|  |
| --- |
| **KDI 1903TCR - TCRE5 - TC** |
| **KDI 1903TCR / KDI 1903TCRE5 Workshop manual (Rev. 16)** |



Sommario

[1. TITOLO 1 2](#_Toc495648770)

[1.1. Asdfsdfsdf 2](#_Toc495648771)

[1.2. Asdfsdfsdfggg 2](#_Toc495648772)

# General information

## Useful information

* This manual contains the instructions needed to carry out  proper use and maintenance of the engine, therefore it must always be available, for future reference when required.
* Information, descriptions and pictures contained in this manual reflect the basic configuration of the engines ( [**Par. 1.4**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=96&parent=1000) and [**Par. 1.5**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=97&parent=1000) ).
* However, the development of engines is continuous. Therefore, the information in this manual is subject to change without notice.
* **KOHLER** reserves the right to make, at any time, changes on the engines for technical or commercial reasons.
* These changes do not require **KOHLER** to intervene on the production marketed up to that time and nor to consider this manual as inappropriate.
* The paragraphs, tables and figures are numbered by chapter and followed by the progressive paragraph, table and/or figure number.

Es: **Par. 1.3** - chapter **1** paragraph **3** . **Tab. 2.4** - chapter **2** table **4** . **Fig. 4.5** - chapter **4** figure **5** .

**NOTE:** The paragraphs may contain sub-paragraphs.

* All technical terms, specific components and symbols ( [**Tab. 15.1**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=193&parent=1000) ) that are in the manual are listed and described inside the glossary, which can be consulted in ( [**Chap. 15**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=193&parent=1000) ).
* The references of the objects described in the text and in the figure are indicated by letters and numbers, which are always and only related to the paragraph you are reading unless there are specific references to other figures or paragraphs.
* Reference to values are indicated by letters or numbers.
* The mark ( operazione_utile.gif ) after the title of a paragraph, indicates that the procedure is not required in order to disassemble the engine, however the procedures are featured in order to illustrate the disassembly of components.
* Any additional section that **KOHLER** will deem necessary to supply at a later stage must be kept with the manual and considered as an integral part of it.
* The information contained in this manual is the sole property of **KOHLER** , therefore no partial or total reproduction or replication is allowed without the express permission of **KOHLER** .

**1.1.1** **Useful Information -** **accident prevention -** **environmental impact**

* Before proceeding repair - handling the motor , read the entire chapter 3, which contains important information about the procedures to be followed for safety and environment .

## Manufacturer and engine identification

The engine identification name plate is situated in the lower part of the crankcase; it is visible from the intake or exhaust side.

 **Fig 1.1** - **Fig 1.2**

 **Fig 1.3**

## Homologation labels

**Label for EPA rules** **(compilation example)**



**Tab 1.1**

|  |  |
| --- | --- |
| **POS.** | **DESCRIPTION** |
| 1 | Model year in compliance with the rules |
| 2 | Power category (kW) |
| 3 | Engine displacement (L) |
| 4 | Particulate emission limit (g/kWh) |
| 5 | Engine family ID |
| 6 | Emission Control System = ECS |
| 7 | Fuel with low sulphur content |
| 8 | Injection timing |
| 9 | Electronic injector opening pressure (bar) |
| 10 | Production date (example: 2013.JAN) |

**Label for China Standards** **(compilation example)**



**Tab 1.2**

|  |  |
| --- | --- |
| **POS** | **DESCRIPTION** |
| 1 | Manufacturer |
| 2 | Engine model |
| 3 | Manufactoring date |
| 4 | Certificate N° |
| 5 | Power range (kW) |
| 6 | Emission level |
| 7 | Rated power |
| 8 | Aftertreat system |

**Label for Korea Standards** **(compilation example)**



**Tab 1.3**

|  |  |
| --- | --- |
| **POS** | **DESCRIPTION** |
| 1 | Tier 4 Final |
| 2 | Engine model |
| 3 | Manufactoring date and  manufacturer code |
| 4 | N° Korea emission certificate |

## Identification of the main internal components of the engine and operating reference (BASE CONFIGURATION)

**WIEW OF EXHAUST SIDE**

 **Fig 1.5**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| The following chapters contain operating references in order to clearly understand the engine. This paragraph illustrates these references that may be recognised by means of some main internal components.  Should you need to execute complex operations, always consult this paragraph | **Tab 1.2**   |  |  | | --- | --- | | **REF.** | **DESCRIPTION** | | A rightredarrow.gif | View of timing system side (2 nd PTO) | | B rightredarrow.gif | View of flywheel side (1 nd PTO) | | C rightredarrow.gif | View of exhaust side | | D rightredarrow.gif | View of intake side | | 1 | Cylinder/Piston N. 1 (KDI 1903 - KDI 2504) | | 2 | Cylinder/Piston N. 2 (KDI 1903 - KDI 2504) | | 3 | Cylinder/Piston N. 3 (KDI 1903 - KDI 2504) | | 4 | Cylinder/Piston N. 4 (KDI 2504) | | **POS.** | **DESCRIPTION** | | 5 | Crankshaft pulley (2 nd PTO) | | 6 | Gear timing system | | 7 | Thermostatic valve | | 8 | Oil pump | | 9 | Oil suction hose | | 10 | Crankshaft | | 11 | Exhaust manifold | | 12 | Intake manifold | | 13 | Camshaft | | 14 | Gears adaptor for 3 th /4 th PTO (optional) | | 15 | Flywheel (1 st PTO) | |

