Описание двигателя

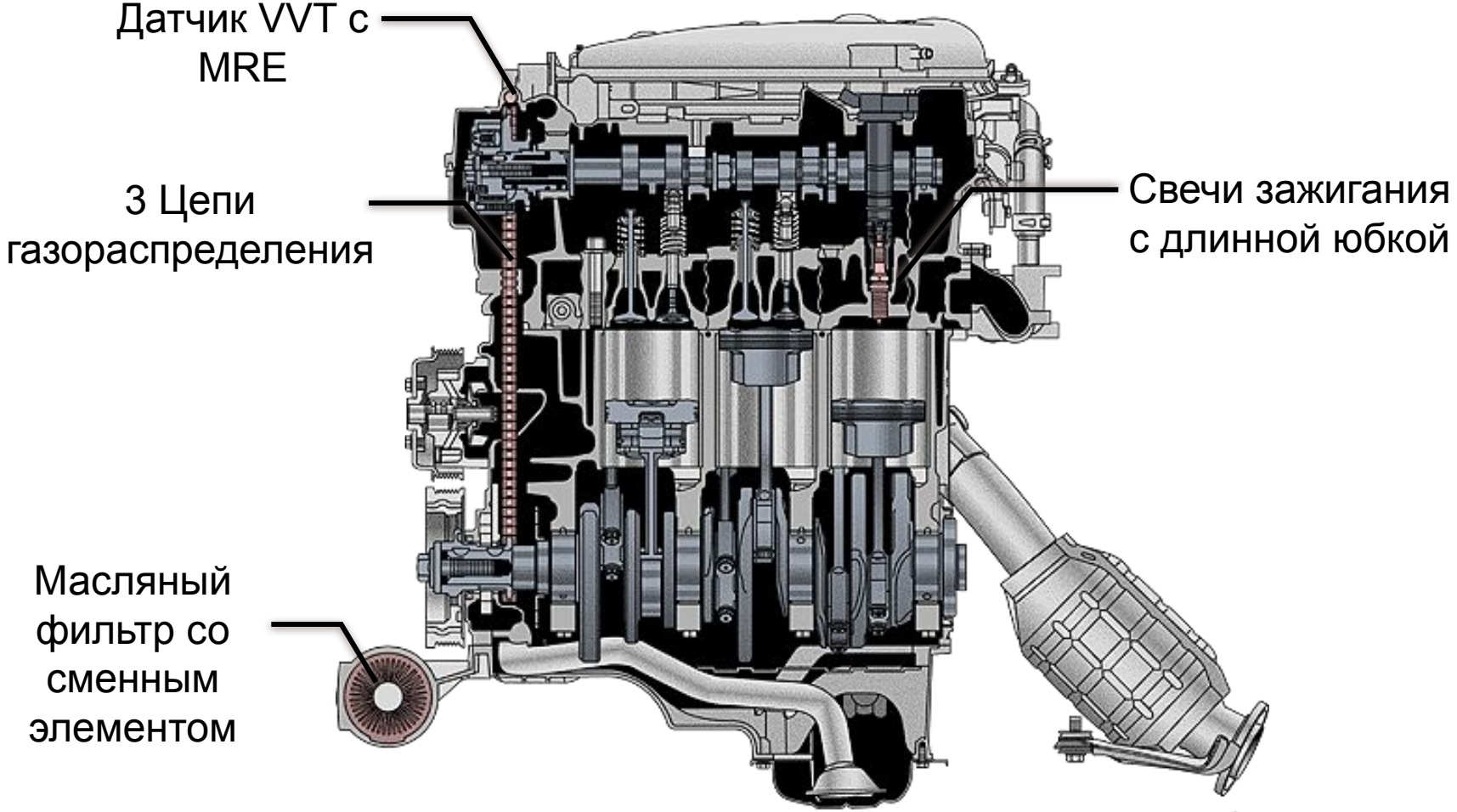
- Общие сведения
  - V-образный 6-ти цилиндровый, угол развала блока 60^0, рабочий объём 2.5 л, 24-клапана, система газораспределения DOHC с механизмом VVT-i, на впуске и выпуске, система ACIS электронный дроссель (система ETCS-i)

4GR-FSE

Система D-4 [Непосредственное впрыскивание]

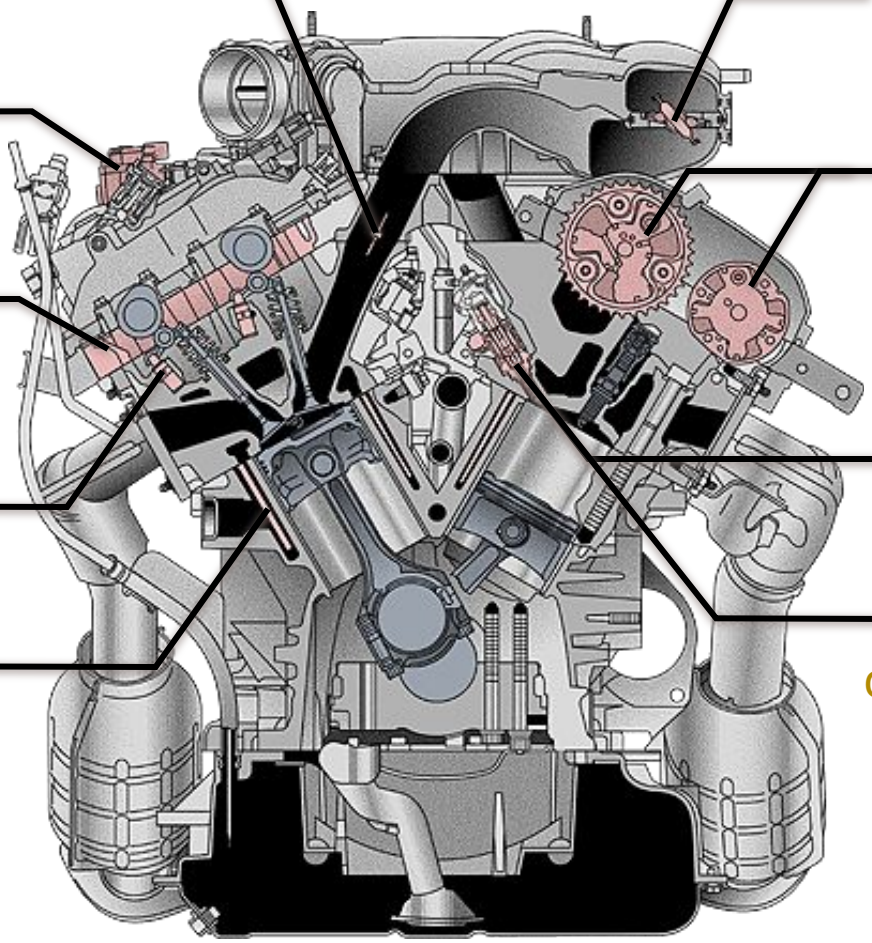
Описание двигателя

- Характеристики **4GR-FSE**



Описание двигателя

- Характеристики **4GR-FSE**



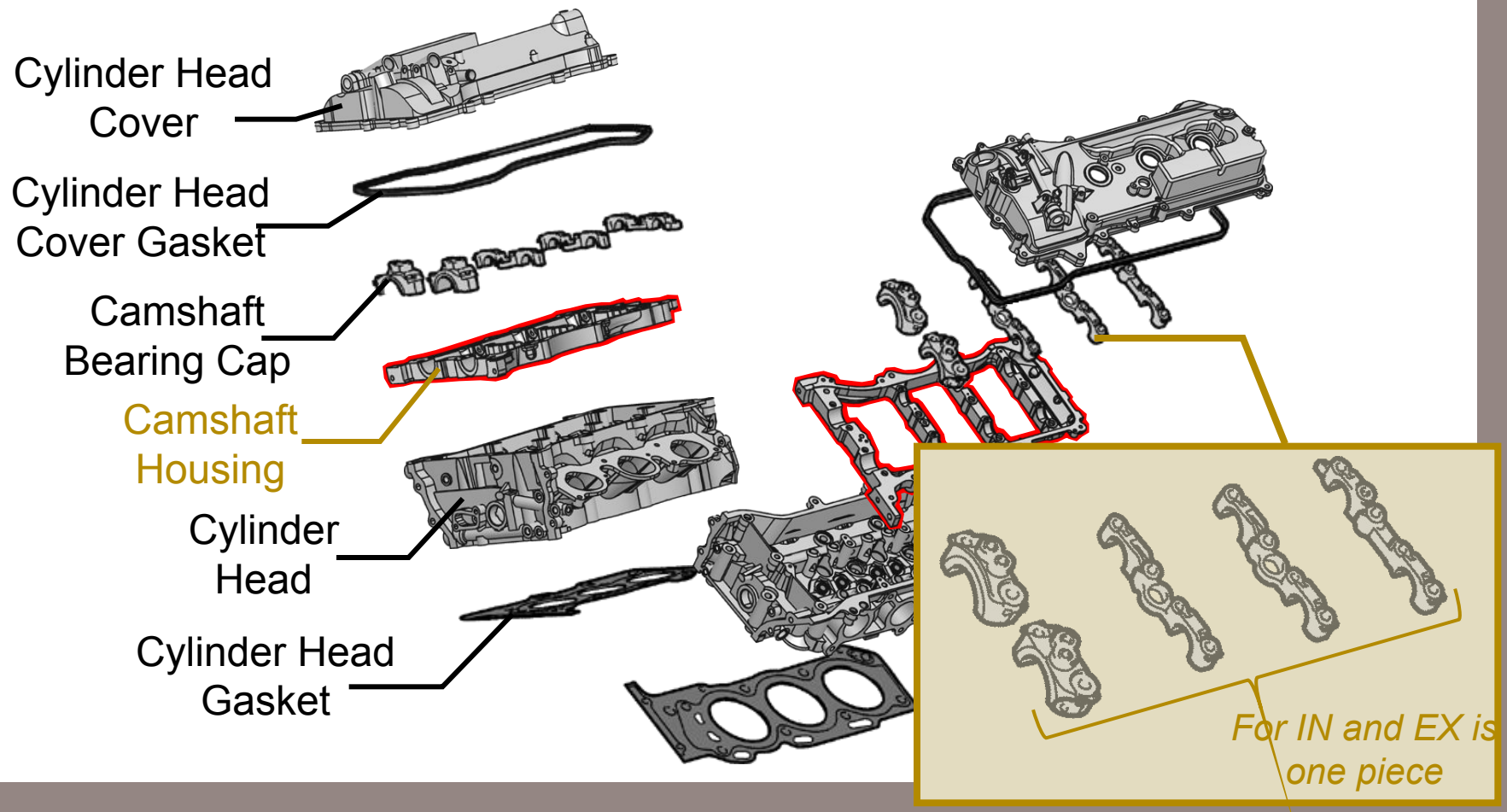
Описание двигателя

- Основные характеристики

	4GR-FSE
Число и расположение цилиндров	6, V-образно
Механизм газораспределения	24-клапана, DOHC, цепной привод, два VVT-i
Тип камеры сгорания	Шатровая
Раб. Объём, cm^3	2499
Диаметр цилиндра x ход поршня mm	83.0 x 77.0
Степень сжатия	12.0
Макс. мощность кВт @ обор. (л.с. @ обор.)	152 @ 6,400 (204 @ 6,400)
Макс. кр. момент N·m @ обор.	250 @ 4,800

Engine Proper

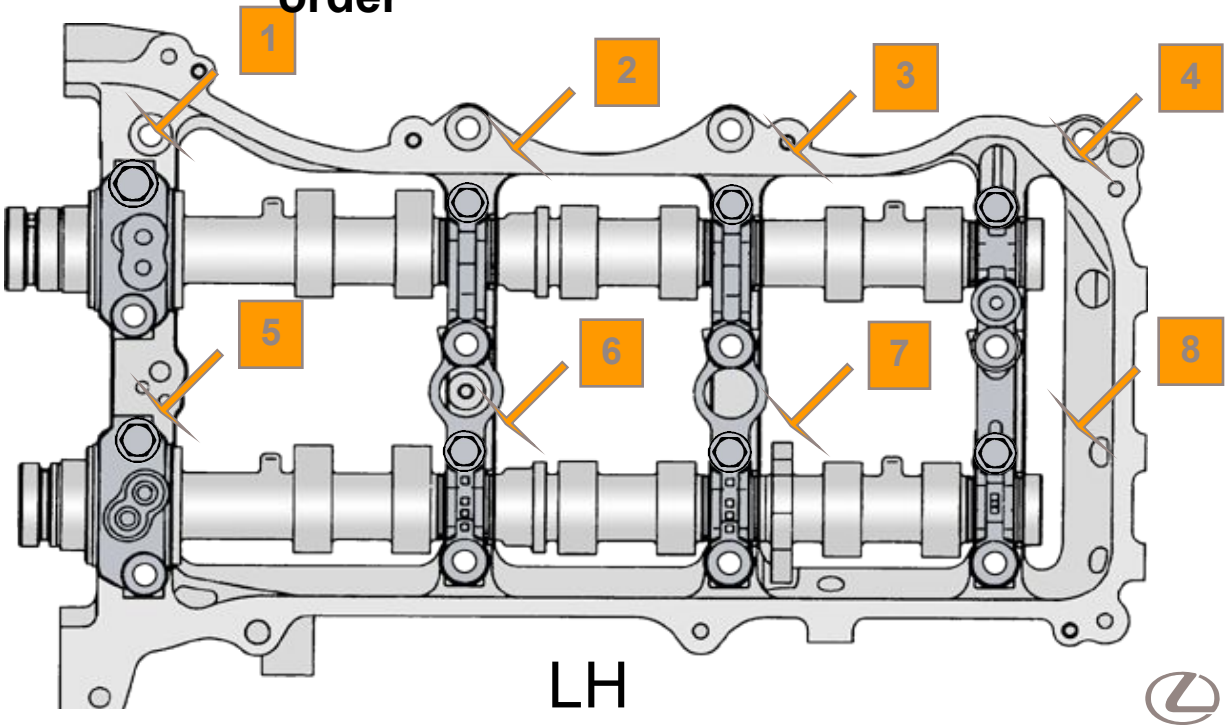
- Cylinder Head
  - Camshaft housing to simply the cylinder head structure
  - Camshaft bearing cap for IN and EX is one piece



Service Point (Engine Proper)

- Cylinder Head
  - Camshaft and camshaft housing installation

Step 1	X	**: Temporary tighten (Torque: 10N·m [102kgf·cm])** **: Tightening order**

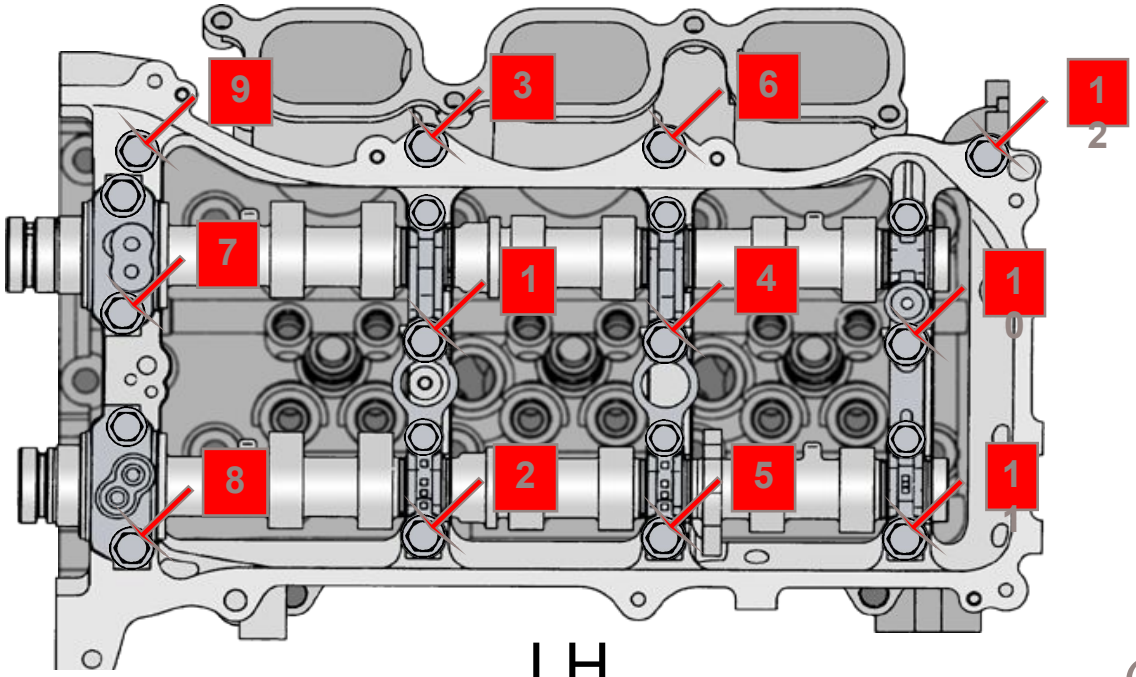


LH Bank

Service Point (Engine Proper)

- Cylinder Head
  - Camshaft and camshaft housing installation

Step 2		**: Tighten (Torque: 28N·m [286kgf·cm])**
	X	**: Tightening order**

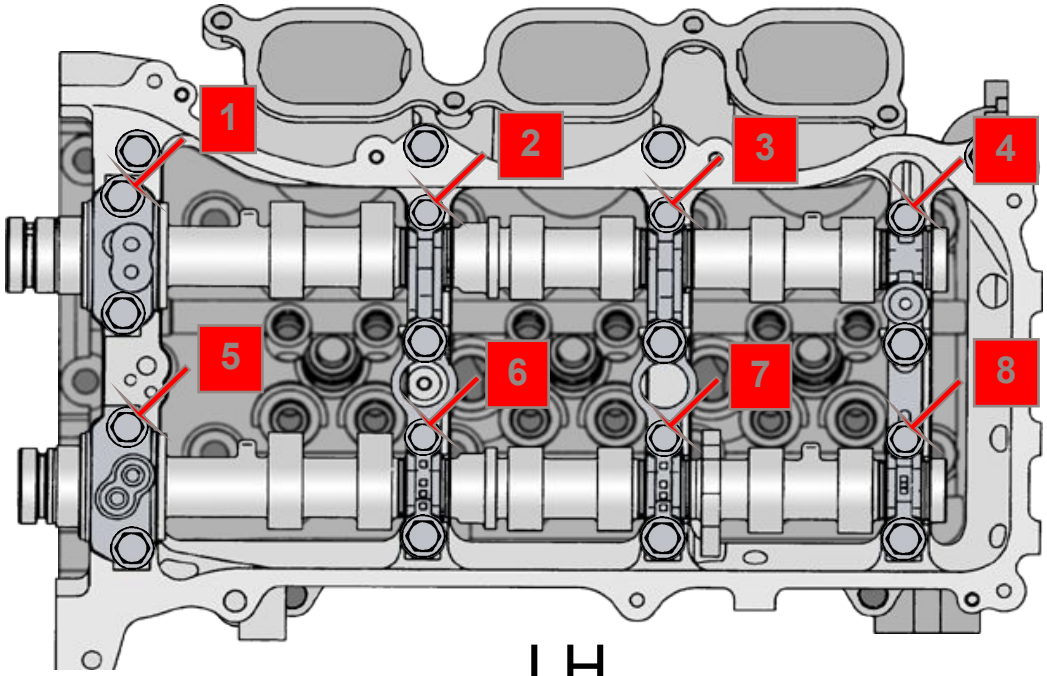


LH Bank

Service Point (Engine Proper)

- Cylinder Head
  - Camshaft and camshaft housing installation

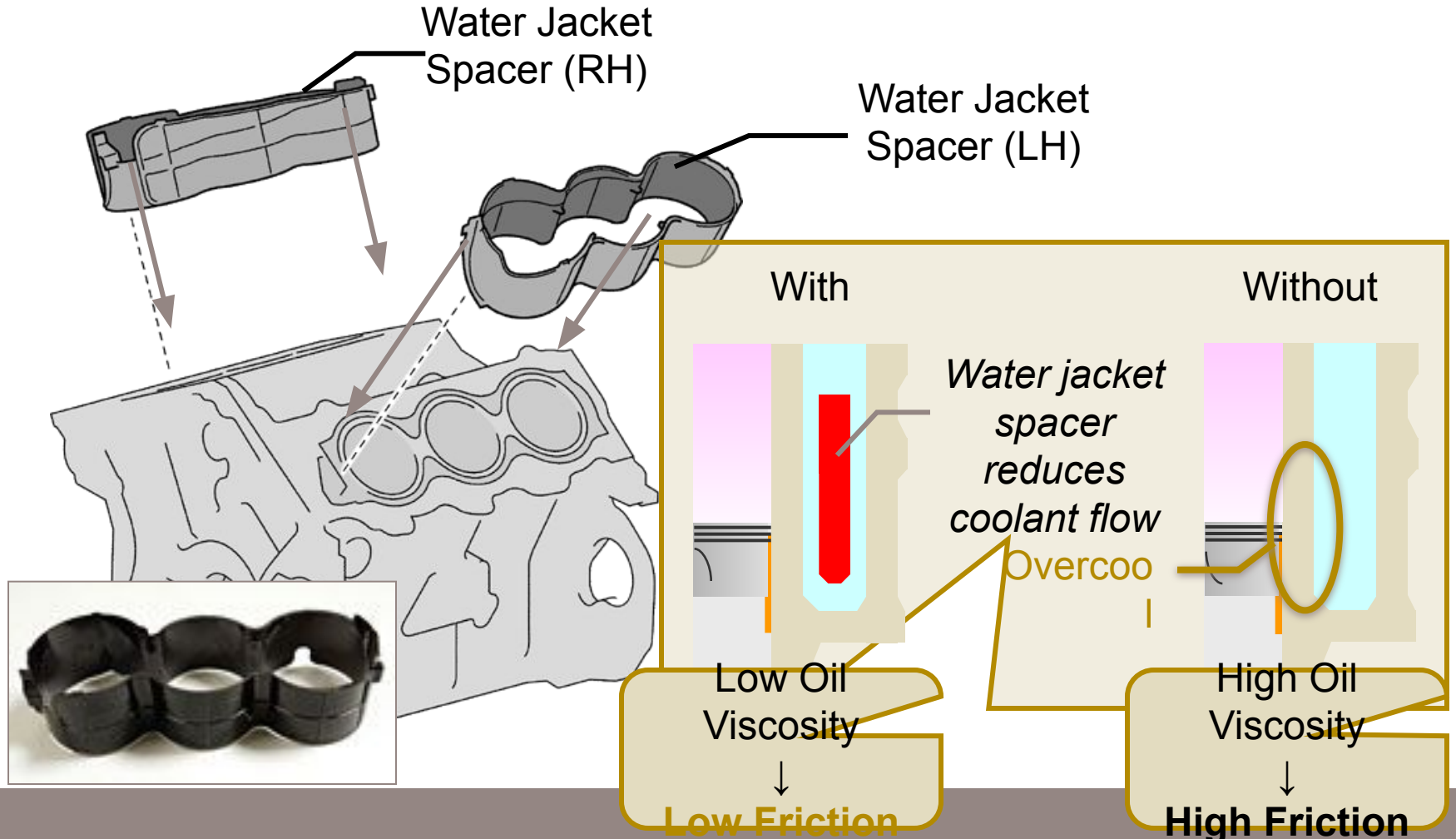
Step 3	✓	**: Tighten (Torque: 16N·m [163kgf·cm])**
	X	**: Tightening order**



LH Bank

Engine Proper

- Cylinder Block
  - Water jacket spacer optimizes the cylinder bore temp. to reduce friction

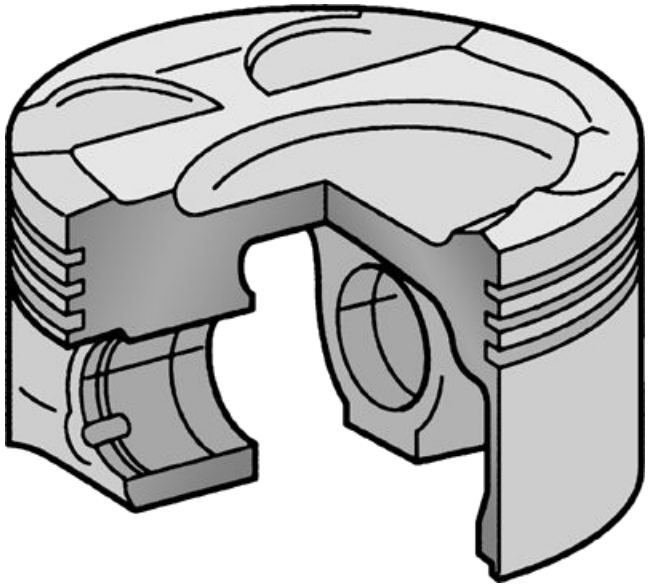


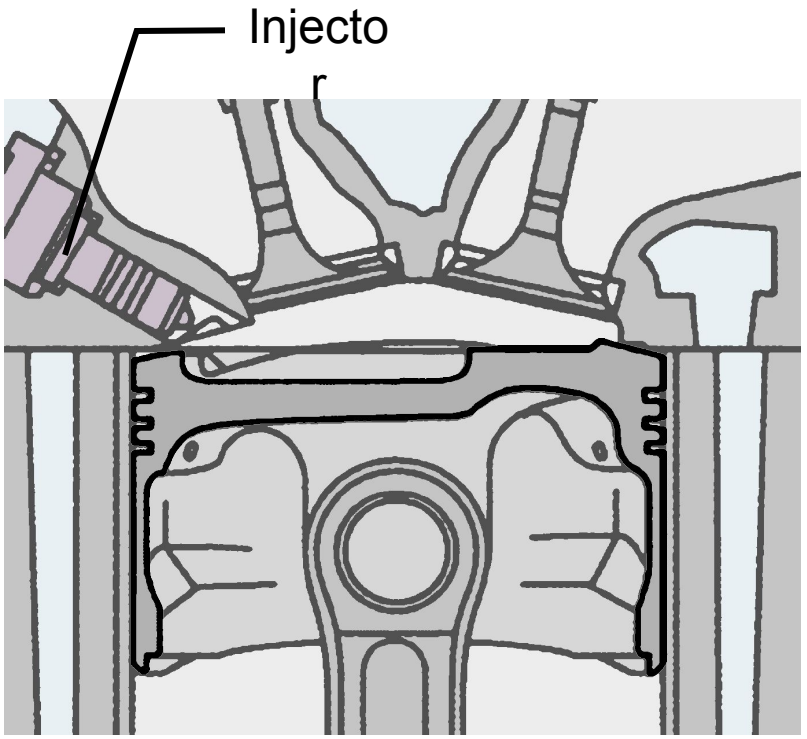
Engine Proper

- Cylinder Block
  - Spiny liner is used to increase cooling performance

Engine Proper

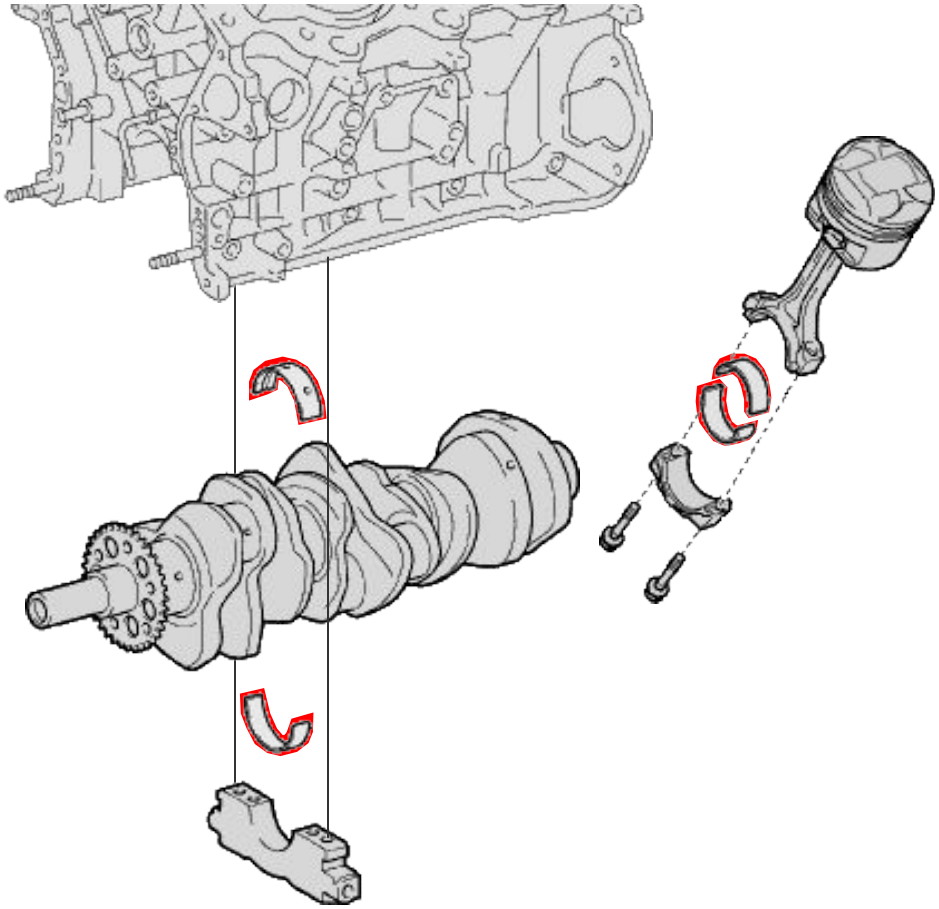
- Piston
  - Optimal piston head shape to promote the mixture of fuel and air





Engine Proper

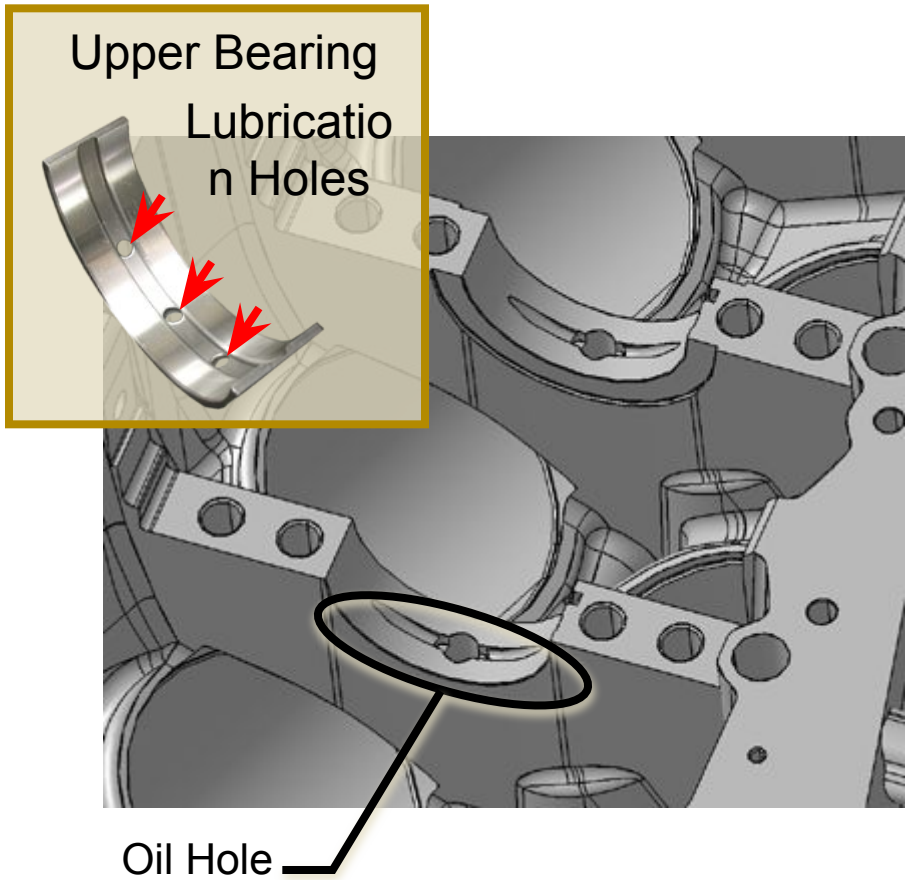
- Bearing
  - Bearing without bearing claw is used for crankshaft bearings and connecting rod bearings

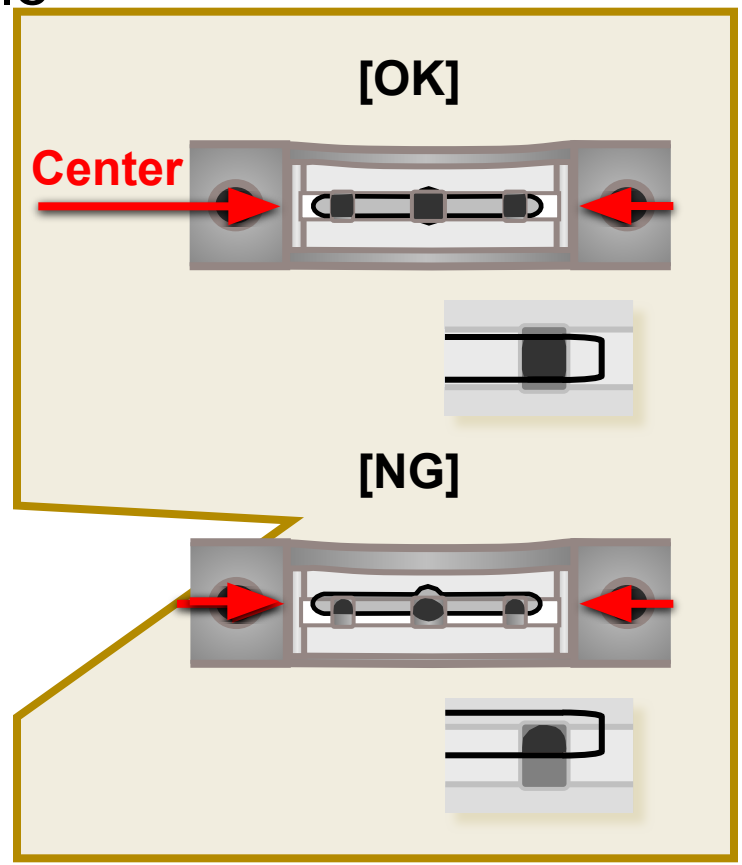


Without bearing claw

Service Point (Engine Proper)

- Installation of Crankshaft Upper Bearing
  - Bearing position should be centered to the cylinder block journal to align the oil hole

