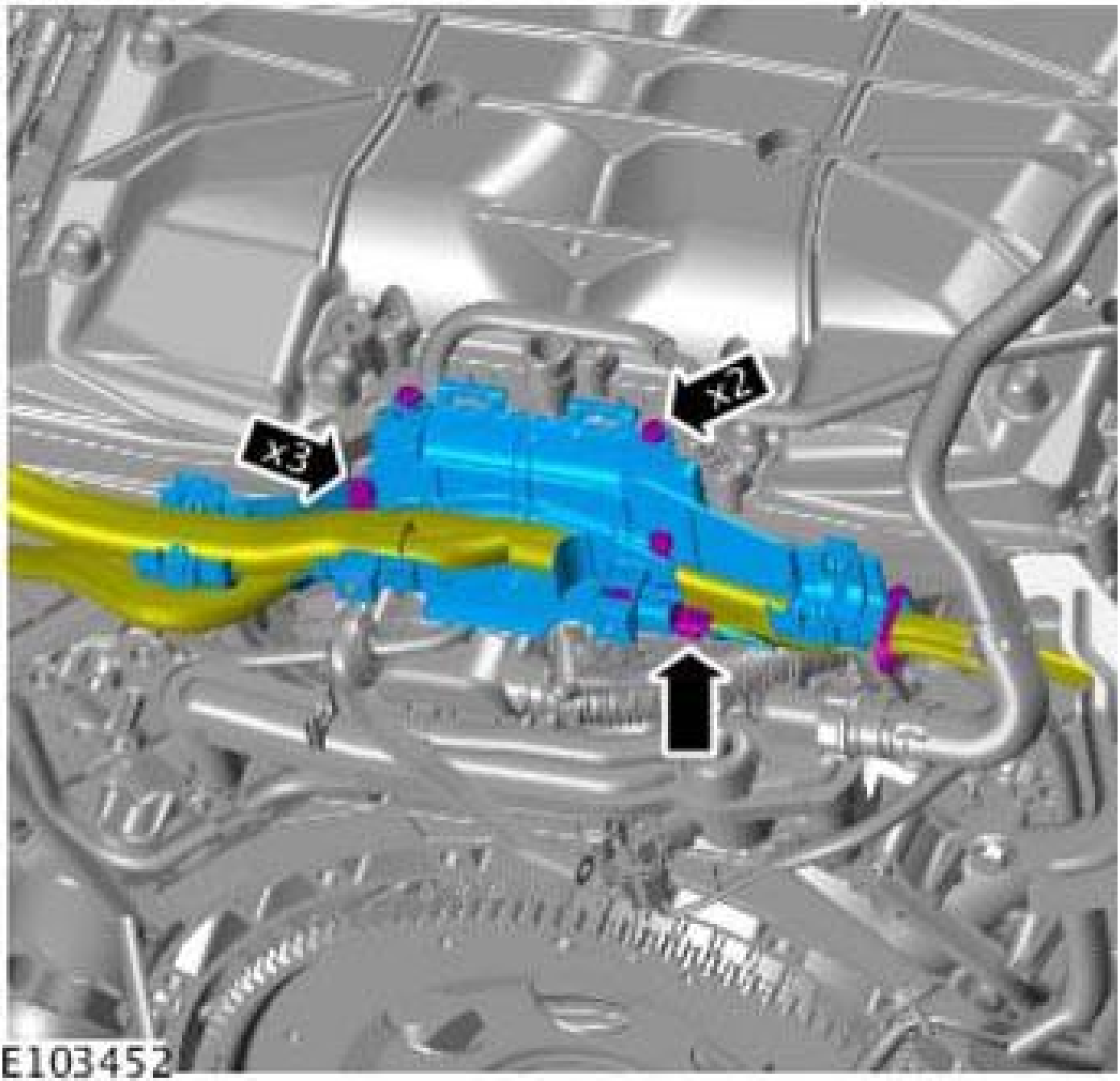


Torque Specification: **10 Nm**

3.

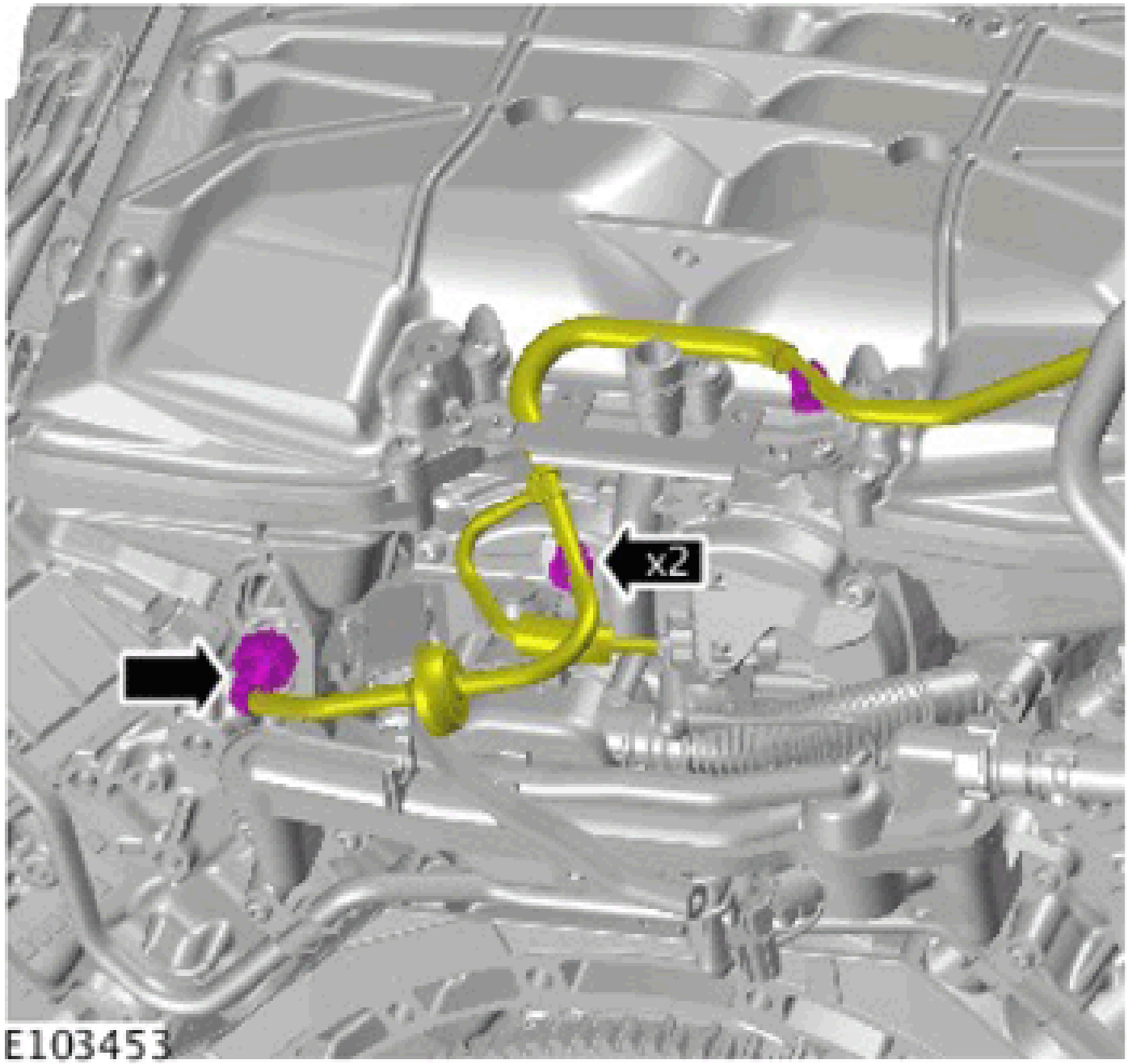


4.

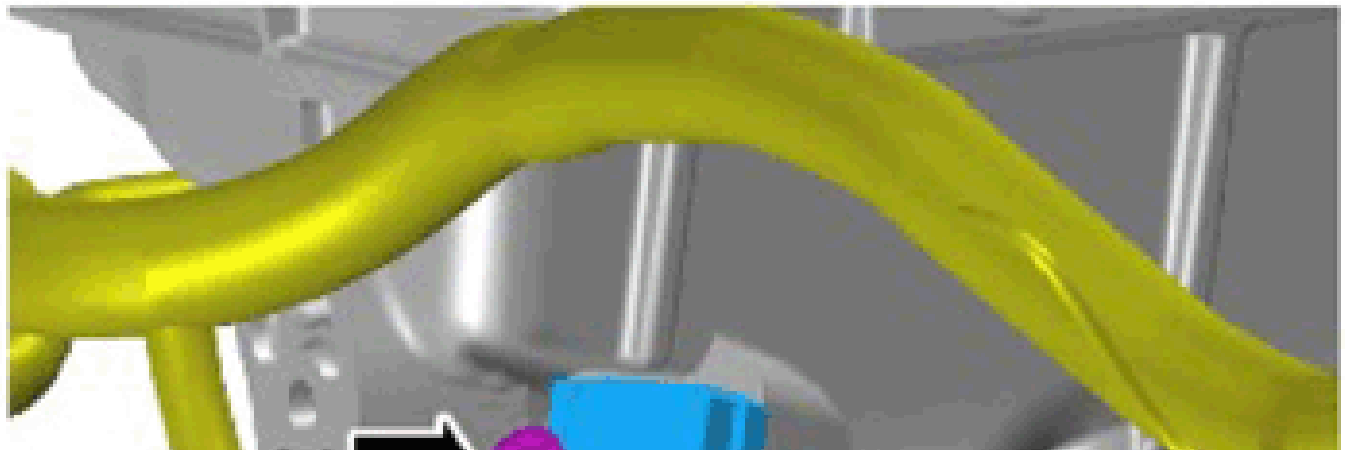


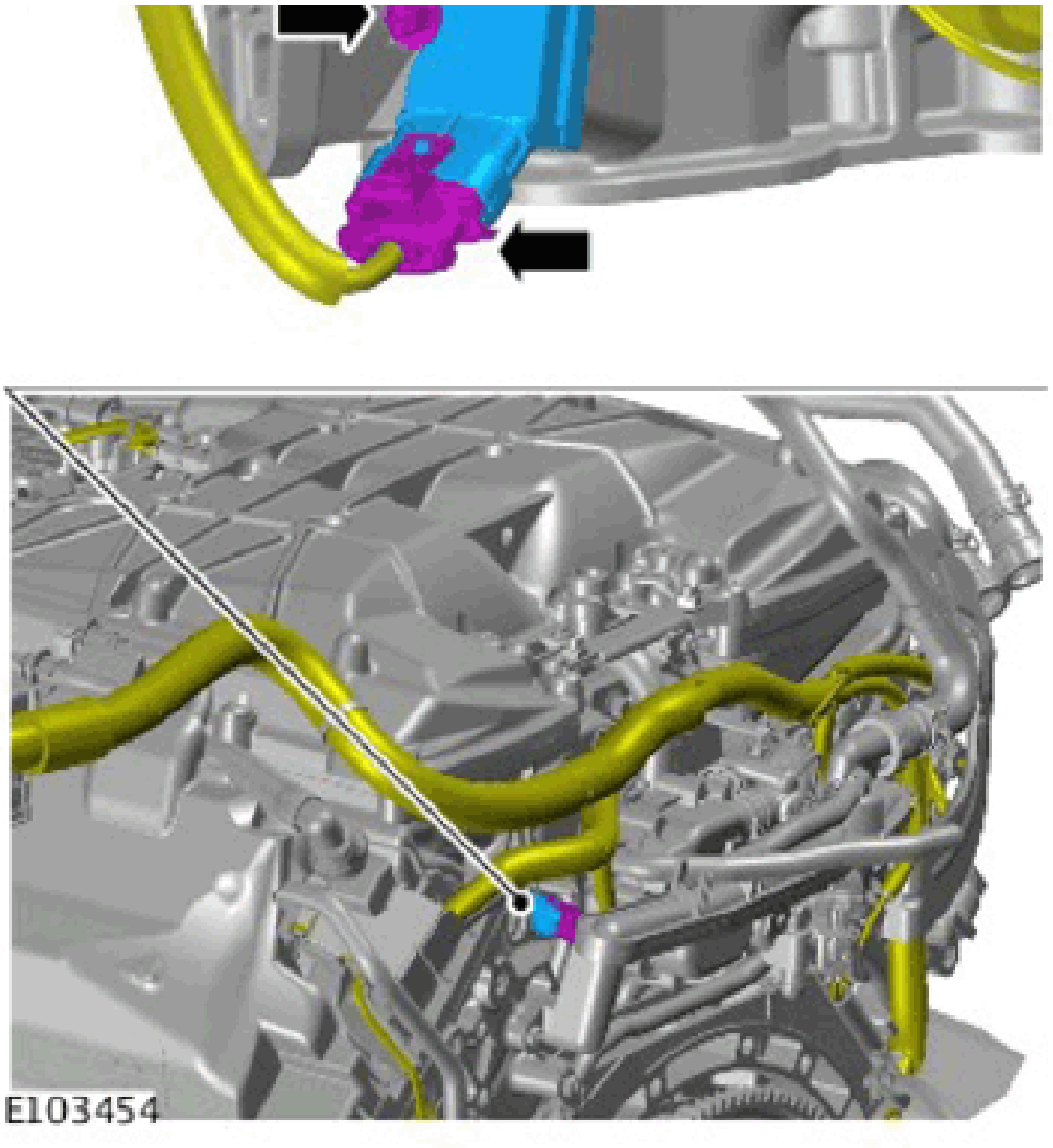
Torque Specification: **10 Nm**

5.



6.





Torque Specification: **5 Nm**

INSTALLATION

1. To install, reverse the removal procedure.

MASS AIR FLOW (MAF) SENSOR (G1917138)

REMOVAL

NOTE:

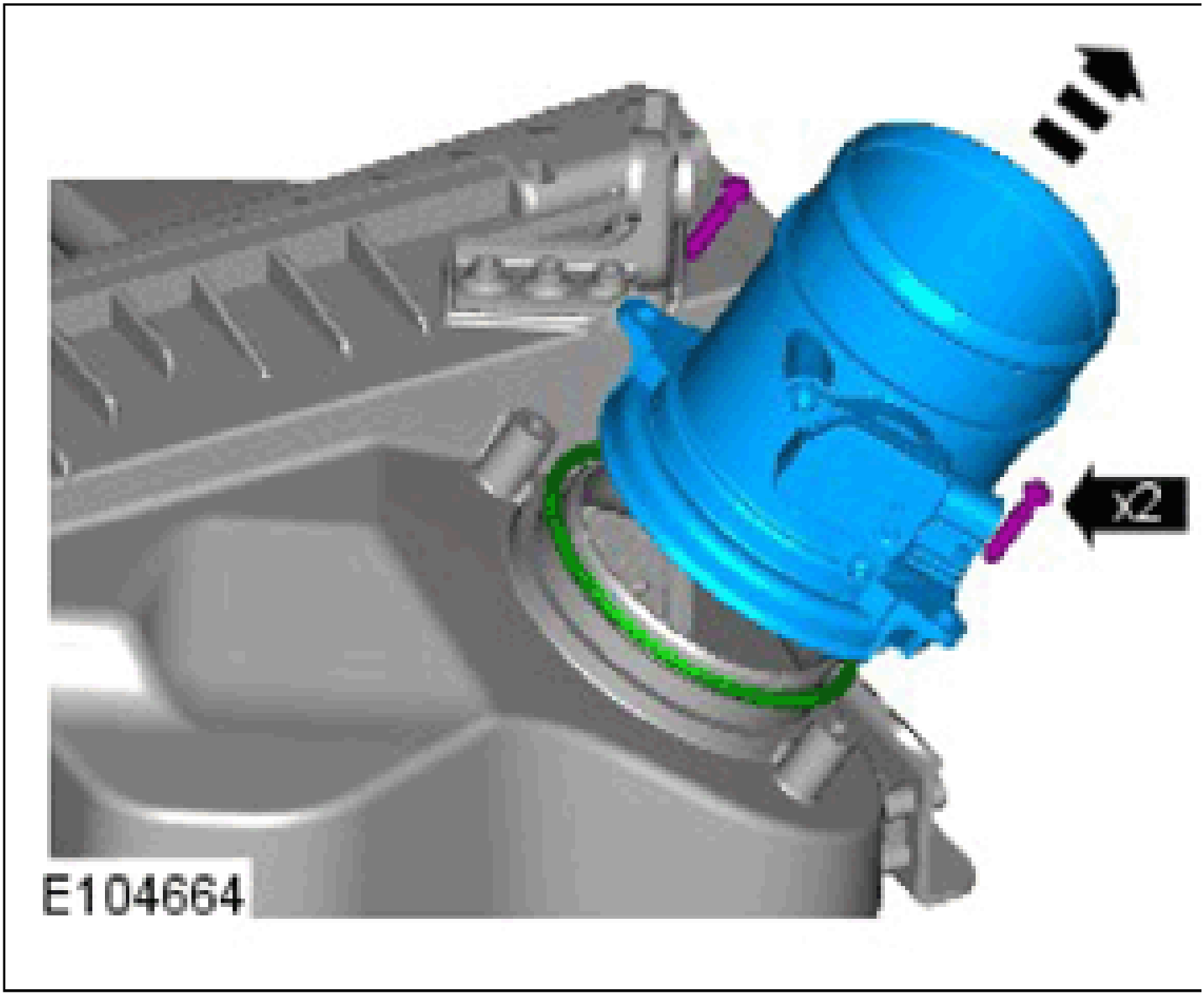
- **Removal steps in this procedure may contain installation details.**
- **LH illustration shown, RH is similar.**

1. Refer to: **Air Cleaner LH** (Removal and Installation).

Refer to: **Air Cleaner LH** (Removal and Installation).

2. **CAUTION: Make sure support the vehicle, with axle stands.**

   Raise and support the vehicle.

3. 