**WIEW OF FLYWHEEL SIDE** **Fig 1.6**

**WIEW OF TIMING SYSTEM SIDE** **Fig 1.7**

## Identification of the external components of the engine (BASE CONFIGURATION)

**VIEW OF TIMING SYSTEM SIDE - EXHAUST** **Fig 1.8**

**VIEW OF FLYWHEEL SIDE** **Fig 1.9**

|  |  |
| --- | --- |
| This paragraph illustrates all external components that are present in the base configuration of the engine. For components present on engines that differ from those represented in these illustrations, refer to [**Chap. 11** .](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=176&parent=1000) | **NOTE:** The illustrated components may differ from those illustrated; the illustration is only as an example. |
| **Tab 1.3**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Oil filler cap | | 2 | Wiring | | 3 | ECU | | 4 | Turbocharger | | 5 | Oil pressure switch | | 6 | Starter motor | | 7 | Oil steam separator | | 8 | Oil drain plug | | 9 | Engine identification name plate | | 10 | Alternator | | 11 | Coolant pump | | 12 | Coolant temperature sensor | | 13 | Oil filler cap side | | 14 | Thermostatic valve | | 15 | Catalyst | | 16 | EGR Cooler | | 17 | High-pressure fuel injection pump | | |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 18 | Oil Cooler | | 19 | Lub. oil filter | | 20 | Oil dipstick | | 21 | Fuel filter | | 22 | EGR valve | | 23 | Crankshaft pulley (2 nd PTO) | | 24 | Flywheel (1 st PTO) | | 25 | Intake manifold | | 26 | Waste Gate valve control actuator | | 27 | Exhaust manifold | | 28 | Flange bell | | 29 | Electronic injectors | | 30 | Common Rail | | 31 | Air intake hose | |

**UPPER VIEW** **Fig 1.10**

## ATS (After Treatment System)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **1.6.1 ATS with DOC filter**    **NOTE:**  The ATS system can be installed in a different way than shown.  2.27.png  **Fig 1.10** | **Tab 1.4**   |  |  | | --- | --- | | **POS.** | **DESCRIZIONE** | | 4 | Turbocharger | | 5 | Gas exhaust flange | | 13 | DOC | | 14 | Flexible exhaust tube | |
| **1.6.2 ATS with DOC+DPF filter**    **NOTE:**  the ATS system with DPF filter is only present for versions compliant with "Stage V" emission regulations.  The ATS system can be installed in a different way than shown. | **Tab 1.5**   |  |  | | --- | --- | | **POS.** | **DESCRIZIONE** | | 1 | Turbocharger | | 2 | Turbine exhaust pipe | | 3 | DOC | | 4 | DPF | | 5 | ETB | |
| 1_6.png  **Fig 1.11** | |

# Technical information

## Engine specifications

|  |  |  |  |
| --- | --- | --- | --- |
| **MANUFACTURER SPECIFICATIONS AND OPERATION** | | | |
| **GENERAL INFORMATION** | **UNIT OF MEASURE** | **KDI 1903 TCR** | **KDI 2504 TCR** |
| Operating cycle |  | diesel - 4 stroke | |
| Cylinders | N° | 3 | 4 |
| Bore x stroke | mm | 88x102 | |
| Displacement | cm 3 | 1861 | 2482 |
| Compression ratio |  | 17.4:1 | |
| Intake |  | Supercharged with Turbocharger | |
| Cooling |  | Liquid | |
| Crankshaft rotation (view from flywheel side) |  | Counterclockwise | |
| Combustion sequence |  | 1-3-2 | 1-3-4-2 |
| **Timing System** | | | |
| Valves per cylinder | N° | 4 | |
| Timing System |  | Rods and rocker arms - Camshaft in the crankcase | |
| Tappets |  | Hydraulic | |
| Injection |  | Direct - Common Rail | |
| Engine dry weight | Kg | 233 | 267 |
| **MAX** inclination 30' continuous operation | α | 25° | |
| **MAX** inclination 1' continuous operation | α | 35° | |
| Volume of aspirated air (2600 rpm) | m 3 /h | 2.4 | 2.8 |
| **POWER AND TORQUE** | | | |
| **GENERAL INFORMATION** | **UNIT OF MEASURE** | **KDI 1903 TCR** | **KDI 2504 TCR** |
| **MAX** operating speed | Rpm | 2600 | |
| **MAX** operating power (ISO TR 14396 - SAE J1995 - CE 97/68) | kW | 42 | 55.4 |
| Maximum torque (at 1500 rpm) | Nm | 225 | 300 |
| Admissible axial load on crankshaft | Kg | 300 | |
| **CONSUMPTIONS** | | | |
| **GENERAL INFORMATION** | **UNIT OF MEASURE** | **KDI 1903 TCR** | **KDI 2504 TCR** |
| Specific fuel consumption (best point) | g/kWh | 210 | |
| Oil consumption | %Fuel | < 0.05 | |
| **FUEL SUPPLY SYSTEM** | | | |
| **GENERAL INFORMATION** | **UNIT OF MEASURE** | **KDI 1903 TCR** | **KDI 2504 TCR** |
| Type of fuel |  | Diesel UNI-EN590 - ASTM D975 | |
| High-pressure fuel injection pump |  | DENSO HP3 | |
| Fuel supply |  | Low pressure electric pump (if necessary) | |
| **Fuel filter** | | | |
| Filtering surface | cm 2 | 2300 | |
| Degree of filtration | µm | 5 | |
| Maximum pressure at injection pump inlet | bar | 0,2 | |
| **LUBRICATION CIRCUIT** | | | |
| **GENERAL INFORMATION** | **UNIT OF MEASURE** | **KDI 1903 TCR** | **KDI 2504 TCR** |
| **Lubrication** | | | |
| Recommended oil |  | See [**Par. 2.4**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=55&parent=1000) | |
| Circuit forced |  | Lobe pump | |
| Oil sump capacity ( **MAX** ) | Lt. | 8,9 | 11,5 |
| **Oil pressure switch** | | | |
| Intervention pressure ( **MIN** ) | bar | 0.8±0.1 | |
| **Oil filter** | | | |
| Maximum operating pressure | bar | 4.0 | |
| Degree of filtration | µm | 17±2 | |
| Filtering surface | cm 2 | 1744 | | |
| **COOLING CIRCUIT** | | | |
| **GENERAL INFORMATION** | **UNIT OF MEASURE** | **KDI 1903 TCR** | **KDI 2504 TCR** |
| Coolant | % | See [**Par. 2.6**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=195&parent=1000) | |
| Coolant pump | Lt./min | 75 | |
| **Thermostatic valve** | | | |
| Opening temperature | °C | +79 | |
| Stroke at 91°C | mm | 7.50 | |
| Liquid recirculation | Lt./h | 9 | |
| **ELECTRICAL SYSTEM - ELECTRIC FAN** | | | |
| **GENERAL INFORMATION** | **UNIT OF MEASURE** | **KDI 1903 TCR** | **KDI 2504 TCR** |
| Circuit rated voltage | V | 12 | |
| External alternator (rated current) | A | 80 | |
| Starter motor power | kW | 2 | |
| System electrical consumption, excluding: heater, electric pump, electric fan, starter motor | W | 25 | |
| **Coolant temperature indicator light** | | | |
| Indicator light operating temperature | °C | +100/+110 | |