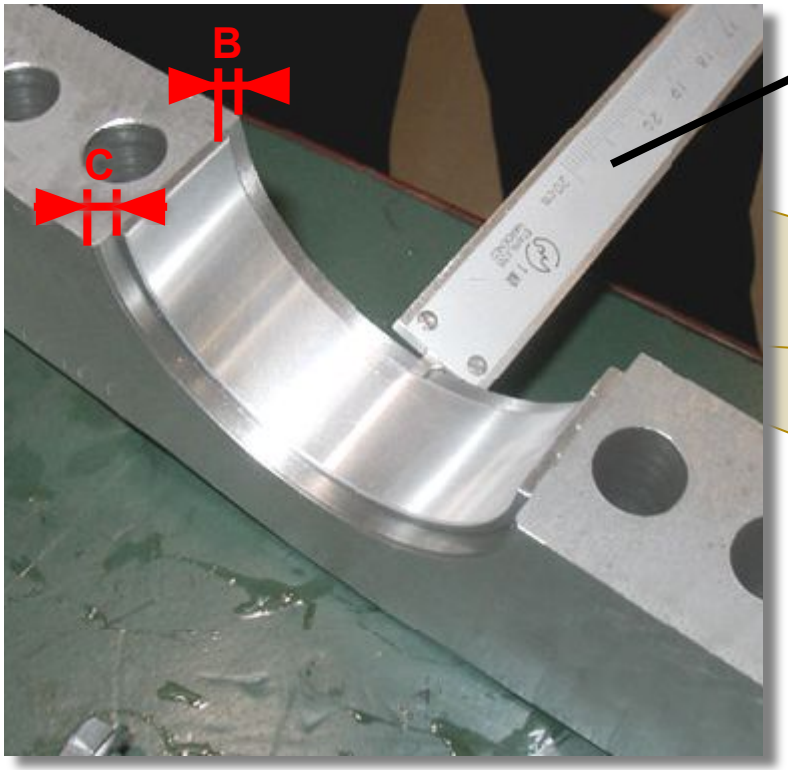




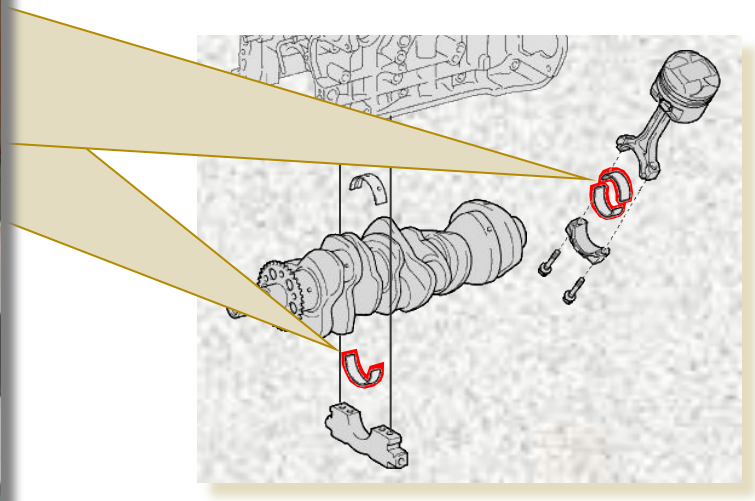
Service Point (Engine Proper)

- Installation of Crankshaft Lower Bearing, Connecting Rod Upper and Lower Bearings
  - Bearing should be positioned in center and measure the position

    Difference Between “B” and “C”: 0.7 mm (0.028 in.) or less

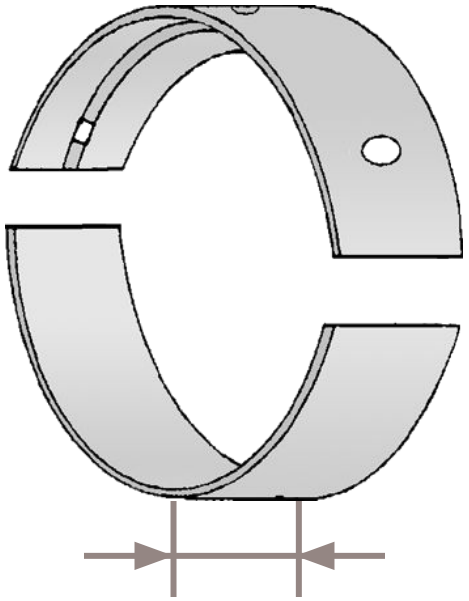


Vernier Caliper



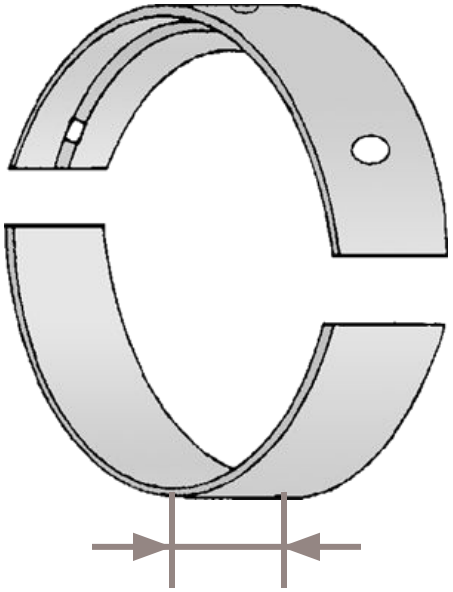
Service Point (Engine Proper)

- Crankshaft Bearing (upper and lower)
  - Combination of different width of the Bearings



21.0 mm
(0.827 in.)

No.1 and No.4 Journals

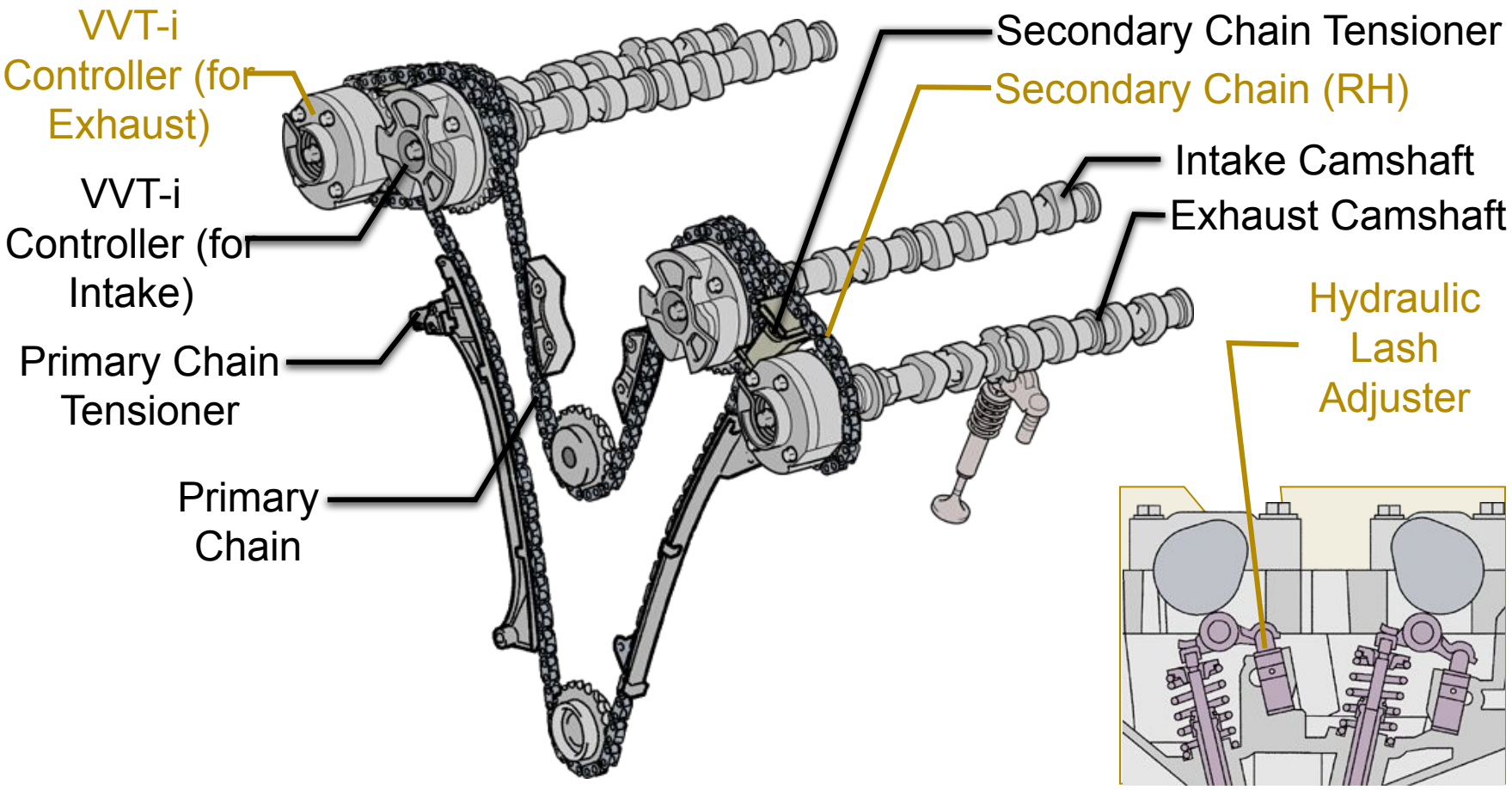


18.0 mm
(0.709
in.)

No.2 and No.3 Journals

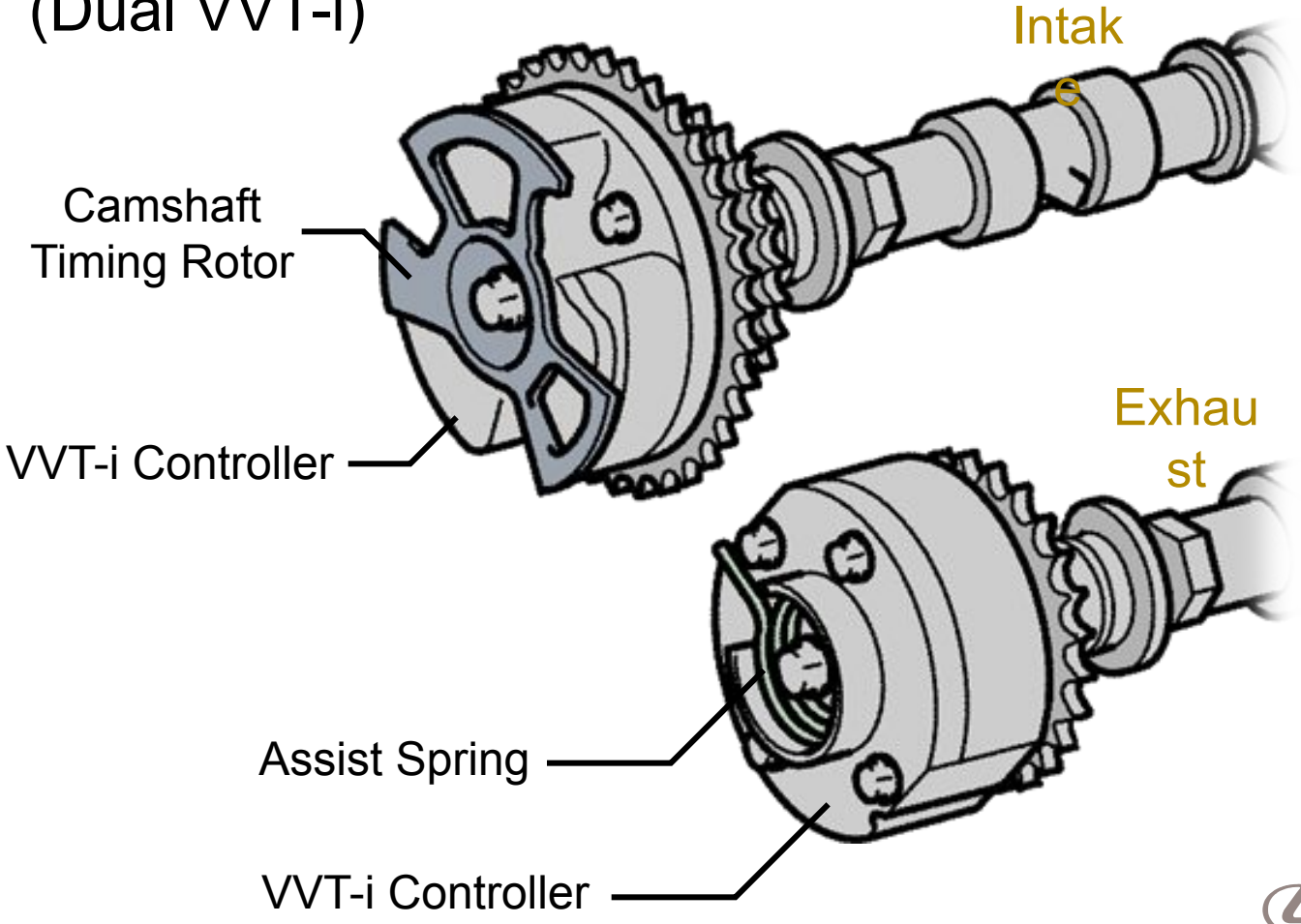
Valve Mechanism

- General
  - Three timing chains to drive intake and exhaust camshafts of each bank



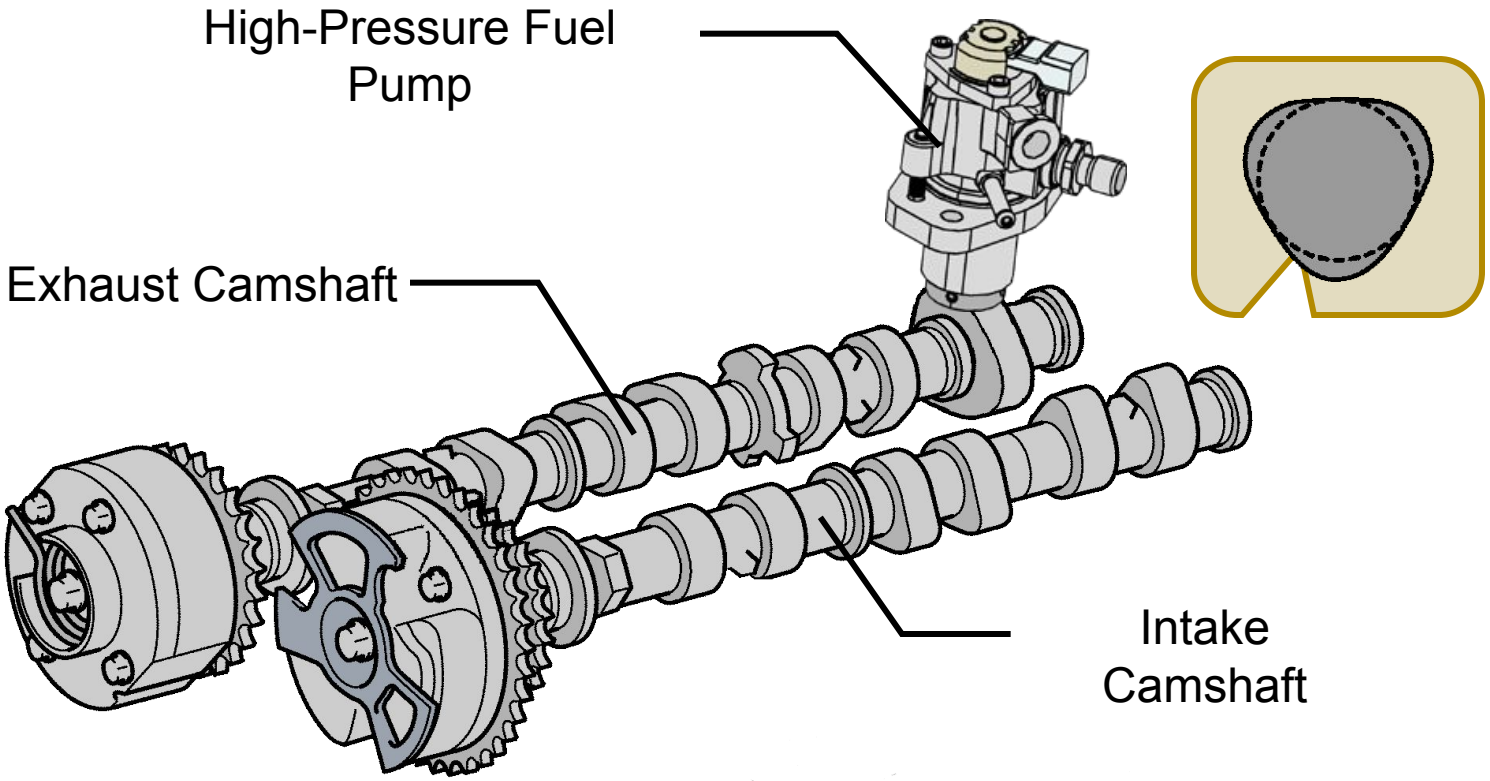
Valve Mechanism

- Camshaft
  - VVT-i system is used for intake & exhaust camshafts (Dual VVT-i)



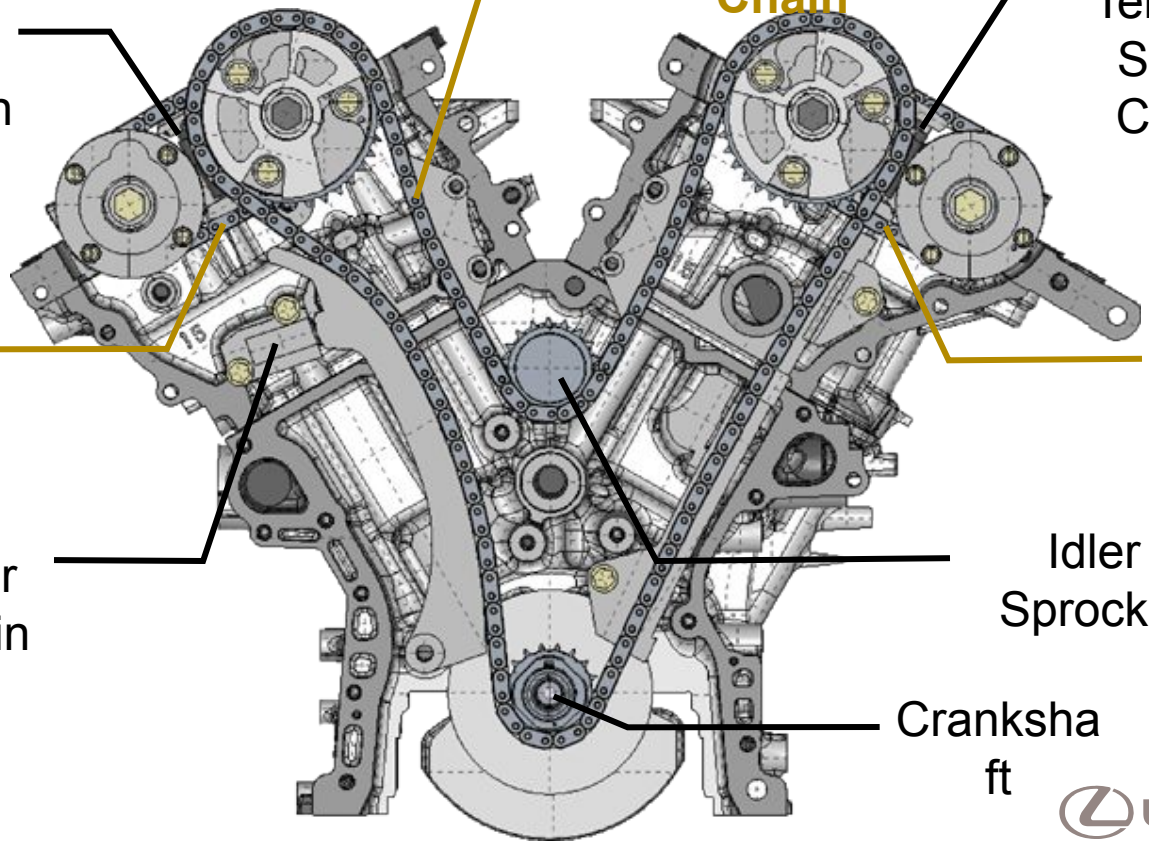
Valve Mechanism

- Camshaft
  - RH bank exhaust camshaft is provided with the cam to drive the high-pressure fuel pump



Valve Mechanism

- Timing Chain
  - Three timing chains to drive intake and exhaust camshafts of each bank



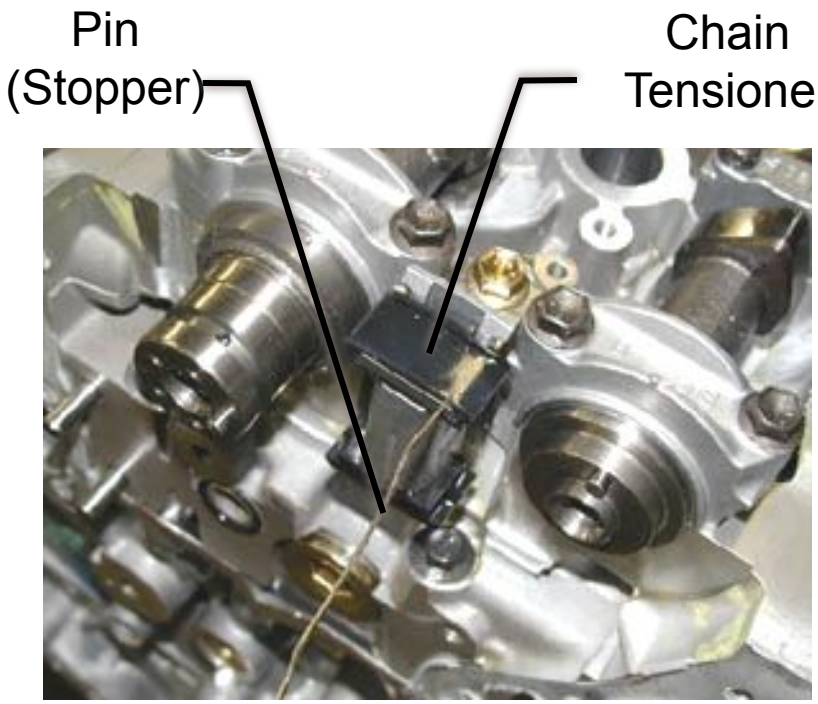
Valve Mechanism

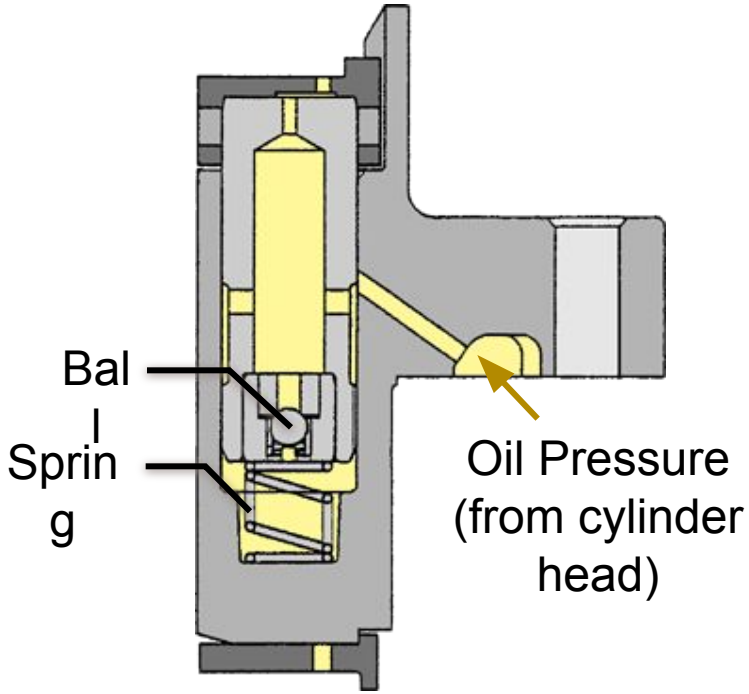
- Chain Tensioner
  - Primary chain tensioner
    - Ratchet type non-return mechanism

Service hall for
remove and replace

Valve Mechanism

- Chain Tensioner
  - 2 secondary chain tensioners are used for left and right bank

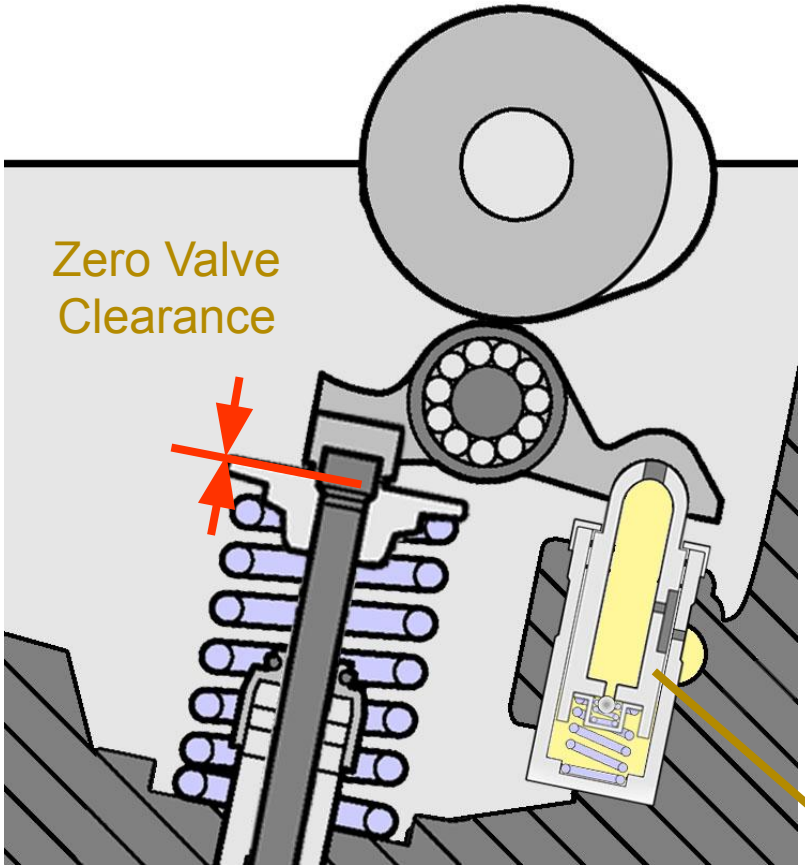


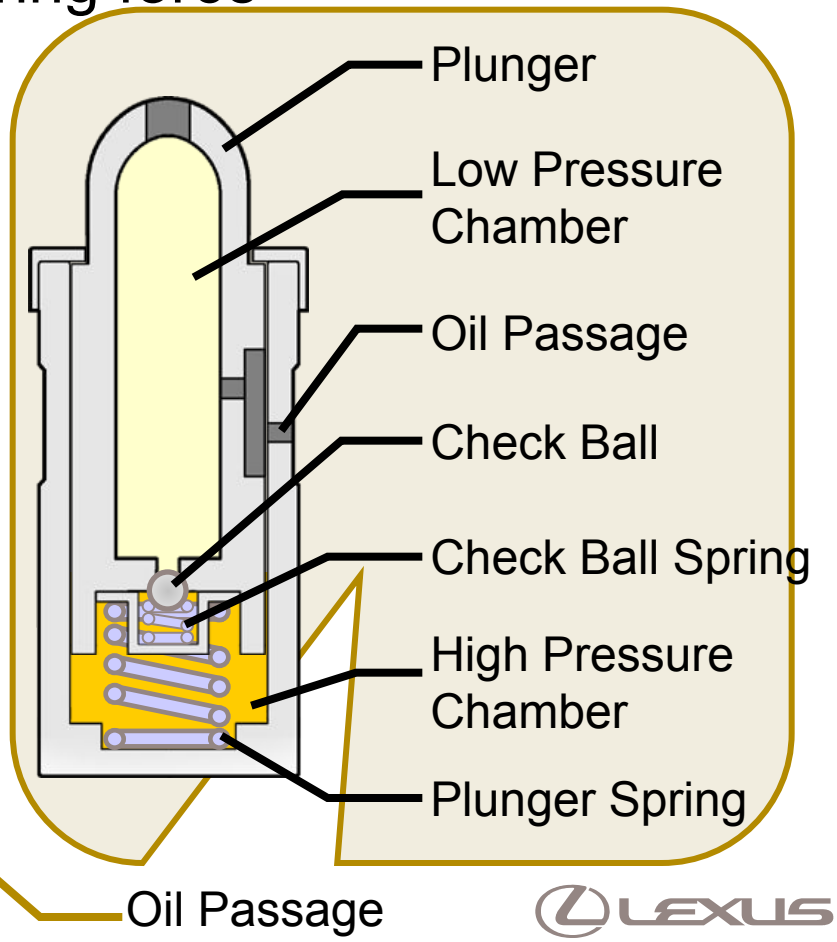


Left Bank

Reference (Valve Mechanism)

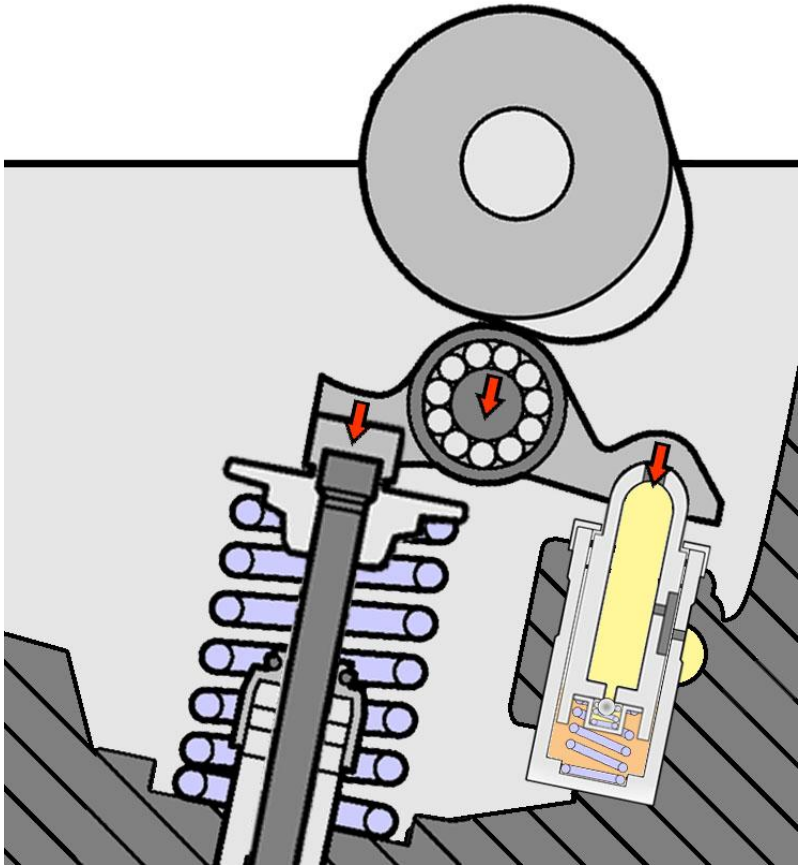
- Hydraulic Lash Adjuster
  - Maintaining a constant zero valve clearance through use of oil pressure and spring force

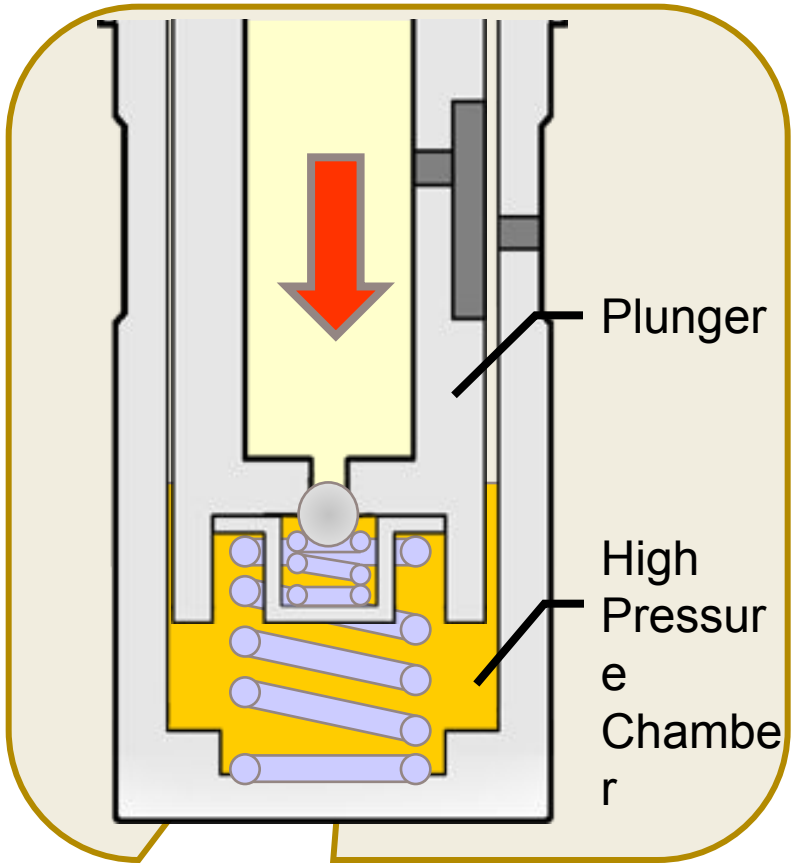




Reference (Valve Mechanism)

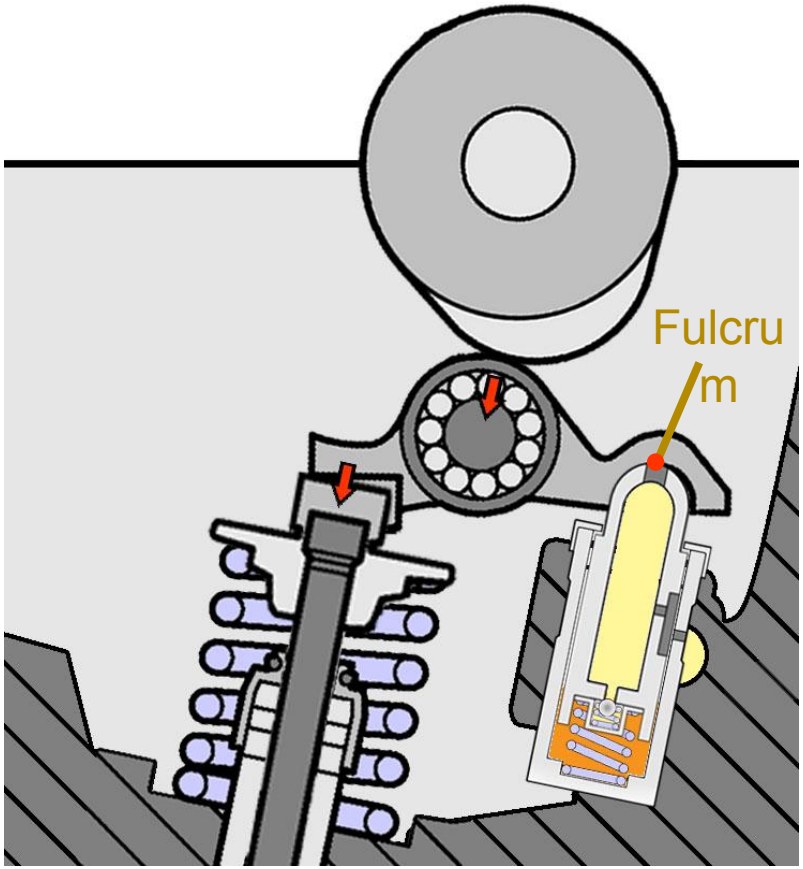
- Hydraulic Lash Adjuster
  - Start cam lift, plunger is pressed and oil in high pressure chamber is kept