   Torque Specification: **3.5 Nm**

INSTALLATION

1. To install, reverse the removal procedure.

POWERTRAIN CONTROL MODULE (PCM) (G1917144)

REMOVAL

1. Authoring Template

INSTALLATION

1. Authoring Template

POST CATALYST HEATED OXYGEN SENSOR (HO2S) (G1917136)

SPECIAL TOOL(S)

	310-121 Wrench, H02S

REMOVAL

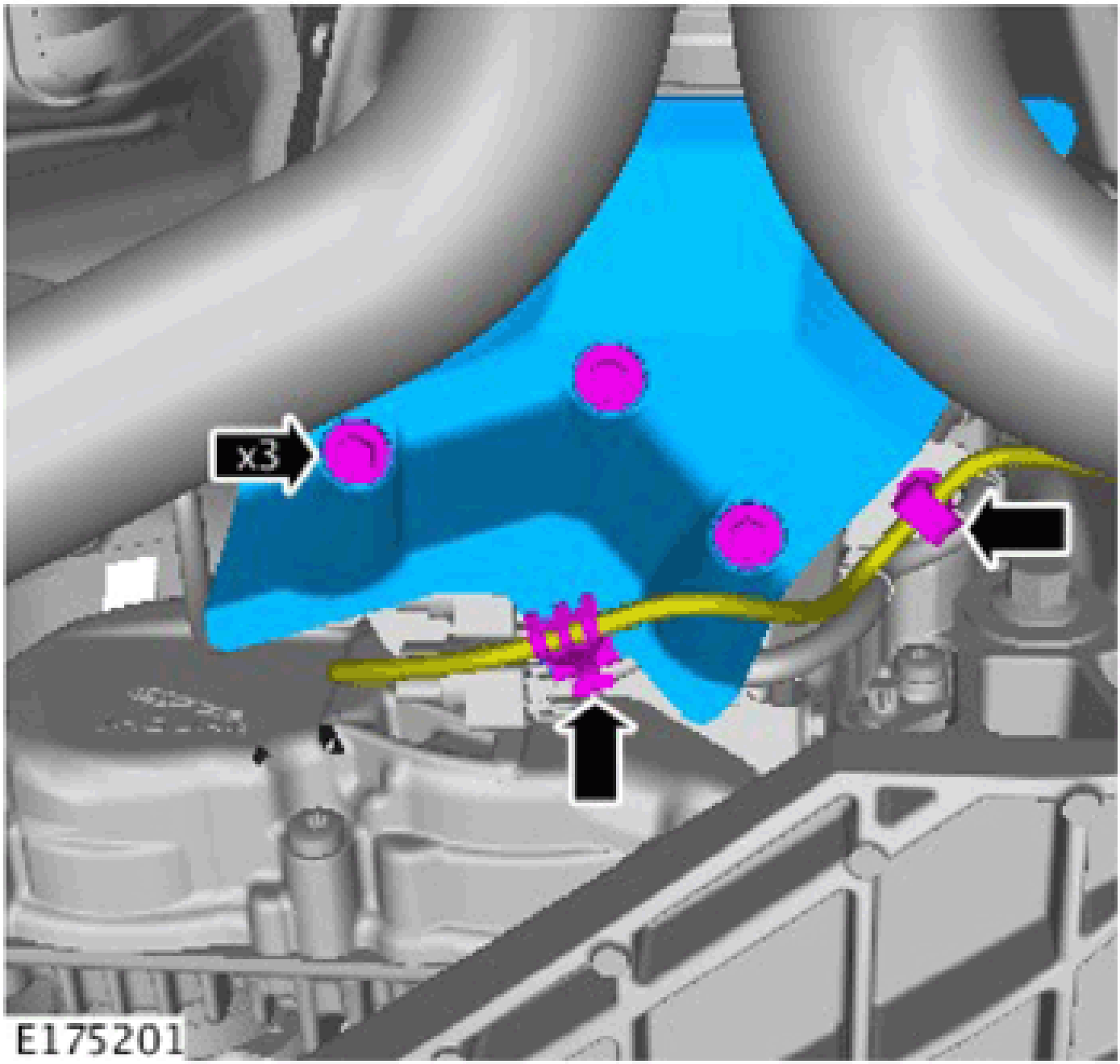
WARNING: **Observe due care when working near a hot exhaust system.**

NOTE: **Removal steps in this procedure may contain installation details.**

1. **WARNING:** **Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.**

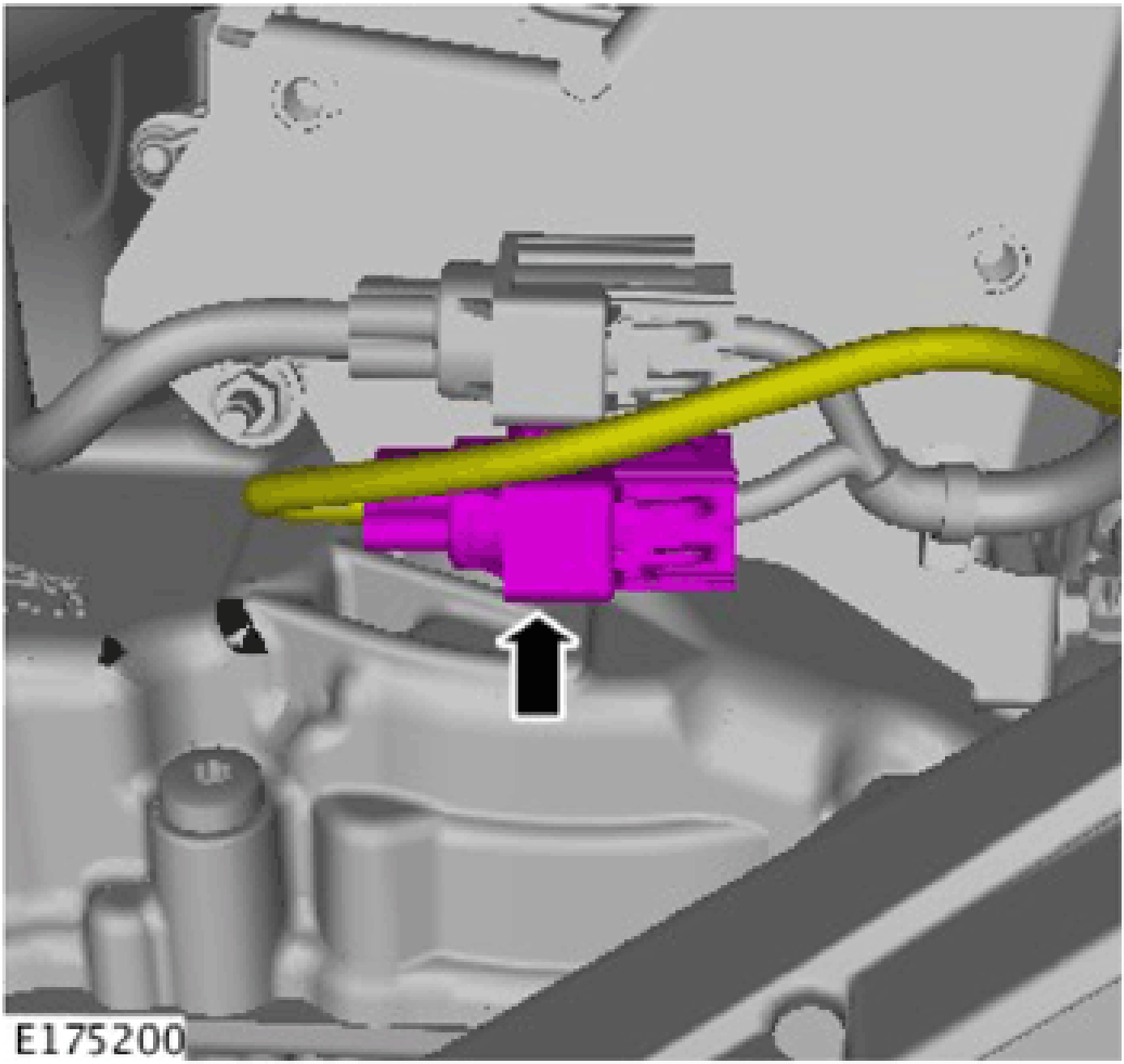
   Raise and support the vehicle.

2.

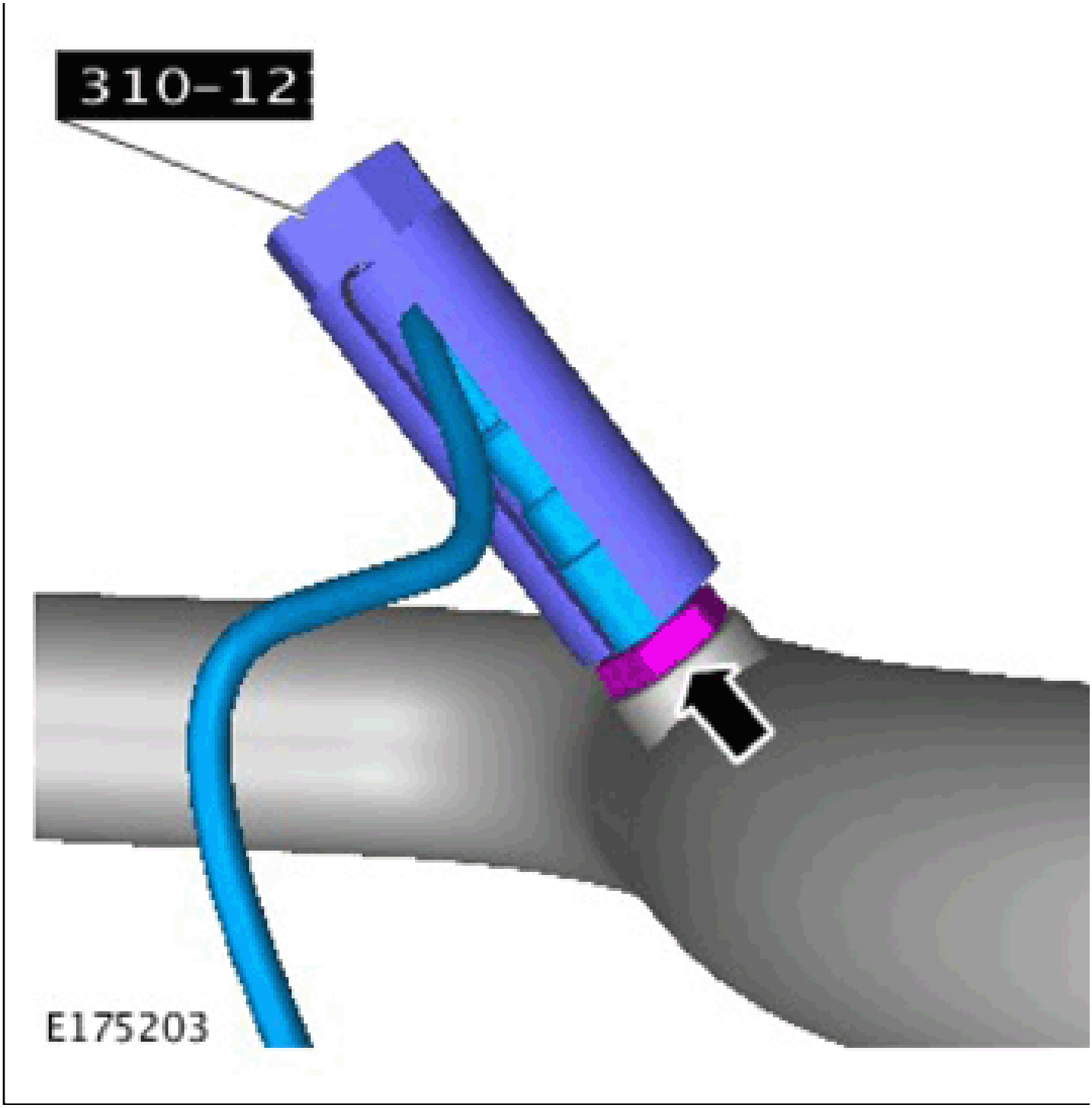


Torque Specification: **9 Nm**

3. **NOTE:** **RH illustration shown, LH is similar.**



4.

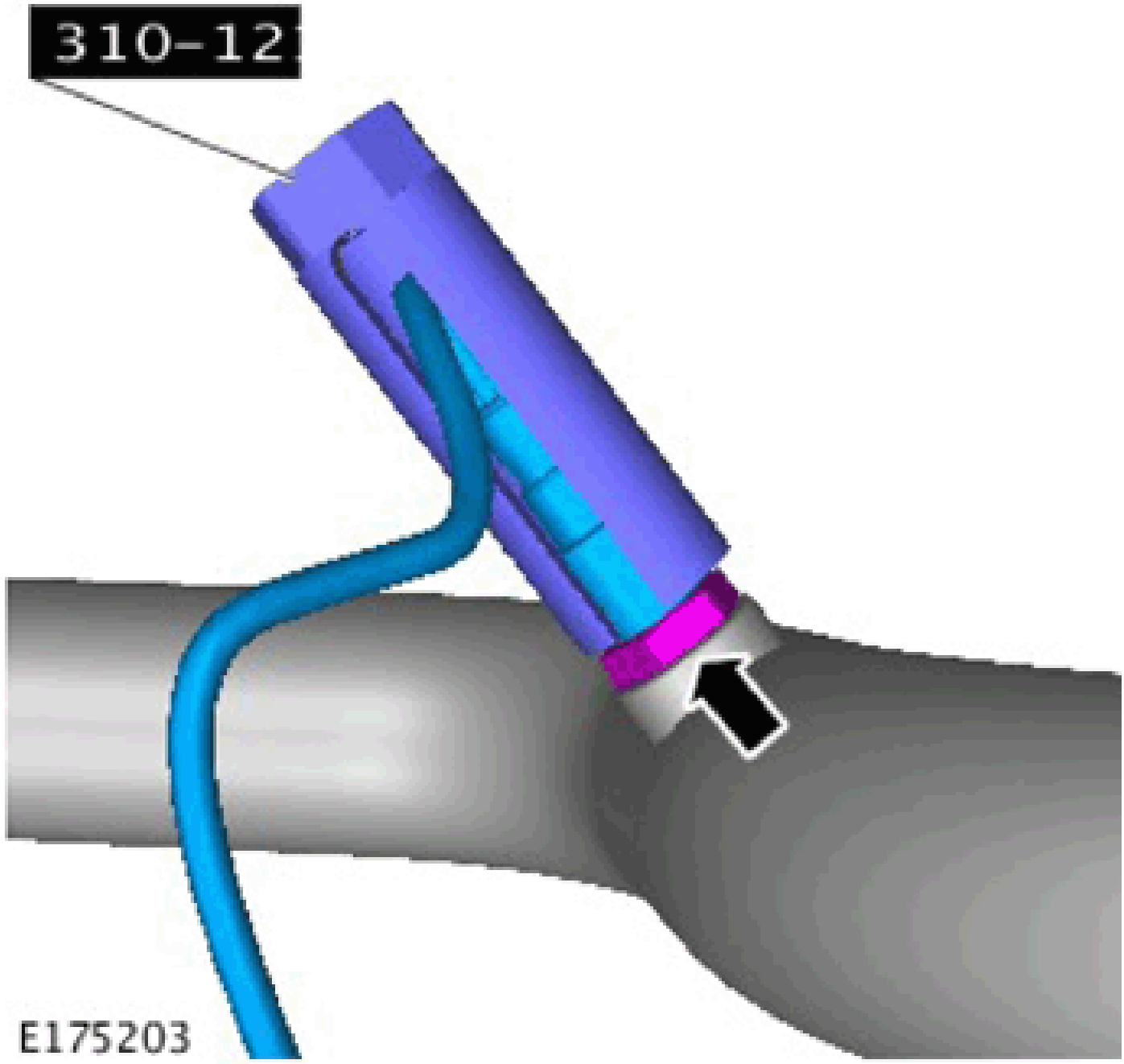


Special Tool(s): 310-121

INSTALLATION

1. **CAUTION:**
   - **Make sure that the mating faces are clean and free of corrosion and foreign material.**
   - **Make sure the anti-seize compound does not contact the HO2S tip.**
   - **If accidentally dropped or knocked install a new sensor.**

NOTE: **If the original sensor is to be installed, apply lubricant meeting specification ESE-M12A4-A to the thread of the sensor.**



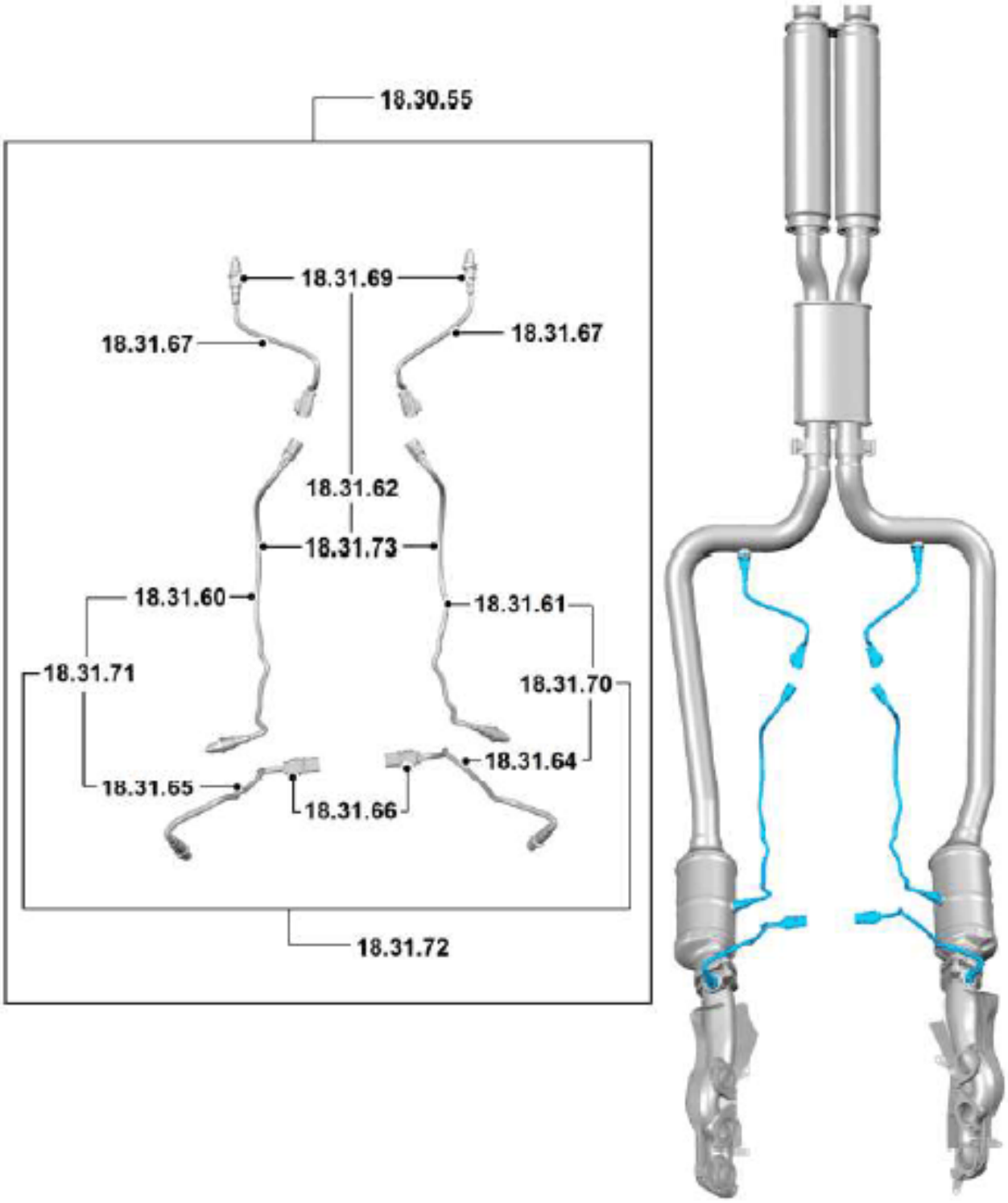
To install, reverse the removal procedure.