## Engine dimensions (mm)

**NOTE** : Dimensions vary according to engine configuration.

 **Fig 2.1**

## Performance

|  |
| --- |
| Diagrammi_1903_TCR.jpg  **Fig. 2.3** |
| **N**  =  Automotive rating curve  **MN**  =  Torque curve  **C**  =  Specific fuel consumption curve   |  | | --- | | **NOTE:**  Refer to  **KOHLER**  for power curves, torque curves and specific consumptions at speeds other than those given above. |   ***Key***     * **N (ISO TR 14396 - SAE J1995 - CE 97/68)  AUTOMOTIVE RATING CURVE :** Intermittent duty at variable speed and load.  Engine capacity at intermittent conditions with variable speed and load.        * **MN:** =  **TORQUE RATING CURVE :** Also called twisting moment, it is the push generated by the engine through transmission. The highest engine performance is obtained at the maximum torque.        * **C**  =  **SPECIFIC CONSUMPTION CURVE :** Engine fuel consumption in a given time at a certain revolution value.  Expressed in g/kW (grams/kilowatt), it expresses fuel yield.       \* The above curves express indicative values, in that the overall performance depends on the type of application and the ECU control uni.     * The ratings reported in the diagram regard the run-in engine, fitted with air and exhaust filters, at the atmospheric pressure of 1 Bar and at a room temperature of +20°C * Maximum rating is guaranteed with a 5% tolerance.     Z_Avvertenza.jpg  **Warning**       * Non approval by  **KOHLER**  for any modification releases the company from liability for damage incurred on the engine. |

## Oil

Z_importante.jpg **Important**

* The engine may be damaged if operated with improper oil level.
* Do not exceed the **MAX** level because a sudden increase in engine rpm could be caused by its combustion.
* Use only the recommended oil to ensure adequate protection, efficiency and service life of the engine.
* The use of lubricants other than recommended may shorten the engine life.
* Viscosity must be appropriate to the ambient temperature to which the engine is to be exposed.

Z_Pericolo.jpg **Danger**

* Prolonged skin contact with the exhausted engine oil can cause cancer of the skin.
* If contact with oil cannot be avoided, thoroughly wash your hands with soap and water as soon as possible.
* For the exhausted oil disposal, refer to the **Par.** **DISPOSAL and SCRAPPING** .

**2.4.1 SAE oil classification**

* In the SAE classification, oils are identified according to viscosity without considering any other qualitative characteristic.
* The code is composed of two numbers, which indicate, and must correspond to, the ambient temperature in which the engine operates, the first number refers to the viscosity when cold, for use during winter (" **W** "), while the second number is for viscosity at high temperatures.

**2.2**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **RECCOMENDED OIL** | | | | | |
| **VISCOSITY** | **SAE** | 15W-40 (-15°C ÷ +50°C) 10w-30 (-25°C ÷ +40°C)  10w-40 (-25°C ÷ +50°C)  5w-30 (-30°C ÷ +40°C)  0w-40 (-40°C ÷ +50°C) | | | |

|  |  |  |  |
| --- | --- | --- | --- |
|  | | **TCR TIER IV FINAL - STAGE V (\*1) (\*2)** | **TCR/D TIER III or UNCERTIFIED (\*3)** |
|  | |
| **WITH SPECIFICATIONS** | **API** | CJ-4 Low S.A.P.S | CI-4 Plus |
| CI-4 |
| CH-4 |
| **ACEA** | E6 Low S.A.P.S. | E7 |
| E5 |

* Low S.A.P.S. technology (oil with low Sulfated Ash, Phosphorus, Sulfur content) keeps catalyst in good working conditions. The presence of sulfated ash, phosphorus and sulfur causes with time the catalyst clogging and its consequent inefficiency.
* For Mid S.A.P.S oil sequence the sulfated ash level is the same as API CJ-4 ≤ 1.0% but as per ACEA standardization those oils are referenced as mid SAPS.
* Filtration of oils is critical to proper operation and lubrication; always change filters regularly as specified in this manual.