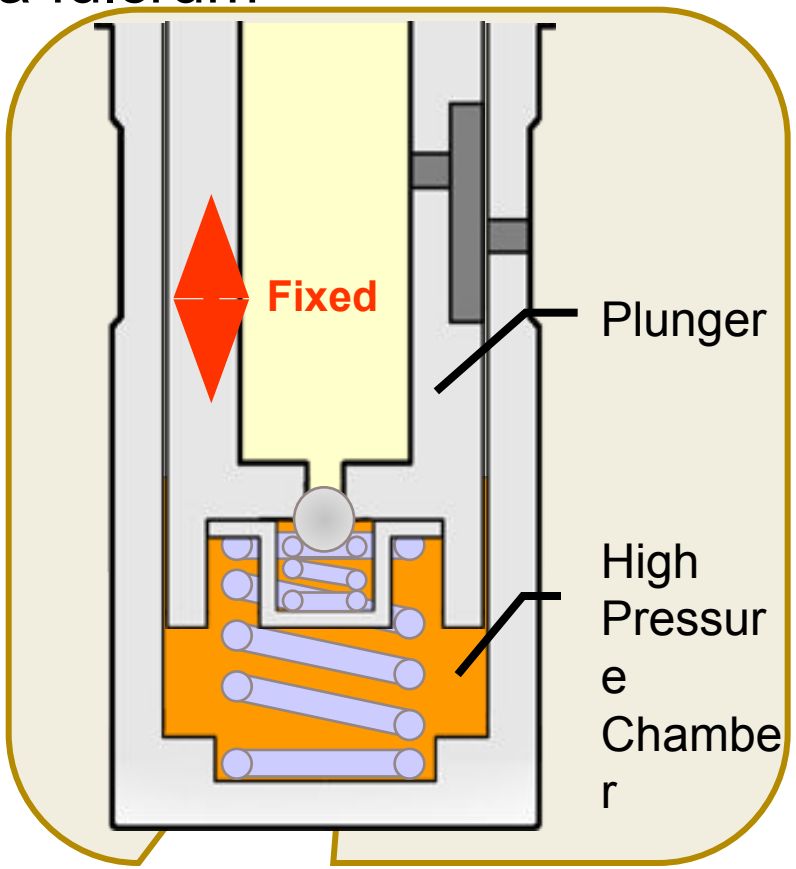




Reference (Valve Mechanism)

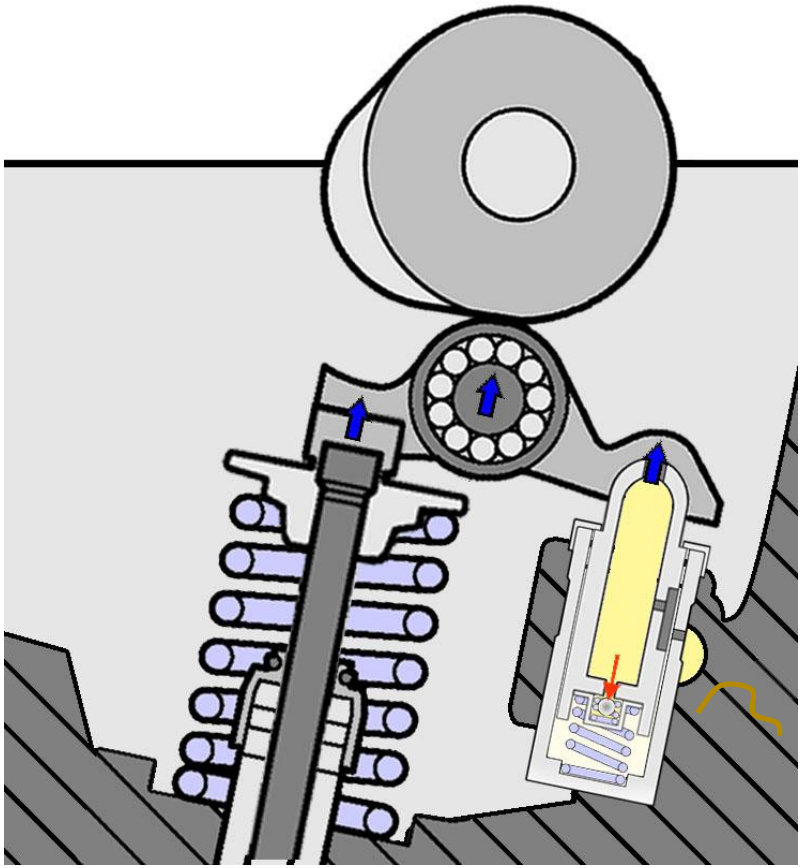
- Hydraulic Lash Adjuster
  - Then the rocker arm pushes the valve by using hydraulic lash adjuster as a fulcrum

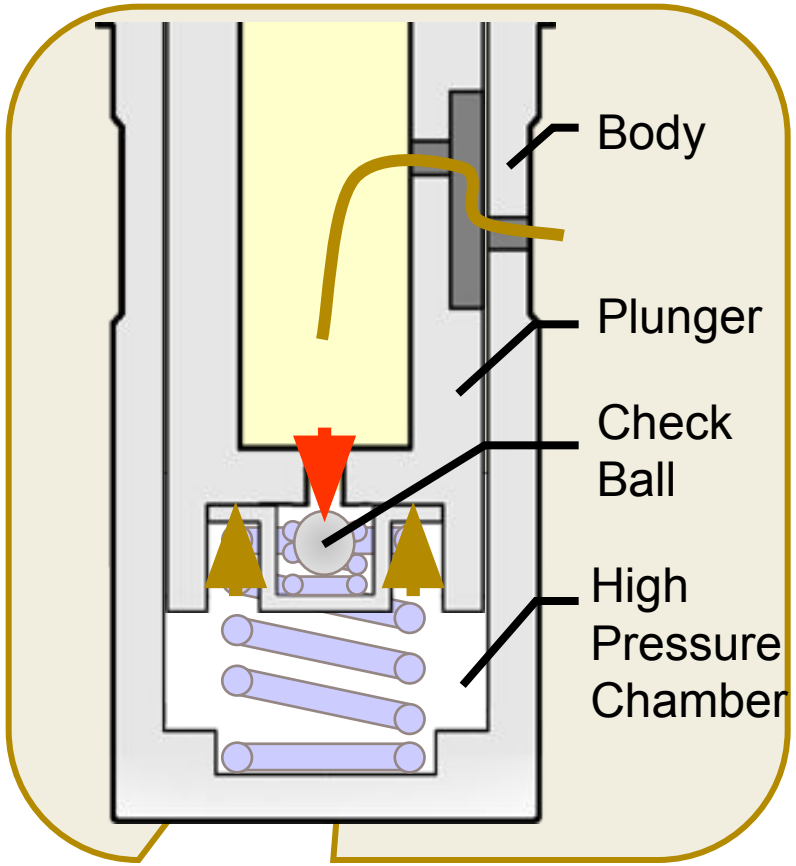




Reference (Valve Mechanism)

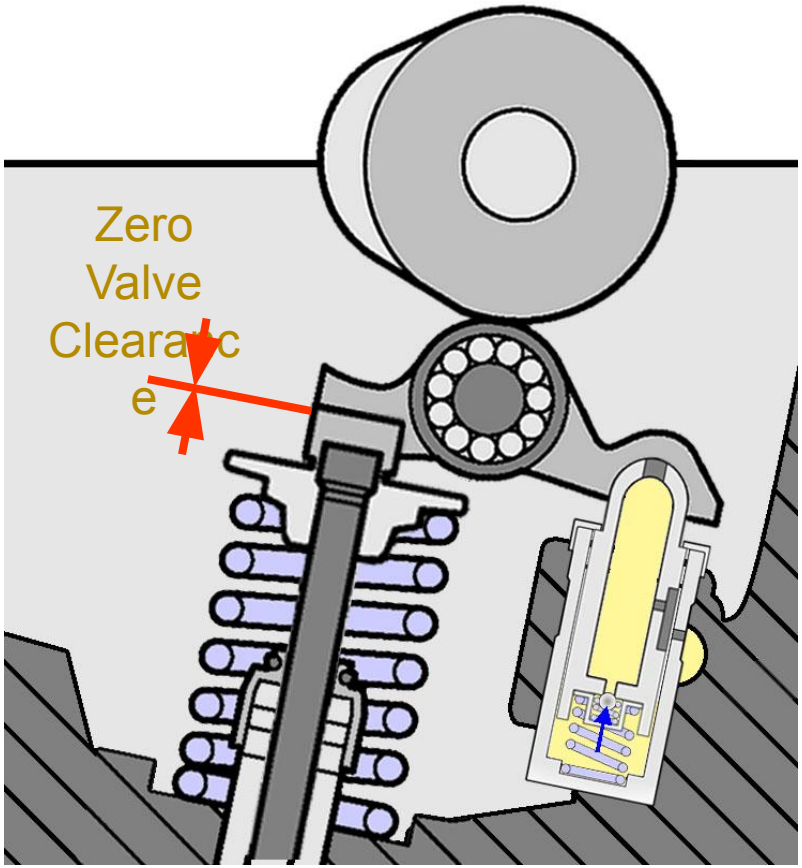
- Hydraulic Lash Adjuster
  - Plunger pushes back, check valve is opened and fills up oil

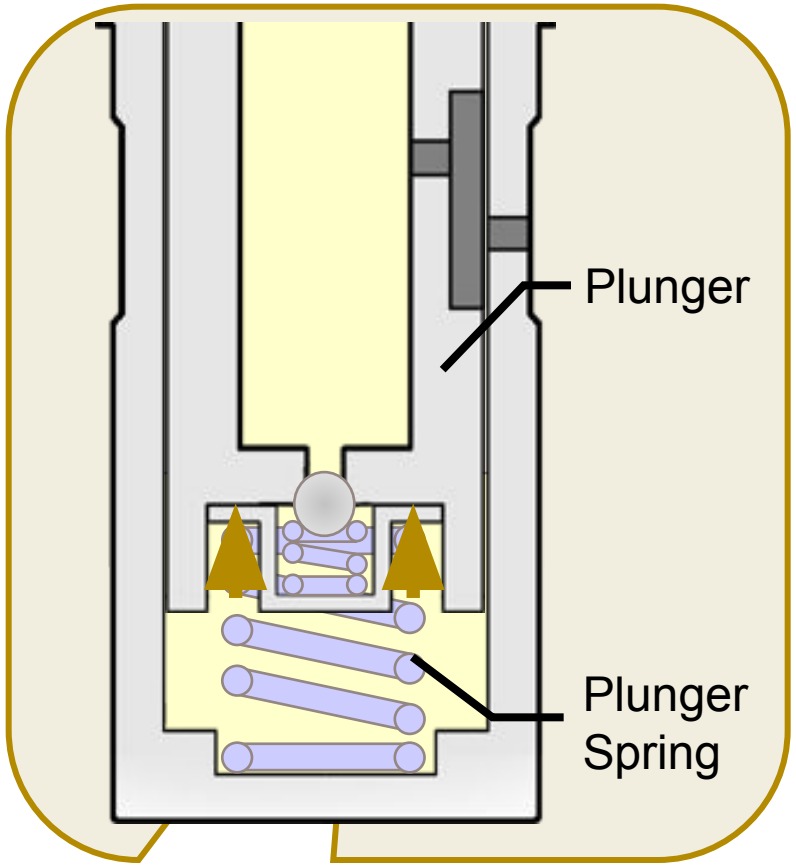




Reference (Valve Mechanism)

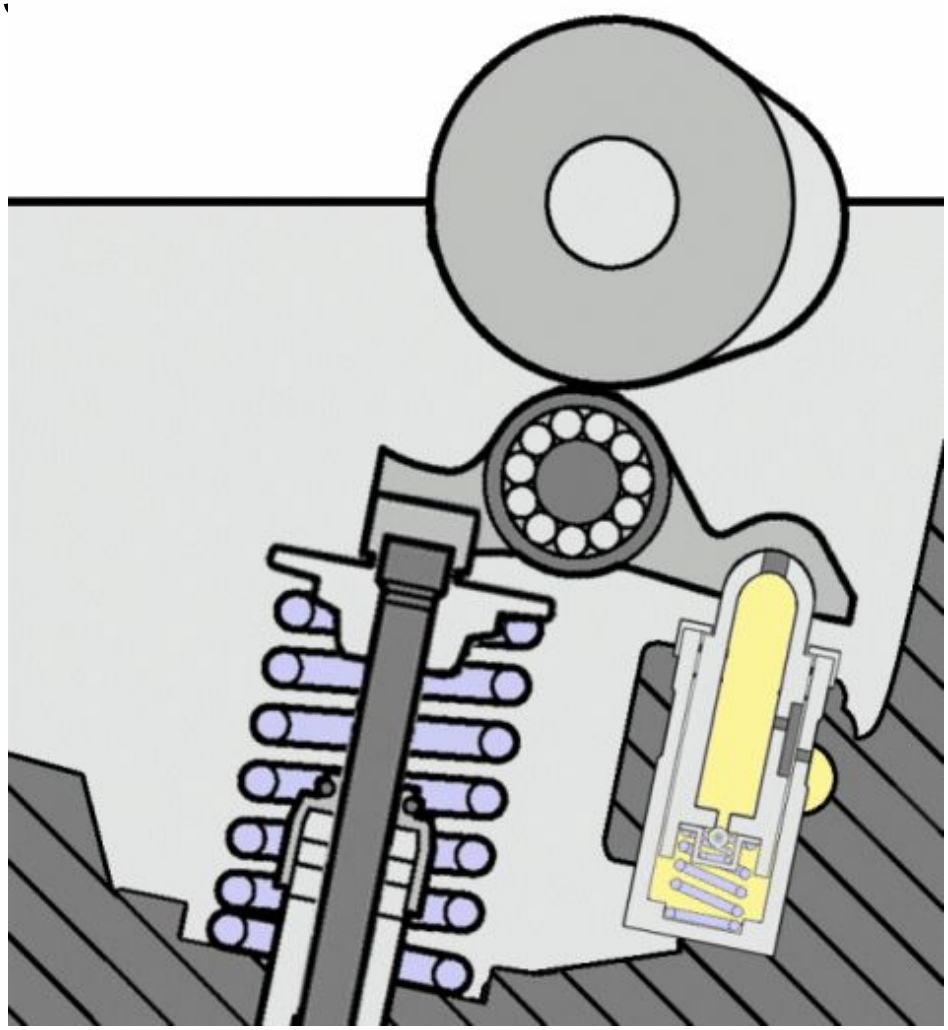
- Hydraulic Lash Adjuster
  - Plunger is pushed up, then, valve clearance is maintained at zero





Reference (Valve Mechanism)

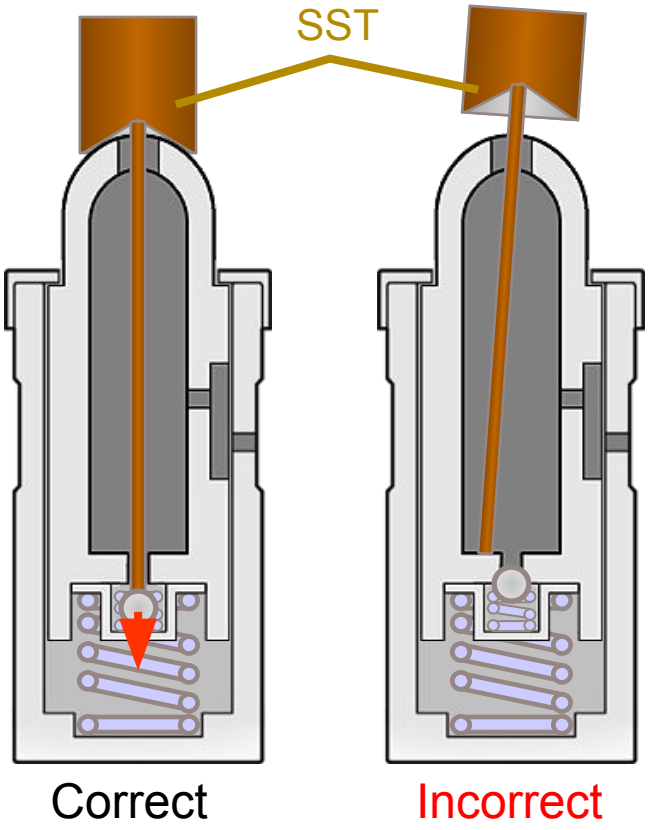
- Hydraulic La
  - Operation



Service Point (Valve Mechanism)

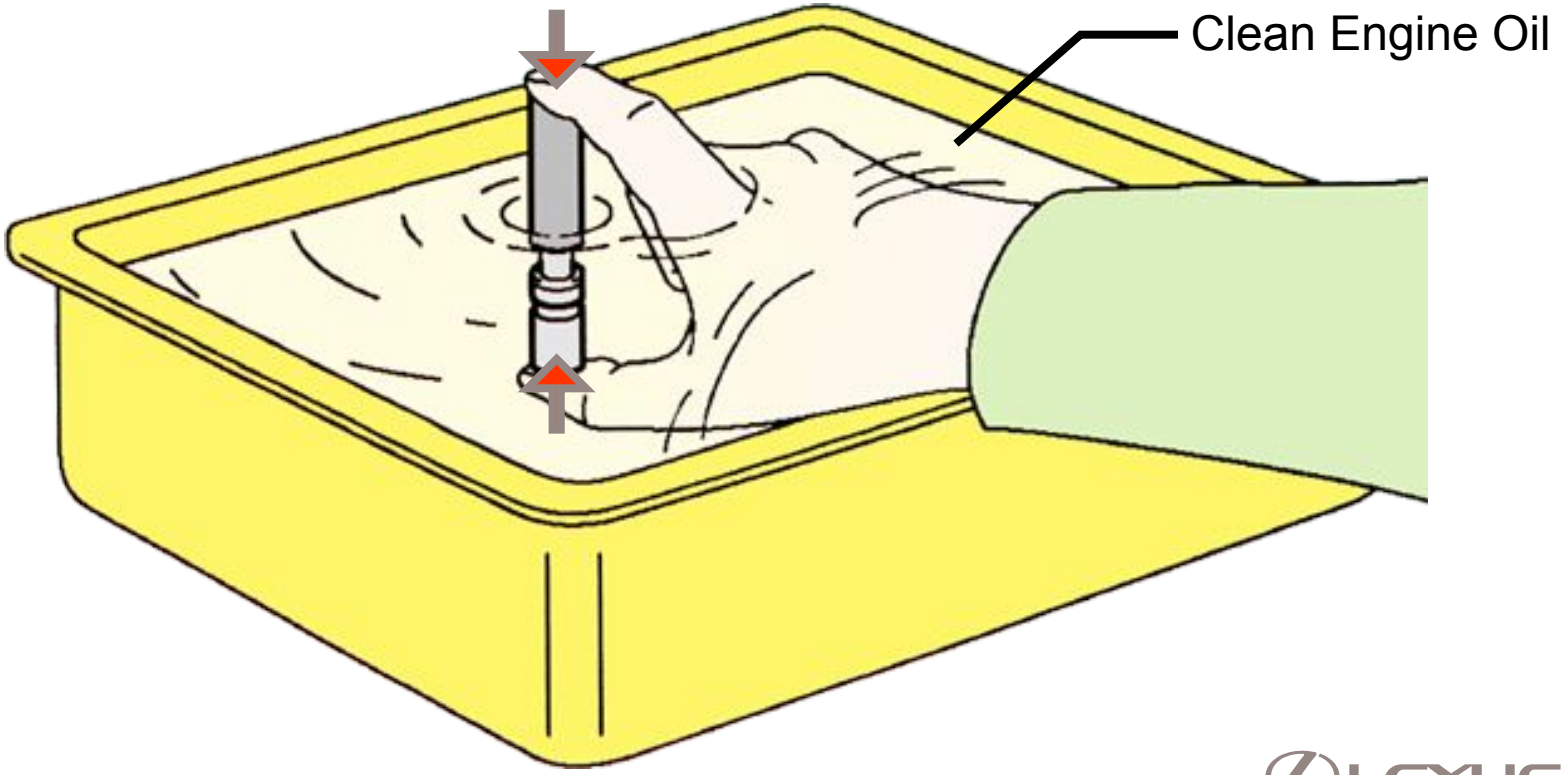
- Hydraulic Lash Adjuster
  - Engine oil changing procedure
    - 1. Pushing check ball down by using SST

Hydraulic Lash Adjuster



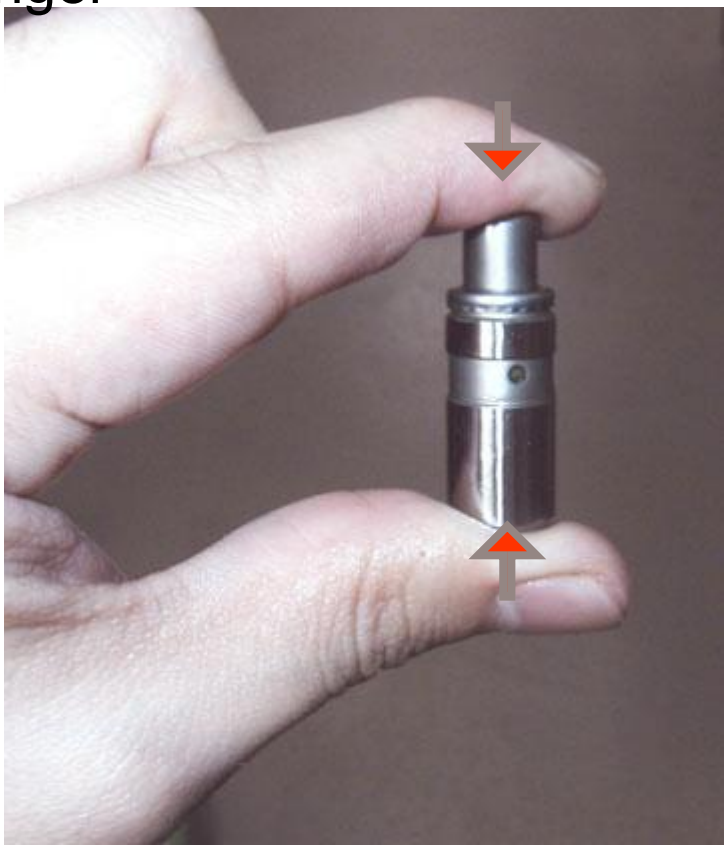
Service Point (Valve Mechanism)

- Hydraulic Lash Adjuster
  - Engine oil changing procedure
    - 2. Immerse hydraulic lash adjuster in clean engine oil, then compress and return the plunger with SST 5 to 6 times



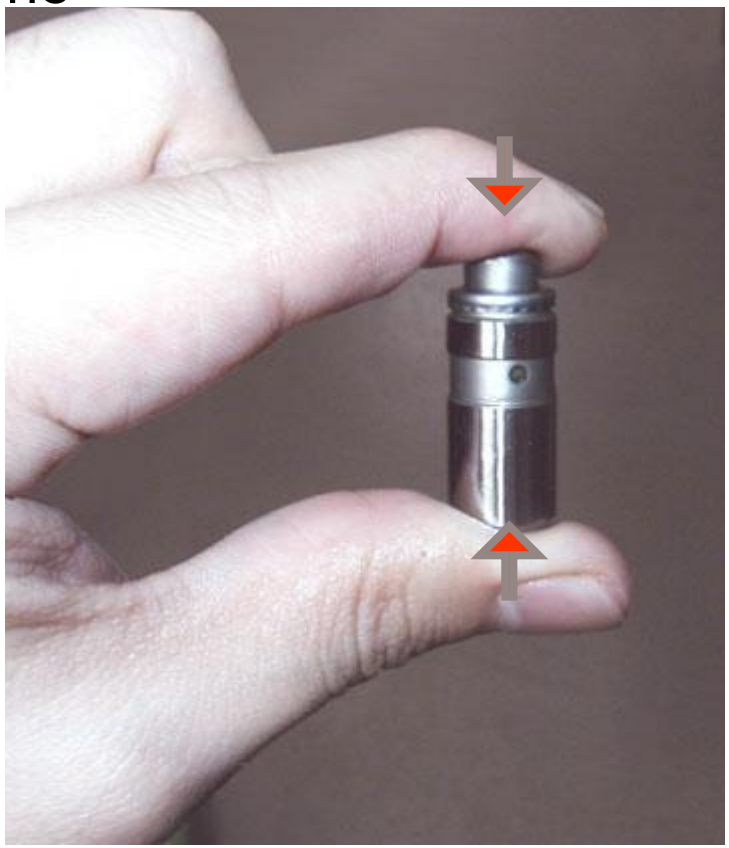
Service Point (Valve Mechanism)

- Hydraulic Lash Adjuster
  - Engine oil changing procedure
    - 3. Press the plunger by finger and check the blockage of plunger



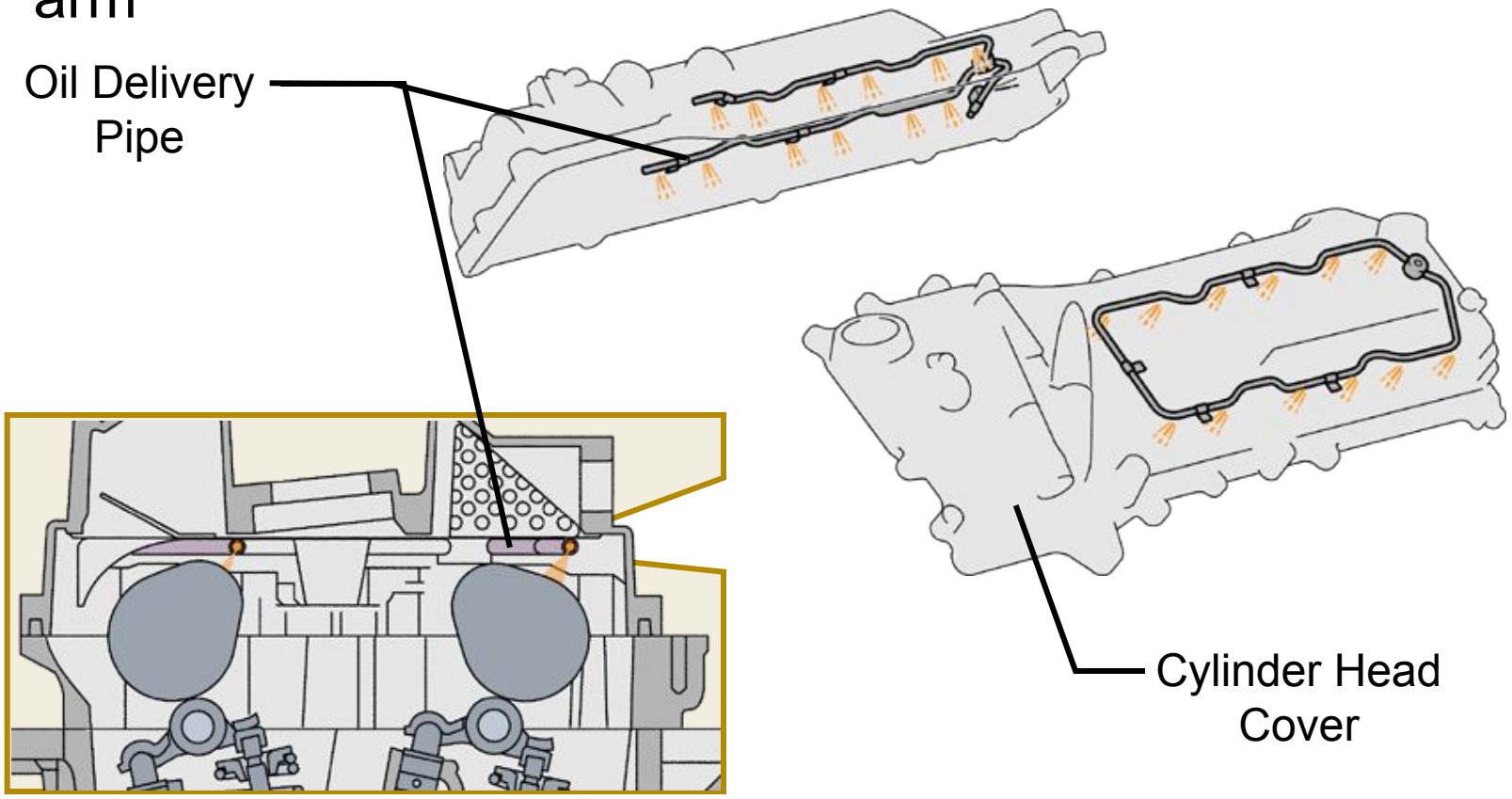
Service Point (Valve Mechanism)

- Hydraulic Lash Adjuster
  - Engine oil changing procedure
    - If plunger is compressed after 3 times trial, replace to new one



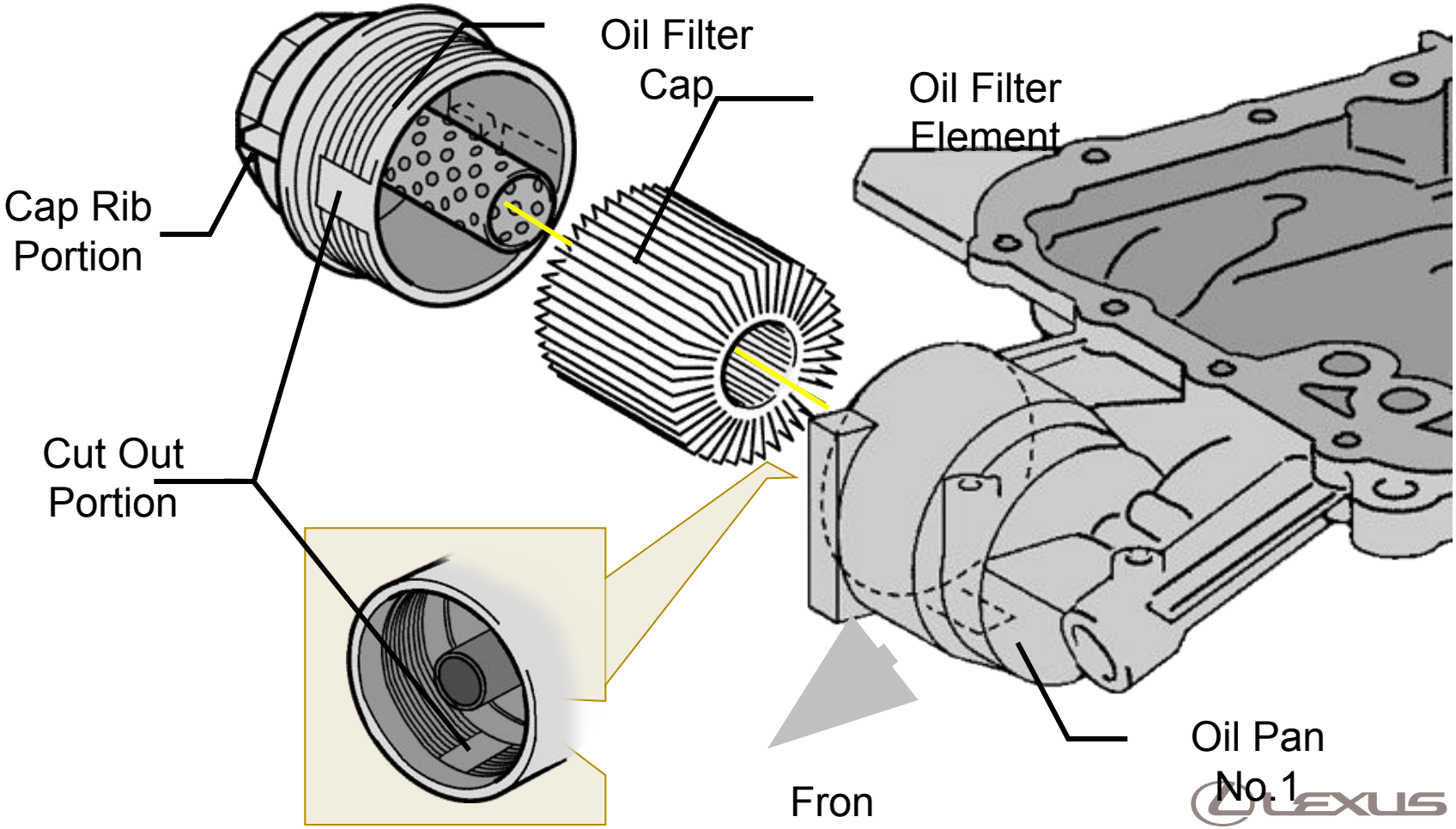
Lubrication System

- Oil Delivery Pipe
  - Oil delivery pipe is used to lubricate cam and rocker arm



Lubrication System

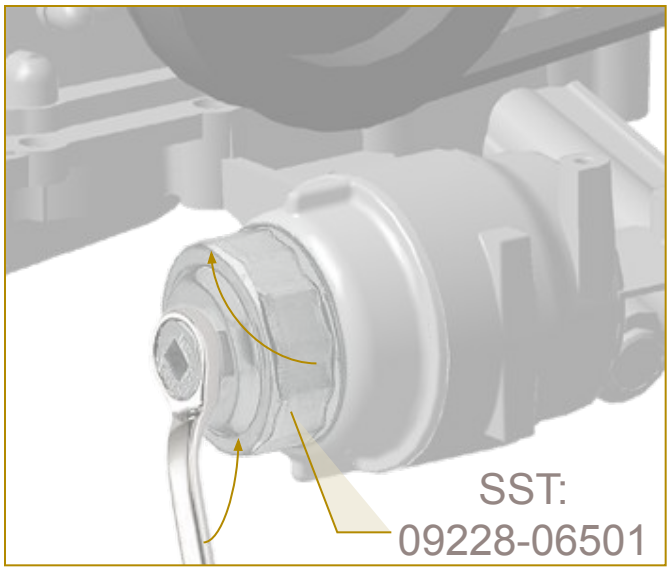
- Oil Filter (2WD)
  - Element replacing type oil filter is used



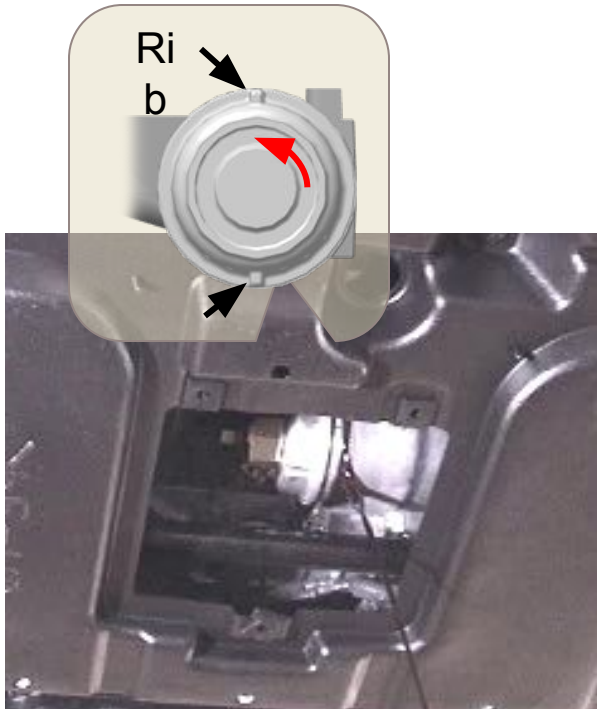
Service Point (Lubrication System)

- Oil filter (4WD)
  - Oil filter replacement
    - Removal

Remove filter element



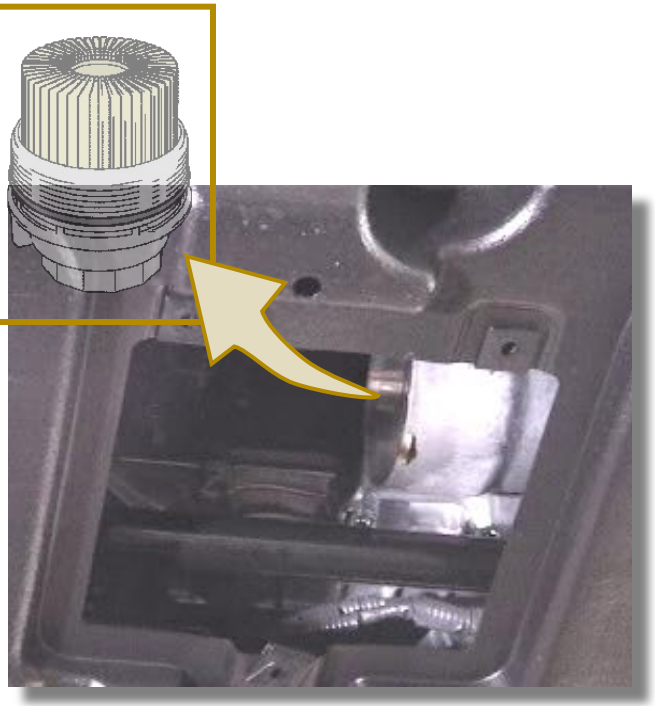
Loosen the filter cap for approx. 4 rev.