Special Tool(s): 310-121

Torque Specification: **48 Nm**

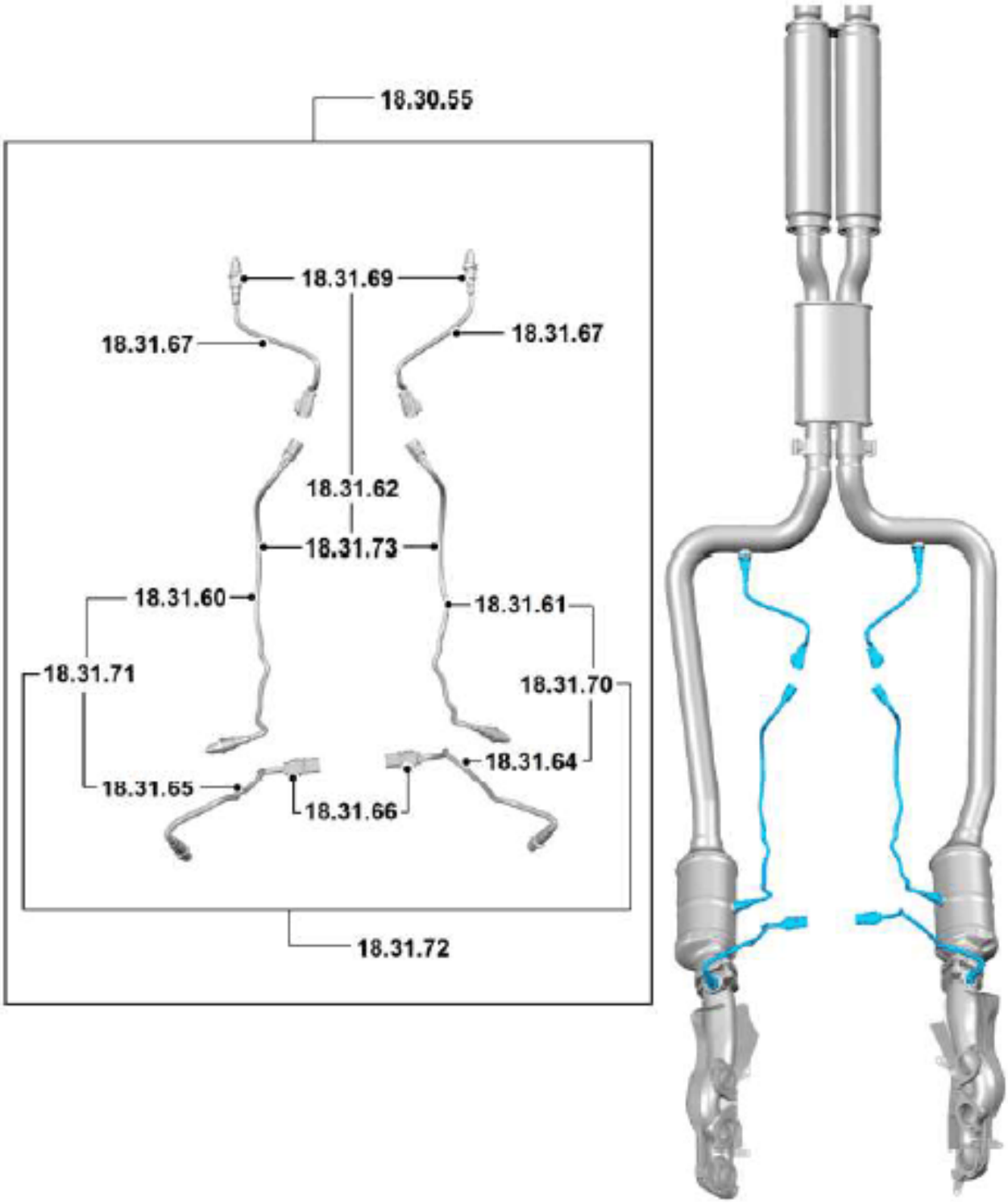
RIGHT MID CATALYST HEATED OXYGEN SENSOR (HO2S) (G1917135)

18.31.60	HEATED OXYGEN SENSOR (HO2S) - MID CATALYST - RIGHT BANK - RENEW	3000 CC, AJ V6 (AJ126)	1.1


18.30.55
18.31.69
18.31.67
18.31.67
18.31.62
18.31.73
18.31.60
18.31.61
18.31.71
18.31.70
18.31.64
18.31.65
18.31.66
18.31.72

JRT1558

18.31.60	HEATED OXYGEN SENSOR (HO2S) - MID CATALYST - RIGHT BANK - RENEW	5000 CC, AJ V8	1.2


18.30.55
18.31.69
18.31.67
18.31.67
18.31.62
18.31.73
18.31.60
18.31.61
18.31.71
18.31.70
18.31.64
18.31.65
18.31.66
18.31.72

JRT1558

SPECIAL TOOL(S)

	**310-121** Wrench, H02S

REMOVAL

WARNING: **Observe due care when working near a hot exhaust system.**

NOTE: **Removal steps in this procedure may contain installation details.**

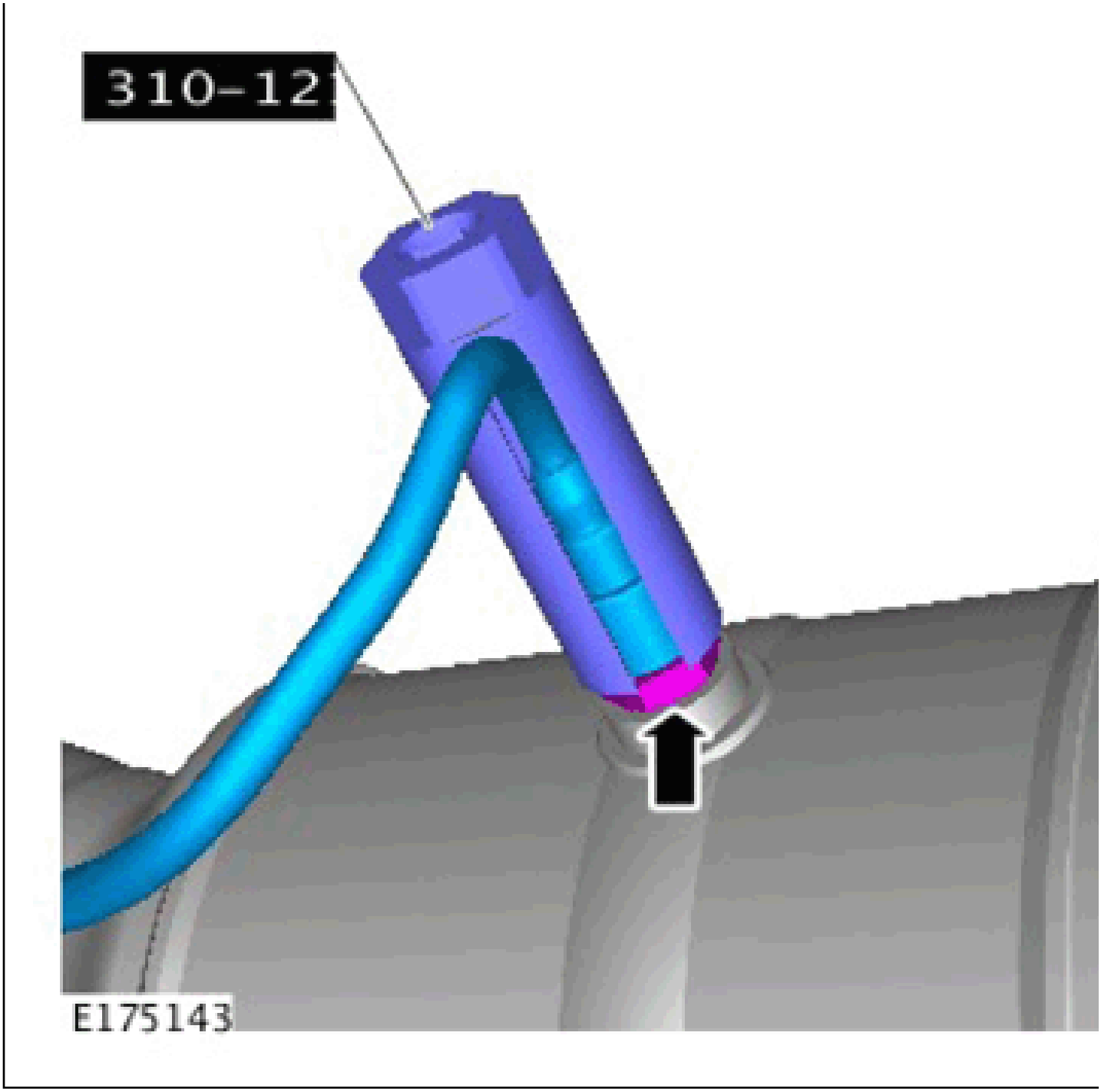
1. Raise and support the vehicle.

   WARNING: **Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.**

2. Refer to: **Catalytic Converter RH** (Removal and Installation).

   Refer to: **Catalytic Converter RH** (Removal and Installation).

3.

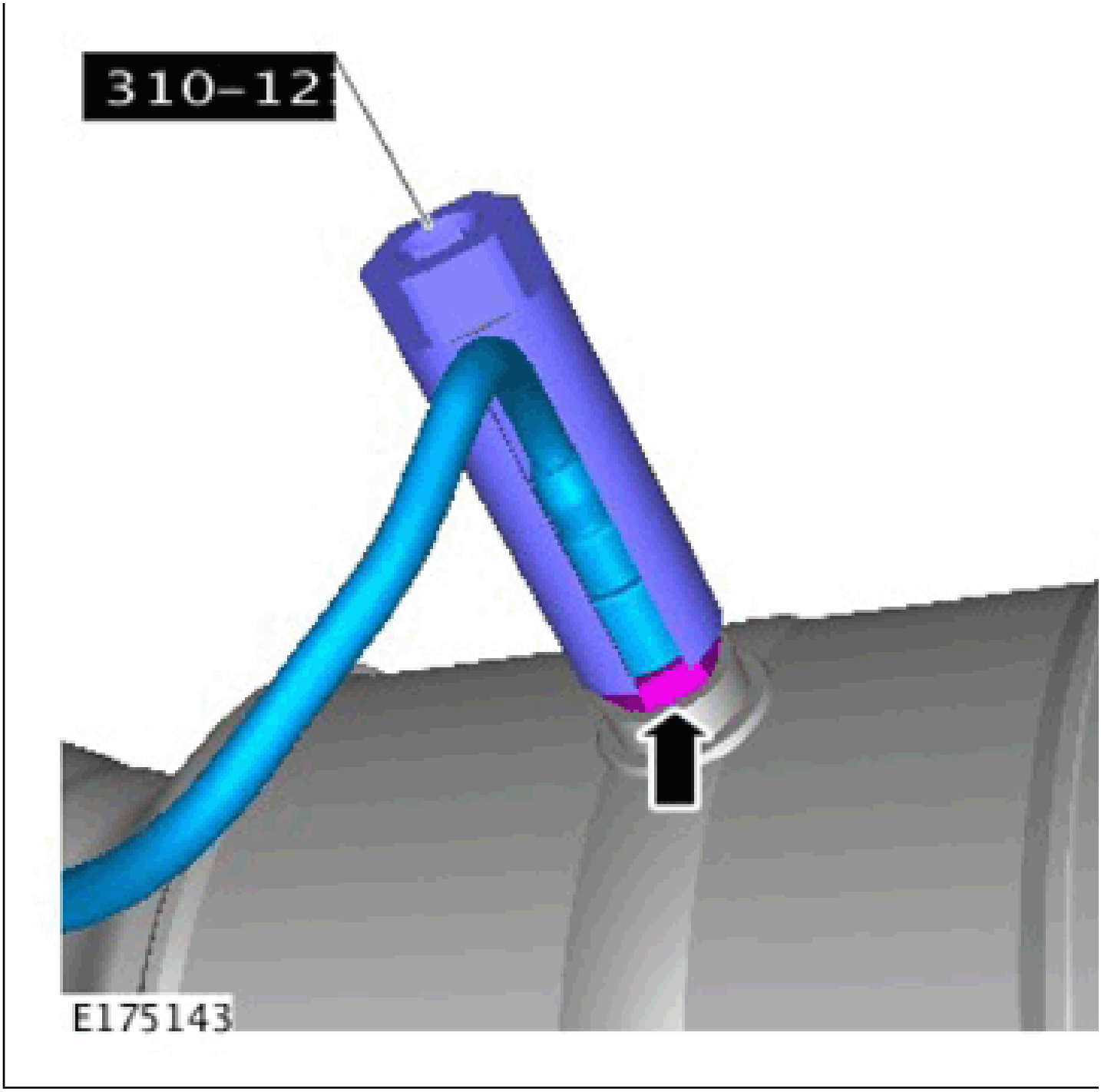


Special Tool(s): 310-121

INSTALLATION

1. **CAUTION:**
   - **Make sure that the mating faces are clean and free of corrosion and foreign material.**
   - **Make sure the anti-seize compound does not contact the HO2S tip.**
   - **If accidentally dropped or knocked install a new sensor.**

NOTE: **If the original sensor is to be installed, apply lubricant meeting specification ESE-M12A4-A to the thread of the sensor.**



To install, reverse the removal procedure.

Special Tool(s): 310-121

Torque Specification: **48 Nm**

REAR KNOCK SENSOR (KS) LH (G1917139)

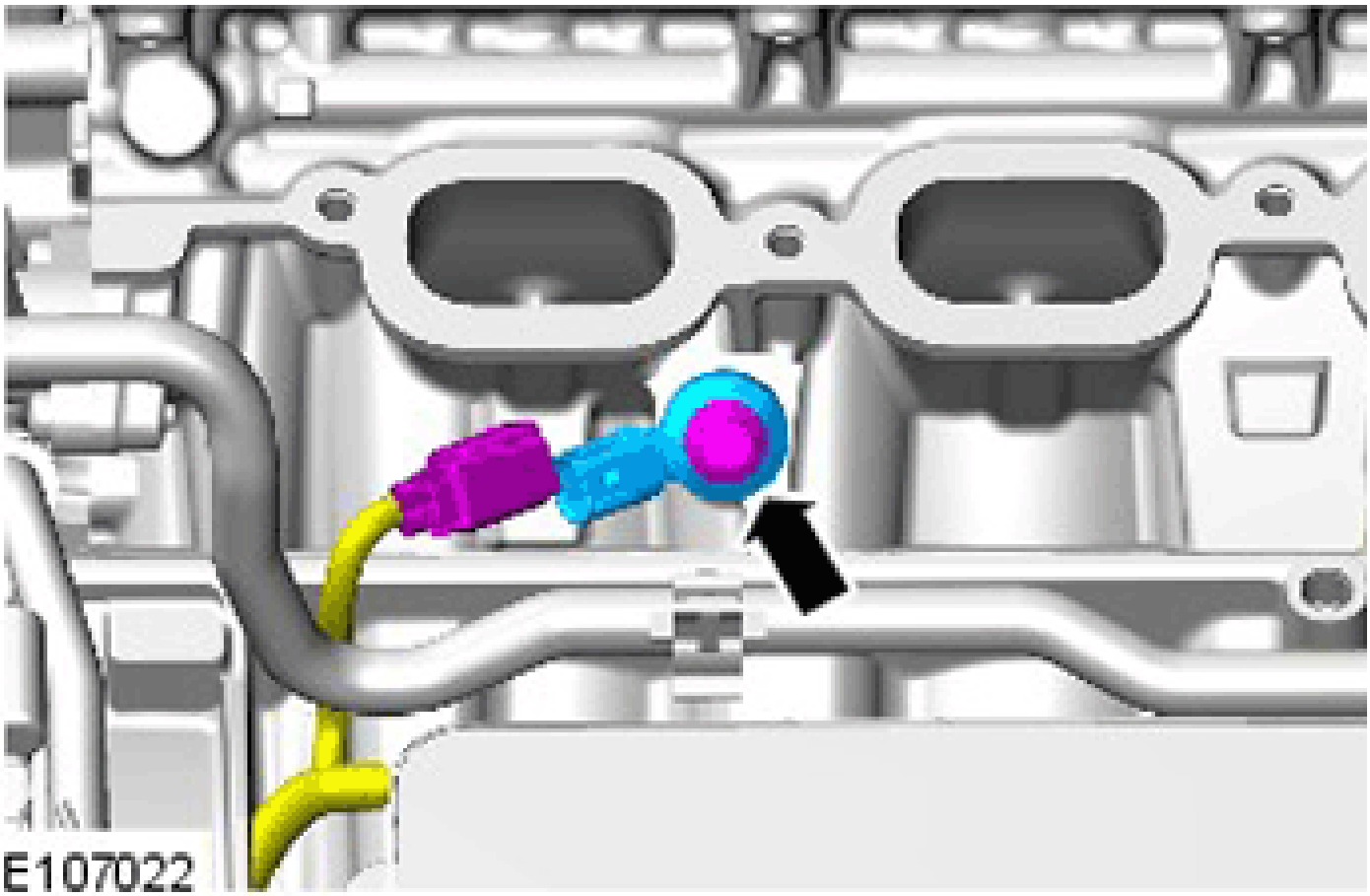
REMOVAL

NOTE: **Removal steps in this procedure may contain installation details.**

1. Refer to: **Battery Disconnect and Connect** (General Procedures).
2. Refer to: **Supercharger** (Removal and Installation).
3. Raise and support the vehicle.

WARNING: **Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.**

4. *Torque Specification:* **20 Nm**



INSTALLATION

1. To install, reverse the removal procedure.

REAR KNOCK SENSOR (KS) RH (G1917140)

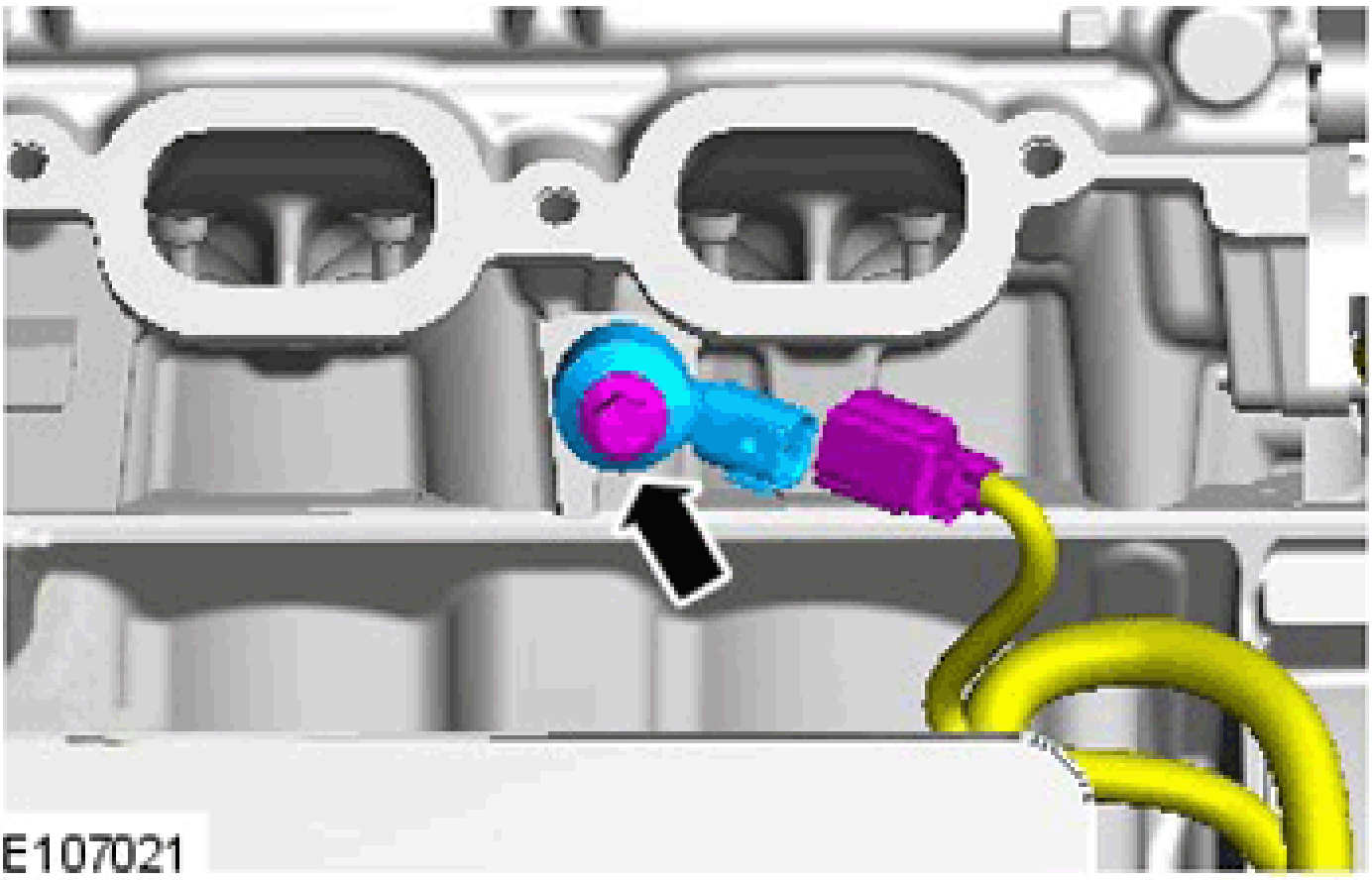
REMOVAL

NOTE: **Removal steps in this procedure may contain installation details.**

1. Refer to: **Battery Disconnect and Connect** (General Procedures).
2. Refer to: **Supercharger** (Removal and Installation).
3. Raise and support the vehicle.