**(\*1) NOTA** : Do NOT use fuel with sulphur content above 15ppm.

**(\*1) - On all engines equipped with ATS system, the oil with viscosity 15W-40 must comply with the specification API CJ-4 Low S.A.P.S or ACEA E6 Low S.A.P.S. \***

**(\*1) - On all engines compliant with Stage-V emission regulation (engines with DPF device), oil with viscosity 15W-40 cannot be used\***

**(\*2) - On all engines compliant with Stage-V emission regulation (engines with DPF device), the oil to use must comply with the specification API CJ-4 Low S.A.P.S or ACEA E6 Low S.A.P.S. \***

**(\*3) -** **NOTE** : Do NOT use fuel with sulphur content above 500ppm.

**(\*3) -** **NOTE** : Low S.A.P.S. oils, sulfate ashes <1% may not be used with fuels with a sulfur content >50ppm.

## Fuel

Z_importante.jpg **Important**

* Use of other types of fuel could damage the engine. Do not use dirty diesel fuel or mixtures of diesel fuel and water since this will cause serious engine faults.
* **Any failures resulting from the use of fuels other than recommended will not be warranted.**

Z_Avvertenza.jpg **Warning**

* Clean fuel prevents the fuel injectors from clogging. Immediately clean up any spillage during refuelling.
* Never store diesel fuel in galvanized containers (i.e. coated with zinc). Diesel fuel and the galvanized coating react chemically to each other, producing flaking that quickly clogs filters or causes fuel pump and/or injector failure.

**2.3**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **FUEL COMPATIBILITY** | | | | | | | | |
| EN 590 (biodiesel content max. 7% (V/V)) | | | | | | | | |
| ASTM D 975 Grade 1-D S15 | | | | | | | | |
| ASTM D 975 Grade 2-D S15 | | | | | | | | |
| NATO F-54, equivalent to diesel fuel in accordance with EN 590 | | | | | | | | |
| EN 590 or ASTM D 975 Grade 1, 2 -D S15 Arctic Diesel | | | | | | | | |
| JIS K 2204 No. 1, No. 2 | | | | | | | | |

**NOTE** : In a warranty case the customer must prove by a certificate from the fuel supplier that an allowed fuel was used.

***KDI Electronic Injection Tier 4 final – Stage IIIB – Stage IV- Stage V certified Engines***

* Those engines are designed for fuels in accordance with EN 590 and ASTM D975 for a cetane number of at least 45. Since those engines are equipped with exhaust gas after-treatment such as Diesel Oxidation Catalyst (DOC), Diesel Particulate Filter (DPF), Selective Catalytic Reduction (SCR), they may only be operated with sulfur-free diesel fuels (EN 590, DIN 5168, ASTM D975 Grade 2-D S15, ASTM D975 Grade 1-D S15). Otherwise, compliance with the emission requirements and durability are not guaranteed.  
  Insufficient lubricating capacity can lead to serious wear problems above all in common rail injection systems. Too low a lubricating capacity is particularly a problem in fuels with a low sulfur content (and in this respect sulfur contents ‹500 mg/kg can already be considered low). An adequate lubricating capacity is guaranteed by the appropriate additives in low-sulfur (‹50 mg/kg) or sulfur-free (‹10 mg/kg or ‹15 mg/kg) diesel fuels according to EN 590 and ASTM D 975. In low-sulpur and sulfur-free diesel fuels which do not comply with this standard, the lubricating capacity may have to be guaranteed by additives. The parameter for sufficient lubricating capacity is a maximum wear spot of 460 micrometers in the HFRR test (EN ISO 12156-1).

***KDI Electronic Injection Tier 3 – Stage IIIA emission equivalent certified Engines (EGR engines)***

* Those engines are designed for fuels in accordance with EN 590 and ASTM D975 for a cetane number of at least 45. Since those engines are not equipped with exhaust gas after-treatment, they can be operated with diesel fuels with sulfur content up to 500 mg/kg (ppm). Compliance with the emission requirements is guaranteed only with sulfur content up to 350 mg/kg (ppm).  
  Fuels with a sulfur content > 50 mg/kg demand a shorter lubricating oil change interval. This is set at 250hrs. However, the engine oil must be changed when the Total Base Number TBN is reduced to 6.0 mgKOH/g test method ASTM D4739. Do not use low SAPS engine oils.

***KDI Electronic Injection uncertified Engines (no EGR engines)***

* Those engines are designed for fuels in accordance with EN 590 and ASTM D975 for a cetane number of at least 45. Since those engines are not equipped with exhaust gas after-treatment, they can be operated with diesel fuels with sulfur content up to 2000 mg/kg (ppm). Fuels with a sulfur content > 15 mg/kg demand a shorter lubricating oil change interval. This is set at 250hrs. However, the engine oil must be changed when the Total Base Number TBN is reduced to 6.0 mgKOH/g test method ASTM D4739.

**2.5.1** **Fuel for low temperatures**

* When operating the engine in ambient temperatures lower than 0 degrees C, use suitable low temperature fuel normally available from fuel distributors and corresponding to the specifications of **Tab. 2.3** .
* These fuels reduce the formation of paraffin in diesel at low temperatures.
* When paraffin forms in the diesel, the fuel filter becomes blocked interrupting the flow of fuel.

**2.5.2 Biodiesel fuel**

* Fuels containing 10% methyl ester or B10, are suitable for use in this engine provided that they meet the specifications listed in the Tab. 2.3.
* **DO NOT USE** vegetable oil as a biofuel for this engine.