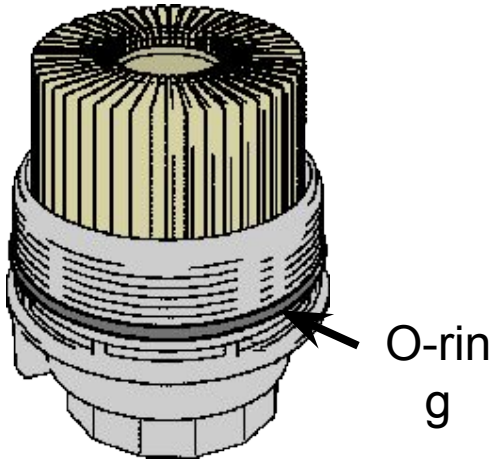
Align the cap rib vertically and drain oil

Service Point (Lubrication System)

- 3UR-FE (4WD)
  - Oil filter replacement
    - Removal



Remove oil filter cap and filter element

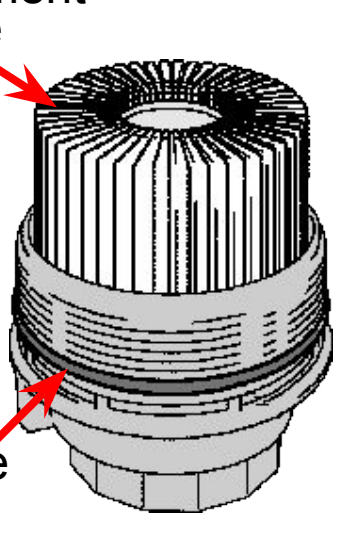


Remove filter element and O-ring from filter cap

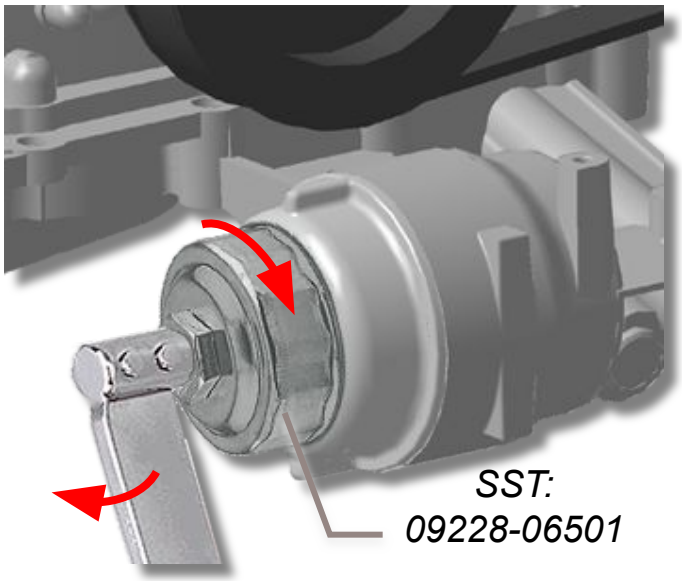
Service Point (Lubrication System)

- Oil filter (4WD)
  - Oil filter replacement
    - Installation

Install filter element



Set new filter element and O-ring

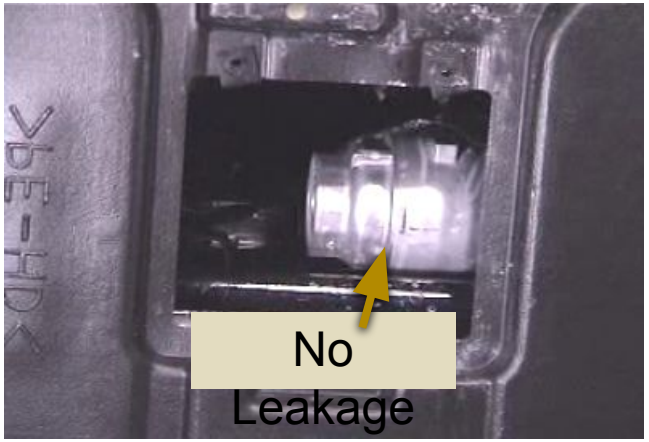


Install filter cap using SST

Service Point (Lubrication System)

- Oil filter (4WD)
  - Oil filter replacement
    - Installation

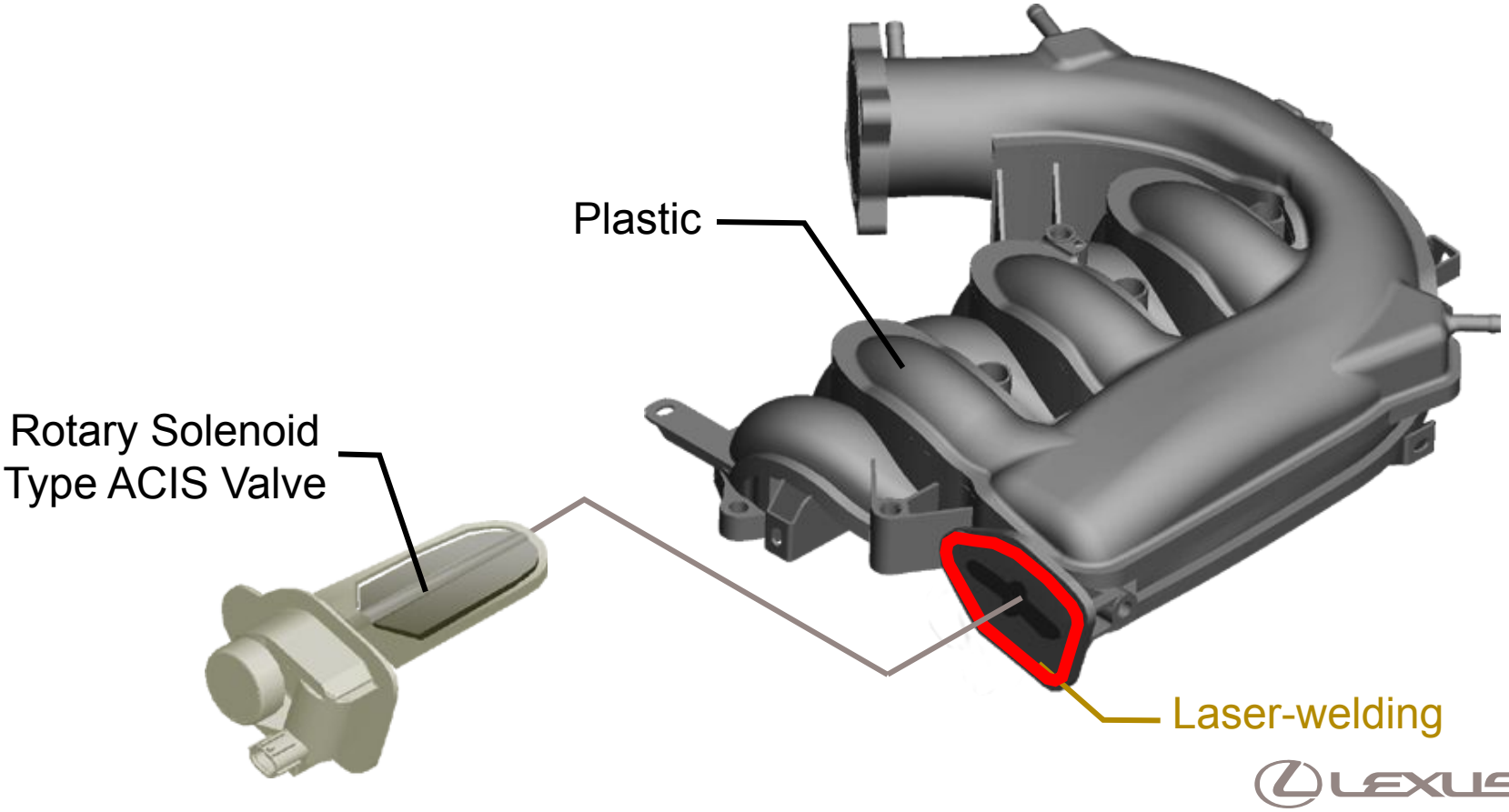
Refill engine oil



Run the engine and check oil leakage

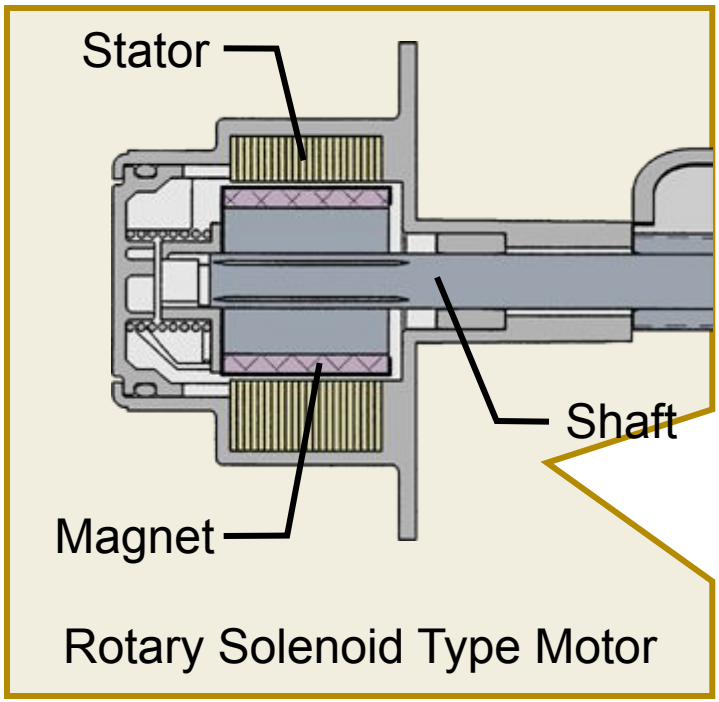
Intake and Exhaust System

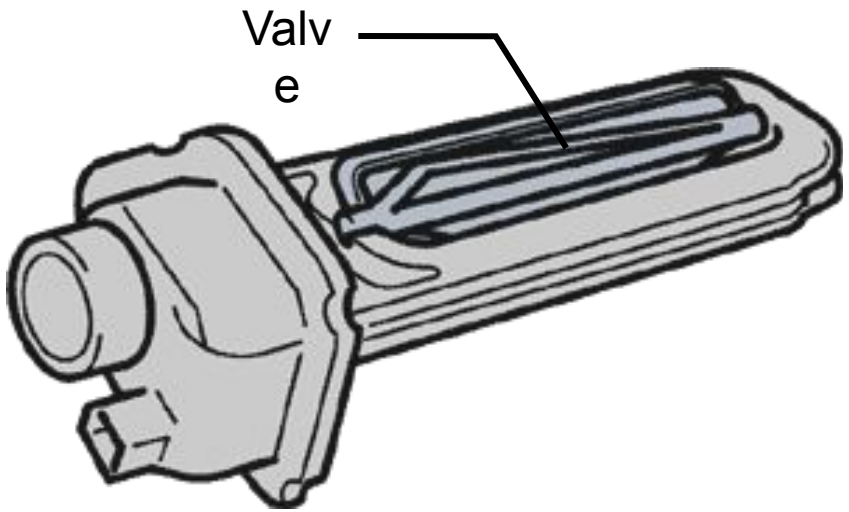
- ACIS Valve
  - Rotary solenoid type ACIS valve is used
  - ACIS valve is unified by laser-welding



Reference (Intake & Exhaust System)

- ACIS Valve
  - Rotary solenoid type ACIS valve is used



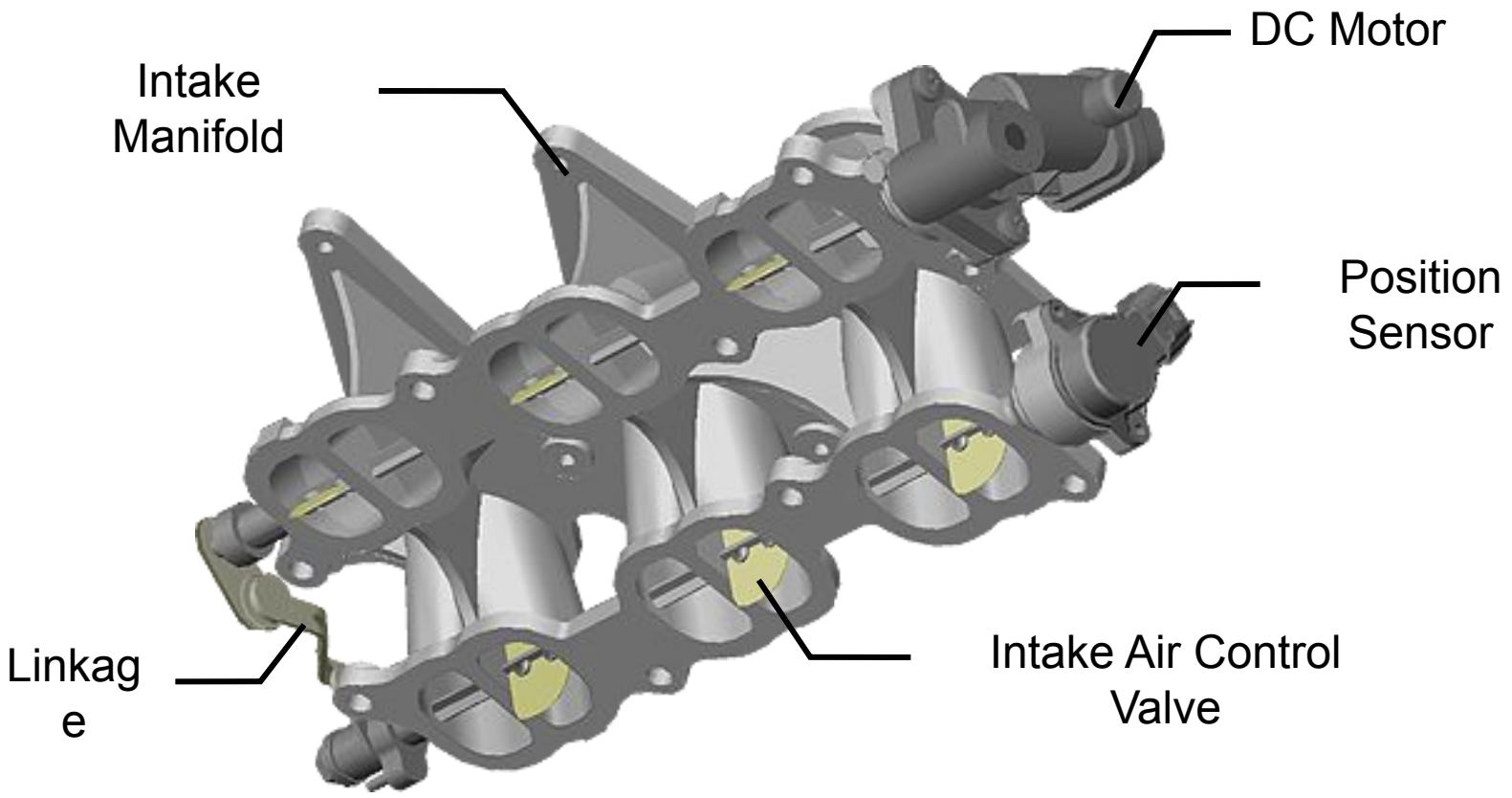


ACIS Valve

LEXUS

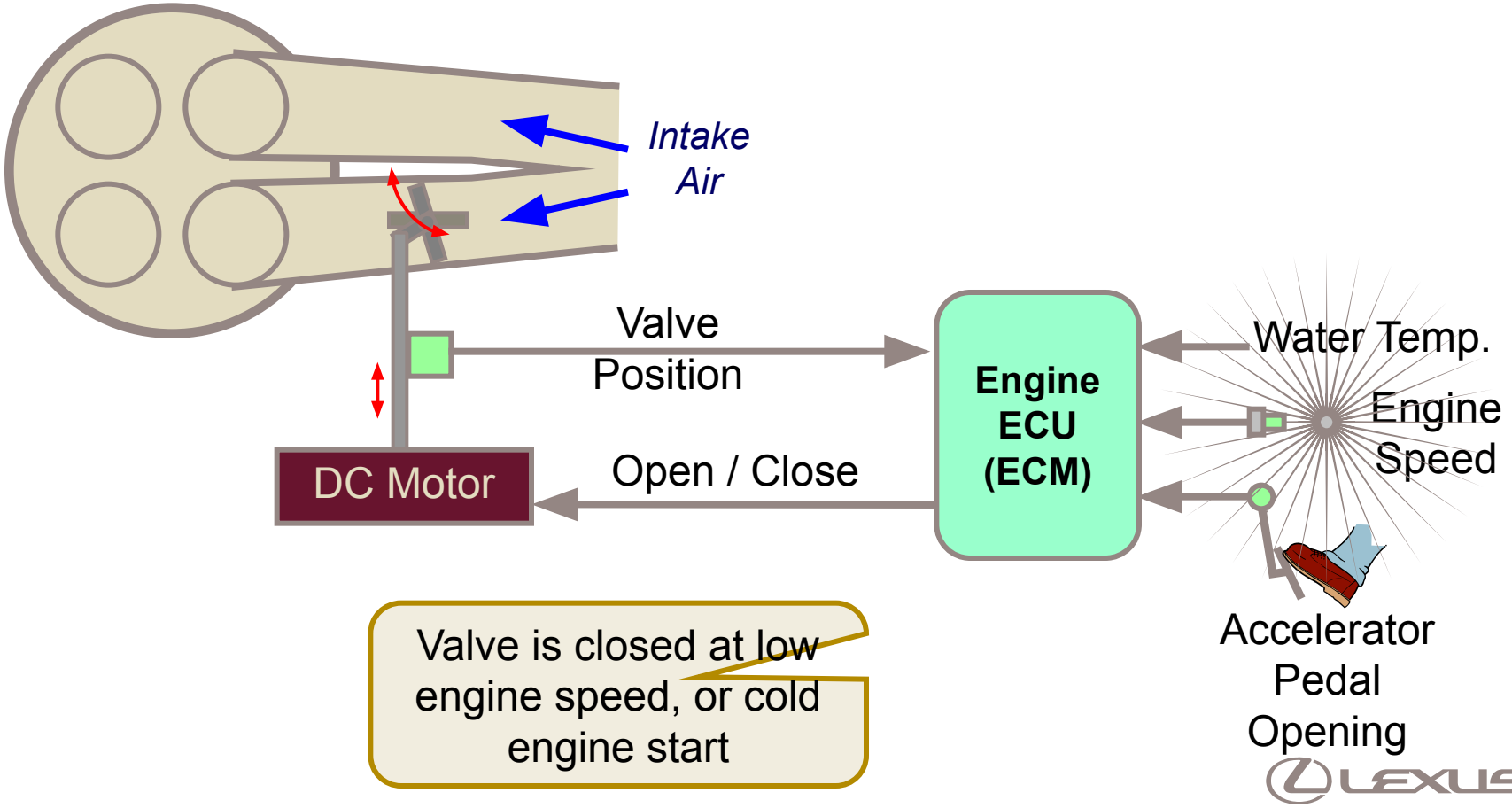
Intake and Exhaust System

- Intake Air Control Valve
  - Intake air control valve is operated by DC motor



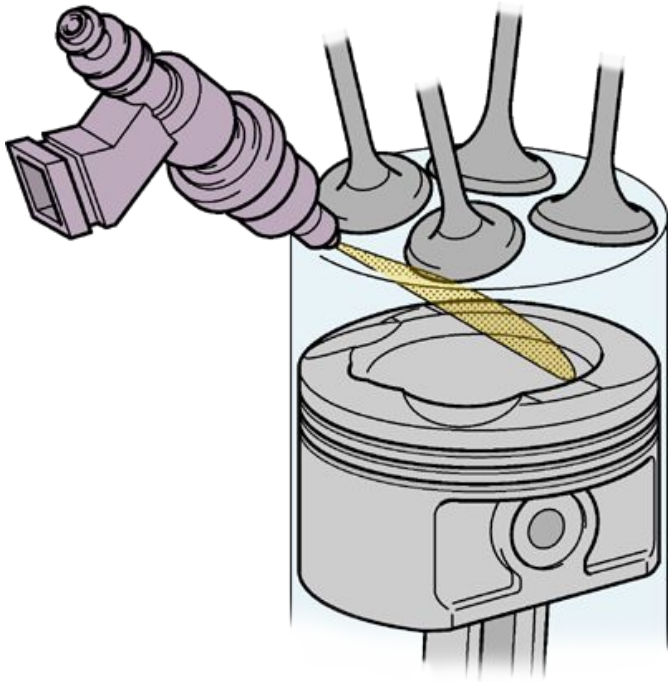
Intake and Exhaust System

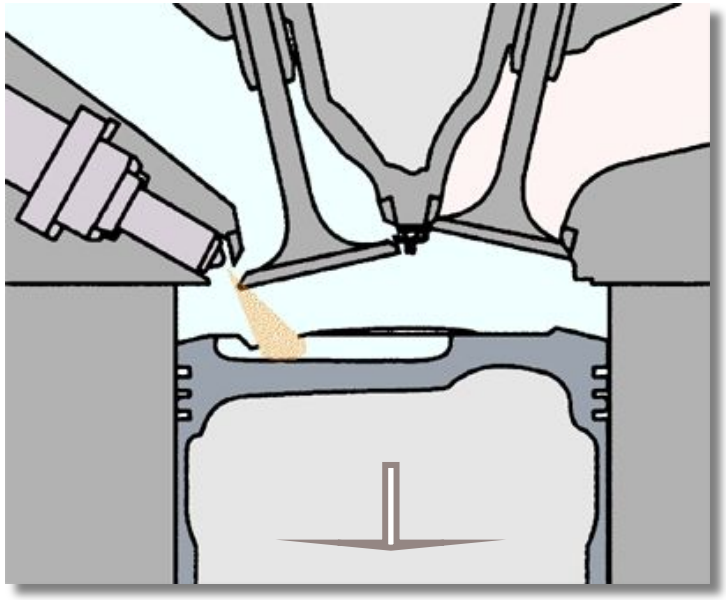
- Intake Air Control Valve
  - Operation



D-4 System

- General
  - 4GR-FSE engine uses D-4 System

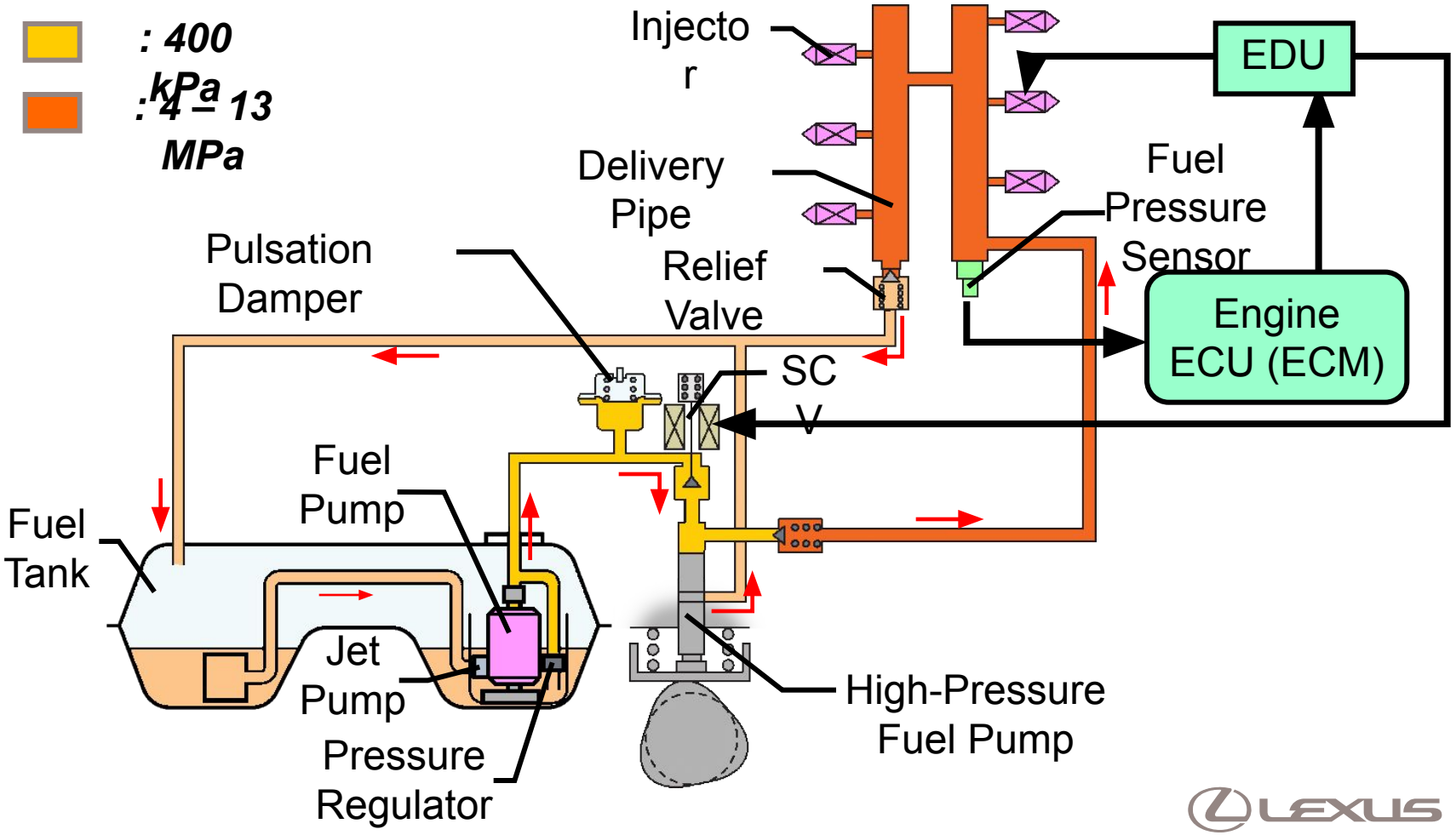




D-4 (Direct injection 4-stroke gasoline engine)