WARNING: **Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.**

4. *Torque Specification:* **20 Nm**

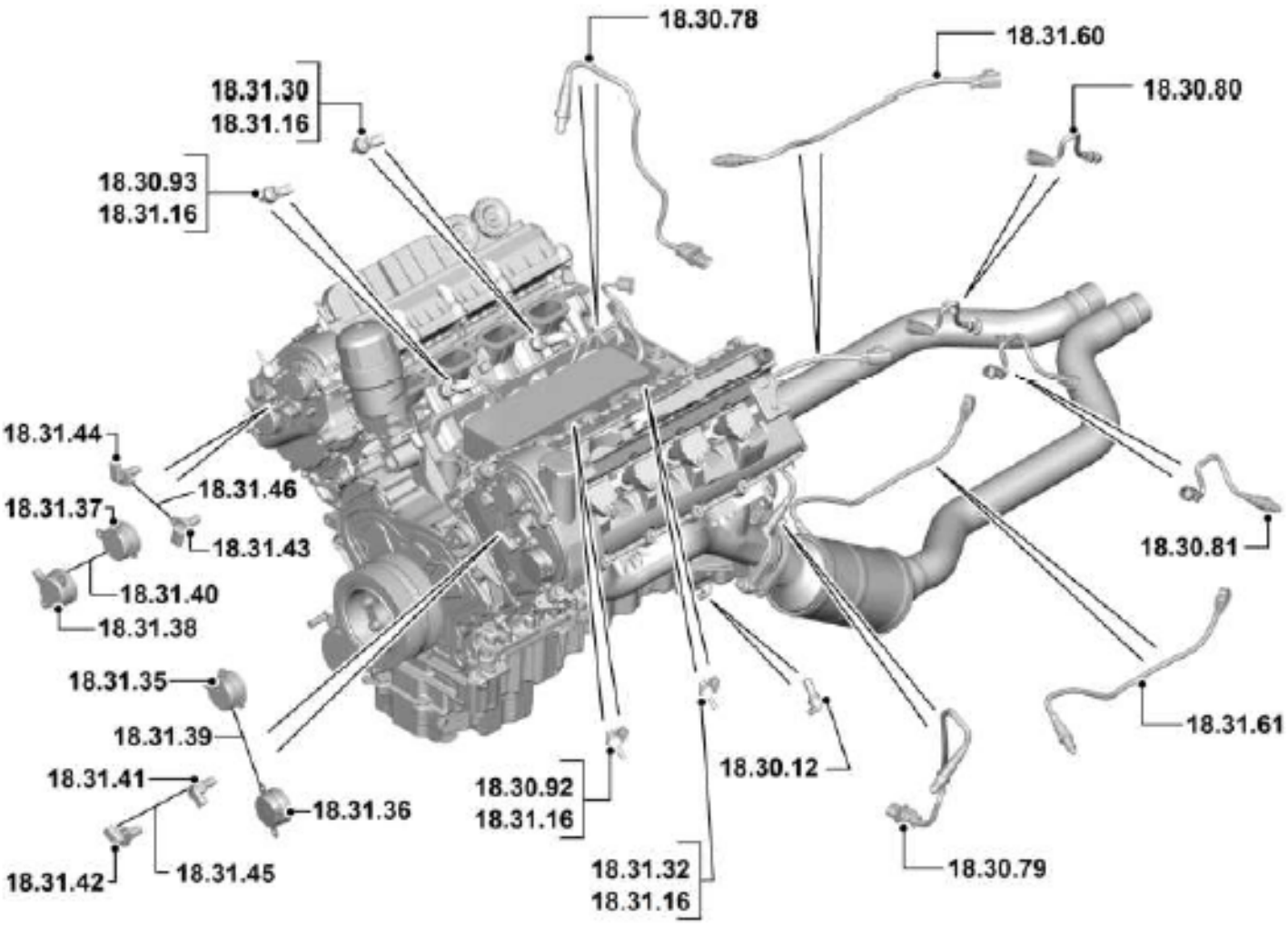


INSTALLATION

1. To install, reverse the removal procedure.

VARIABLE VALVE TIMING (VVT) OIL CONTROL SOLENOID LH (G1917141) (2016)

18.31.35	VARIABLE INTAKE VALVE TIMING SOLENOID - B BANK - RENEW	ALL DERIVATIVES	1.3



REMOVAL

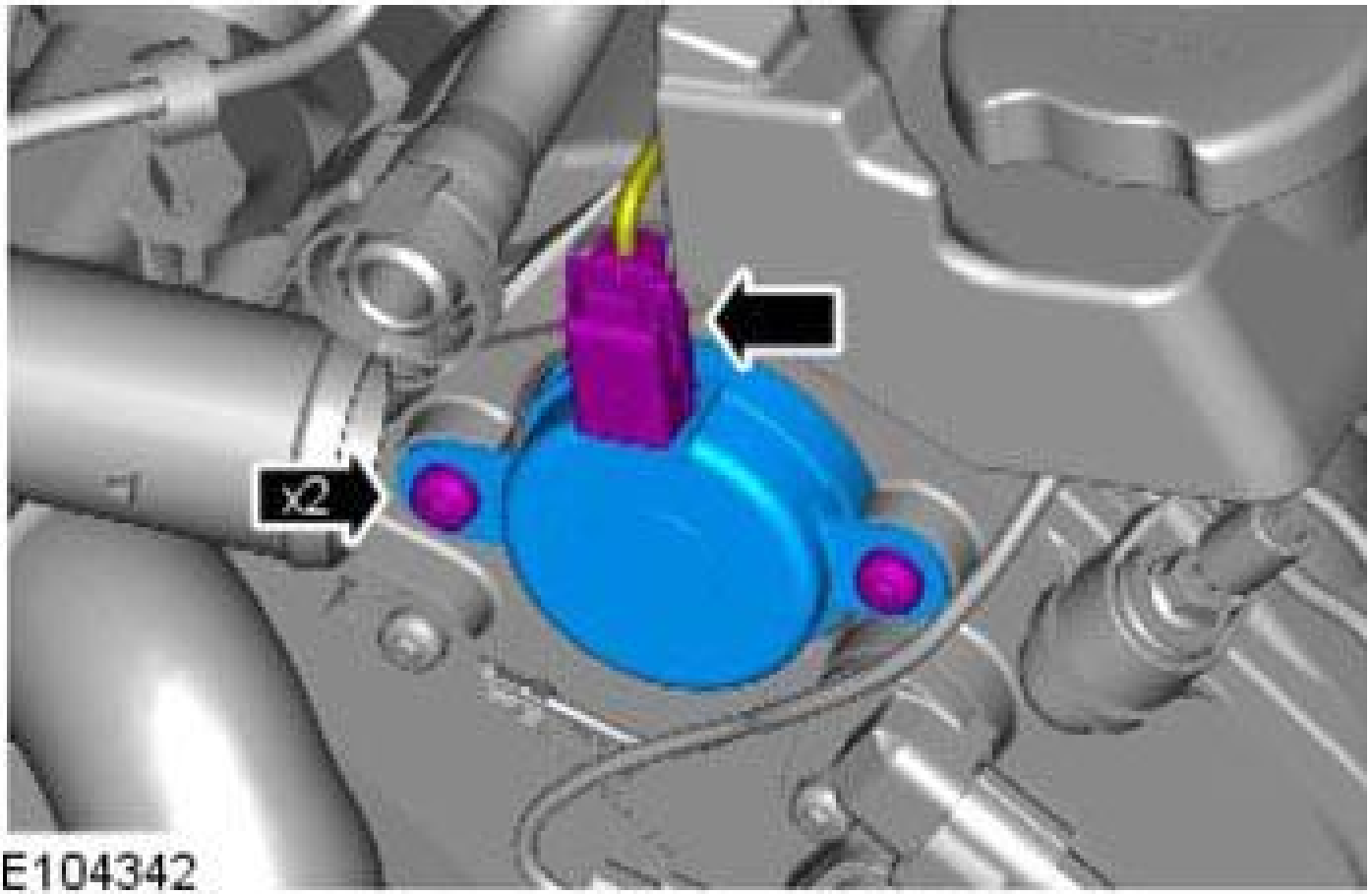
NOTE: **Removal steps in this procedure may contain installation details.**

1. WARNING: **Make sure to support the vehicle with axle stands.**

   Raise and support the vehicle.

2. Refer to: Thermostat Housing (Removal and Installation).

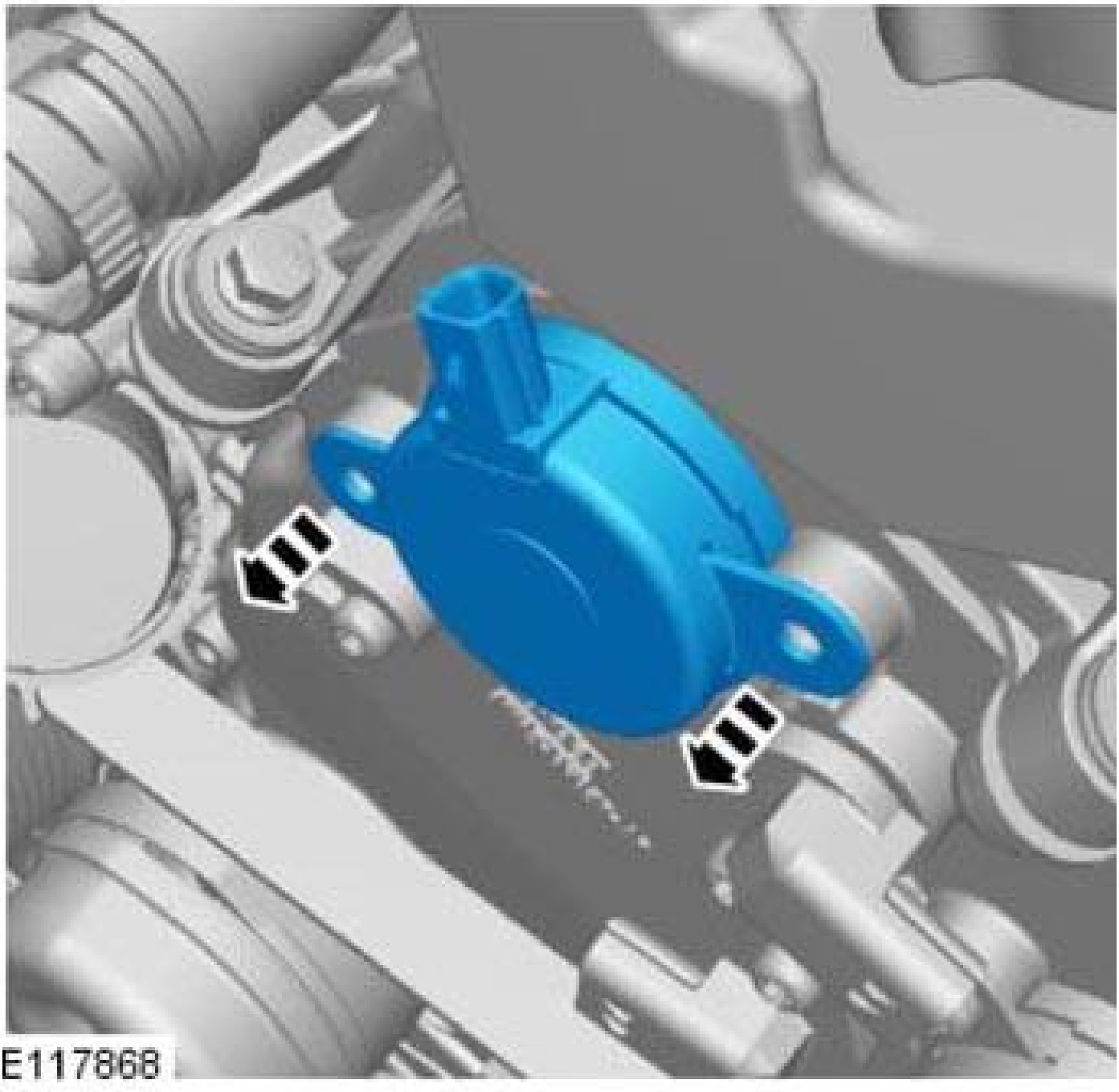
3. **NOTE:** **Some variation in the illustrations may occur, but the essential information is always correct.**



- *Torque Specification:* **10 Nm**

4. **CAUTION: Evenly and progressively, remove the VVT units from each side.**

   NOTE: Some variation in the illustrations may occur, but the essential information is always correct.



INSTALLATION

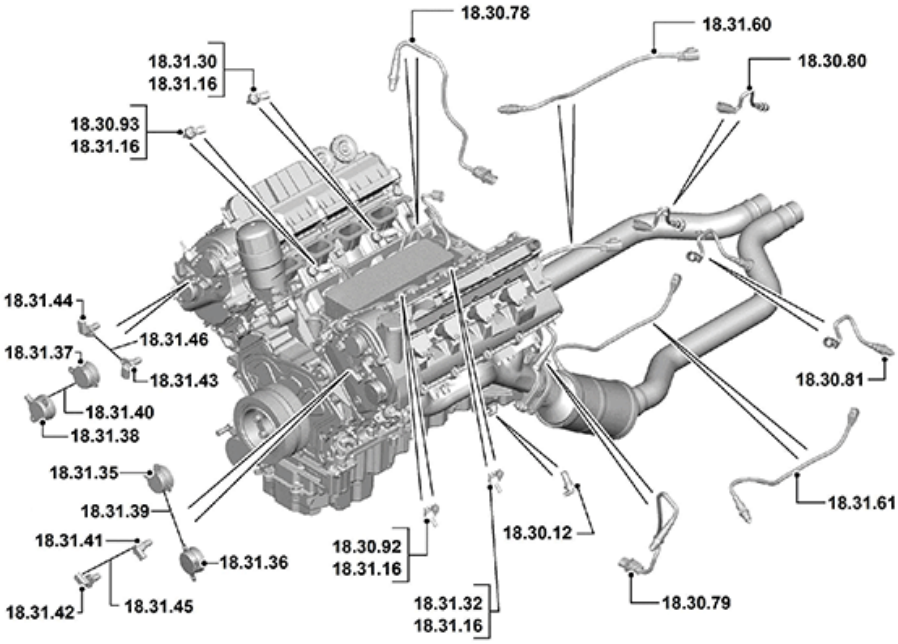
1. **CAUTION:** **Make sure that the mating faces are clean and free of foreign material.**

   NOTE: **Lubricate the O-ring seal with clean engine oil.**

   To install, reverse the removal procedure.

LEFT VARIABLE VALVE TIMING OIL CONTROL SOLENOID (G1917141) (2017-18)

18.331.35	VARIABLE INTAKE VALVE TIMING SOLENOID - B BANK - RENEW	ALL DERIVATIVES	1.3	USED WITHINS	+



JRT1218

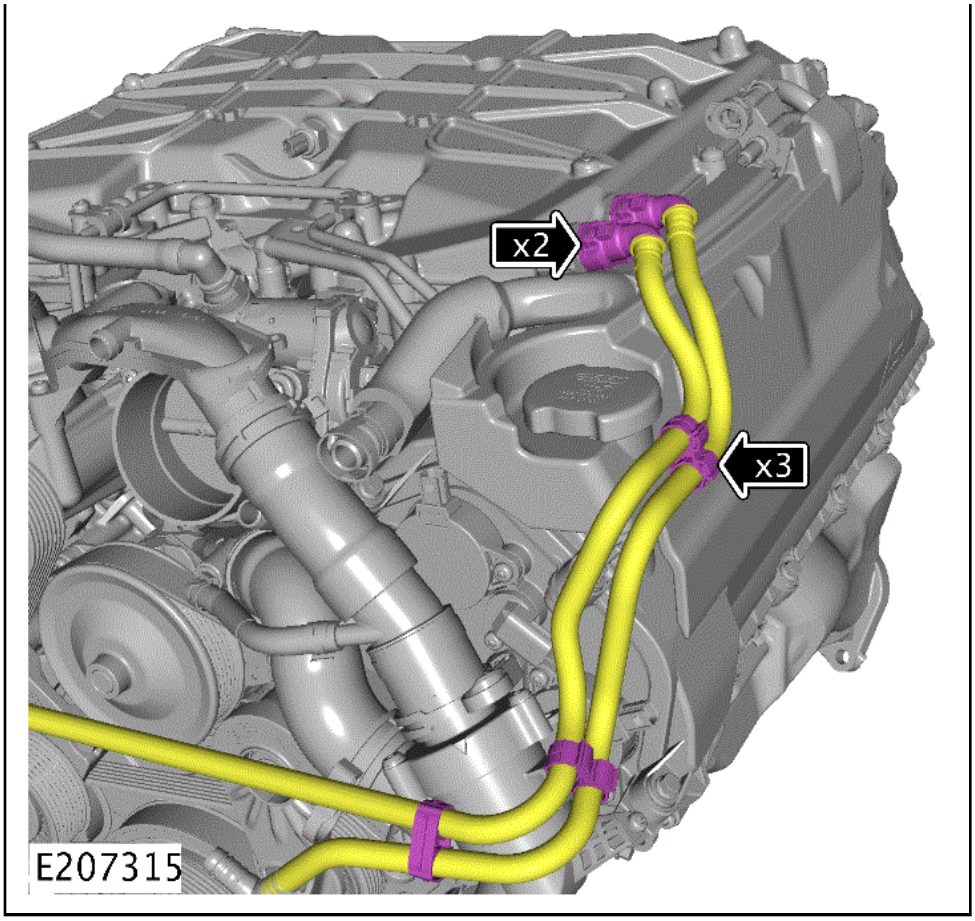
REMOVAL

WARNING: **Be prepared to collect escaping coolant.**

NOTE:

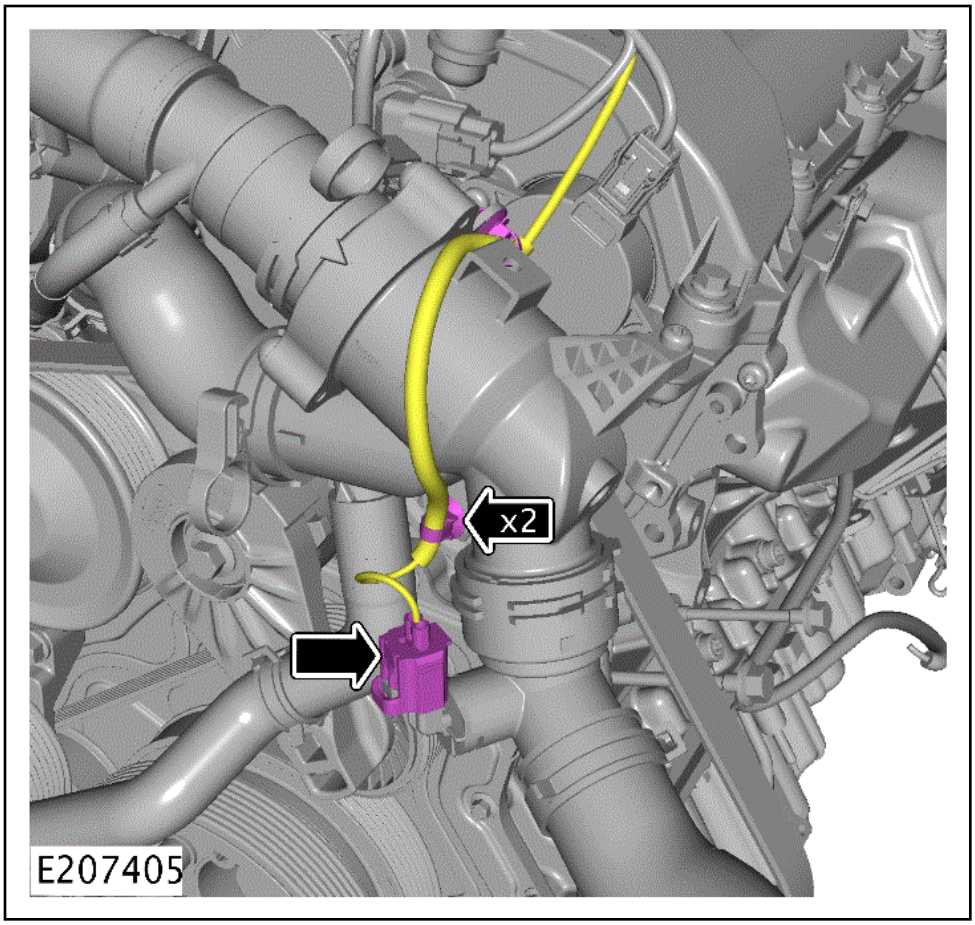
- **This procedure contains some variation in the illustrations depending on the vehicle specification, but the essential informatio always correct.**
- **This procedure contains illustrations showing certain components removed to provide extra clarity.**

1. Raise and support the vehicle on a suitable 2 post lift. Refer to: **Jacking & Lifting** (Description and Operation).
2. Remove the hood. Refer to: **Hood (G1580216)** (Removal and Installation).
3. Remove the engine cover. Refer to: **Engine Cover (G1580231)** (Removal and Installation).
4. Partially drain the cooling system. Refer to: **Cooling System Partial Draining And Vacuum Filling (G1816921)** (General Procedures).
5. Remove the left air cleaner outlet intermediate pipe. Refer to: **Air Cleaner Outlet Intermediate Pipe LH (G1581640)** (Removal and Installation).
6.

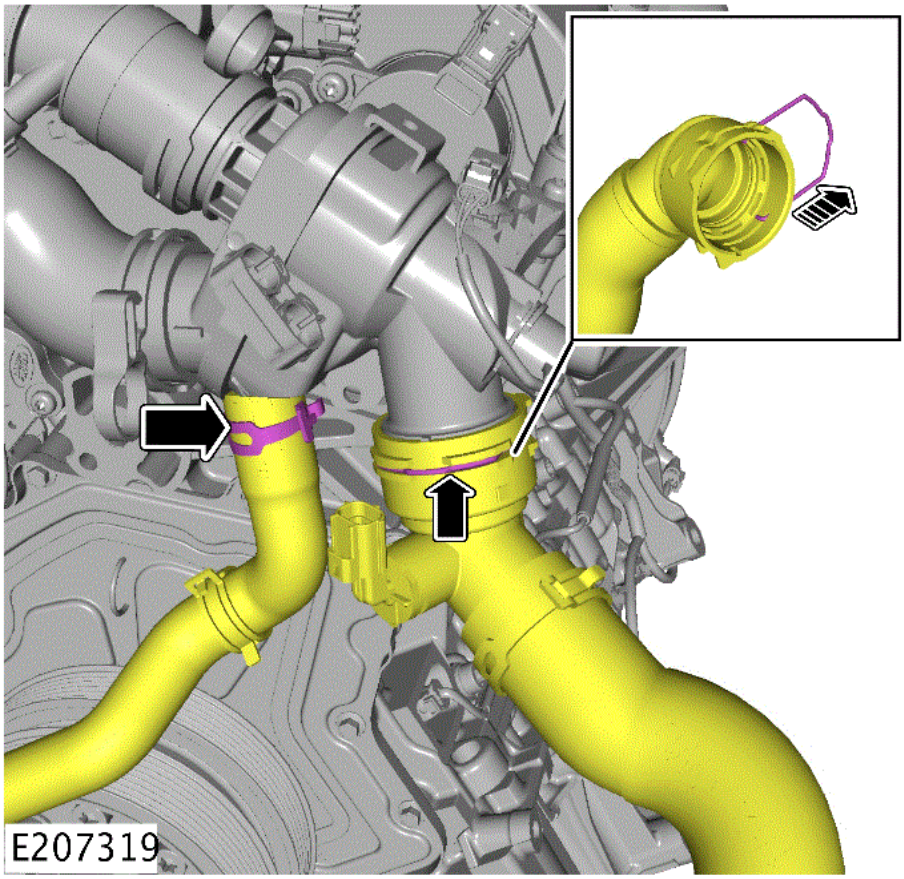


- Disconnect the 2 left supercharger coolant pipes.
- Release the 3 retaining clips.

7.

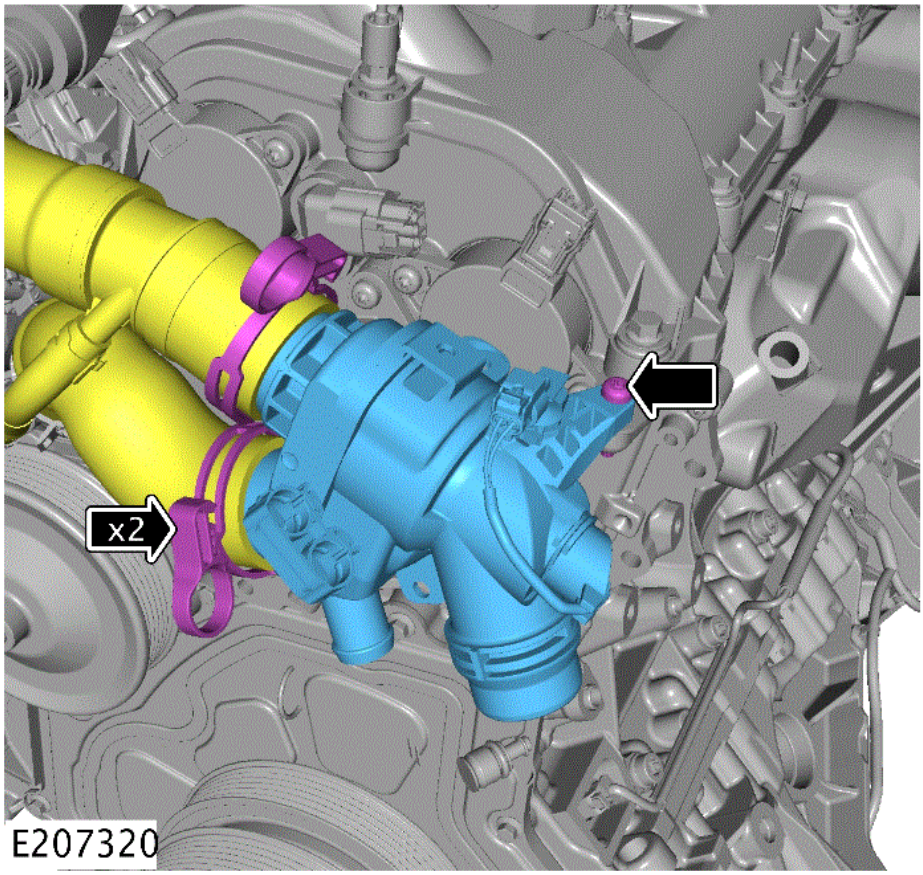


- Disconnect the Engine Coolant Temperature (ECT) sensor electrical connector.
- Release the 2 retaining clips.

8. 

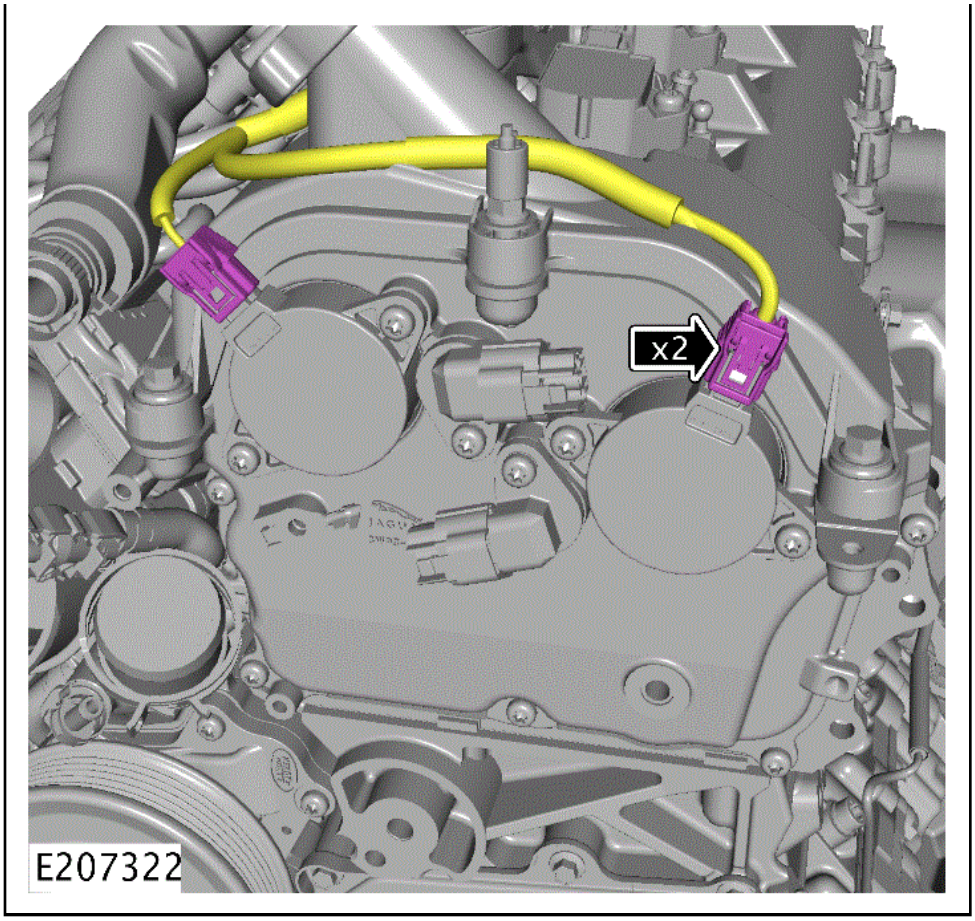
- Release the 2 retaining clips.
- Reposition the 2 thermostat coolant hoses.

9.

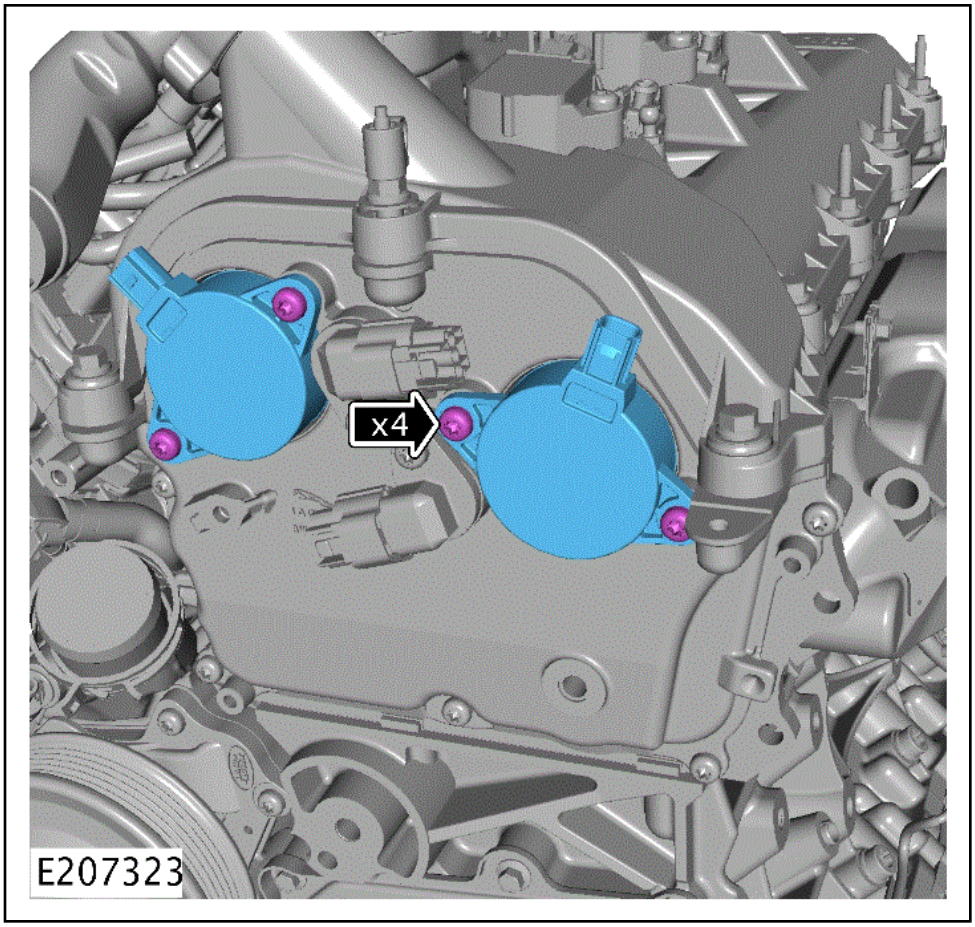


- Release the 2 thermostat coolant hose retaining clips.
- Remove the thermostat retaining bolt.
- Remove the thermostat.

10. Disconnect the 2 variable valve timing solenoid electrical connectors.



11. **CAUTION: Evenly and progressively, remove the variable valve timing solenoids.**

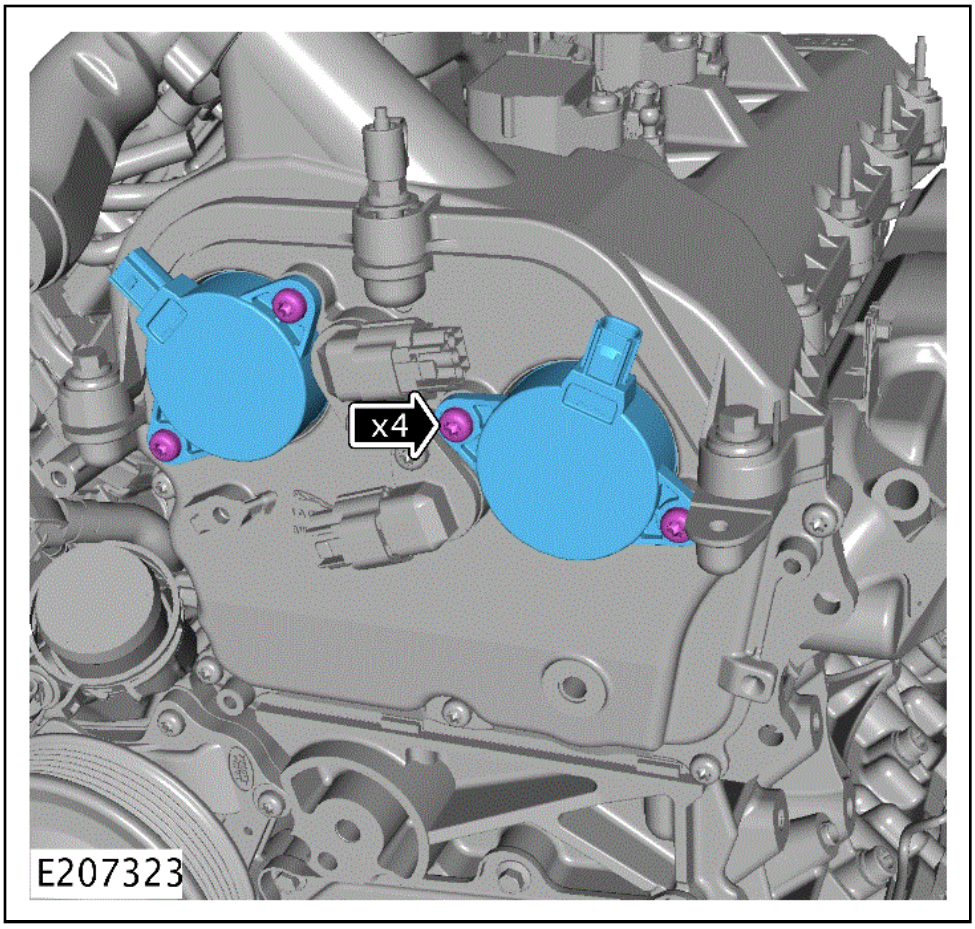


- Remove the 4 variable valve timing solenoid retaining bolts.

- Remove the 2 variable valve timing solenoid solenoids.