**2.4**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **BIODIESEL COMPATIBILITY** | | | | | | | | |
| Biodiesel according to EN 14214 (only permissible for mixture with diesel fuel at max. 10% (V/V)) | | | | | | | | |
| US biodiesel according to ASTM D6751 – 09a (B100) (only permissible for mixtures with diesel fuel at 10% (V/V)) | | | | | | | | |

**2.5.3 Synthetic fuels: GTL, CTL, BTL, HV**  
 It is a well-known fact that engines which are operated for longer periods with conventional diesel fuel and then converted to synthetic fuels suffer shrinkage of polymer seals in the injection system and thus fuel leaks. The reason for this behavior is that the aromatic-free synthetic fuels can lead to a change in the sealing behavior of polymer seals.  
Therefore, conversion from diesel fuel to synthetic fuel may only be done after changing the critical seals. The problem of shrinkage does not occur when an engine was operated with synthetic fuel from the start.

**2.5.4 Non-Road Fuels**

*Only for KDI De- Contented Electronic Injection Tier 3 – Stage IIIA emission equivalent certified Engines (EGR engines) and KDI De- Contented Electronic Injection Uncertified Engines (no EGR engines).*

Other non-road fuels may be used if they comply with all the limit values of EN 590 except for the fuel density, the cetane number and the sulfur content.  
The following limits apply for these parameters:

**2.5**

|  |  |  |
| --- | --- | --- |
| **FUEL PARAMETER** | **UNIT** | **LIMIT VALUE** |
| Cetane number |  | Min. 49 |
| Fuel density at 15°C | Kg/m 3 | 820 - 860 |
| Sulfur content | mg/kg or ppm | max. 500 |

**2.5.5 Jet Fuels**  
 *Only for KDI De- Contented Electronic Injection Uncertified Engines (no EGR engines).*  
The following jet fuels can be used but only adopting an additional fuel filter with lubricity doser:

**2.6**

|  |  |
| --- | --- |
| **FUEL** | |
| F-34/F-35 (kerosene, NATO designation) | JP-8 (kerosene, US military designation) |
| F-44 (kerosene, NATO designation | JP-5 (kerosene, US military designation) |
| F-63 (kerosene, NATO designation, equivalent to F-34/F-35 with additives) | Jet A (kerosene for civil aviation) |
| F-65 (kerosene, NATO designation, 1:1 mixture of F-54 and F-34/F-35) | Jet A1 (kerosene for civil aviation) |

**2.5.6 Emission-Related Installation Instructions** Failing to follow the instructions in the applications guidebook when installing a certified engine in a piece of nonroad equipment violates federal law (40 CFR 1068.105(b)), subject to fines or other penalties as described in the Clean Air Act.

OEM must apply a separate label with the following statement: “ULTRA LOW SULFUR FUEL ONLY” near the fuel inlet.

Ensure you are installing an engine appropriately certified for your application. Constant speed engines may only be installed on constant speed equipment for constant speed operation.

If you install the engine in a way that makes the engine's emission control information label hard to read during normal engine maintenance, you must place a duplicate label on the equipment, as described in 40 CFR 1068.105.

## Coolant recommendation

|  |
| --- |
| A mixture of 50% demineralized water and 50% low silicate ethylene glycol based coolant liquid must be used. Use a Long Life or Extended Life Heavy Duty OAT coolant free of: silicates, phosphates, borates, nitrites and amines.    The following ethylene-glycol based engine coolant for all models within KDI engine family may be used:     * OAT (Organic Acid Technology) Low Silicate: **ASTM D-3306 D-6210** * HOAT (Hybrid Organic Acid Technology) Low Silicate: **ASTM D-3306 D-6210**   The above coolants in concentrated formulation must be mixed with distilled, deionized, or demineralized water. A pre-mixed formulation (40-60% or 50-50%) can be used directly when available.  Importante.png  **Important**   * Do not mix ethylene glycol and propylene glycol based coolants. Do not mix OAT and HOAT based coolant. OAT performance life can be drastically reduced if contaminated with nitrite-containing coolants. * Never use automotive-type coolants. These coolants do not contain the correct additives to protect heavy – duty diesel engines.   OAT coolants are maintenance free up to 6 years or 6000hrs of operation , provided that the cooling system is topped up using the same type of coolant. Do not mix different coolant types. Test the coolant condition annually with coolant test strips. HOAT are not all maintenance free and it is recommended to have SCA (Supplemental Coolant Additives) added at the first maintenance interval. |

## Battery recommendation

**Battery not supplied by Kohler**

**Tab. 2.7**

|  |  |
| --- | --- |
| **RECOMMENDED BATTERIES** | |
| **AMBIENT TEMPERATURE** | **BATTERY TYPE** |
| ≥ - 15°C | 100 Ah - 800 CCA/SAE |
| < -15°C | 120 Ah - 1000 CCA/SAE |

## Periodic maintenance

The intervals of preventive maintenance in **Tab. 2.8, Tab. 2.9, Tab. 2.10 and Tab. 2.11**  refer to the engine operating under normal operating conditions with fuel and oil meeting the recommended specifications.