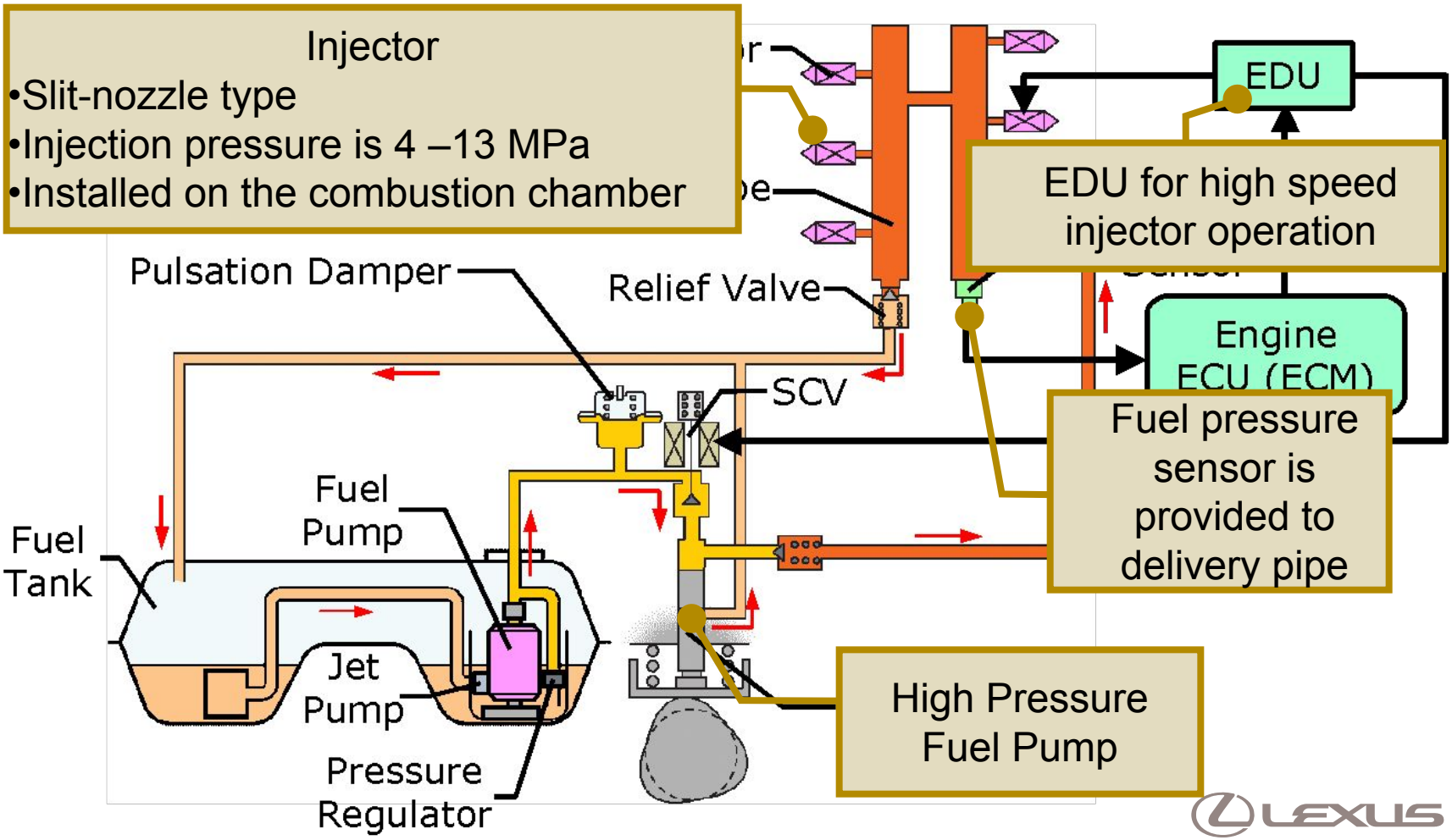
D-4 System

- System Diagram



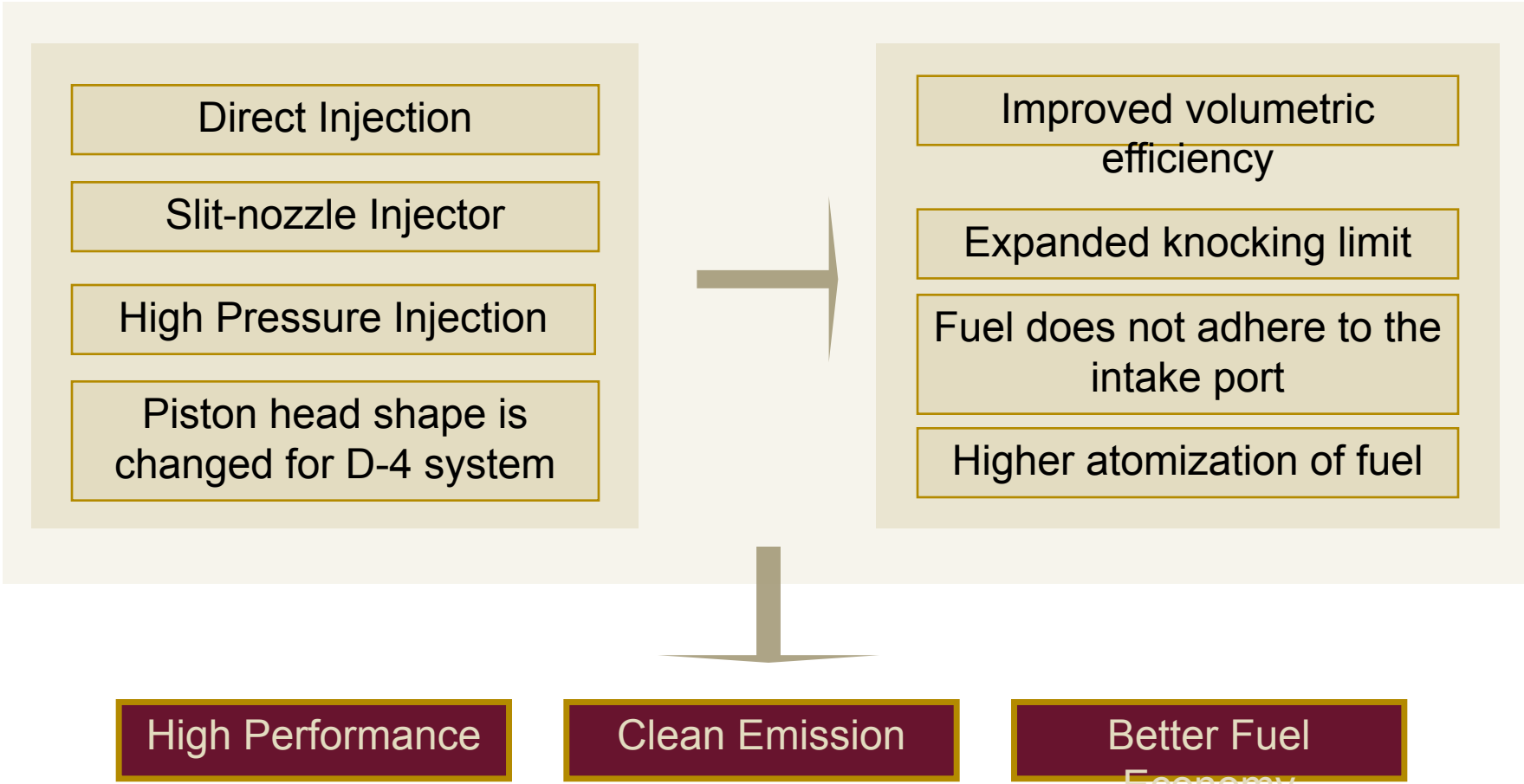
D-4 System

- Difference from usual gasoline EFI



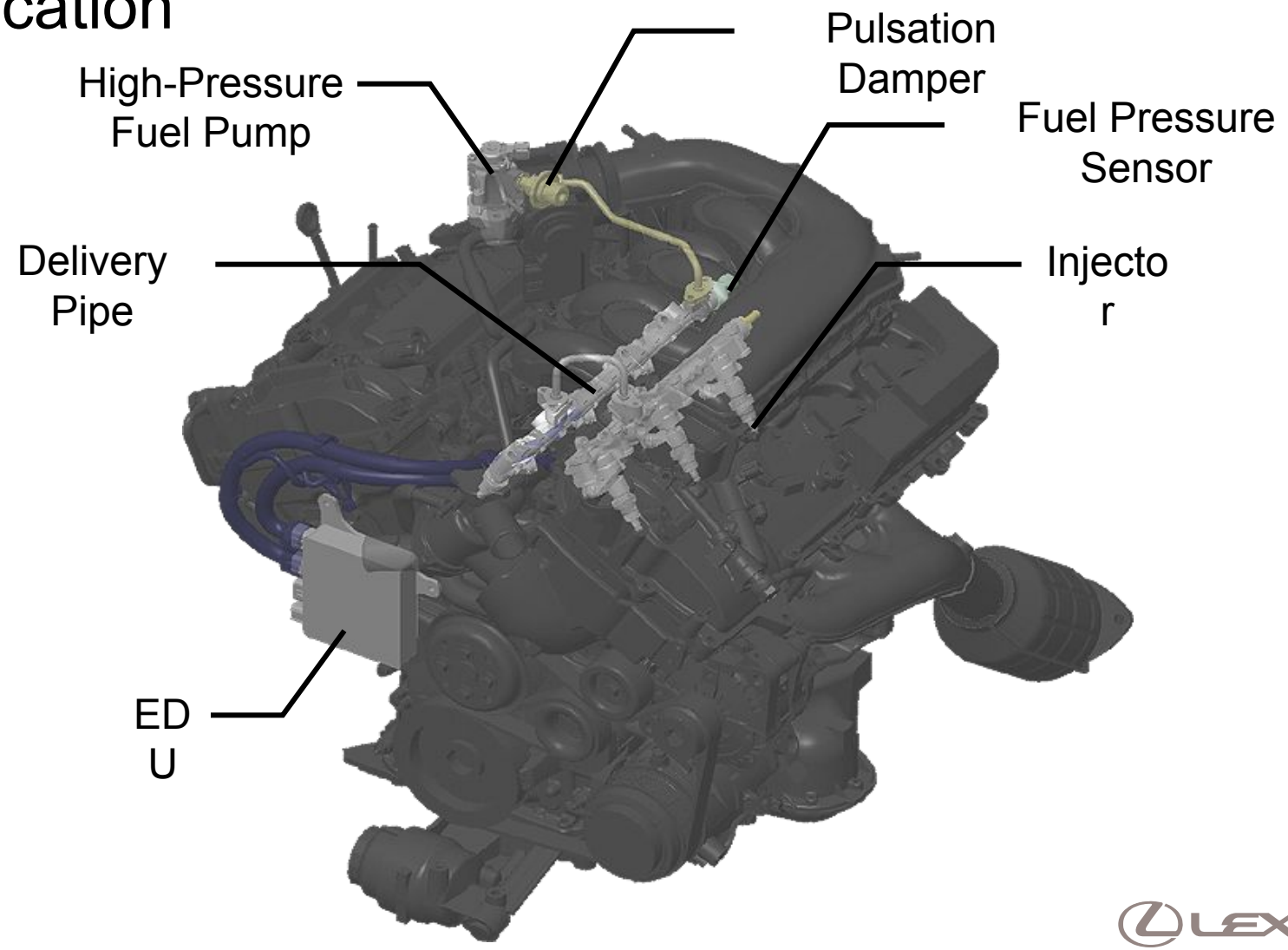
Reference

- Features of D-4 System



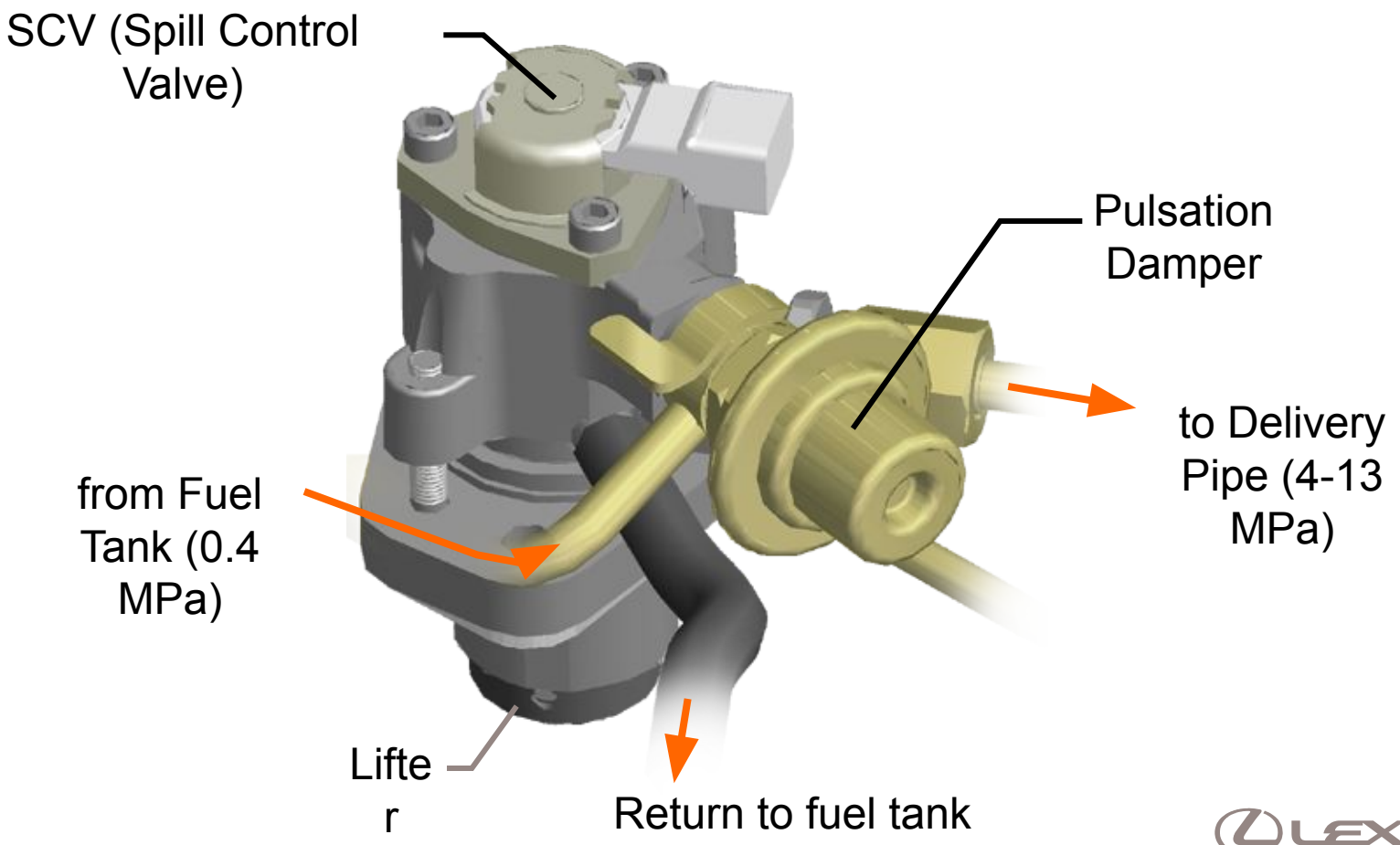
D-4 System

- Location



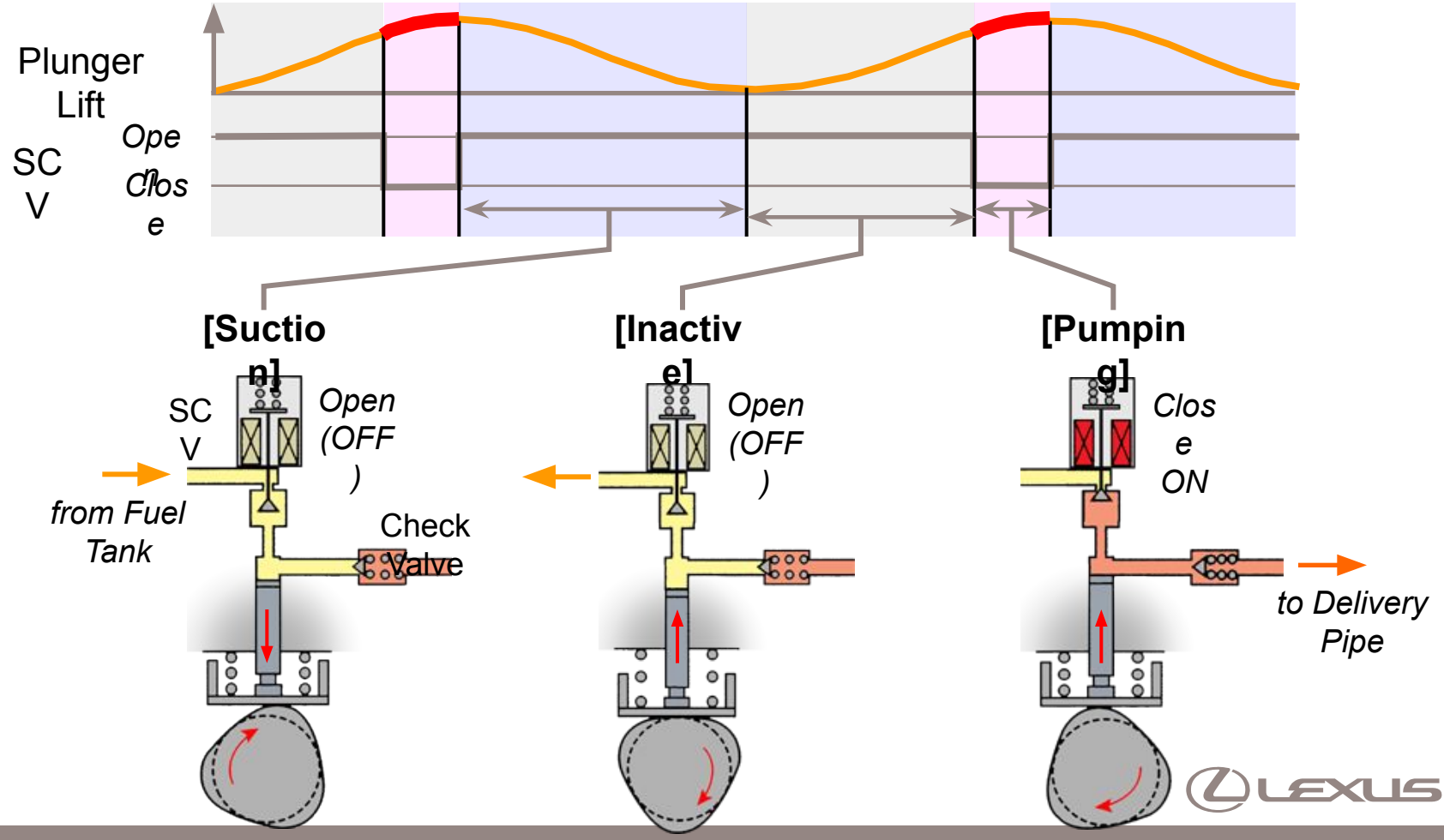
D-4 System

- High-Pressure Fuel Pump
  - Supplies the high pressure fuel to the delivery pipe



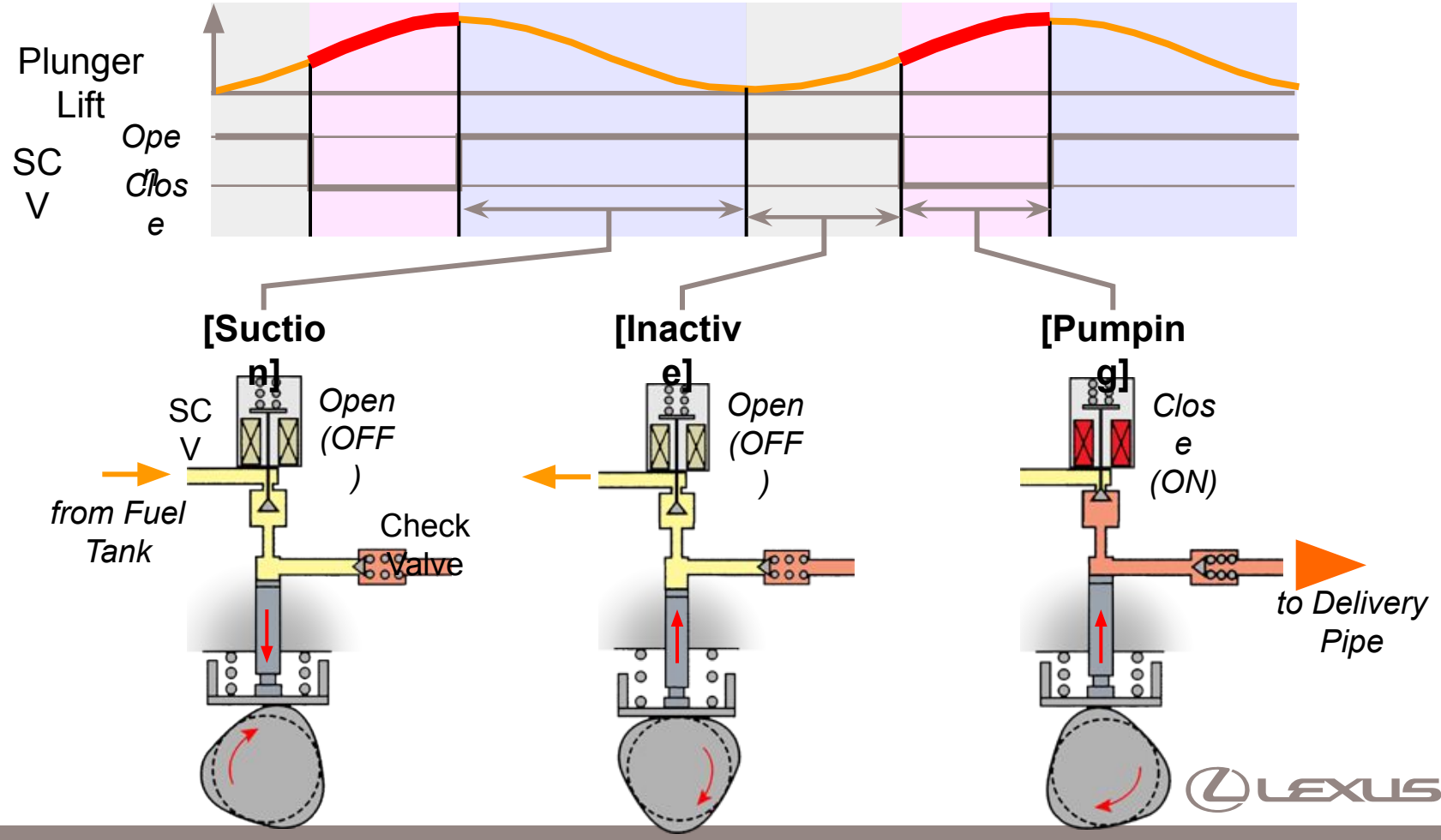
D-4 System

- High-Pressure Fuel Pump
  - Fuel control operation (SCV close timing is **late**)



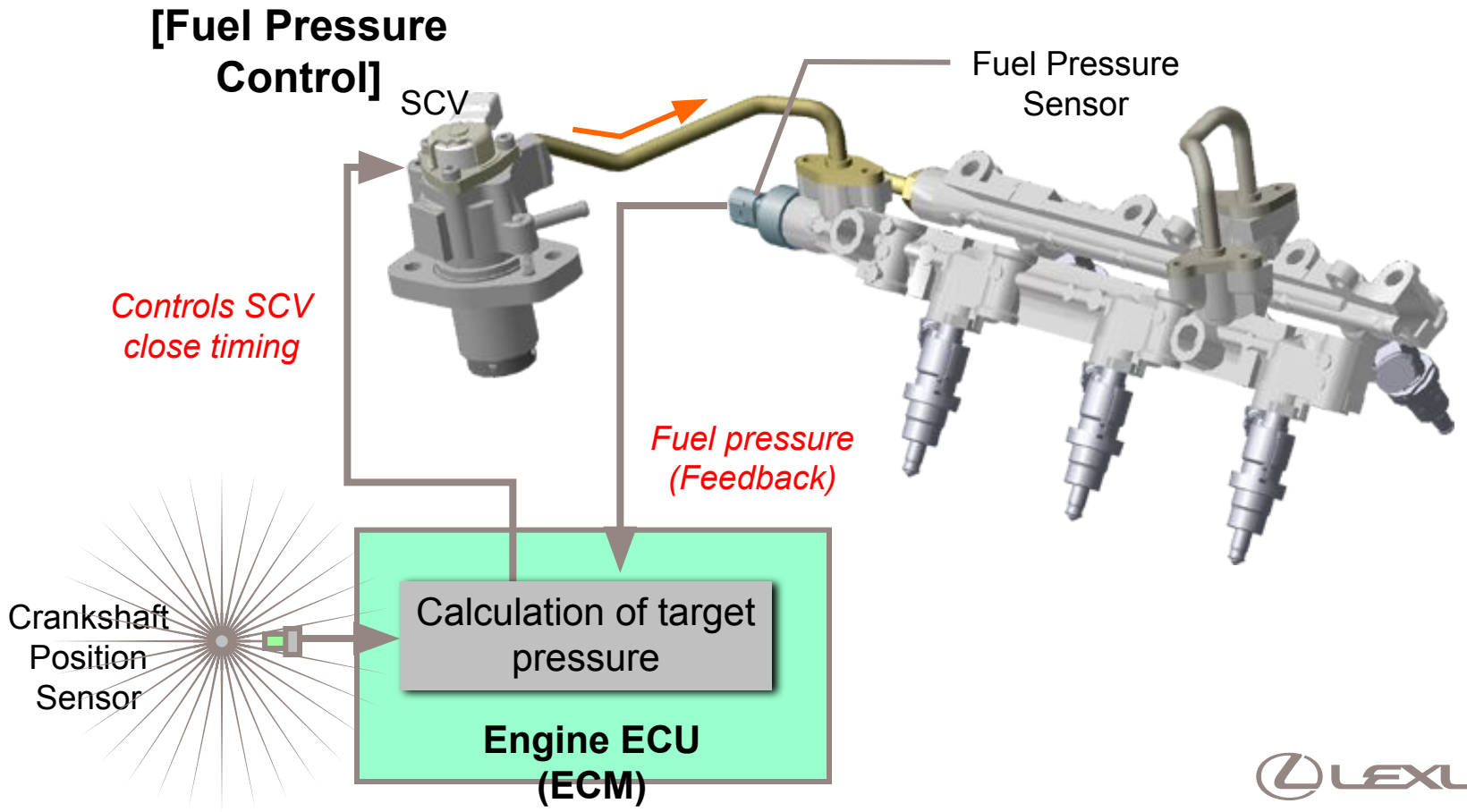
D-4 System

- High-Pressure Fuel Pump
  - Fuel control operation (SCV close timing is **early**)



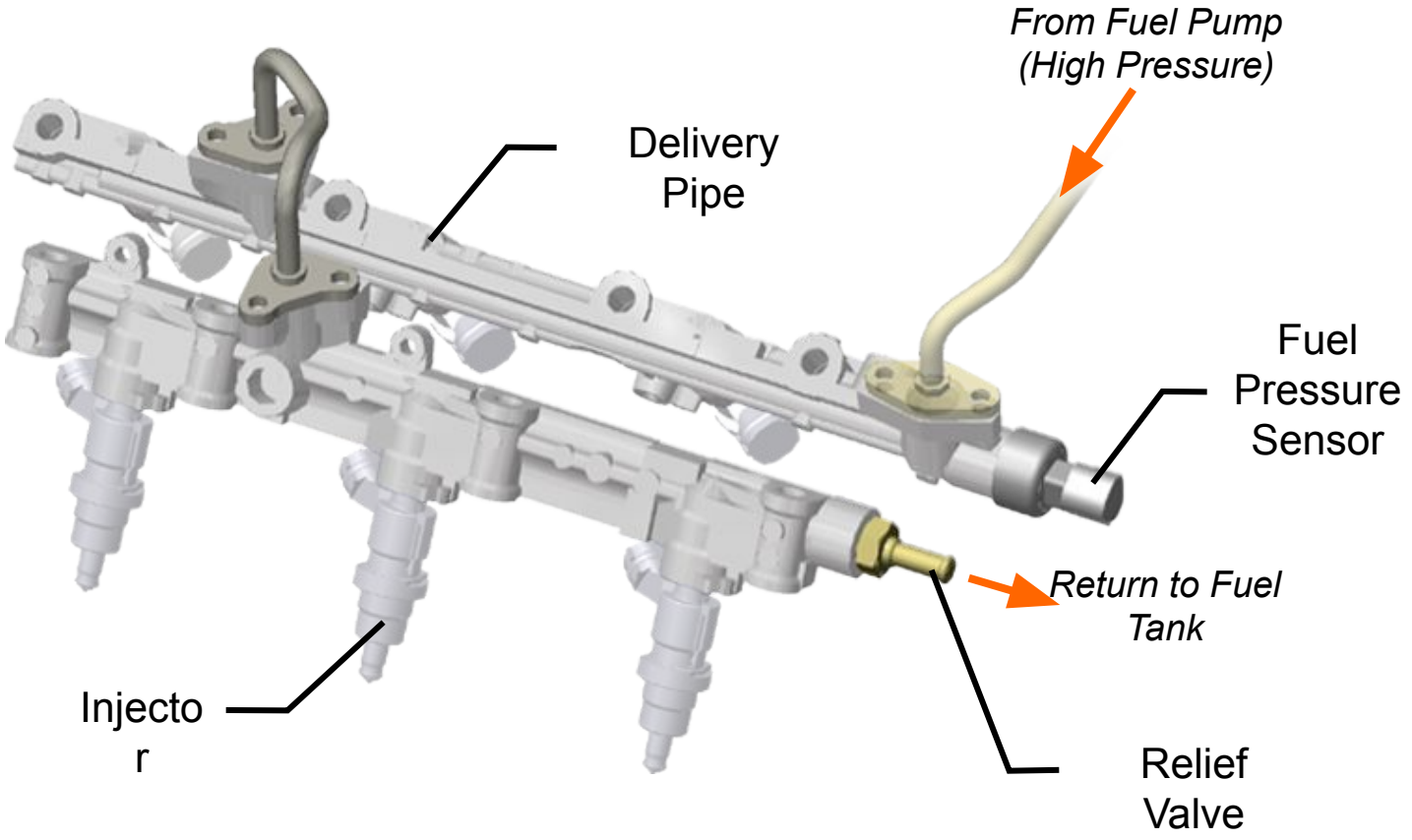
D-4 System

- High-Pressure Fuel Pump
  - The SCV close timing regulates the pumping volume to control fuel pressure



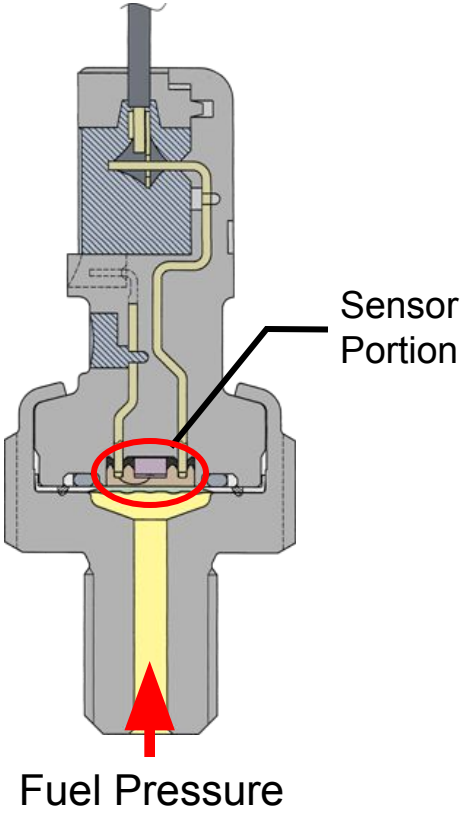
D-4 System

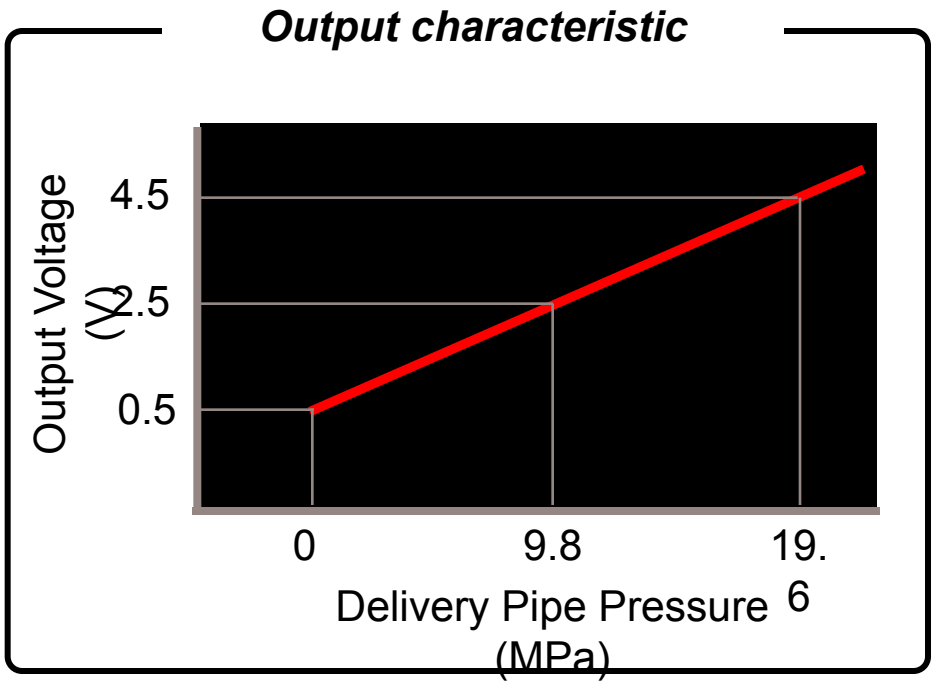
- Delivery Pipe
  - Stores high-pressure fuel (4 – 13 MPa) produced by high-pressure fuel pump



D-4 System

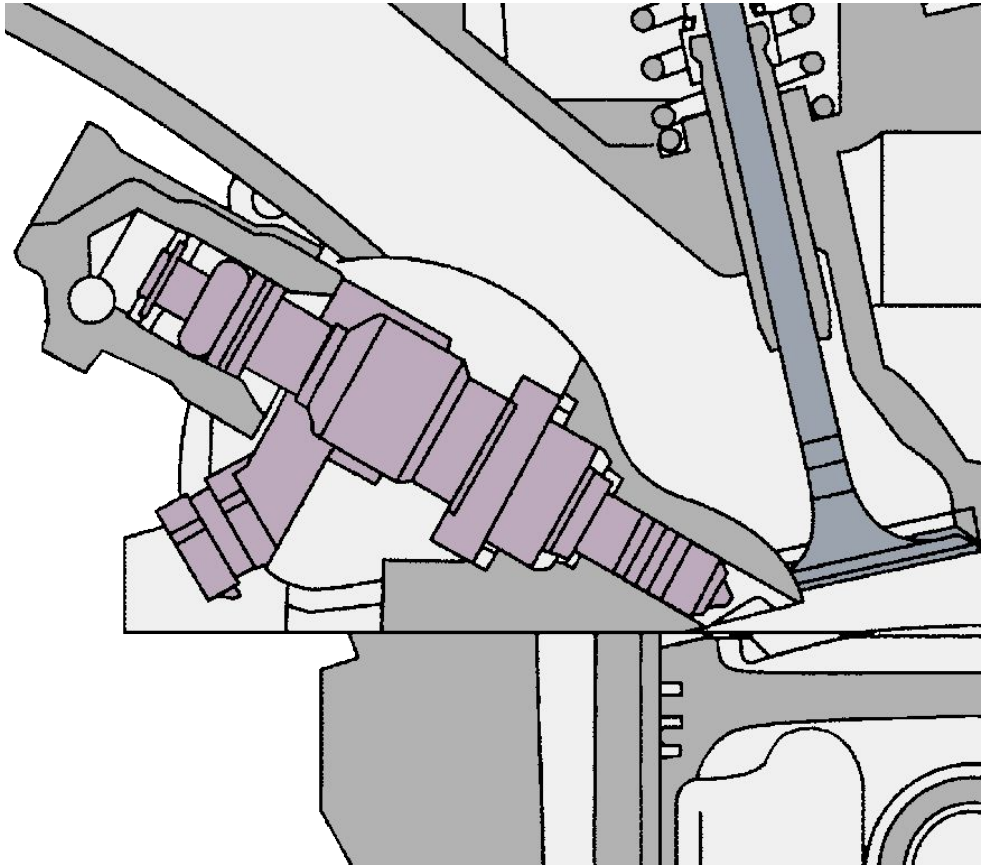
- Delivery Pipe
  - Fuel pressure sensor

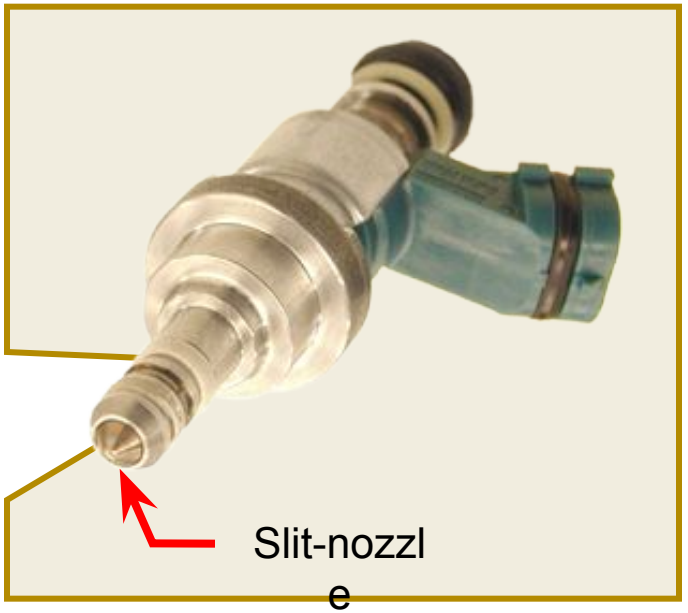




D-4 System

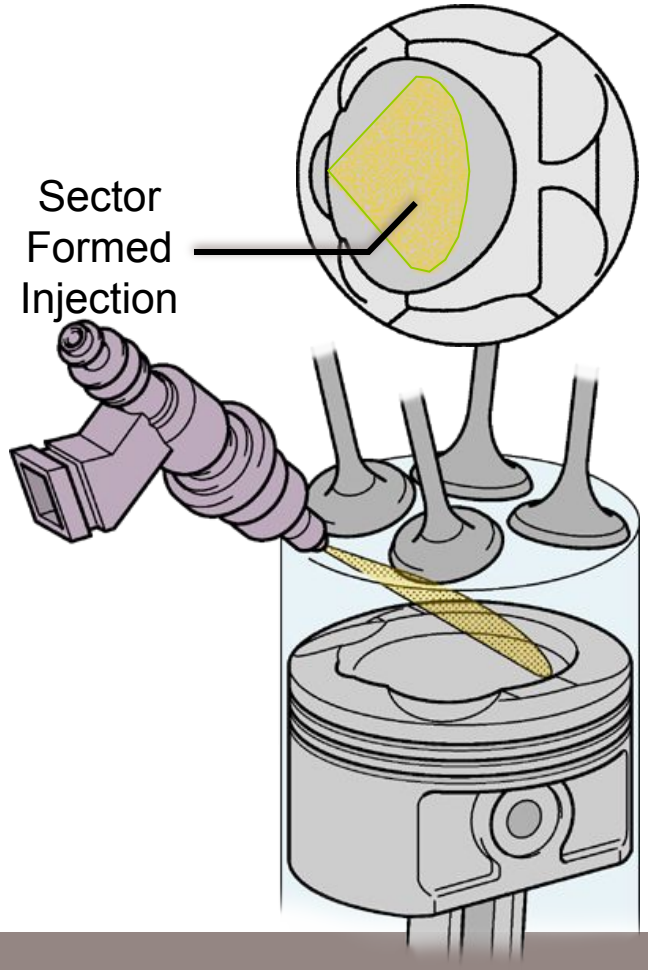
- Injector
  - High pressure, slit-nozzle type injector