INSTALLATION

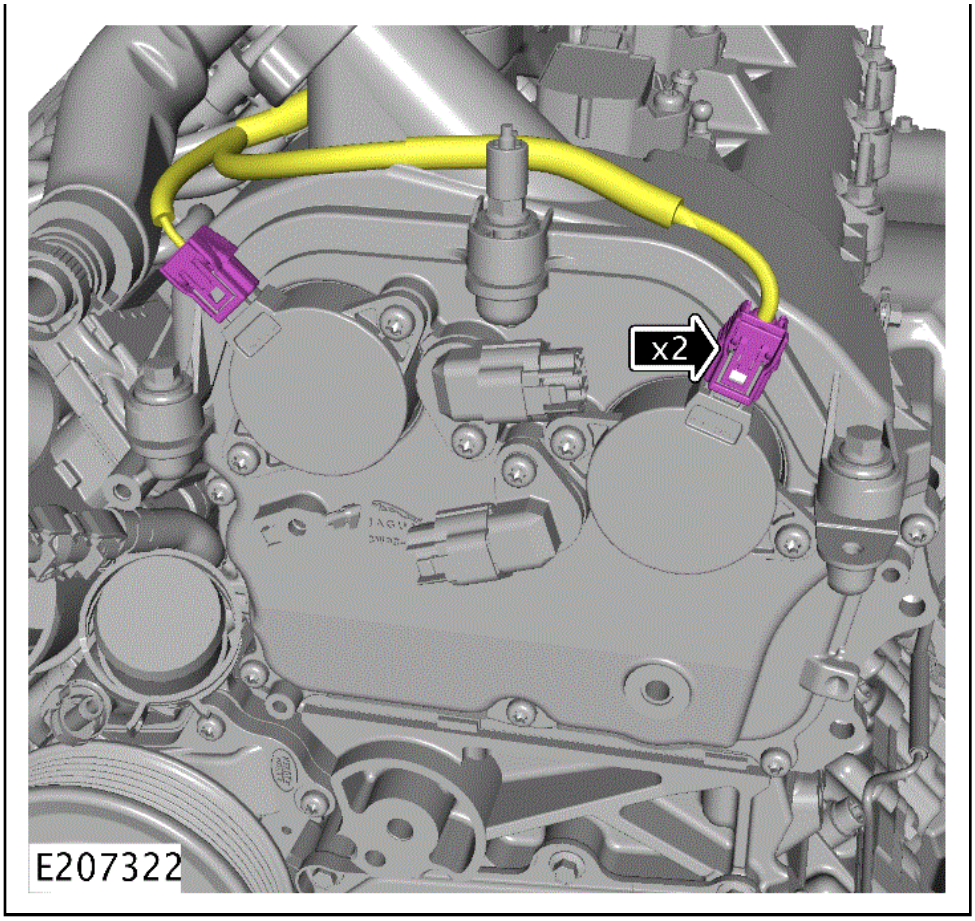
1. **CAUTION: Evenly and progressively, install the variable valve timing solenoids.**



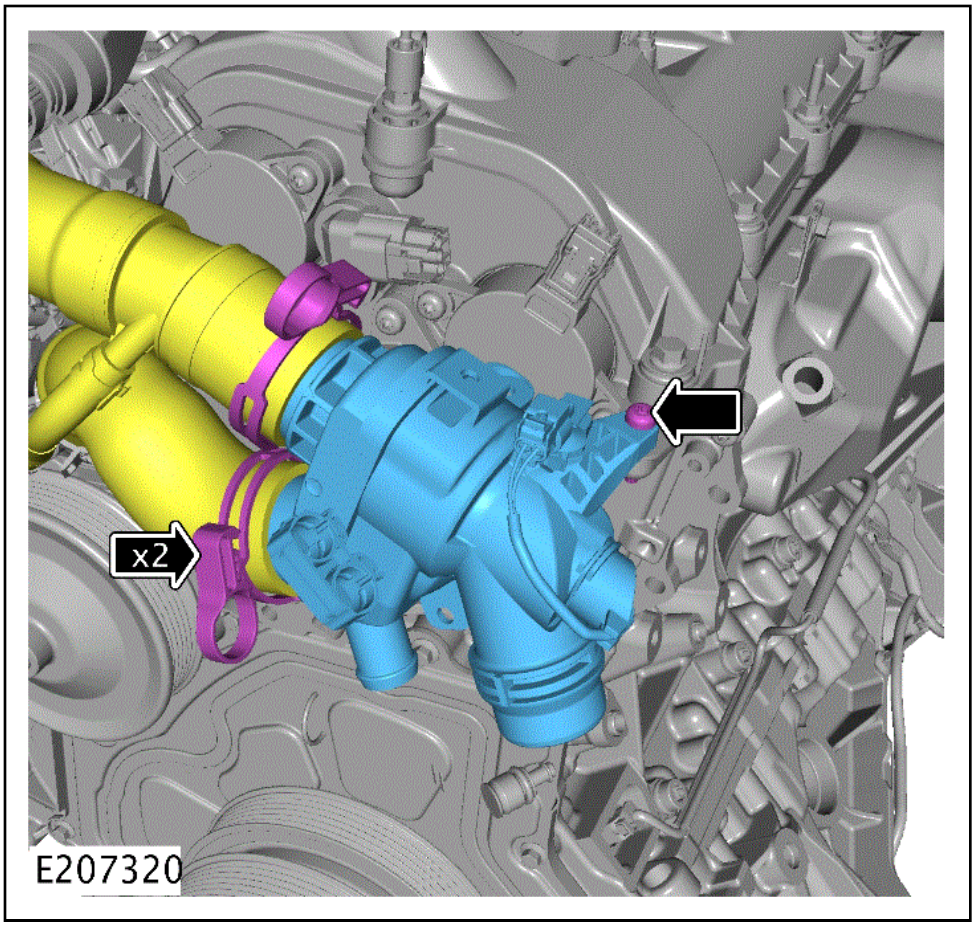
- Install the 2 variable valve timing solenoids.
- Install the 4 variable valve timing solenoid retaining bolts.

  Torque Specification: 10 Nm

2. Connect the 2 variable valve timing solenoid electrical connectors.



3.

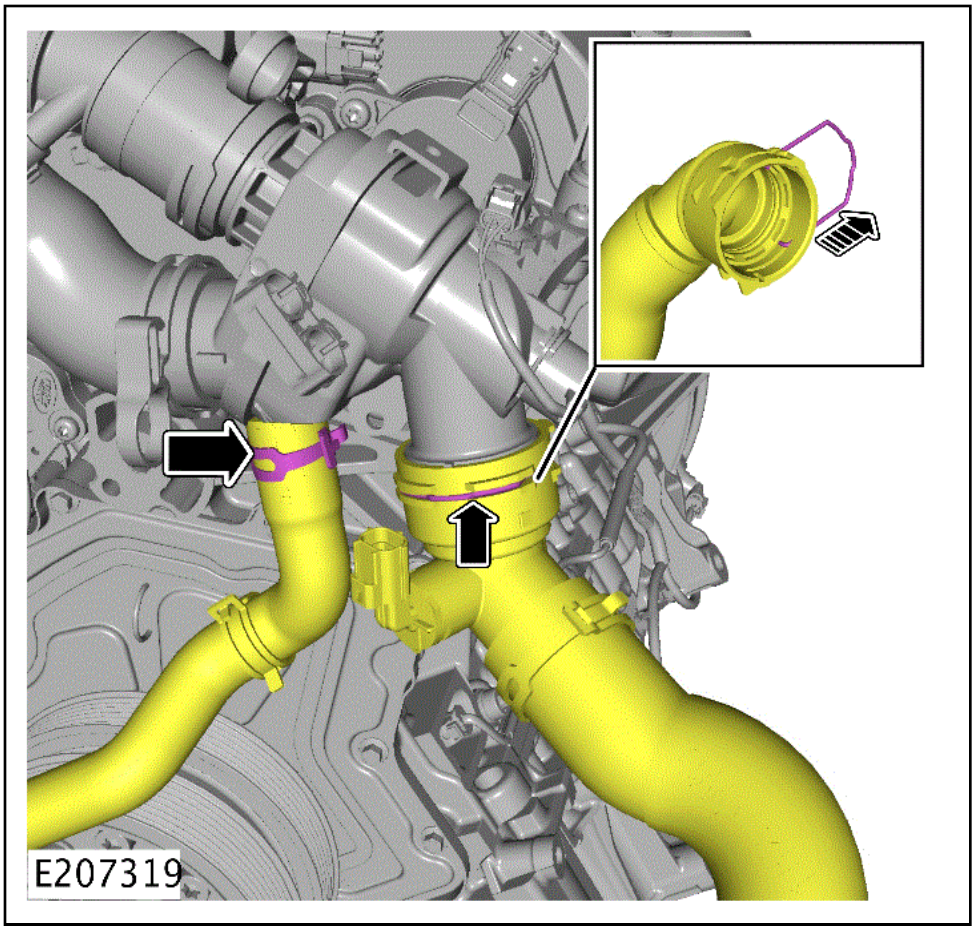


- Install the thermostat.
- Install the thermostat retaining bolt.

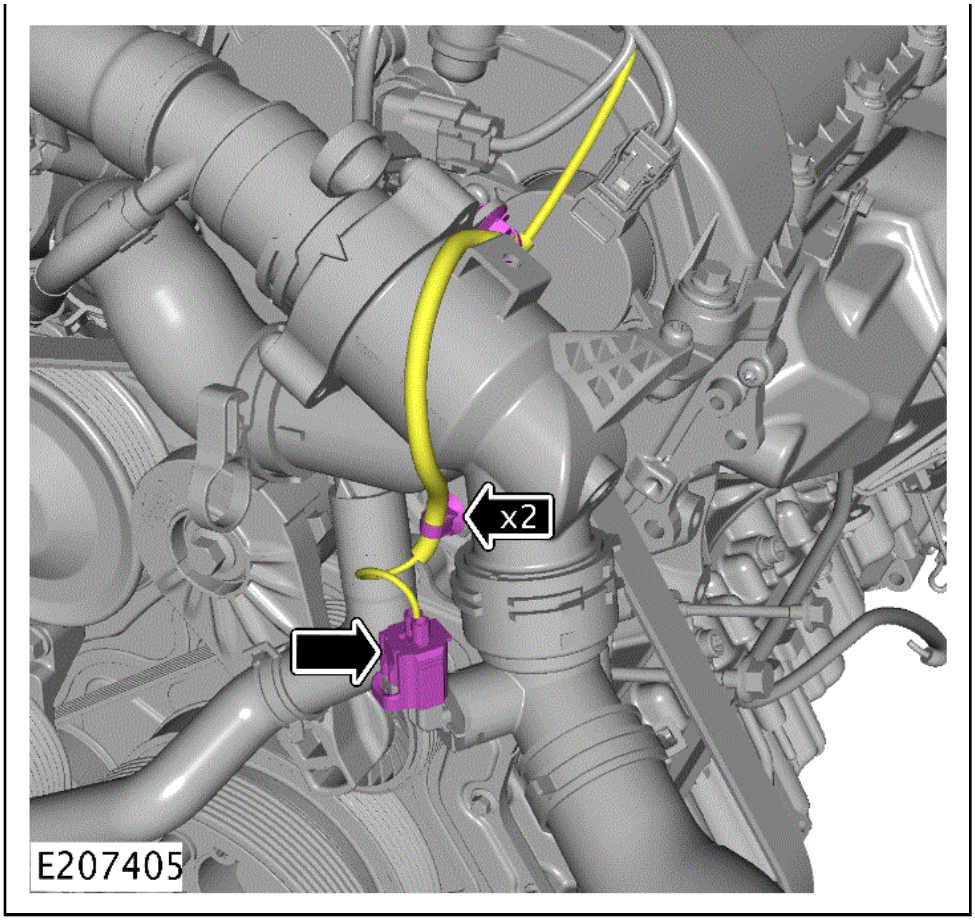
Torque Specification: 9 Nm

- Secure the 2 thermostat coolant hose retaining clips.

4. Secure the 2 thermostat coolant hose retaining clips.

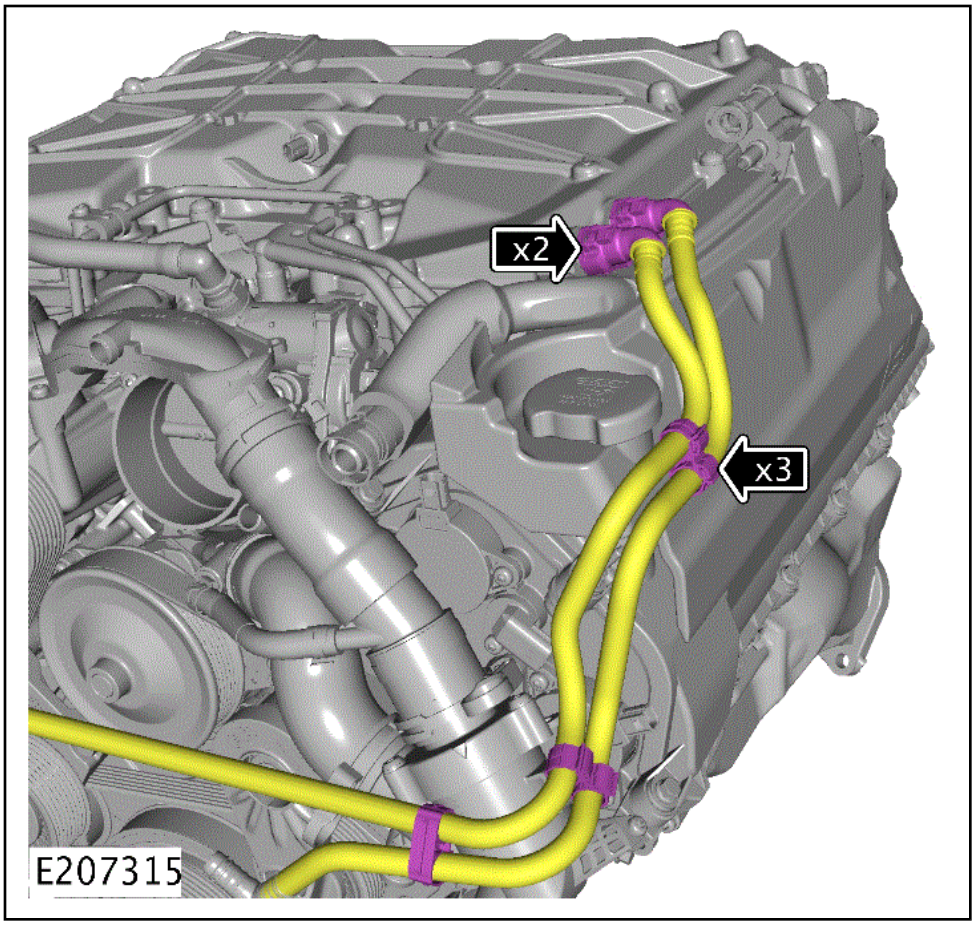


5.



- Connect the Engine Coolant Temperature (ECT) sensor electrical connector.
- Secure the 2 retaining clips.

6.

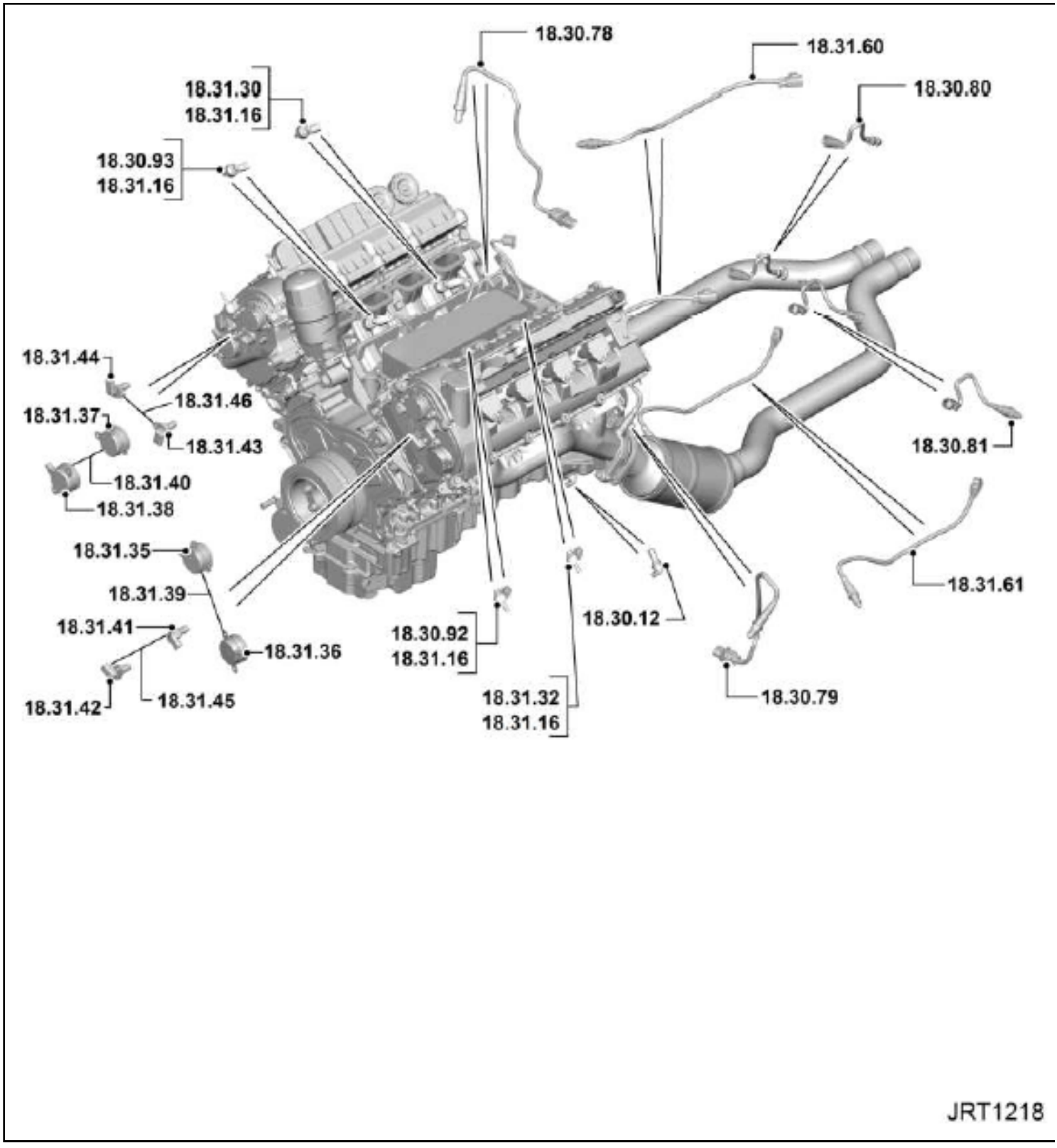


- Connect the 2 left supercharger coolant pipes.
- Secure the 3 retaining clips.

7. Install the left air cleaner outlet intermediate pipe. Refer to: **Air Cleaner Outlet Intermediate Pipe LH (G1581640)** (Removal and Installation).
8. Vacuum fill the cooling system. Refer to: **Cooling System Partial Draining And Vacuum Filling (G1816921)** (General Procedures).
9. Install the engine cover. Refer to: **Engine Cover (G1580231)** (Removal and Installation).
10. Install the hood. Refer to: **Hood (G1580216)** (Removal and Installation).