**2.8**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CLEANING AND CHECKING** | | | | |
| **OPERATION DESCRIPTION** | **PERIOD (HOURS)** | | | |
| **100** | **250** | **500** | **5000** |
| Engine oil level (8) |  |  |  |  |
| Coolant level (8) (9) |  |  |  |  |
| Cartridge dry-type air filter (2) |  |  |  |  |
| Radiator heat-exchange surface and Intercooler (2) (8) |  |  |  |  |
| Standard alternator belt (8) |  |  |  |  |
| Poly-V alternator belt (8) |  |  |  |  |
| Rubber hose (intake air / coolant) |  |  |  |  |
| Fuel hose |  |  |  |  |
| Starter Motor |  |  |  |  |
| Alternator |  |  |  |  |

**2.9**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **REPLACEMENT** | | | | | |
| **OPERATION DESCRIPTION** | | **PERIOD (HOURS)** | | | |
| **500** | **2000** | **5000** | **5000** |
| Cartridge dry-type air filter (2) | |  |  |  |  |
| Intake manifold hose (air filter - intake manifold) (7) | |  |  |  |  |
| Coolant hoses (7) | |  |  |  |  |
| Fuel line hose (7) | |  |  |  |  |
| Alternator belt | Standard alternator belt (trapezoidal) (3) |  |  |  |  |
| Poly-V belt heavy environmental condition |  |  |  |  |
| Poly-V belt standard condition |  |  |  |  |
| Coolant | OAT |  |  |  |  |
| HOAT (10) |  |  |  |  |

**2.10**

|  |  |  |
| --- | --- | --- |
| **ENGINE OIL AND OIL FILTER CARTRIDGE REPLACEMENT** | | |
| **ENGINE VERSION** | **PERIOD (HOURS)** | |
| **250** | **500** |
| KDI TCR Tier 4 final – Stage IIIB – Stage IV- Stage V (1) |  |  |
| KDI TCR/D Tier 3 – Stage IIIA (1) (11) |  |  |
| KDI TCR/D uncertified (1) |  |  |

**2.11**

|  |  |  |
| --- | --- | --- |
| **FUEL FILTER AND PREFILTER CARTRIDGE REPLACEMENT** | | |
| **ENGINE VERSION** | **PERIOD (HOURS)** | |
| **250** | **500** |
| KDI TCR Tier 4 final – Stage IIIB – Stage IV- Stage V (1) |  |  |
| KDI TCR/D Tier 3 – Stage IIIA (1) |  |  |
| KDI TCR/D uncertified (1) |  |  |

(1) - In case of low use: 12 months.

(2) - The period of time that must elapse before checking the filter element depends on the environment in which the engine operates. The air filter must be cleaned and replaced more frequently under very dusty conditions.

(3) - In case of low use: 36 months.

(7) - The replacement interval is only an indication, it strongly depends from environmental condition and hose status detected during regular visual inspection.

(8) -  The first check must be done after 10 hours.

(9) - Test the coolant condition annually with coolant test strips.

(10) - It is recommended to have SCA (Supplemental Coolant Additives) added at the first maintenance interval.

(11) - Read Cap. 2.5, "KDI De- Contented Electronic Injection Tier 3 – Stage IIIA emission equivalent certified Engines (EGR engines)" and "KDI De- Contented Electronic Injection Uncertified Engines (no EGR engines)".