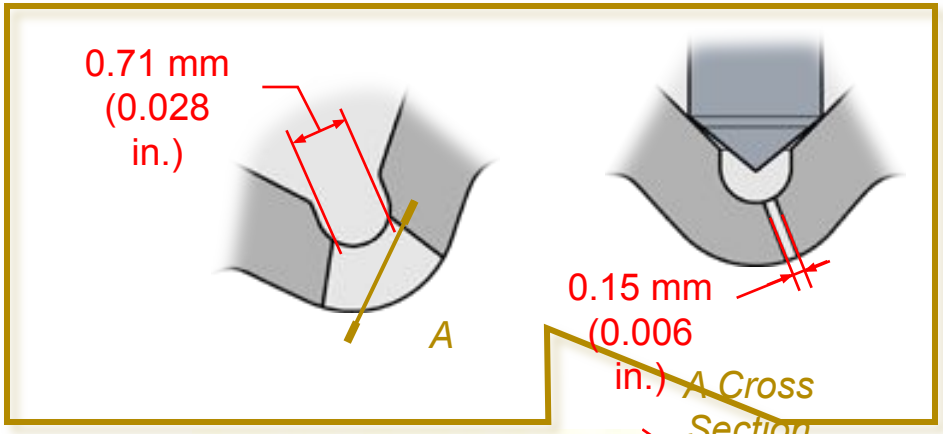




D-4 System

- Injector
  - Slit-nozzle makes sector formed injection

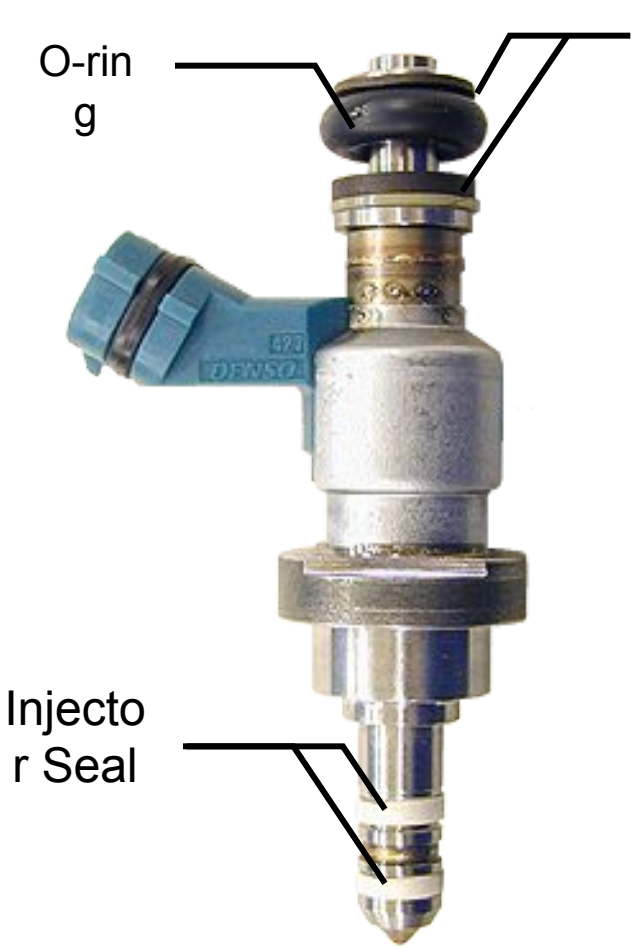


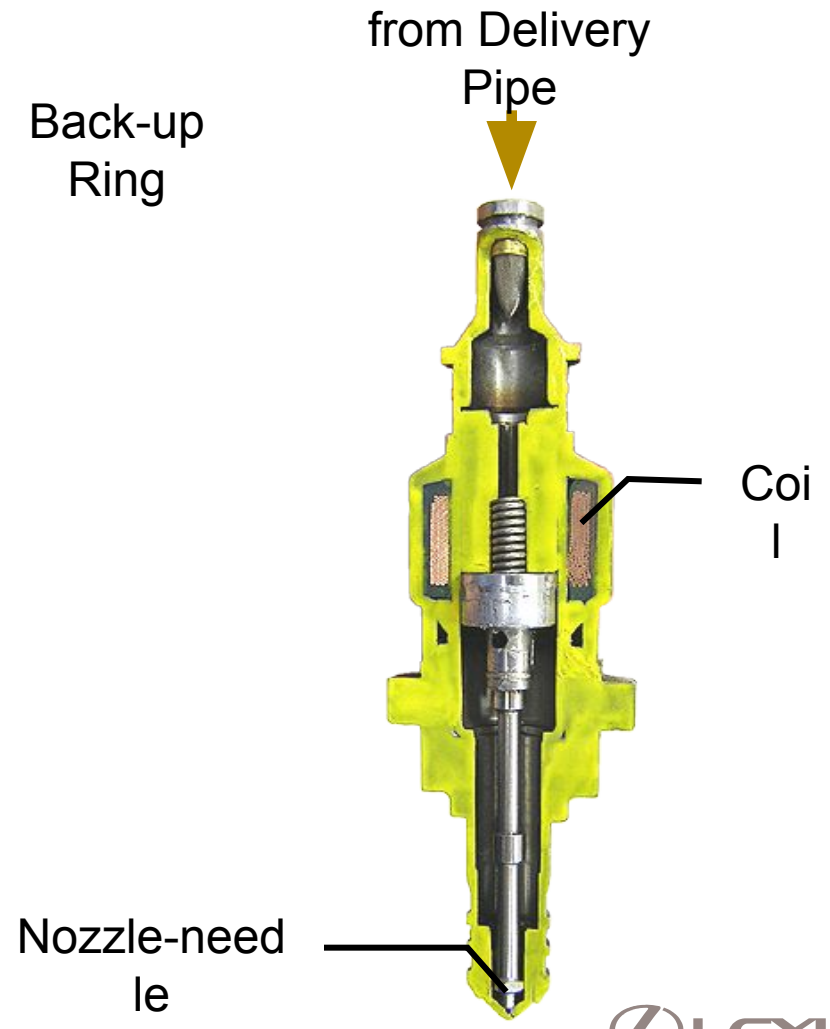


Slit-nozzl
e

D-4 System

- Injector
  - Construction





Service Point (D-4 System)

- Injector
  - When remove the injector from cylinder head, replace the injector seal using new SST

Injector Seal

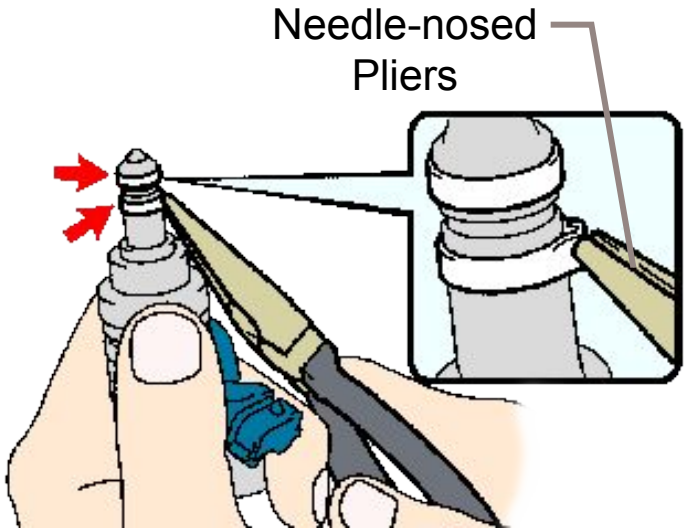
Injector Seal Guide (09268-03020)

Injector Seal Holder (09268-03010)

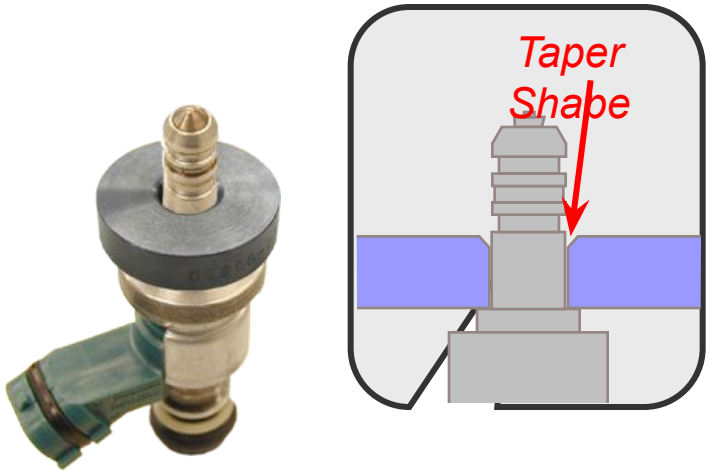
SST
09260-39015

Service Point (D-4 System)

- Injector
  - Replacement of injector seals (using SST)



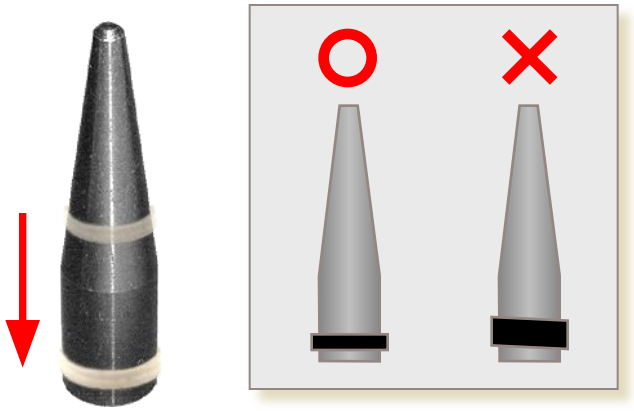
1. Remove injector seals



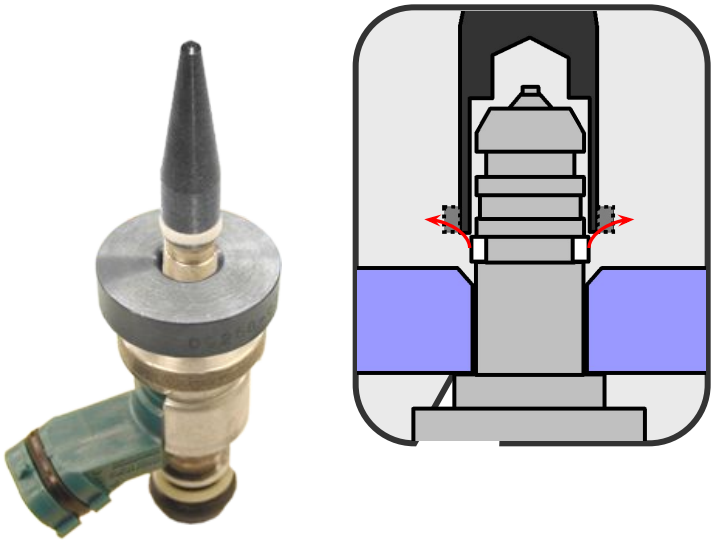
2. Attach the guide (SST)

Service Point (D-4 System)

- Injector
  - Replacement of injector seals (using SST)



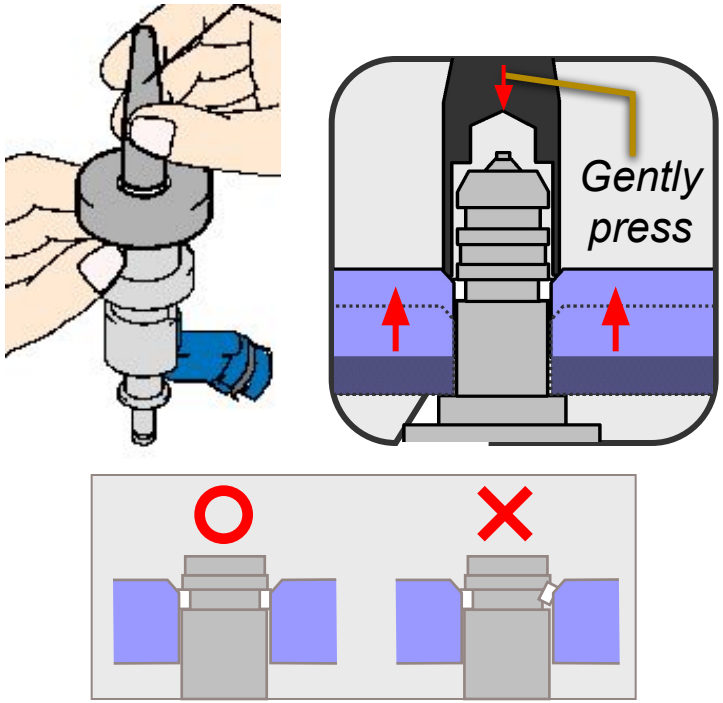
3. Install a new injector



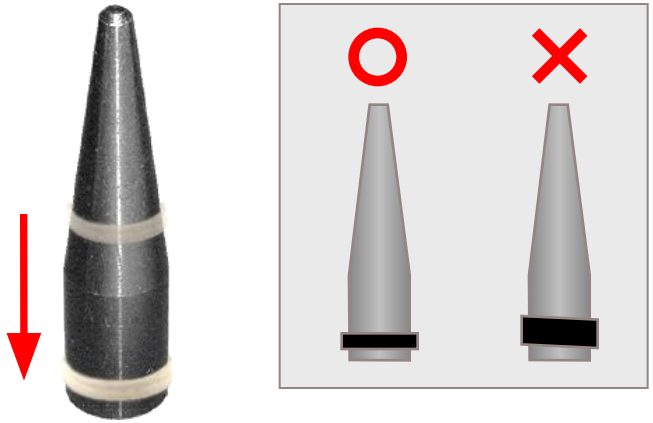
4. Slide the the injector seal into the injector groove

Service Point (D-4 System)

- Injector
  - Replacement of injector seals (using SST)



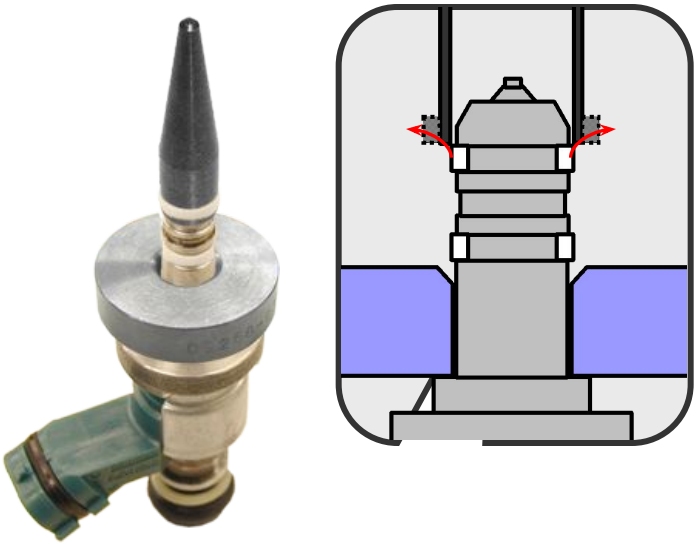
5. Settle the injector seal



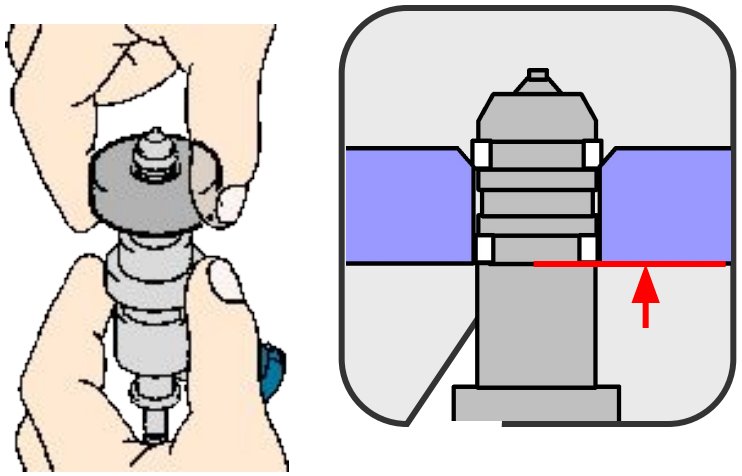
6. Install a new injector seal

Service Point (D-4 System)

- Injector
  - Replacement of injector seals (using SST)



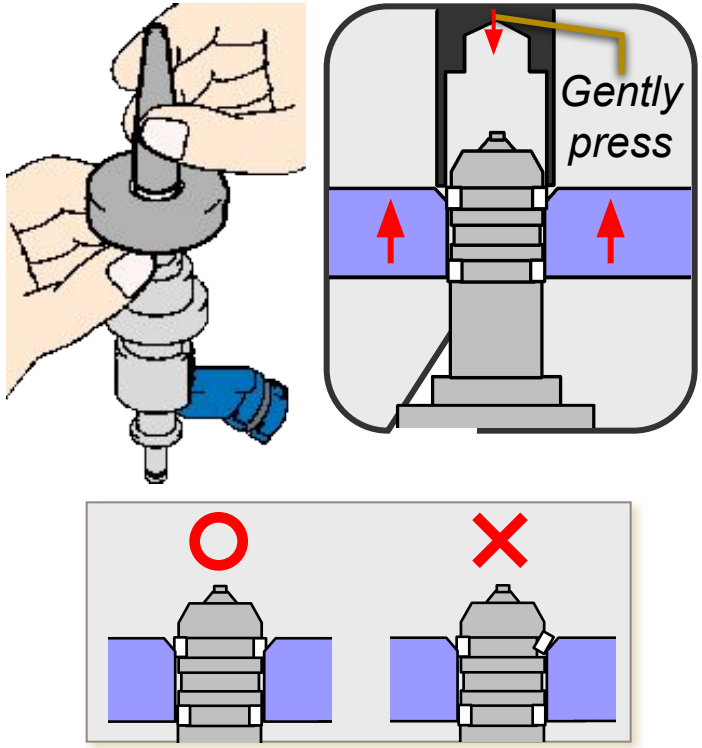
7. Slide the injector seal into the injector groove



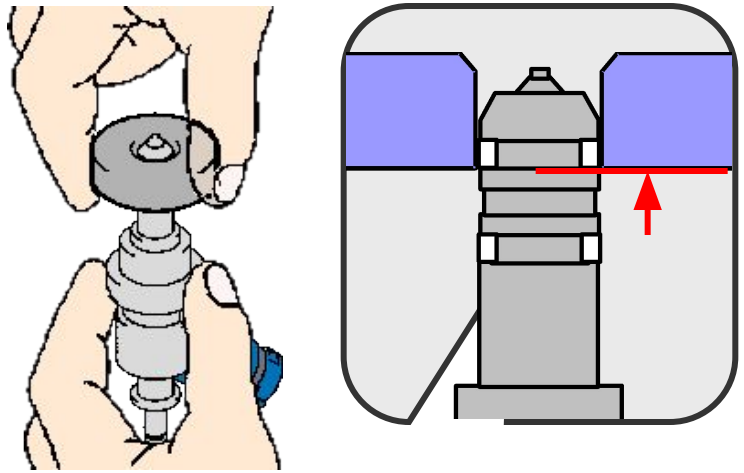
8. Fully align the injector seal

Service Point (D-4 System)

- Injector
  - Replacement of injector seals (using SST)



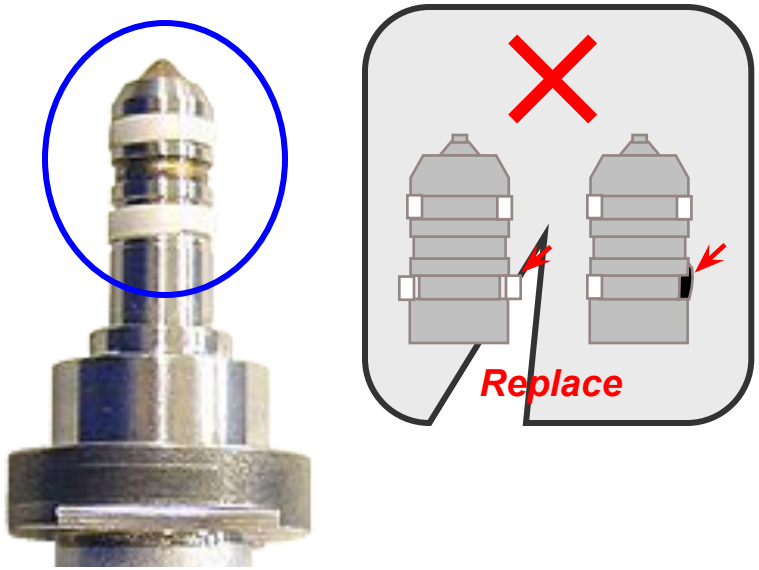
9. Settle the injector seal



10. Fully align the injector seal

Service Point (D-4 System)

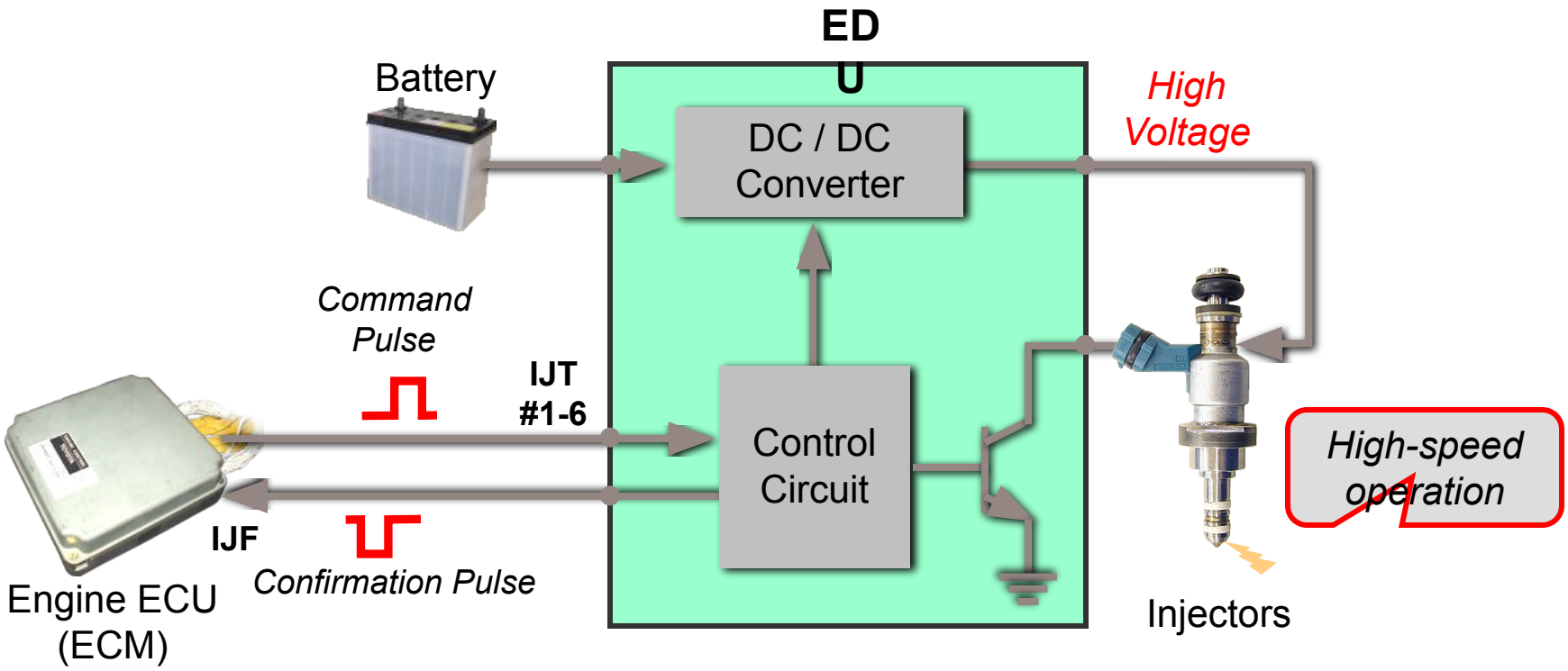
- Injector
  - Replacement of injector seals (using SST)



11. Check the injector seals

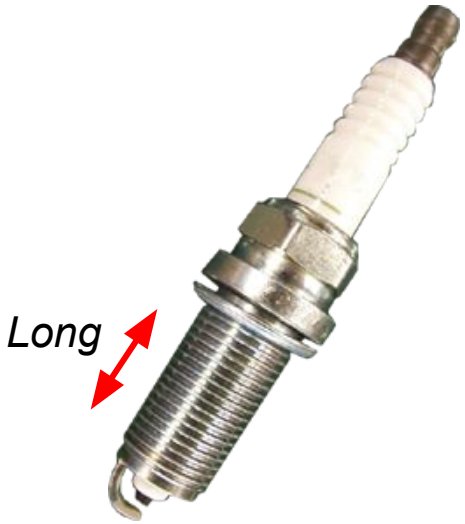
D-4 System

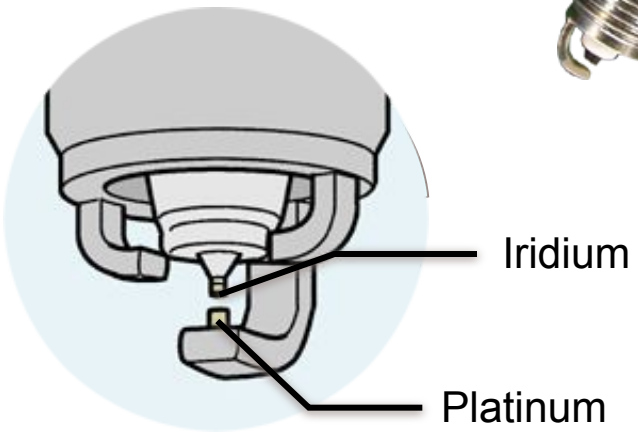
- EDU (Electronic Driver Unit)
  - Drives the injectors at high speed

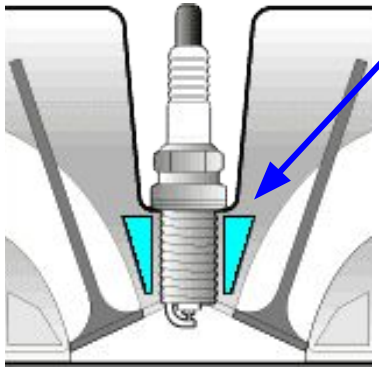


Ignition System

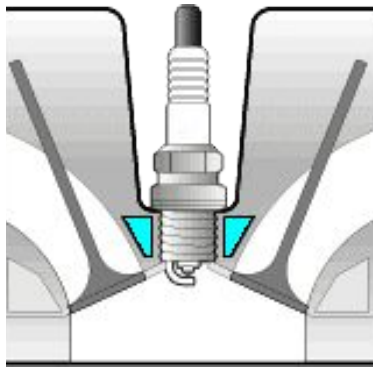
- Spark Plug
  - Long-reach type spark plug to improve cooling performance on cylinder head







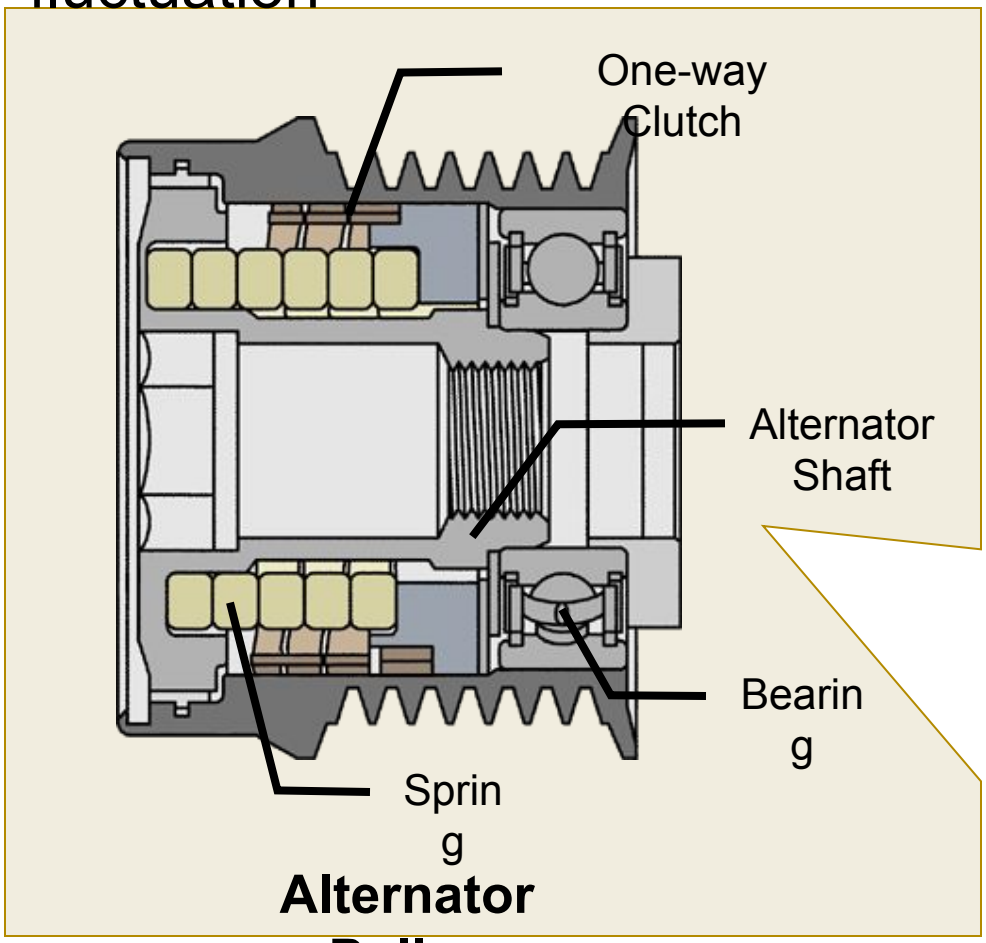
Long-reach Type



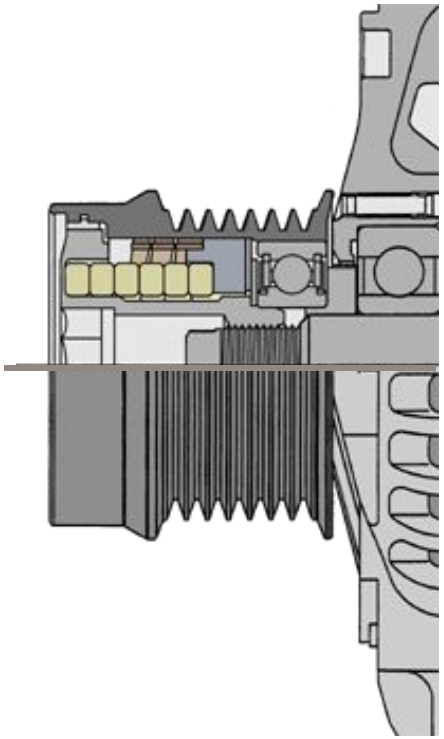
Normal Type

Charging System

- Alternator Pulley
  - One-way clutch is used in the pulley to absorb engine fluctuation



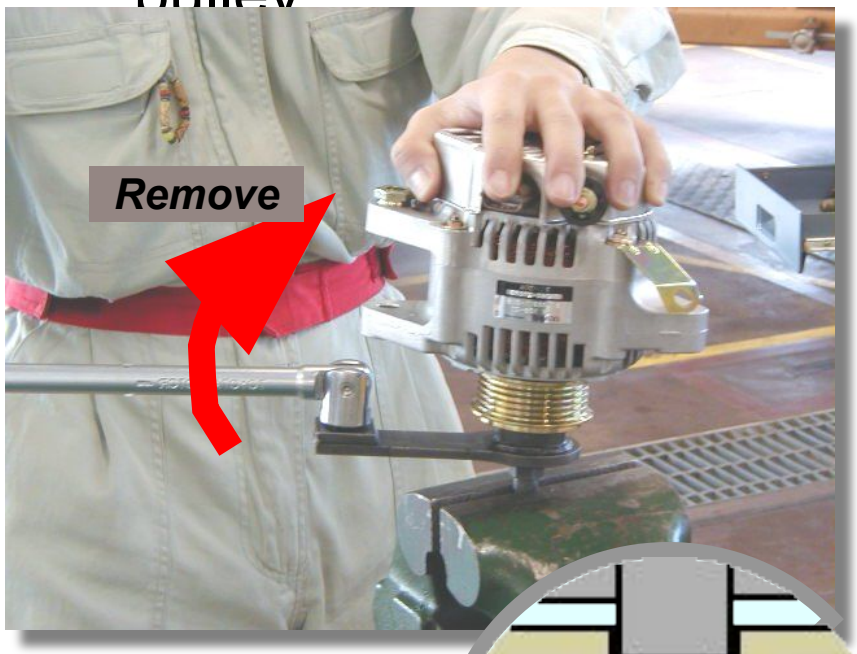
Alternator Pulley

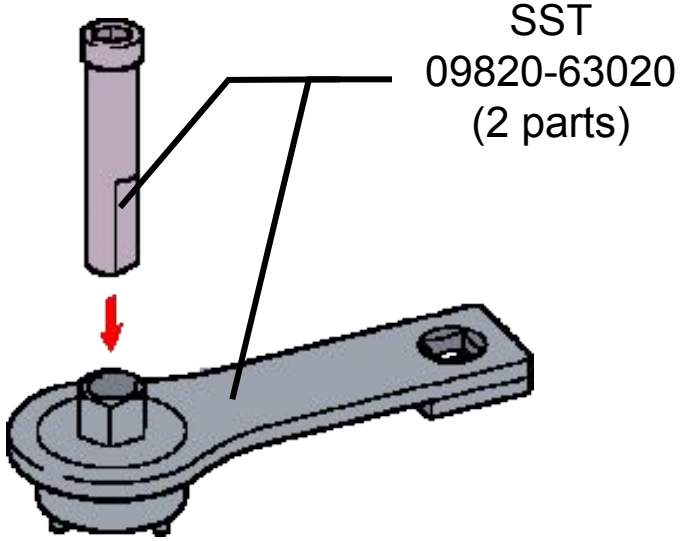


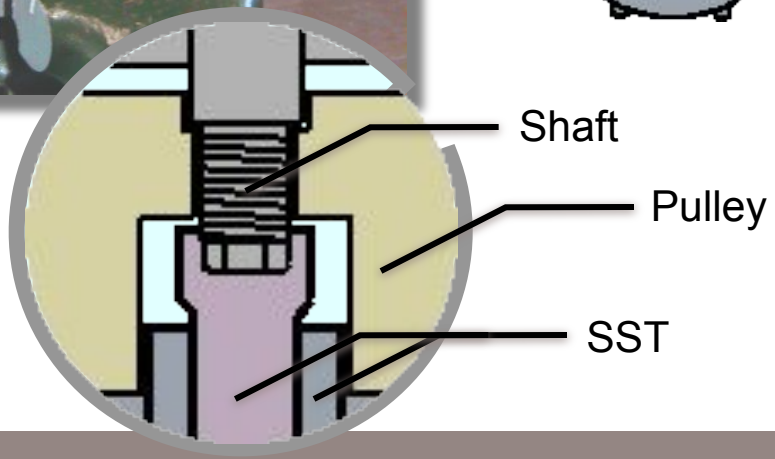
Alternator

Service Point (Charging System)