VARIABLE VALVE TIMING (VVT) OIL CONTROL SOLENOID RH (G1917142) (2016)

18.31.36	VARIABLE EXHAUST VALVE TIMING SOLENOID - B BANK - RENEW	ALL DERIVATIVES	1.3



REMOVAL

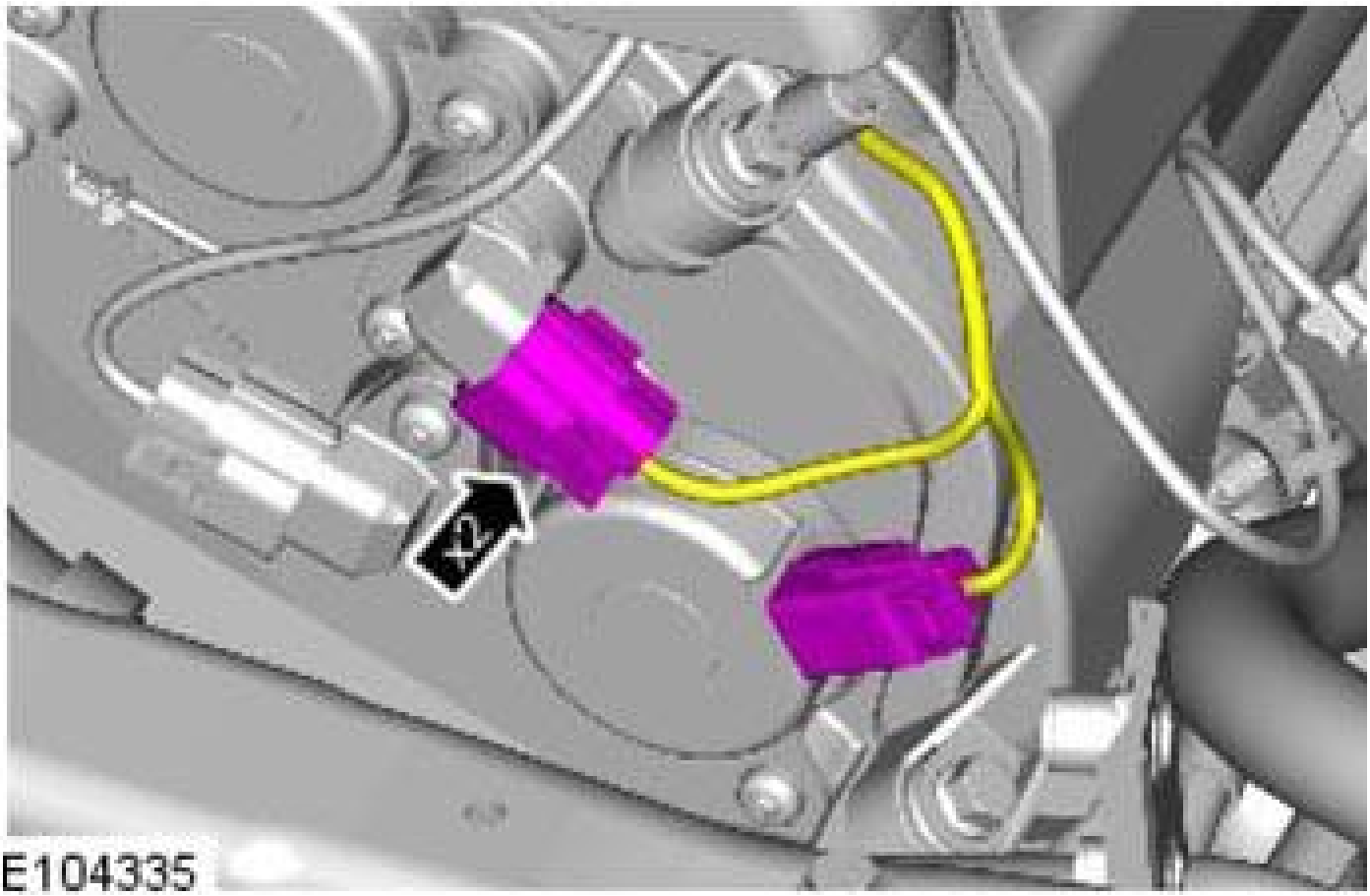
NOTE: **Removal steps in this procedure may contain installation details.**

1. WARNING: **Make sure to support the vehicle with axle stands.**

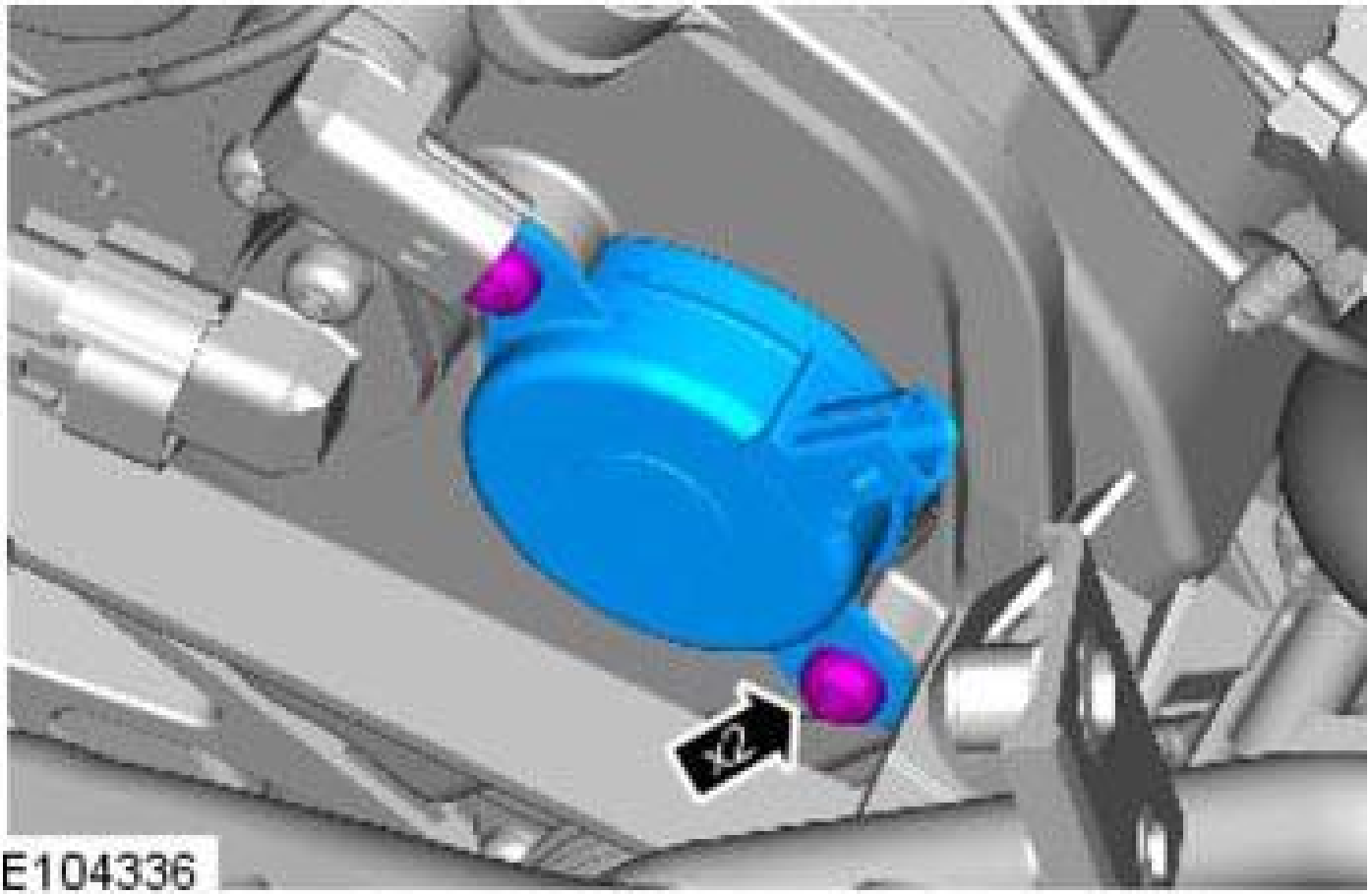
   Raise and support the vehicle.

2. Refer to: **Thermostat Housing** (Removal and Installation).

3. **NOTE:** **Some variation in the illustrations may occur, but the essential information is always correct.**



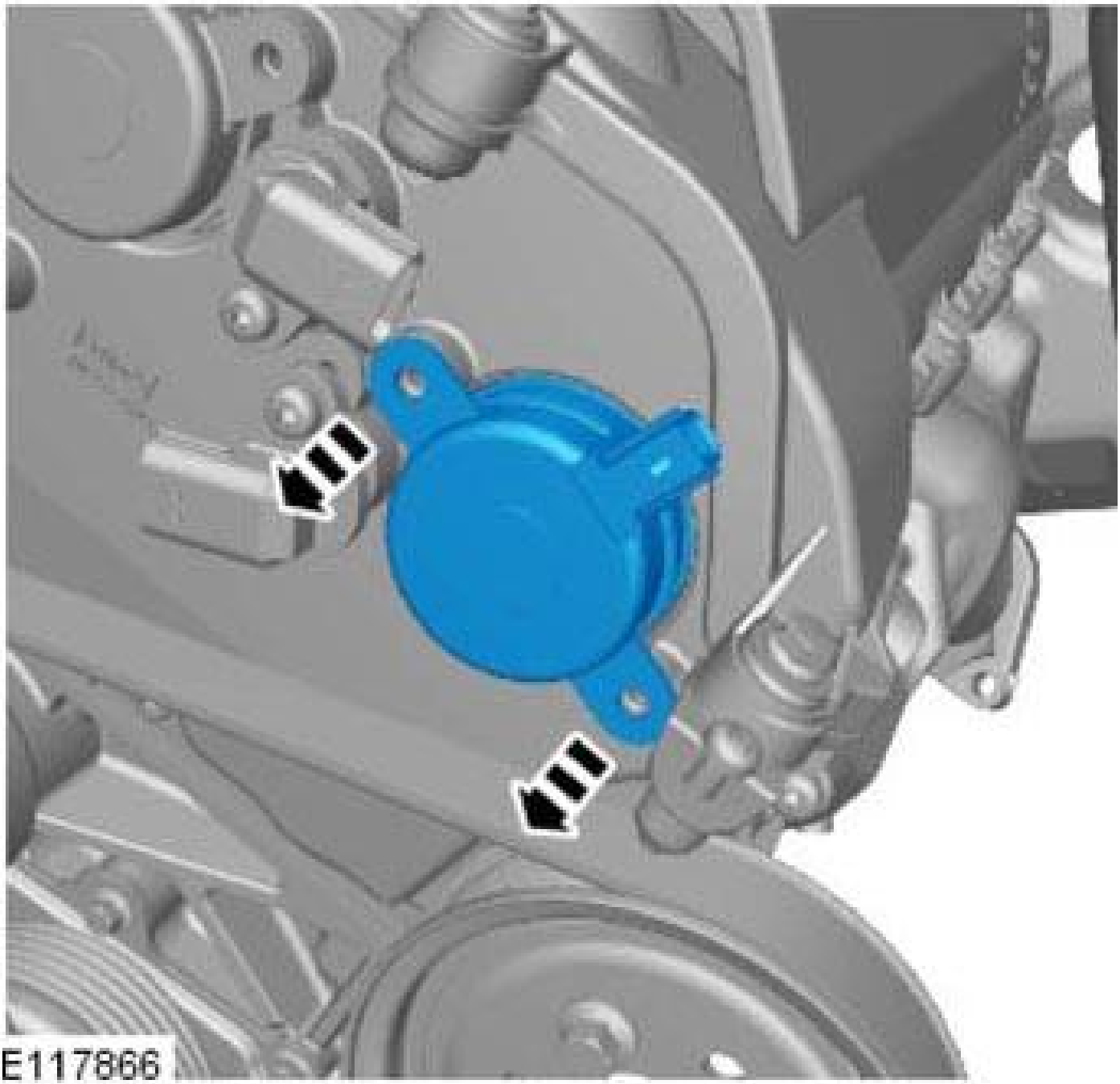
4. **NOTE:** **Some variation in the illustrations may occur, but the essential information is always correct.**



- *Torque Specification:* **10 Nm**

5. **CAUTION: Evenly and progressively, remove the VVT units from each side.**

   NOTE: Some variation in the illustrations may occur, but the essential information is always correct.



INSTALLATION

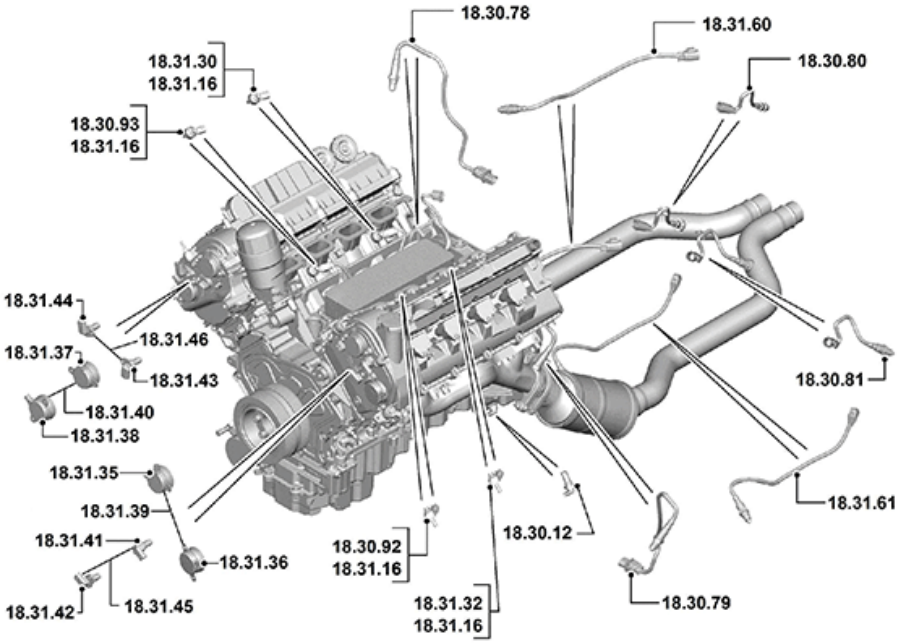
1. **CAUTION:** **Make sure that the mating faces are clean and free of foreign material.**

   NOTE: **Lubricate the O-ring seal with clean engine oil.**

   To install, reverse the removal procedure.

RIGHT VARIABLE VALVE TIMING OIL CONTROL SOLENOID (G1917142) (2017-18)

18.31.36	VARIABLE EXHAUST VALVE TIMING SOLENOID - B BANK - RENEW	All Derivatives	1.3	USED WITHINS	+



JRT1218

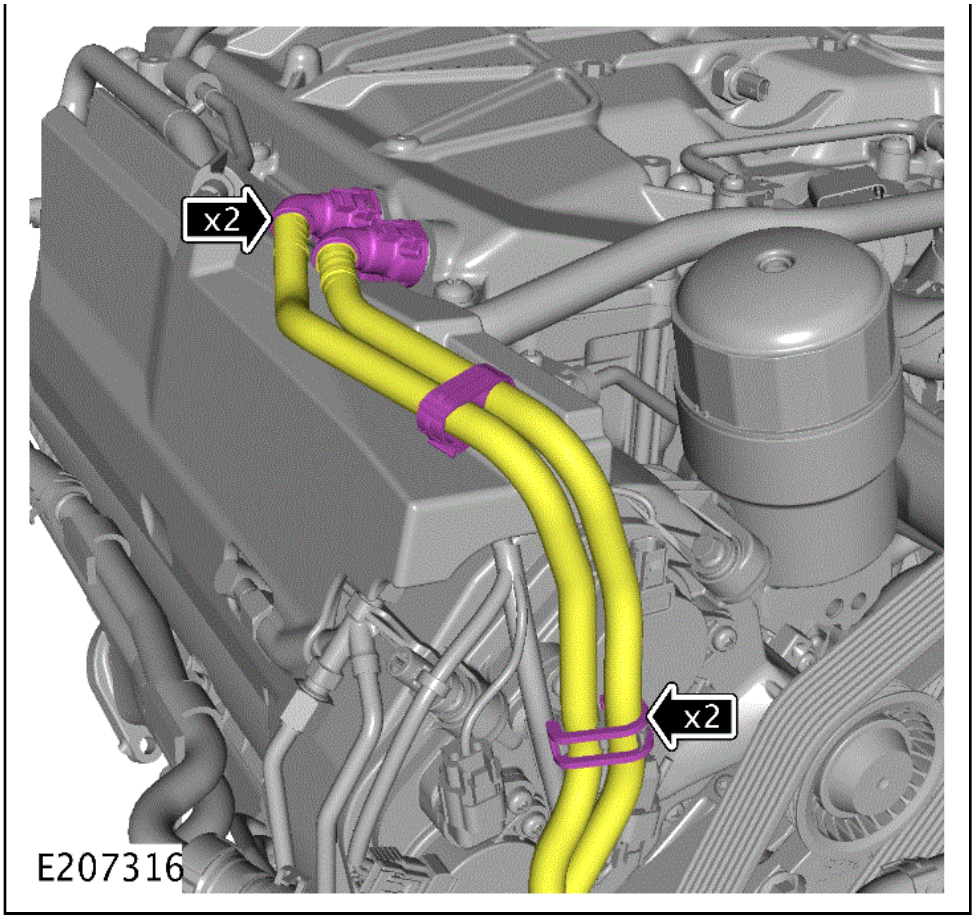
REMOVAL

WARNING: **Be prepared to collect escaping coolant.**

NOTE:

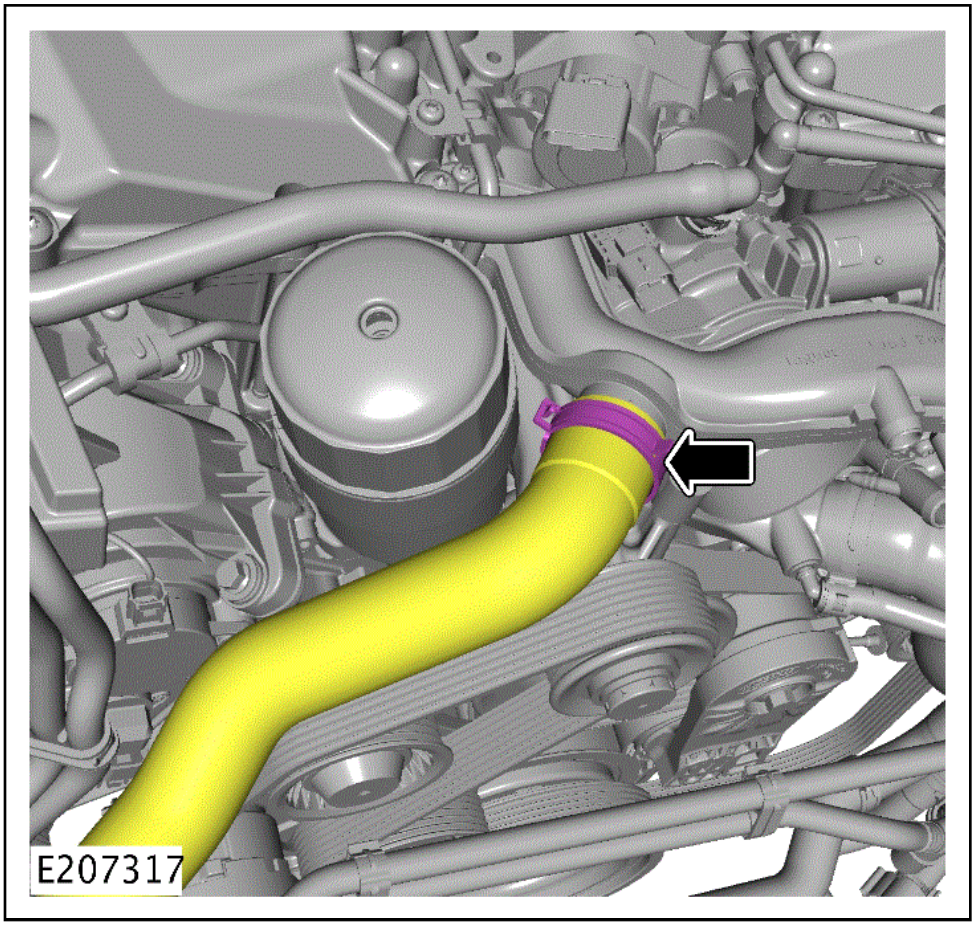
- **This procedure contains some variation in the illustrations depending on the vehicle specification, but the essential informatio always correct.**
- **This procedure contains illustrations showing certain components removed to provide extra clarity.**

1. Raise and support the vehicle on a suitable 2 post lift. Refer to: **Jacking & Lifting** (Description and Operation).
2. Remove the hood. Refer to: **Hood (G1580216)** (Removal and Installation).
3. Remove the engine cover. Refer to: **Engine Cover (G1580231)** (Removal and Installation).
4. Partially drain the cooling system. Refer to: **Cooling System Partial Draining And Vacuum Filling (G1816921)** (General Procedures).
5. Remove the right air cleaner outlet intermediate pipe. Refer to: **Air Cleaner Outlet Intermediate Pipe RH (G1581641)** (Removal and Installation).
6.