## Fuel system

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.9.1 Injection circuit (pressure 2000 bar) (Fig 2.4)**  The materials of the fuel system components (pipes, tank, filters, etc.) and any surface treatments must be free from chemical elements that, transported in the fuel, compromise the operation of the injectors over time (hole clogging).    The most critical chemical element is Zinc (Zn), therefore it is forbidden to use galvanised components.    Other damaging elements are indicated in the table below.  **Tab 2.12**   |  |  |  | | --- | --- | --- | | **METALS** | **LIMIT VALUES OF PRESENCE IN FUEL** | **LIMIT VALUE** | | **Zn** (Zinc) | * Zinc (Zn) is eluted from the rubber (NBR) in the fuel line. Thus, the growing carboxylate (Zn) was adhered on the parts in the injection system for reacting carboxylic acid in the fuel. * In case that the changed injection quantity, nozzle coking occurs the fuel contents Zn≥1ppm. * Zinc (Zn) is ≤ 0.3ppm is the limited value to avoid occur coking. | **Zn ≤ 0.3ppm** | | **Pb** (Lead) | * Lead (Pb)is eluted from Pd coading in the fuel tank. Thus, the growing carboxylate (Pd) was adhered on the injection system for reacting carboxylic acid in the fuel. * In case that the changed injection quantity and nozzle coking occurs the fuel contents Pd. * As interim, the identical level is the limited value with Zn. | **Pd ≤ 0.3ppm** | | **Na** (Sodium) | * The growing carboxylate (Na) was adhered on the parts in the injection system for reacting carboxylic acid in the fuel with fuel contents Na ≥ 0.5ppm. Thus, sliding malfunction was occurred. * In case that the changed injection quantity and nozzle coking occurs the fuel contents Na. * Especially concerns of occurring defects, NaOH is residue for using production process of bio fuel. * ≤ 0.3ppm is the limited value to avoid occur nozzle coking and carboxylate. Combine K with Na equivalent alkali metal that are less than 0.3ppm. | **Na + K ≤ 0.3ppm** | | **K** (Potassium) | | **Ca** (Calcium) | * In case that carboxylate (Ca) was adhered the injection system inside. * Under study on the results in the moment. * Maximum value is 0.3ppm when using fuel that is B100 fuel with regulation EN14214 of contents 7%. | **Ca + Mg ≤ 0.3ppm** | | **Mg** (Magnesium) | | **Cu** (Copper) | * Copper (Cu) on the fuel that can be acted wear and catalyst for making decline. * In case that the changed injector quantity and nozzle coking occurs in the fuel contents Cu. * As interim, the identical level is the limited value with Zn. | **Cu ≤ 0.3ppm** | | **Ba** (Barium) | * In case that changed injection quantity and nozzle coking occurs in the fuel contents Barium (Ba). * As interim, the identical level is the limited value with Zn. | **Ba ≤ 0.3ppm** | | **P** (Phosphorus) | * Phosphorus (P) in the fuel can poison catalyst. * No failure case is in the injection system in the moment. * Maximum value is 0.3ppm when using a B100 fuel with regulation EN 14214 of contents 7%. | **P ≤ 0.3ppm** | | **Na - K - Ca - Mg - P** | These metals are regulated in EN14214 | |     Z_importante.jpg **Important**       * The high pressure supply injection system is highly susceptible to damage if the fuel is contaminated. * It is crucial that all components of the injection circuit are thoroughly cleaned before the components are removed. * Thoroughly wash and clean the engine before maintenance. * Contamination in the injection system may cause a reduction in in performance or engine faults. * If the engine is cleaned with high pressure washer, then the nozzle must be kept at a minimum distance of 200mm from the surface, and not directed at electrical components and connectors. |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| The fuel supply system is under low pressure from fuel tank **1** to the high-pressure fuel injection pump **5** .  **NOTE** : The representation of fuel tank is purely  indicative. Component not necessarily supplied by **KOHLER** .  **Tab 2.13**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Fuel tank | | 2 | Fuel pipe under low pressure from the tank to the fuel filter | | 3 | Fuel filter | | 4 | Low-pressure fuel tube from the fuel filter to the high-pressure injection pump | | 5 | High-pressure fuel injection pump | | 6 | High-pressure fuel tube from the high-pressure fuel injection pump to the Common Rail | | 7 | Common Rail | | 8 | Fuel pipes under high pressure from the Common Rail to the electronic injectors | | 9 | Electronic injectors | | imm2_4.jpg **Fig 2.4** |
| **2.9.2 Fuel return circuit**    The fuel return circuit is under low pressure.  **NOTE** : The representation of fuel tank is purely  indicative. Component not necessarily supplied by **KOHLER** .  **Tab 2.14**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Electronic injectors | | 2 | Common Rail | | 3 | Low-pressure fuel return tube from the Common Rail to the fuel return distributor | | 4 | Low-pressure fuel return tube from the electronic injectors to the fuel return distributor | | 5 | Low-pressure fuel return distributor | | 6 | Low-pressure fuel return tube from the return distributor to the fuel tank | | 7 | High-pressure fuel injection pump | | 8 | Low-pressure fuel return tube from the injection pump to the fuel return distributor | | 9 | Fuel tank | | imm2_5.jpg **Fig 2.5** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.9.3 High-pressure injection pump (2000 bar)**    Z_importante.jpg **Important**       * **DO NOT** use the cylinder connecting pipe (item 5) to carry the pump during movement as this may cause damage resulting in fuel leakag; to handle the injection pump, refer  [**Par. 2.17.1.**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=112&parent=1000) * The injection pump **CANNOT** be repaired. * **DO NOT** attempt to remove the temperature sensor 7 from the pump. Should the sensor 7 be defective, replace the injection pump. * It is **NOT** possible to perform any maintenance on the fuel intake regulating valve 6 as it is an integral part of the injection pump. * **DO NOT** attempt to remove the fuel intake regulating valve 6 from the injection pump. Should the valve be defective, replace the injection pump.   **NOTE:** In the event of leakage from the high pressure circuit do not intervene when the engine is running, but turn it off and wait 5 - 10 minutes before checking the leakage.   The inlet pressure to the high pressure pump must be between 300 mbar (suction pump without electric supply) and 200 mbar (with electric pump power) to the high pressure rail.  The high pressure pump is operated via the pump control gear and sends high pressure fuel to the common rail.  **NOTE:** The supply tube (on union 8) and fuel return (on union 9), have different diameters.  **Tab 2.15**   |  |  | | --- | --- | | **POS.** | **COMPONENTS DESCRIPTION** | | 1 | High-pressure fuel injection pump | | 2 | Name plate with QR code | | 3 | Fitting for high pressure outlet to Common Rail | | 4 | Plunger housing | | 5 | Connection pipe plunger housing | | 6 | Fuel intake regulating valve | | 7 | Fuel temperature sensor | | 8 | Fuel inlet fitting | | 9 | Fuel return fitting | | 10 | Shaft key positioning on the pump control gear | | 11 | Pump control shaft | | 12 | Gasket | | imm2_6.jpg **Fig 2.6**imm2_7.jpg **Fig 2.7** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.9.4 Electronic injector**  The electronic injector is equipped with an integral solenoid valve which, when excited electronically, manages a valve controlled from    inside the electronic injector to commence fuel injection.      The ECU output signal is digital.      Z_importante.jpg **Important**       * The electronic injector is **NOT** repairable. * The electronic injectors are calibrated individually. * They are **NOT** interchangeable with the other cylinders of the same - or other - engines. * It is assembled on the engine; the new calibration code (QR code) must be inserted in the ECU by means of a diagnostics instrument [**(ST\_01).**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) * Do **NOT** fit new or different electronic injectors without the instruments required to enter the injector calibration code. * Fuel containing impurities causes serious damage to the electronic injectors. * The electronic injector for Stage V engines is different and it is not interchangeable with other engine | imm2_8.jpg **Fig 2.8  Tab 2.16**   |  |  | | --- | --- | | **POS.** | **COMPONENTS DESCRIPTION** | | 1 | Connector for solenoid control | | 2 | Solenoid and valve closure ring | | 3 | High pressure pipe inlet fitting | | 4 | Electronic injectors body | | 5 | Nozzle closure ring nut | | 6 | Nozzle | | 7 | QR code (Visual reading) | | 8 | QR code (Electronic reading) | | 9 | Return pipe fitting | | 10 | Electronic injector identification code | |
| **2.9.5 Common Rail**  Fuel is injected under pressure into the Common Rail ( **Pos.3** ), from the high-pressure fuel injection pump.   * The internal volume of the Common Rail is optimised to obtain the best compromise in order to minimise pressure peaks due to the cyclical flow of the injection pump; * Opening the electronic injectors; * The high speed response of the system to the requests of the ECU control unit.   The pressure sensor **5** measures the pressure of the fuel in the Common Rail. Safety valve **2** , only opens if internal pressure of the Common Rail exceeds the maximum value of 2400 bar. Pressure inside the Common Rail is regulated by the highpressure fuel injection pump by means of the fuel intake regulation valve ( **Pos. 6 Fig. 2.6** ).    The fuel ejected from the safety valve is introduced in the circuit of rejection returning to the tank.    Z_importante.jpg **Important**       * Common Rail is **NOT** reparaible. * It is **NOT** possible to perform any maintenance on the fuel pressure sensor **5** , as it is an integral part of the Common Rail unit. * Do **NOT** remove the pressure sensor or the fuel pressure limit valve from the Common Rail. * If the pressure sensor or the pressure limit valve are not working, replace the entire Common Rail unit.   imm2_9.jpg **Fig 2.9**    **Tab 2.17**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Common Rail | | 2 | Pressure limit valve (return due to overpressure) | | 3 | Tube inlet union from high-pressure fuel injection pump | | 4 | Outlet fittings for supply pipes to electronic injectors | | 5 | Fuel pressure sensor | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.9.6 Fuel filter**  The fuel filter is situated on the crankcase of the engine or it may be assembled on the frame of the vehicle.      **Tab 2.18**   |  |  | | --- | --- | | **POS.** | **COMPONENTS DESCRIPTION** | | 1 | Fuel filter support | | 2 | Fuel system filling button | | 3 | Cartridge | | 4 | Water in fuel sensor | | 5 | Wing nut, filter drainage |   **Tab 2.19**   |  |  | | --- | --- | | **DESCRIPTION** | **VALUE** | | Filtering surface | 2.300 cm 2 | | Degree of filtration | 5 µm | | Max operating pressure | 2.0 Bar | | Max flow rate | 190 litres/hour | | imm2_10.jpg **Fig 2.10** |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.9.7 Electric fuel pump (optional)** When the electric fuel pump is installed in a diesel engine, one must:   1. Remove any filters installed on the inlet of the electric injection pump; 2. Insert a pre-filter between the tank and the electric pump; 3. The electric pump may be assembled on application at a maximum height of 500 mm from the position of the fuel tank. 4. Insert a shut-off valve to prevent dry operation due to the emptying of the intake manifold; 5. The supply pressure given from the electric pump must not exceed the pressure of 0.2 bar to the input of highpressure injection pump.   **Tab 2.20**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Arrival pipe from the tank | | 2 | Electric pump | | 3 | Flow pipe to the fuel filter | | 4 | Fuel filter | | imm2_11.jpg **Fig 2.11** |
| **2.9.8 Guards for fuel injection circuit components**  High-pressure injection circuit components are particularly sensitive to impurities.    To prevent impurities, even microscopic ones, from accessing the fuel input or output unions, you are required to close these accesses by means of specific caps as soon as the various tubes are disassembled and disconnected.  Disassembly of any component of the injection circuit must not occur in dusty environments.  Cap protections must remain closed in their housing [**(ST\_40)**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) until the moment they are to be used.  Pay special attention when using the caps and avoid any contamination of dust or dirt of any kind.  Even after using the caps illustrated in this paragraph, all components of the injection circuit must be placed with care in environments that are free of any type of impurity.  **Fig. 2.13, 2.14 and 2.15** illustrate the caps that must be used on components of the injection circuit.  Cap protections must be accurately washed after use and placed back in their housing [**(ST\_40).**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000)    Z_importante.jpg **Important**       * It is highly recommended to have this page visible during disassembly operations of the components of the fuel injection circuit. | imm2_13.jpg **Fig 2.13**imm2_14.jpg **Fig 2.14**imm2_15.jpg **Fig 2.15** |