- Alternator Pulley
  - Using a SST, when remove or install the alternator pulley

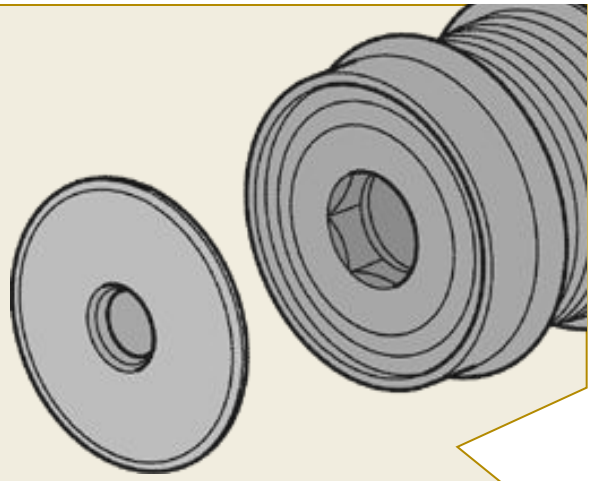






Service Point (Charging System)

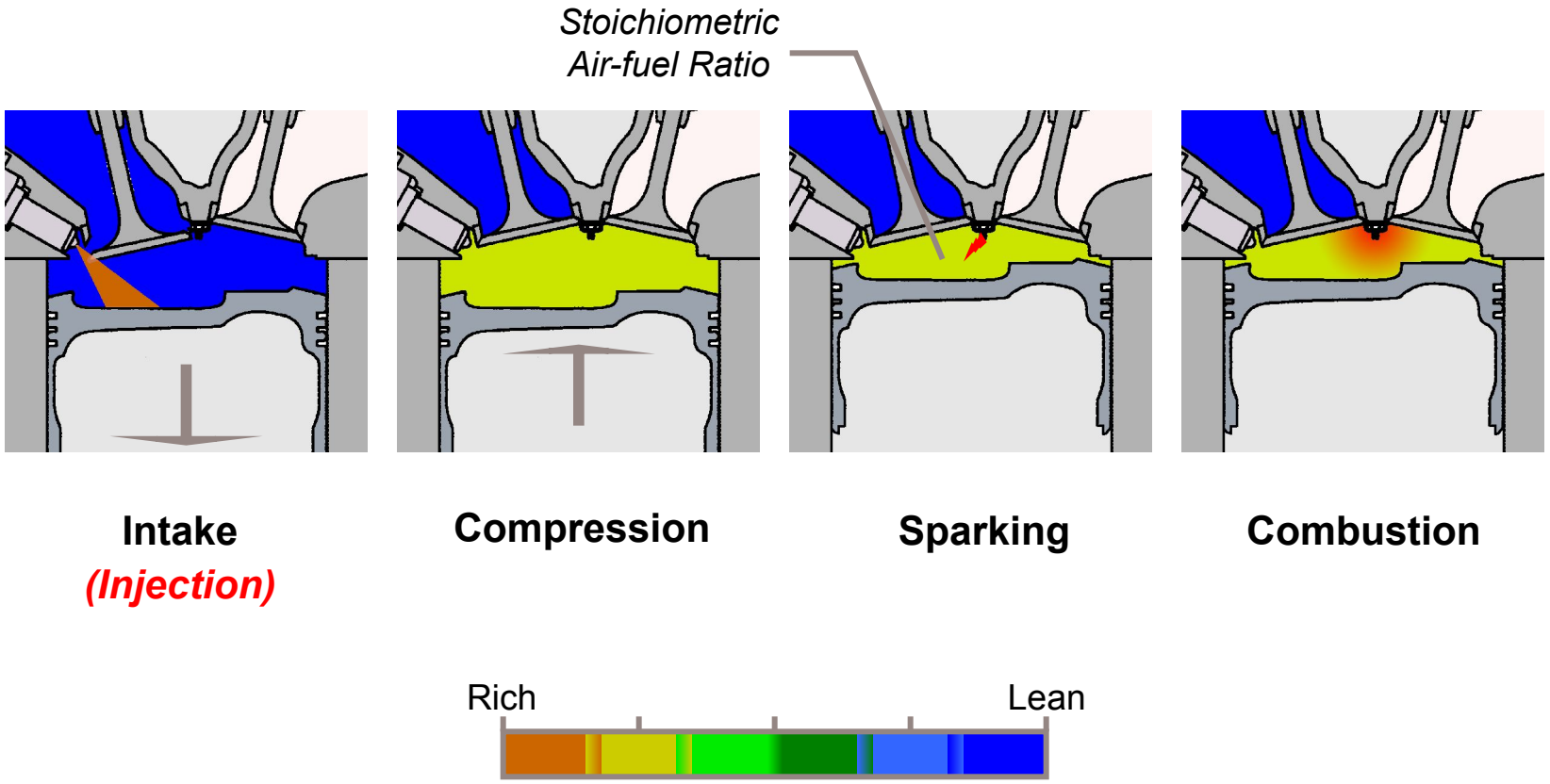
- Alternator Pulley
  - Alternator pulley cap is non-reusable part



Alternator Pulley Cap
(Non-reusable Part)

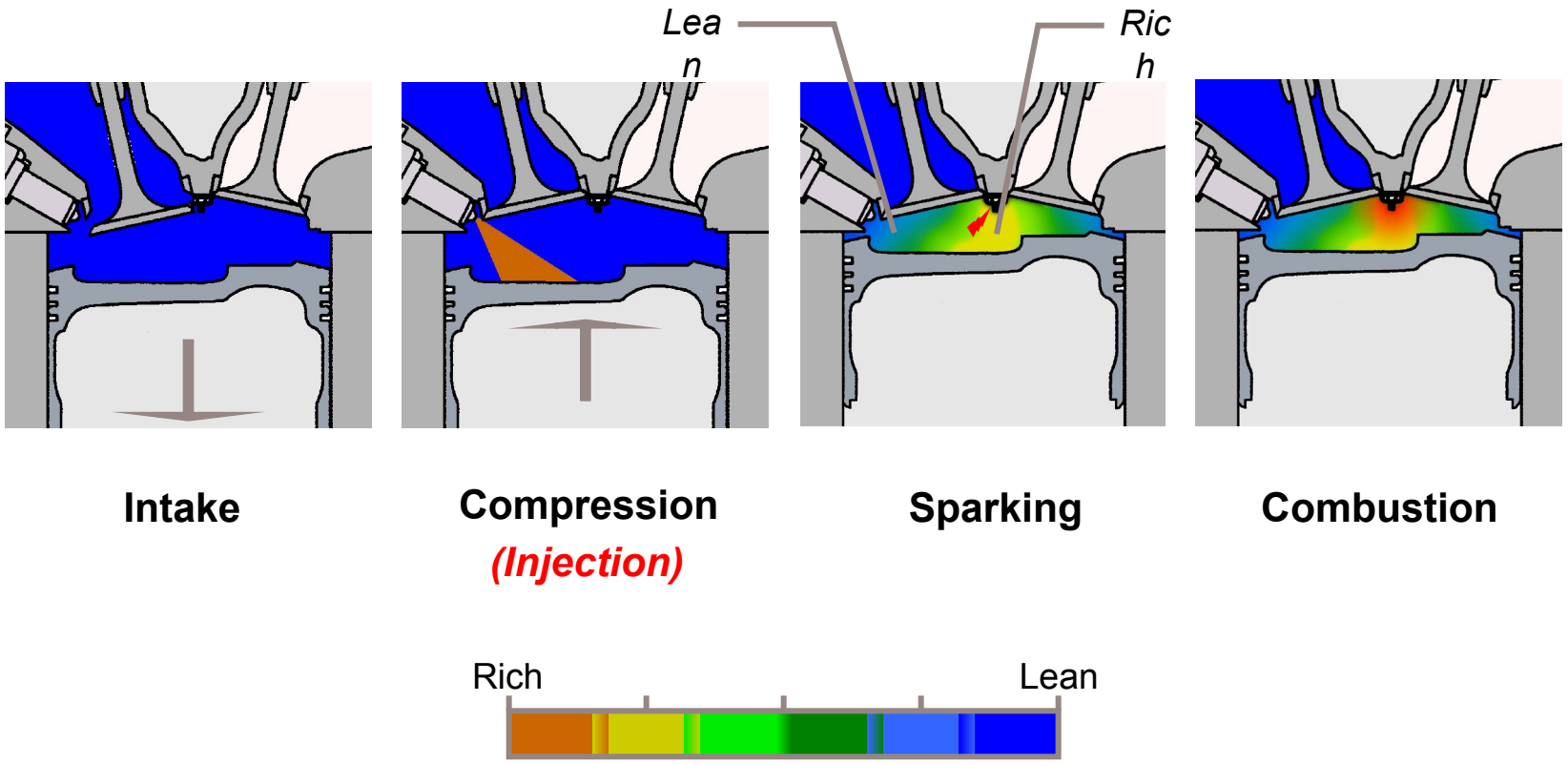
Engine Control System

- D-4 EFI Control (for 4GR-FSE)
  - D-4 EFI conducts the injection volume control and injection timing control simultaneously



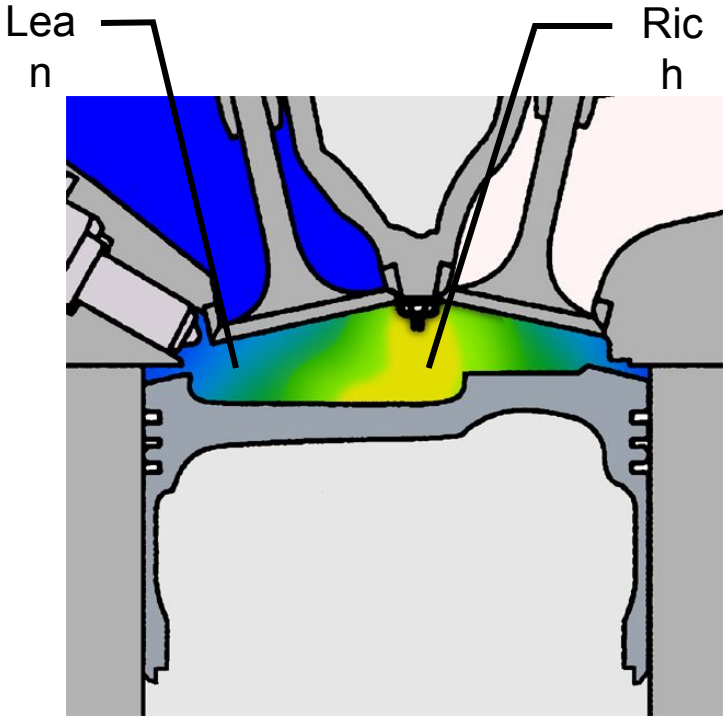
Engine Control System

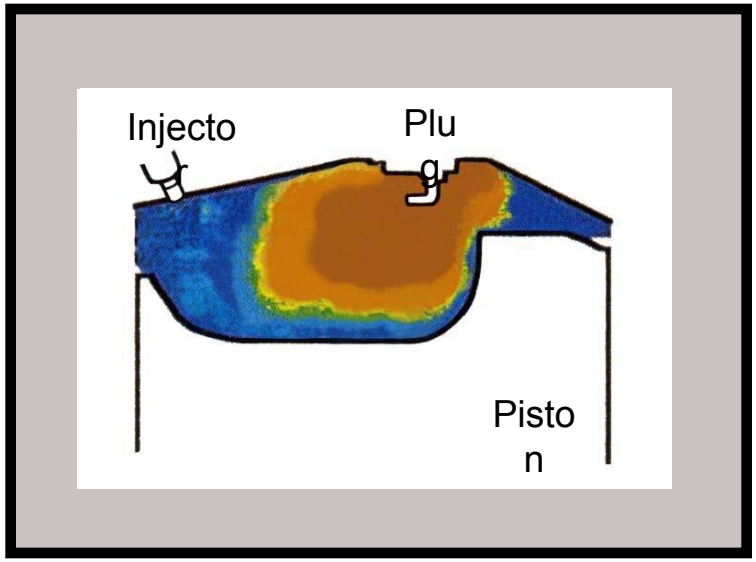
- D-4 EFI Control (for 4GR-FSE)
  - At cold start, weak stratification combustion to improve TWC worm-up performance



Reference (Engine Control System)

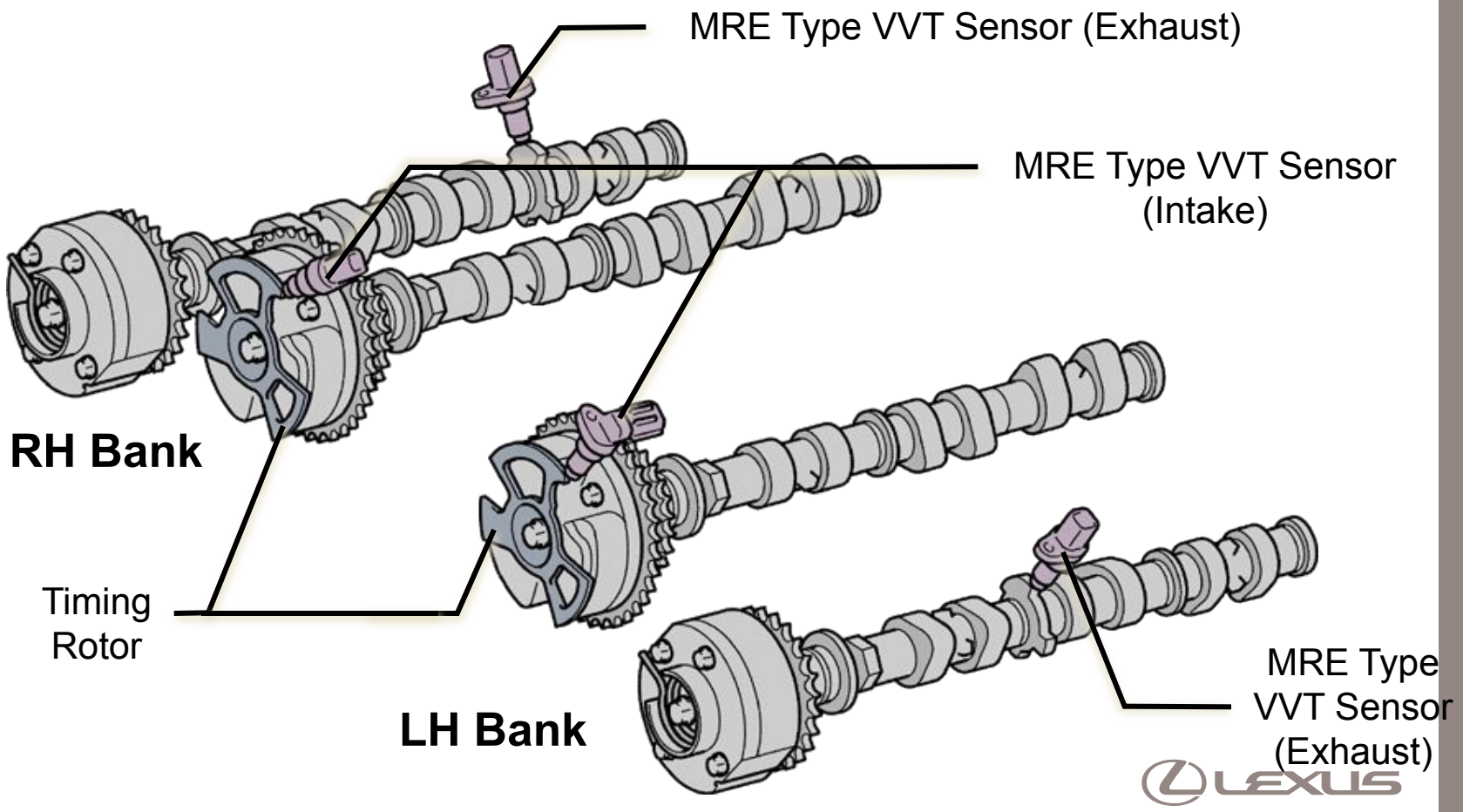
- D-4S fuel control (for 4GR-FSE)
  - Weak stratification combustion
    - Creates rich and lean portions of air-fuel mixture within the combustion chamber





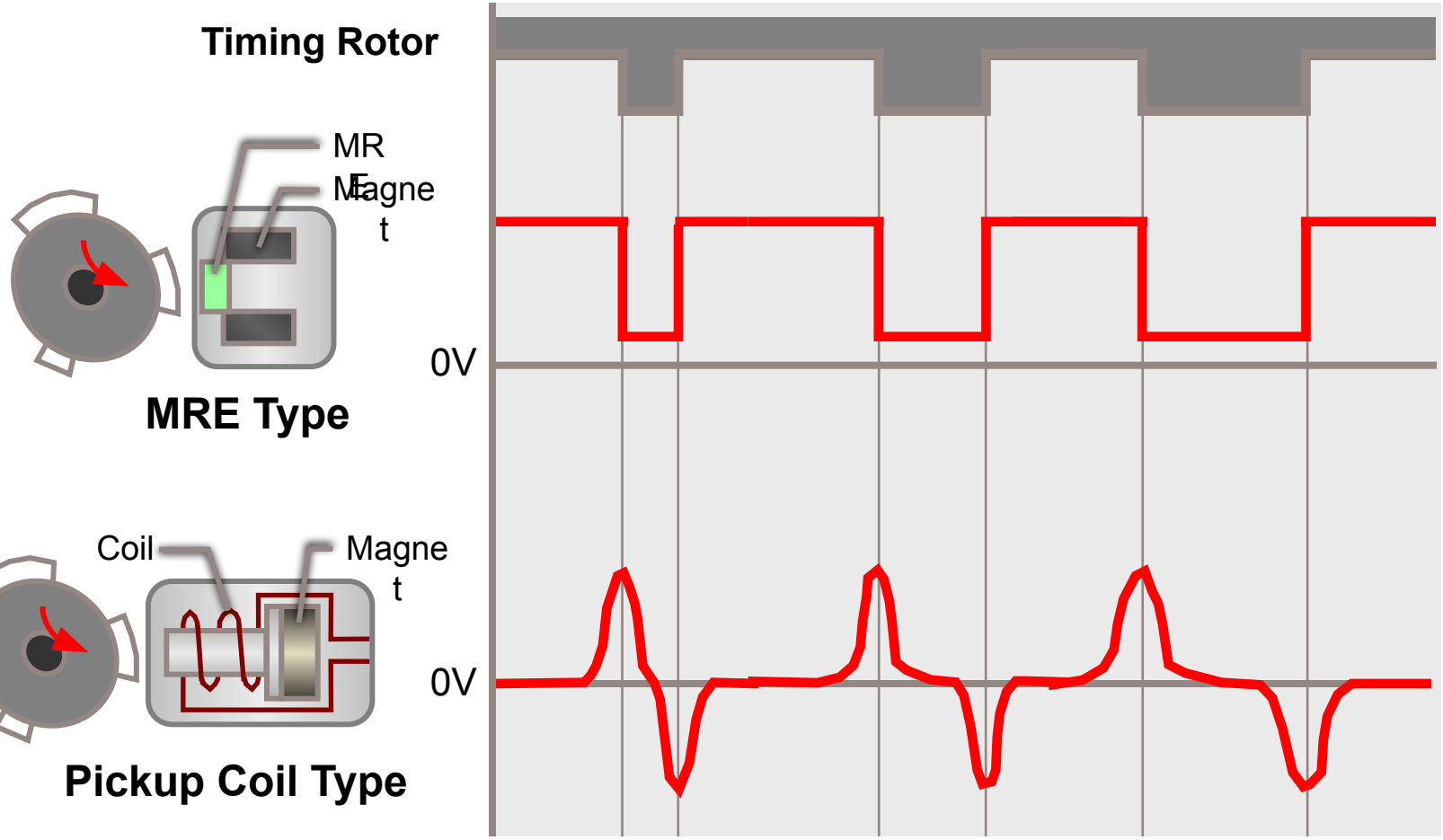
Engine Control System

- VVT Sensor
  - 4 MRE type VVT sensors are used for intake and exhaust camshaft of each bank



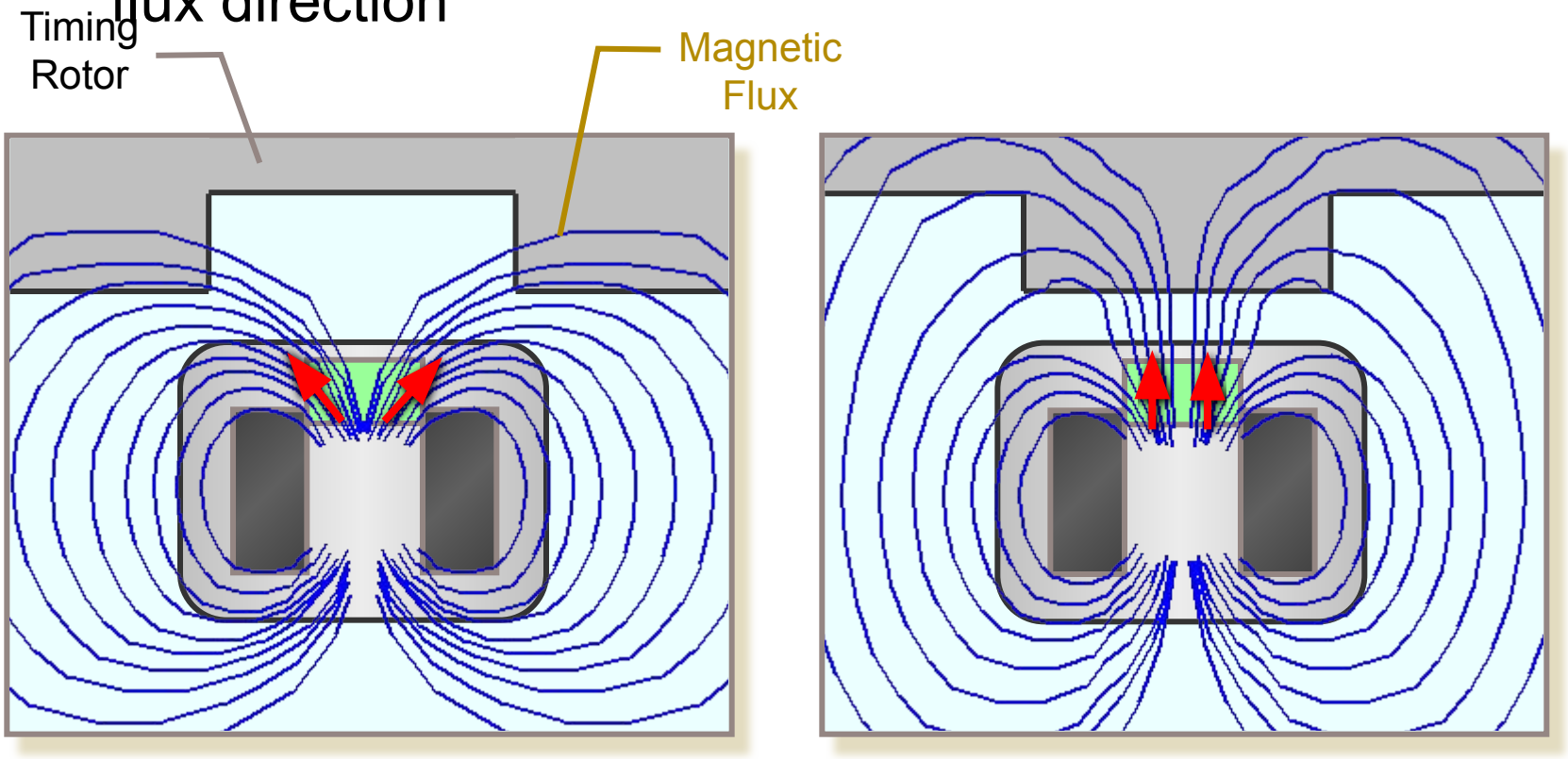
Reference (Engine Control System)

- Wheel Sensor
  - Output signal is digital waveform



Reference (Engine Control System)

- MRE Sensor
  - The resistance of MRE is changed by the magnetic flux direction



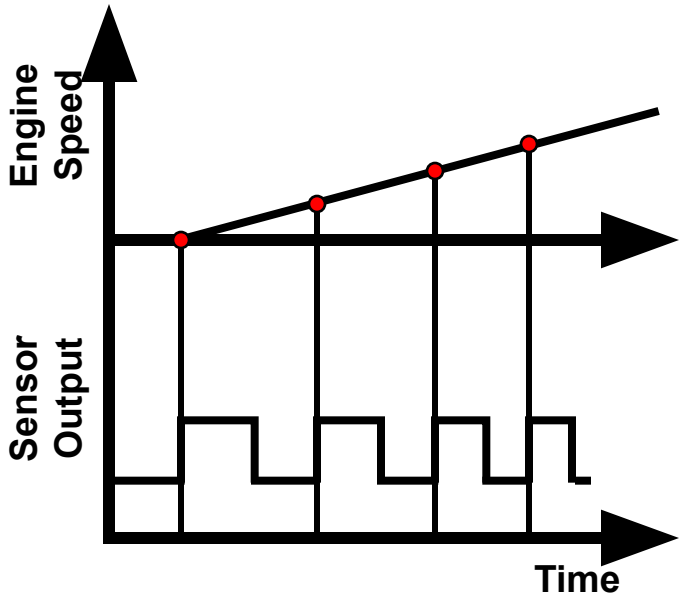
Sensor Output "High"

Sensor Output "Low"

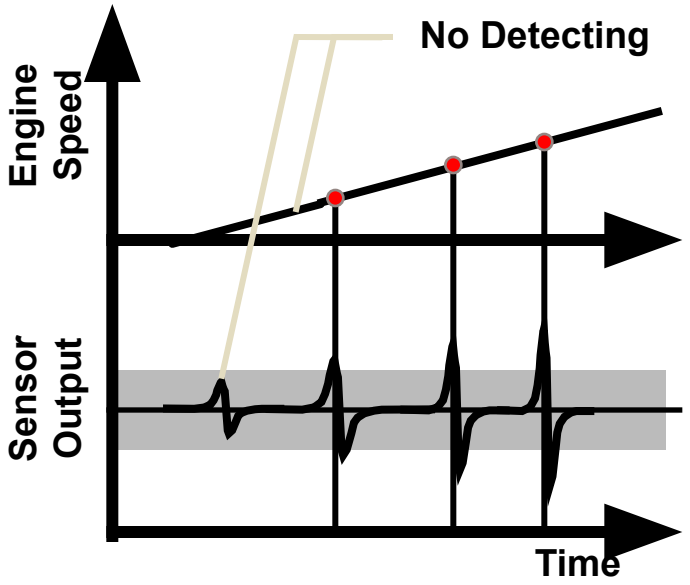
Reference (Engine Control System)

- MRE sensor
  - Signal output at extremely low speed rotation can be ensured

MRE Type

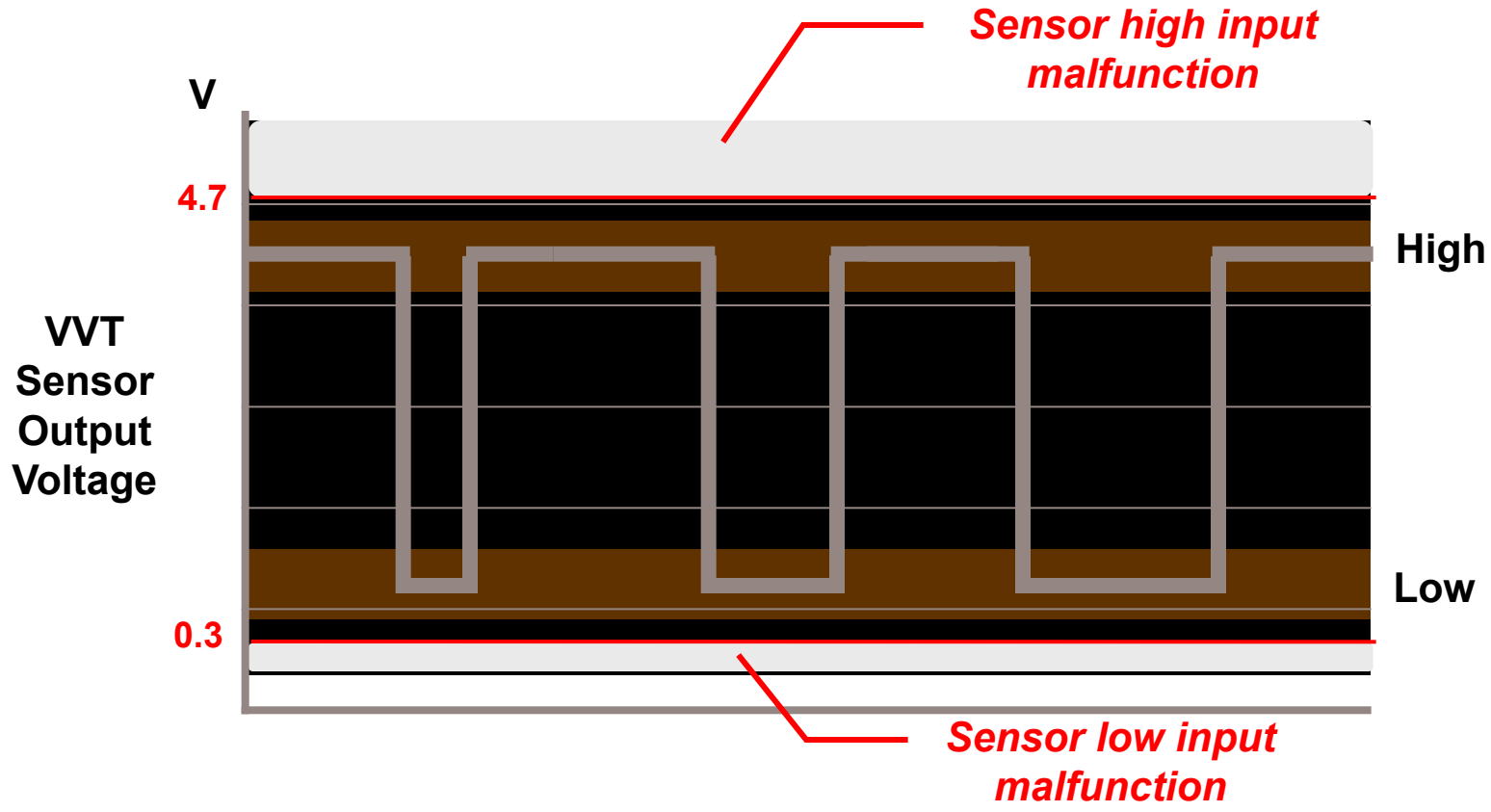


Pickup Coil Type



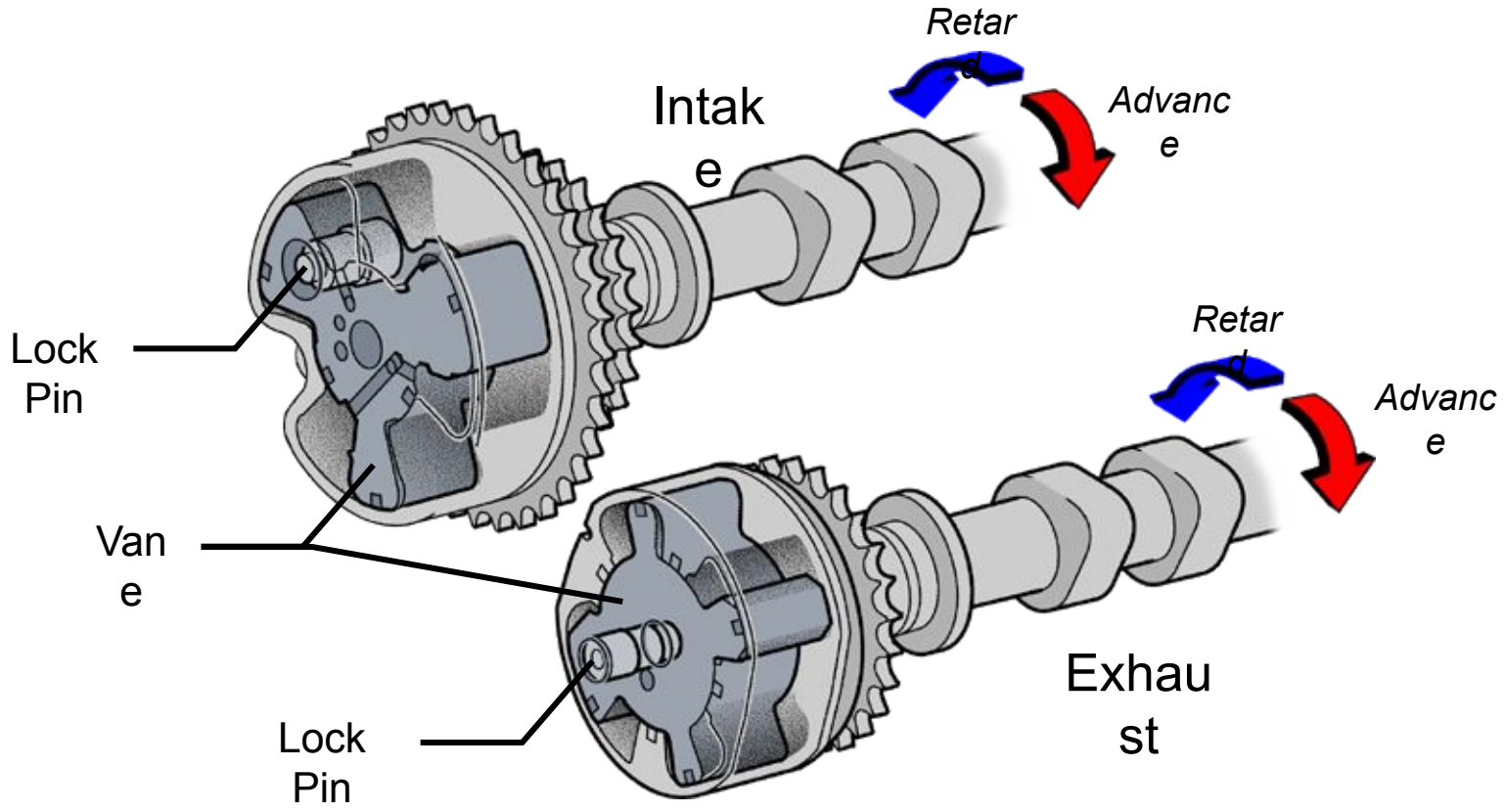
Reference (Engine Control System)