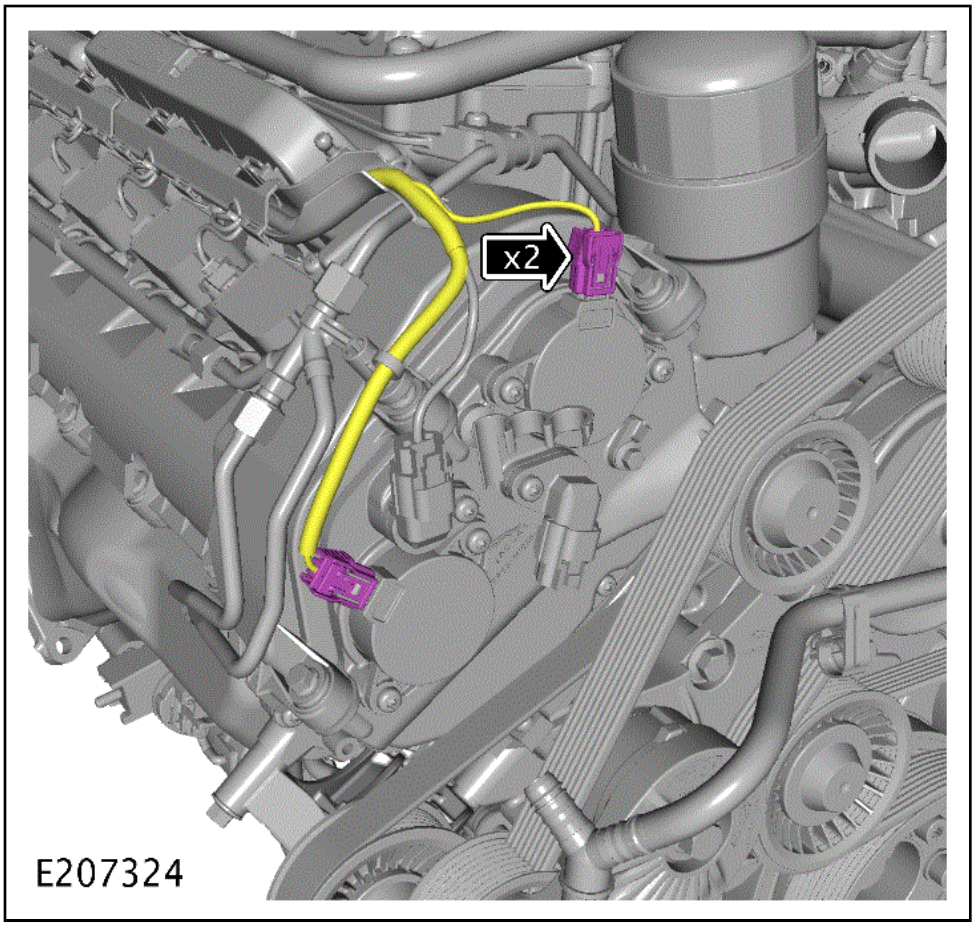


- Disconnect the 2 right supercharger coolant hose retaining clips.
- Release the 2 retaining clips.

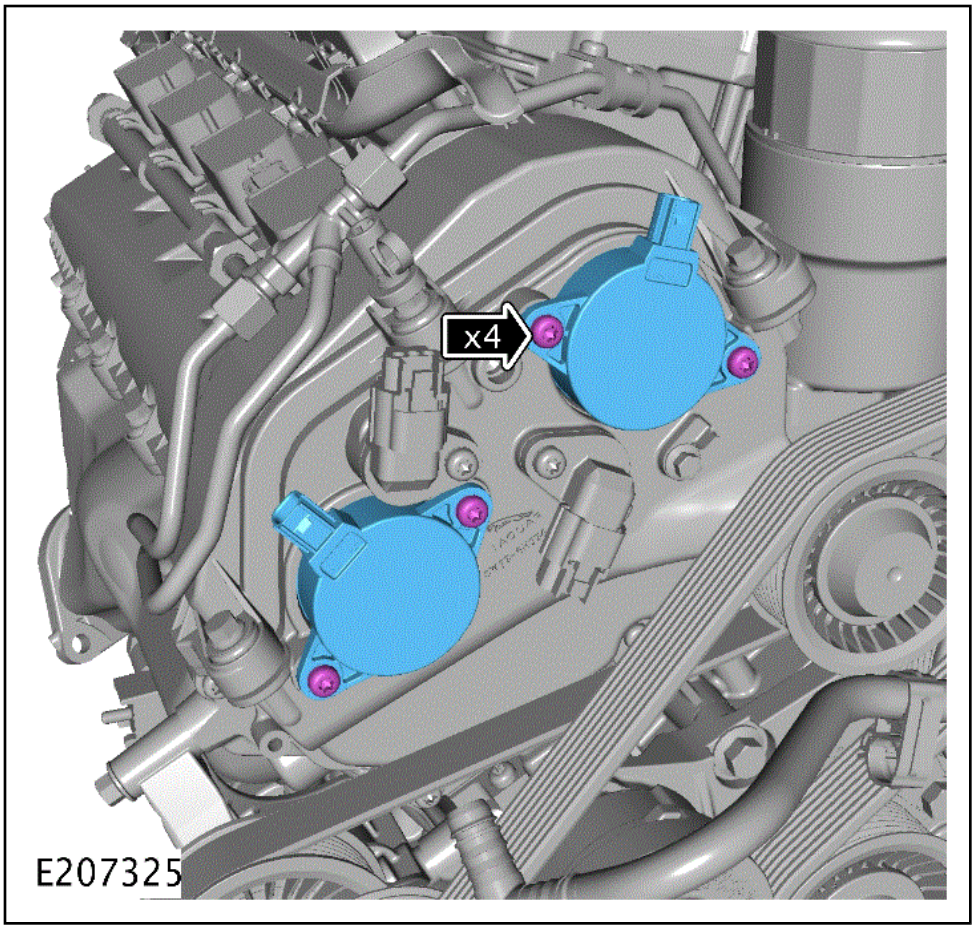
7. Release the coolant hose.



8. Disconnect the 2 variable valve timing solenoid electrical connectors.



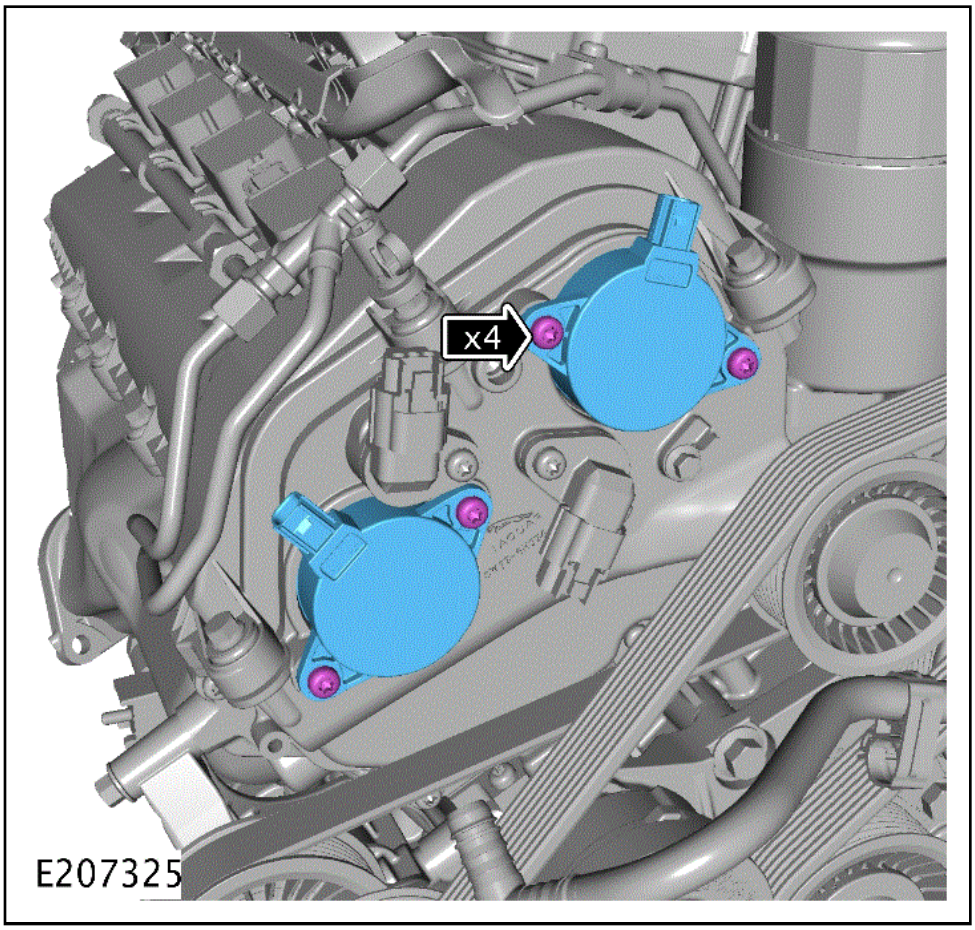
9. **CAUTION: Evenly and progressively, remove the variable valve timing solenoids.**



- Remove the 4 variable valve timing solenoid retaining bolts.
- Remove the 2 variable valve timing solenoids.

INSTALLATION

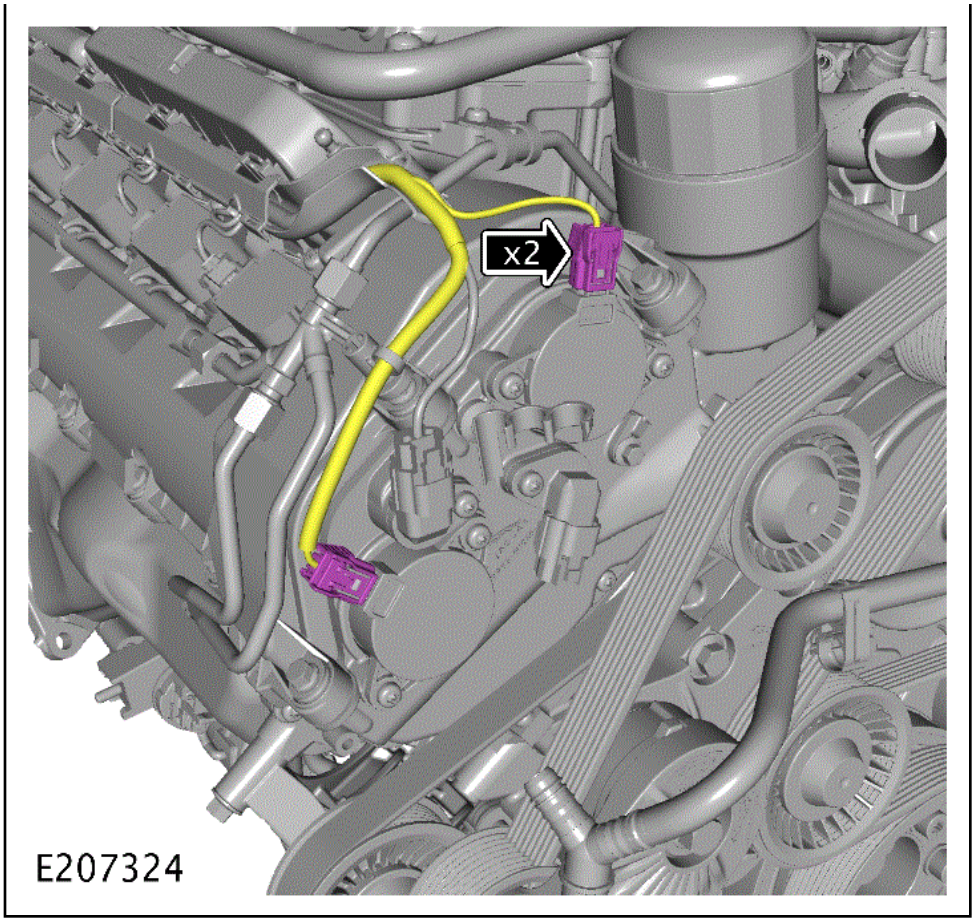
1. **CAUTION: Evenly and progressively, install the variable valve timing solenoids.**



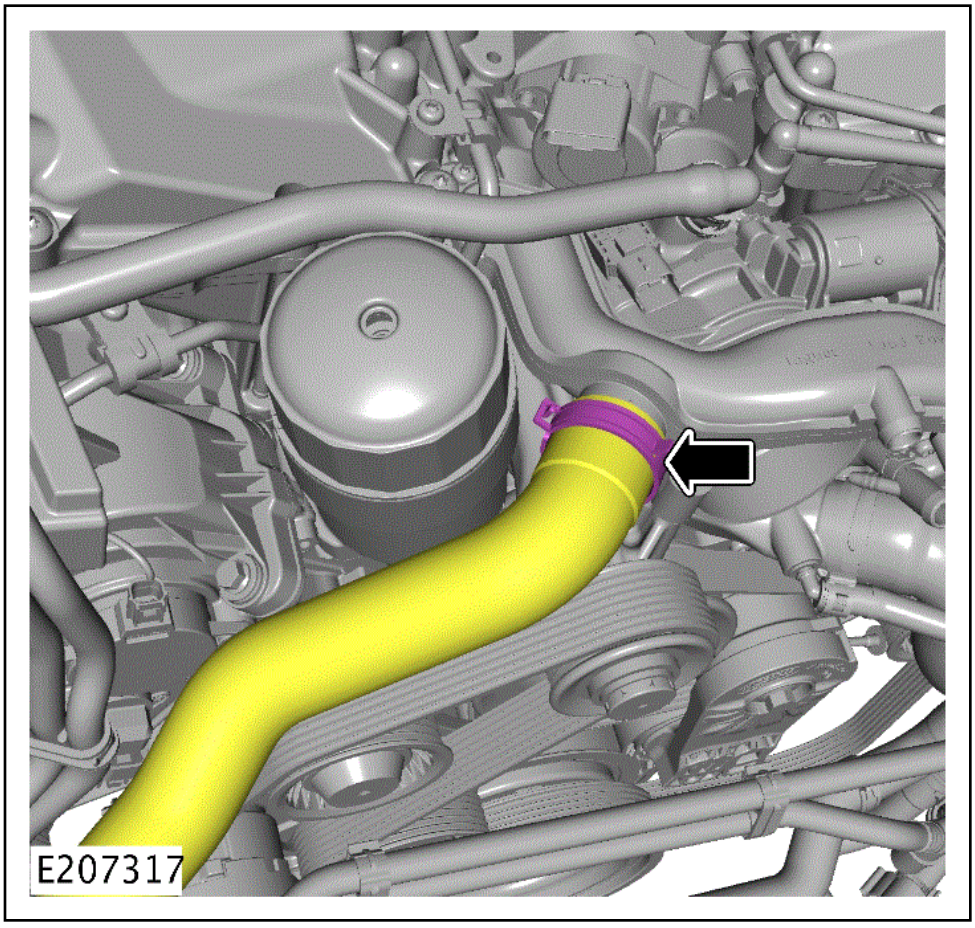
- Install the 2 variable valve timing solenoids.
- Install the 4 variable valve timing solenoid retaining bolts.

  Torque Specification: 10 Nm

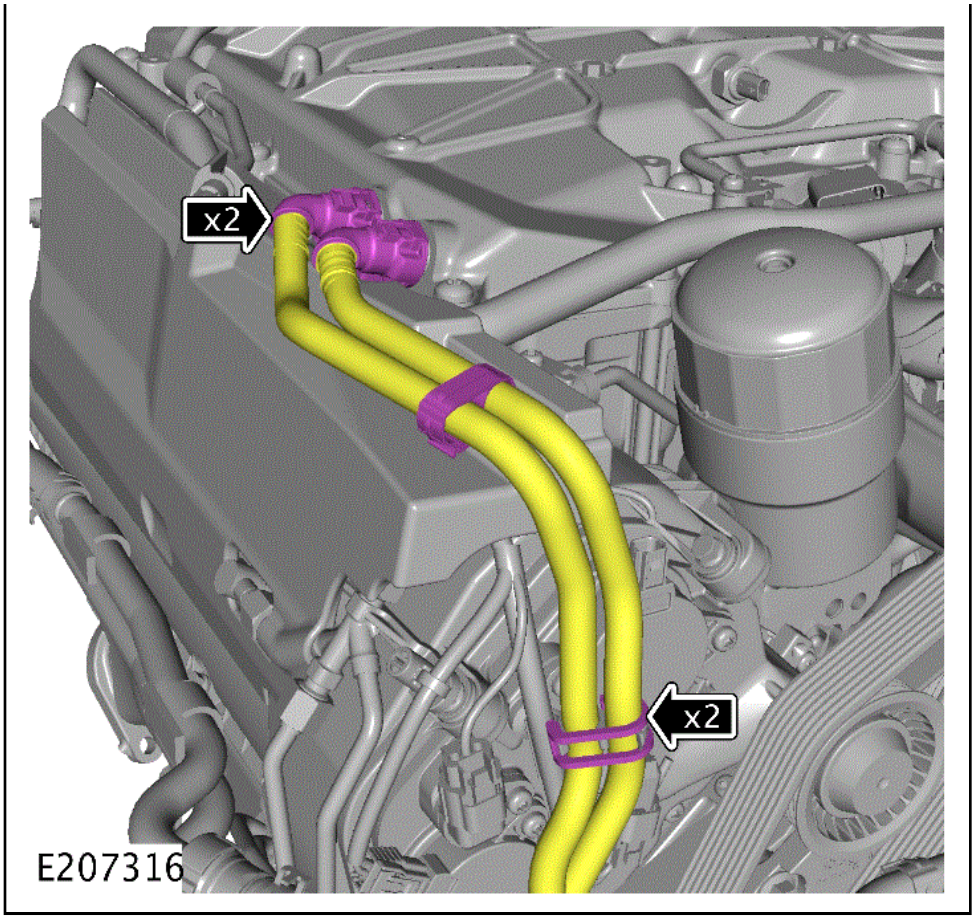
2. Connect the 2 variable valve timing solenoid electrical connectors.



3. Secure the coolant hose.



4.



- Connect the 2 right supercharger coolant hose retaining clips.
- Secure the 2 retaining clips.

5. Install the right air cleaner outlet intermediate pipe. Refer to: **Air Cleaner Outlet Intermediate Pipe RH (G1581641)** (Removal and Installation).
6. Vacuum fill the cooling system. Refer to: **Cooling System Partial Draining And Vacuum Filling (G1816921)** (General Procedures).
7. Install the engine cover. Refer to: **Engine Cover (G1580231)** (Removal and Installation).
8. Install the hood. Refer to: **Hood (G1580216)** (Removal and Installation).

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