- System Sensor
  - By the adoption of MRE type VVT sensor, ECM can detects the sensor low input or high input malfunction



Engine Control System

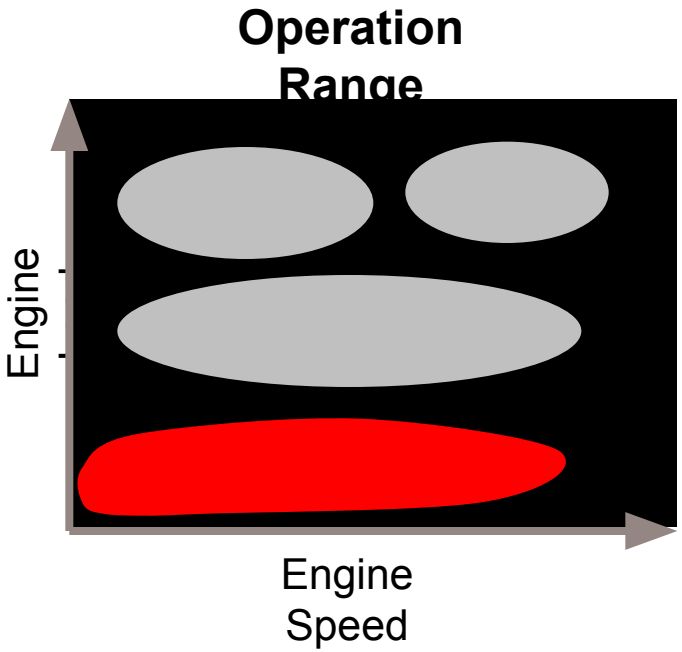
- Dual VVT-i (Variable Valve Timing – intelligent)
  - VVT-i is used for intake and exhaust camshafts



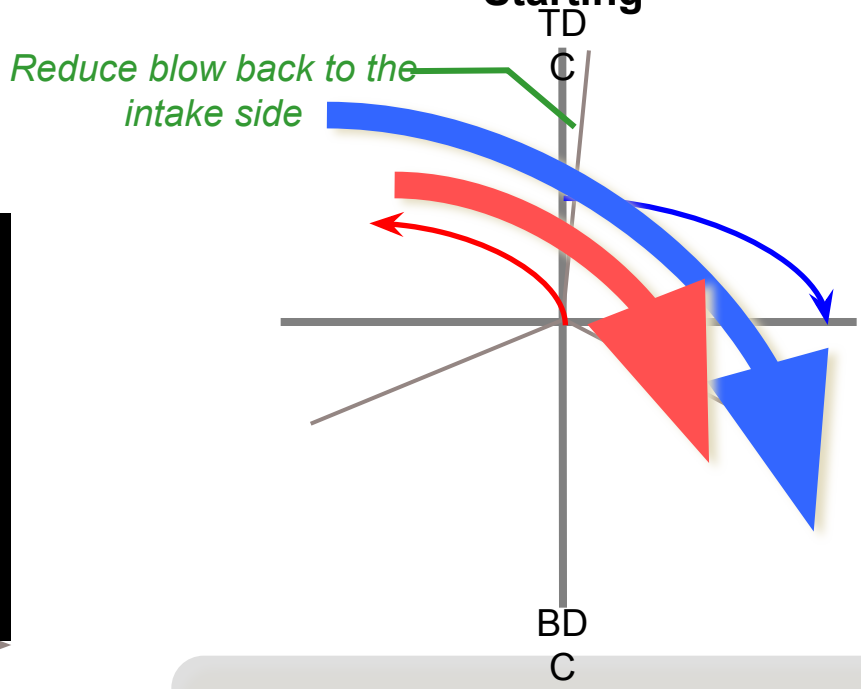
Dual VVT-i for LH Bank

Reference (Engine Control System)

- System
  - Operation



At Idle, Light Load, Low Temp. and Starting

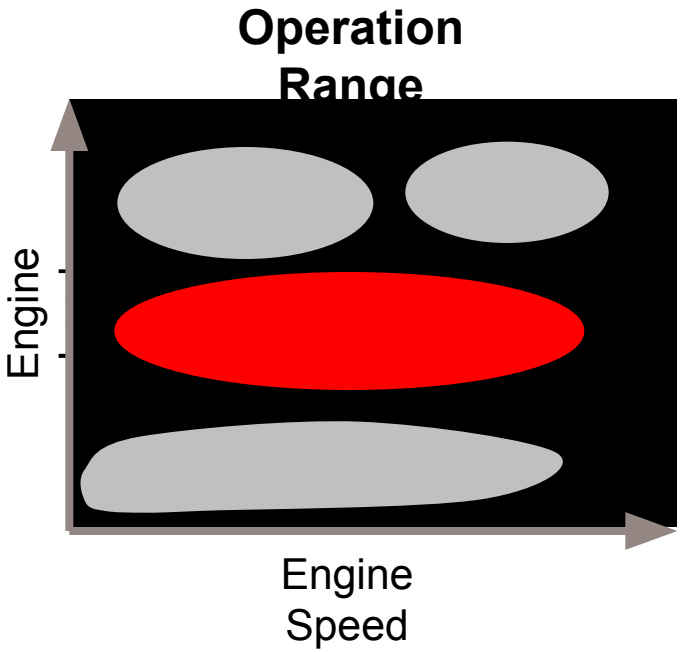


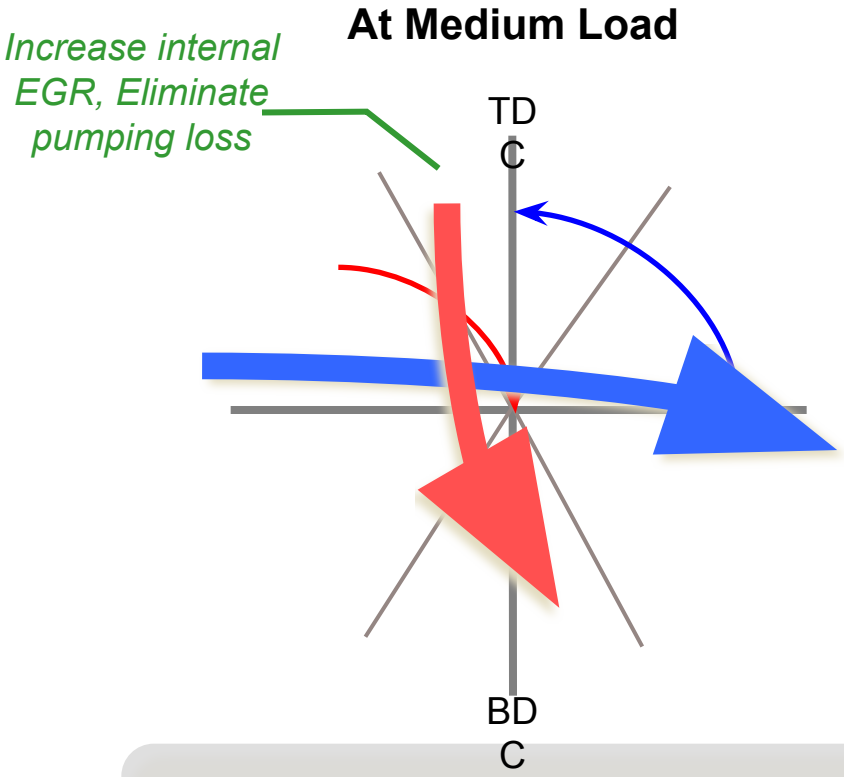
Effect

- Stable combustion for fuel economy

Reference (Engine Control System)

- System
  - Operation

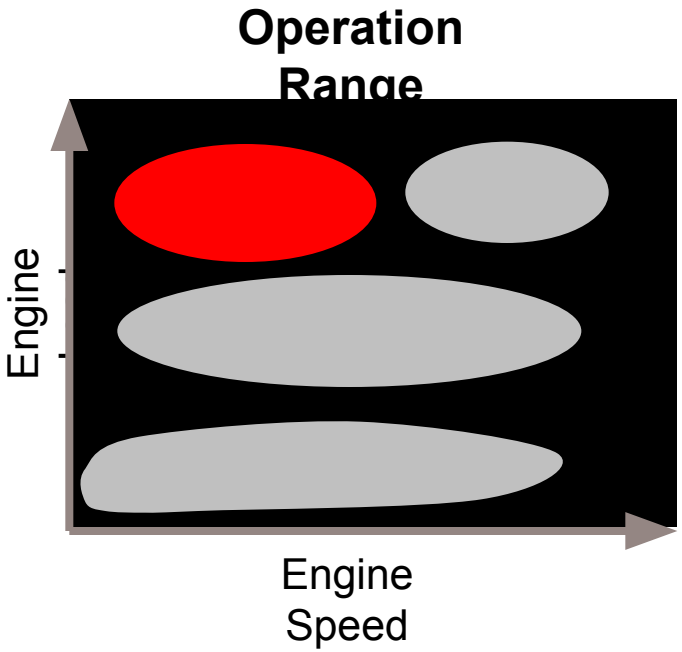


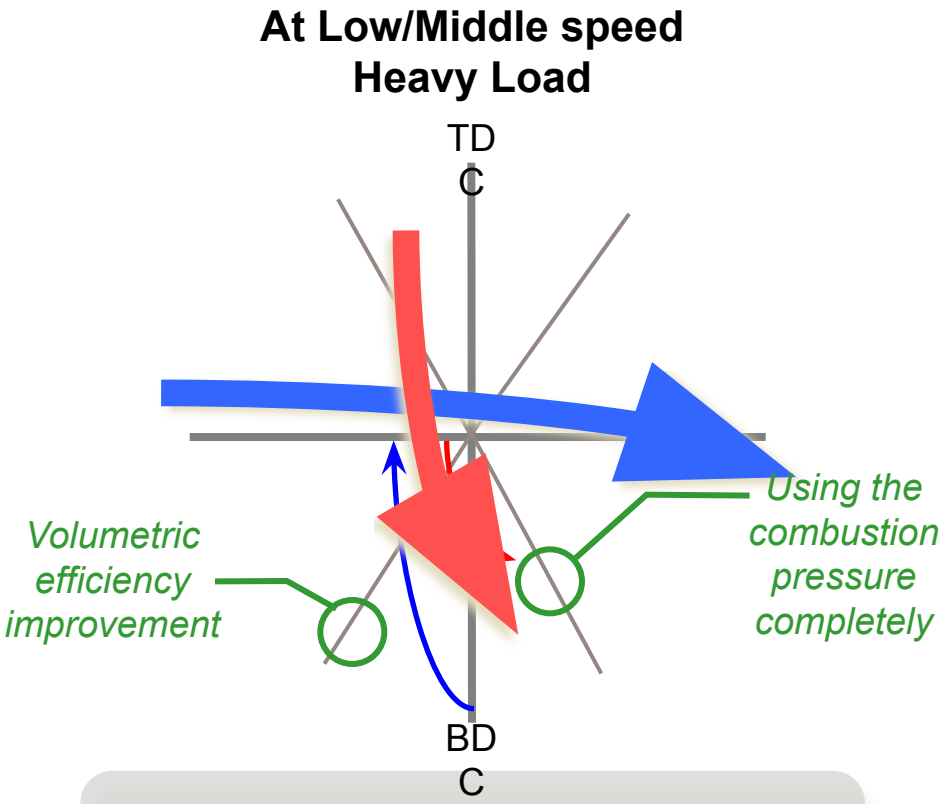


- Effect
  - Improved emission control
  - Better fuel economy

Reference (Engine Control System)

- System
  - Operation



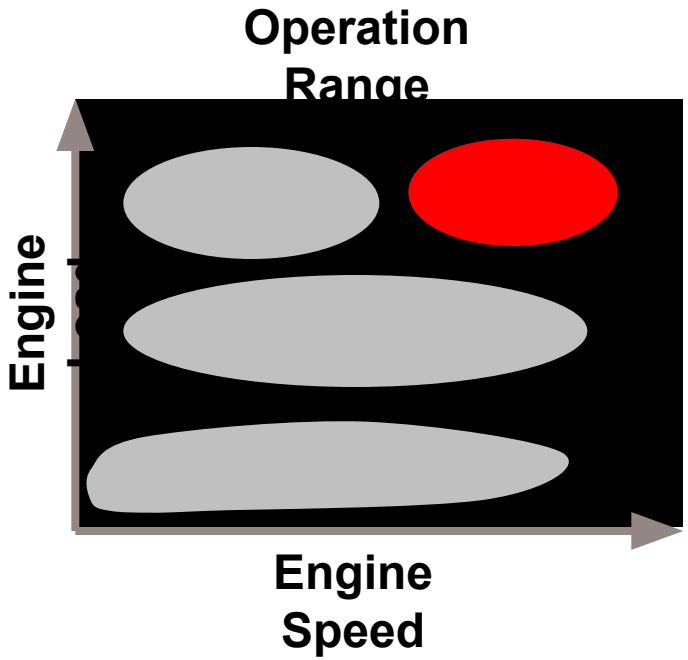


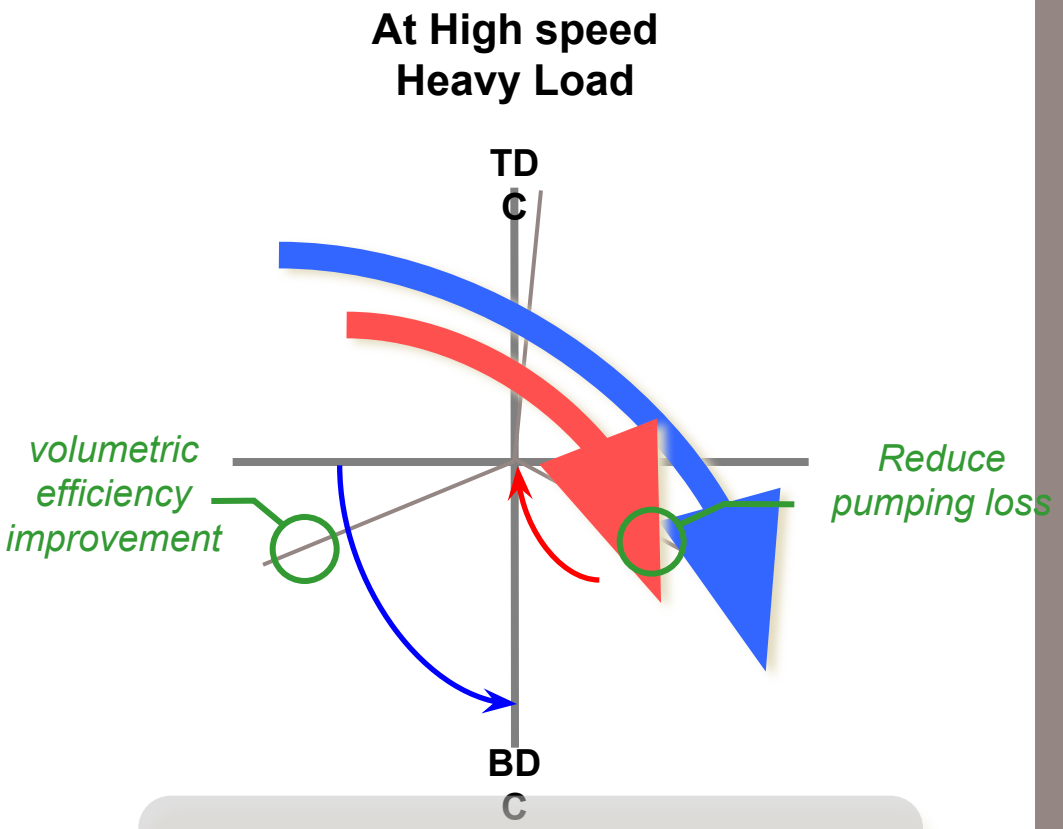
Effect

- Improved torque/output

Reference (Engine Control System)

- System
  - Operation





- Effect
  - Improved output

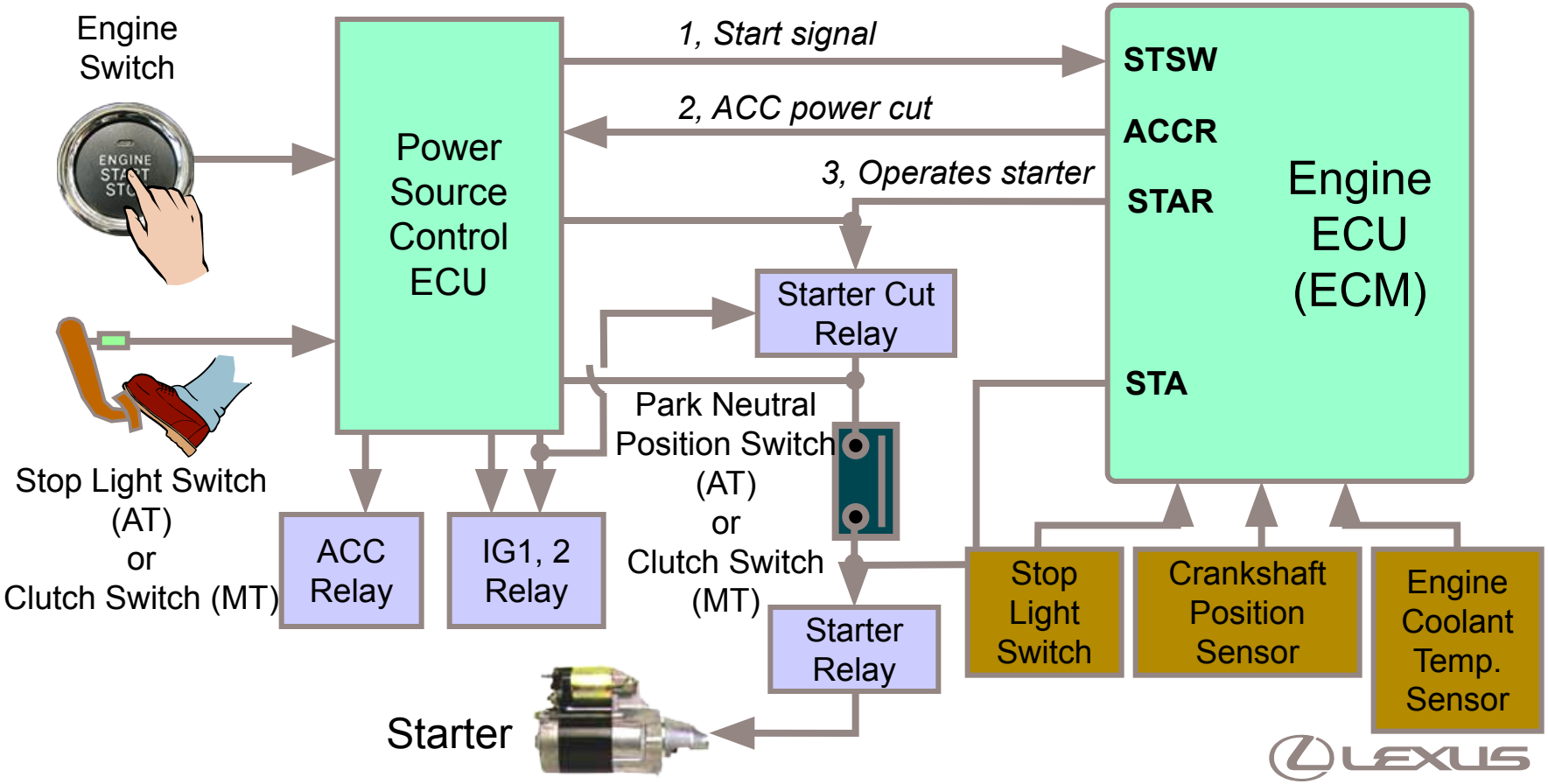
Service Point (Engine Control System)

- Dual VVT-i
  - Following 14 DTCs are added by adoption of exhaust VVT-i

DTC No.	Detection Item	DTC No.	Detection Item
P0013	Camshaft Position "B" Actuator Circuit (Bank 1)	**P0025**	Camshaft Position "B" - Timing Over-Retarded (Bank 2)
P0014	Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 1)	**P0365**	Camshaft Position Sensor "B" Circuit (Bank 1)
P0015	Camshaft Position "B" - Timing Over-Retarded (Bank 1)	**P0367**	Camshaft Position Sensor "B" Circuit Low Input (Bank 1)
P0017	Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor B)	**P0368**	Camshaft Position Sensor "B" Circuit High Input (Bank 1)
P0019	Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor B)	**P0390**	Camshaft Position Sensor "B" Circuit (Bank 2)
P0023	Camshaft Position "B" Actuator Circuit (Bank 2)	**P0392**	Camshaft Position Sensor "B" Circuit Low Input (Bank 2)
P0024	Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 2)	**P0393**	Camshaft Position Sensor "B" Circuit High Input (Bank 2)

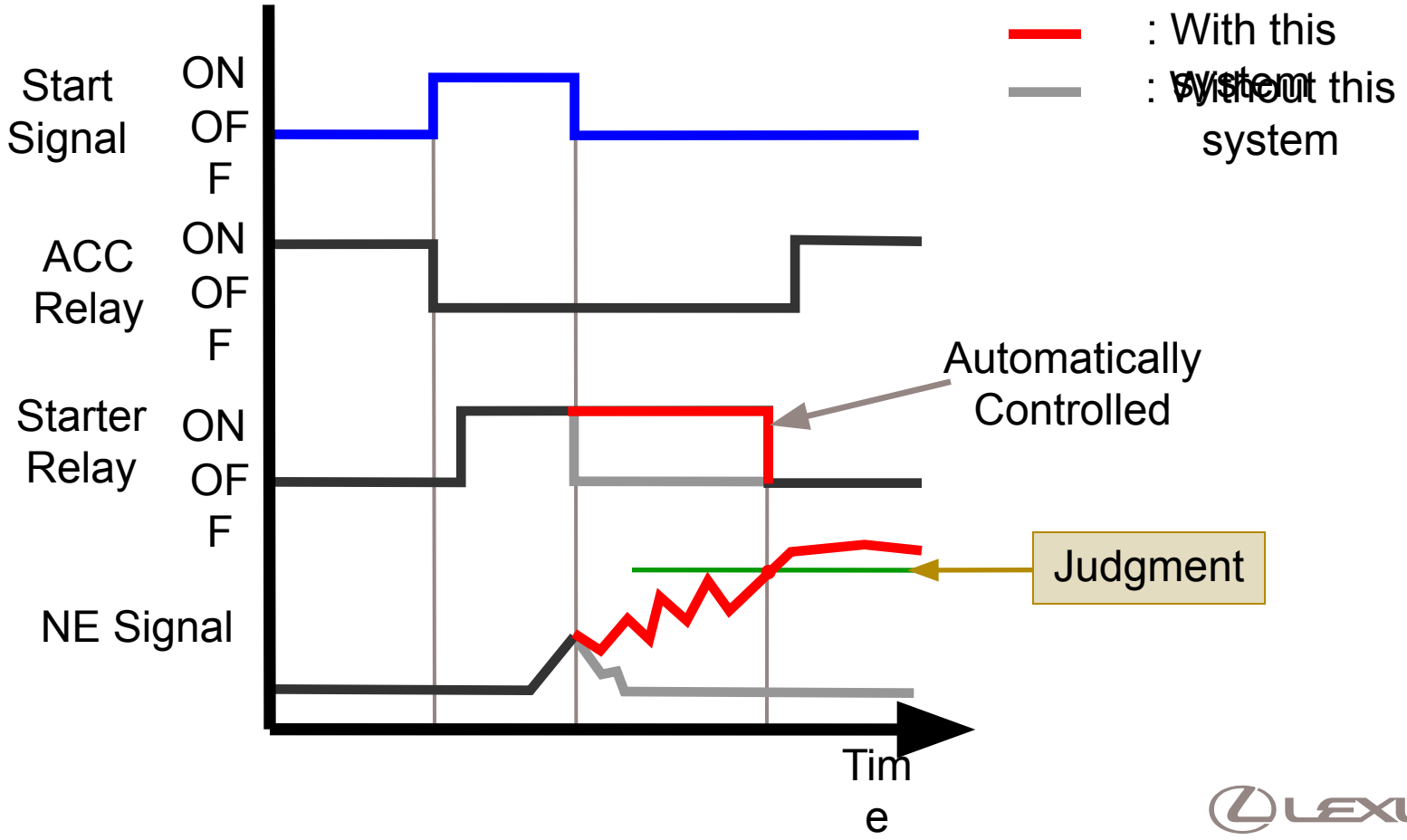
Engine Control System

- Cranking Hold Function
  - Once the power mode is turned to “Engine Starting”, starter operates until engine starting



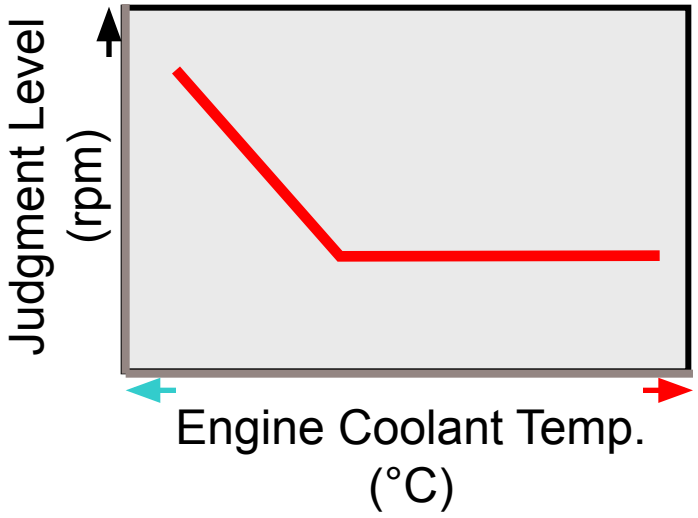
Reference (Engine Control System)

- Cranking Hold Function
  - Operation

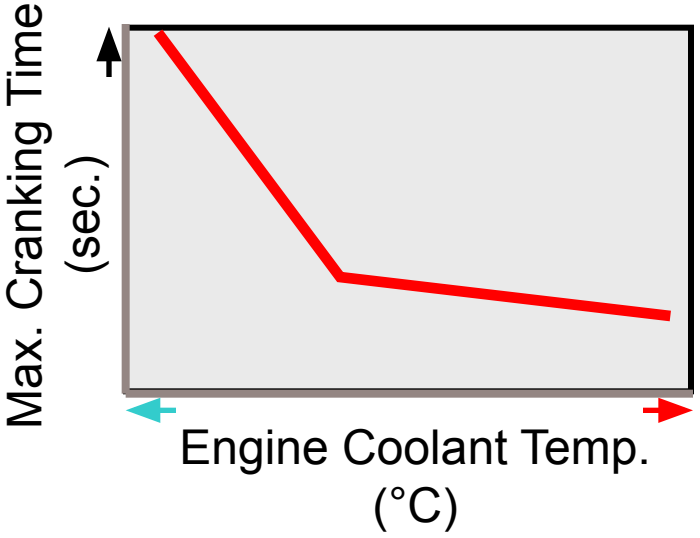


Reference (Engine Control System)

- Cranking Hold Function
  - Judgment of the engine firing
  - Maximum cranking time



Judgment of the engine firing



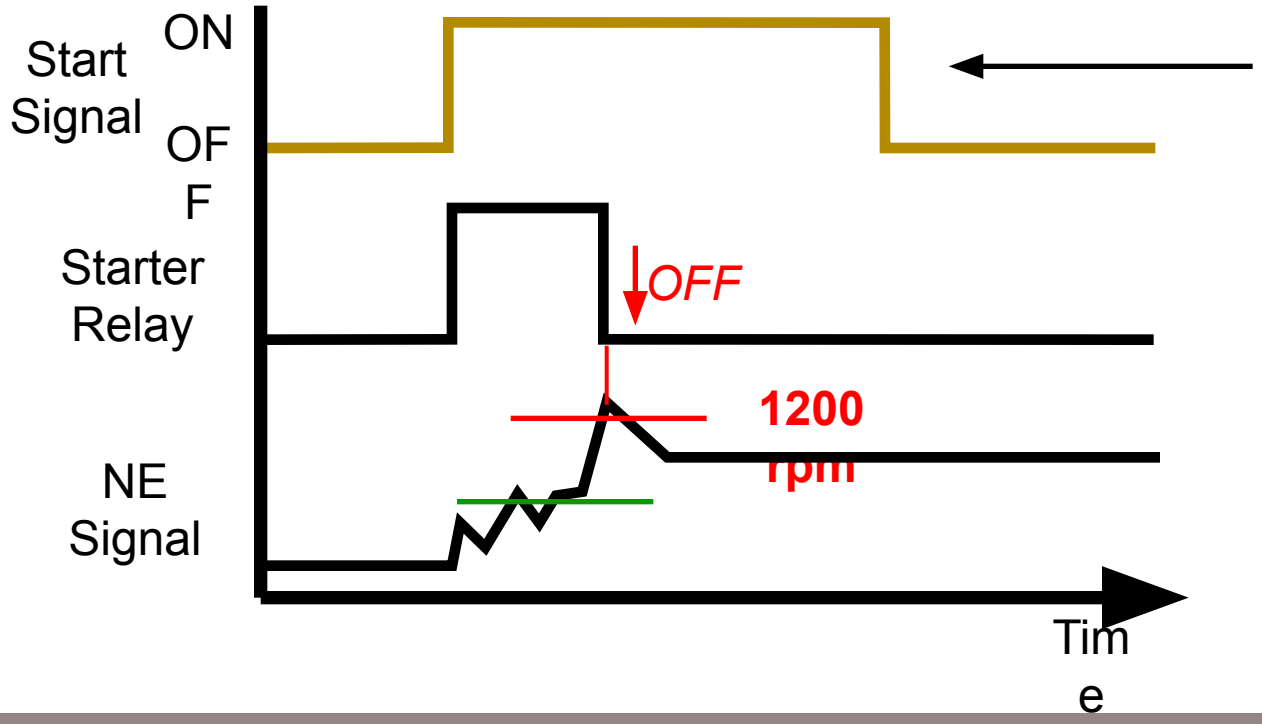
Maximum cranking time

(When engine does not start by some abnormalities)

Reference (Engine Control System)

- Cranking Hold Function
  - Protection during engine starting

If the engine speed becomes 1200 rpm or more while cranking, engine ECU (ECM) stops starter to prevent starter overrun

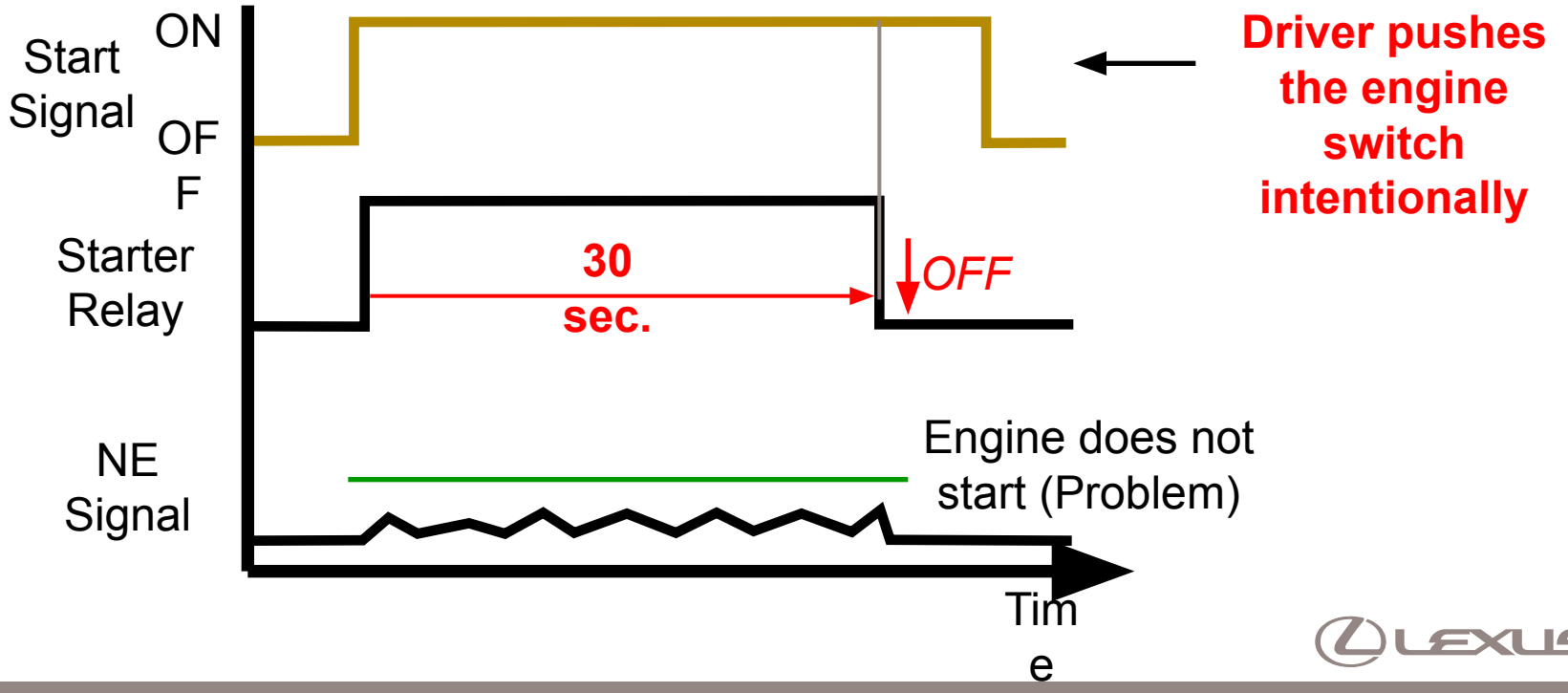


Driver pushes the engine switch intentionally

Reference (Engine Control System)

- Cranking Hold Function
  - Protection during engine starting

Starter overheating protection operates starter max.30 sec.
with intentional starter operation



Engine Control System

- Communication
  - CAN (Controller Area Network) communication for DLC3 and other ECUs