## Lubrication circuit

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.10.1 Lubrication circuit diagram**  The oil pump is driven by the crankshaft on the timing system side.    On the parts of the systems shown in green on In the parts in green, the oil is in intake, in the parts in red, the oil is under pressure and    in those in yellow the oil is returning towards the oil sump **2** (not under pressure).  **Tab 2.21**   |  |  | | --- | --- | | **COLOUR** | **DESCRIPTION** | |  | Oil in intake | |  | Oil under pressure | |  | Oil returning to the oil sump |   **Tab 2.22**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Oil pump rotors | | 2 | Oil sump | | 3 | Crankshaft | | 4 | Camshaft | | 5 | Turbocharger | | 6 | Rocker arm pin | | 7 | Hydraulic tappets | | 8 | Rocker arm cover | | 9 | Cylinder head | | 10 | Upper crankcase | | 11 | Lower crankcase | | 12 | Oil filter | | 13 | Oil Cooler | | 14 | Housing | | imm2_16.jpg **Fig 2.16**imm2_17.jpg **Fig 2.17** |
| **NOTE** : Click by side to play the procedure. | <https://www.youtube.com/embed/Ig3XosQ8h0s?rel=0> |
| **2.10.2 Oil pump** The oil pump rotors are trochoidal (with lobes) and are activated from the crankshaft by means of the key.    The pump body is situated inside the distribution guard.    It is imperative to assemble the rotors with reference **A** visible by the operator.      **Tab 2.23**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Internal rotor | | 2 | External rotor | | 3 | Oil pump crankcase | | 4 | Pump control key | | 5 | Timing system crankcase | | 6 | Crankshaft | | imm2_18.jpg **Fig 2.18** |

|  |  |
| --- | --- |
| **2.10.3 Oil filter and Oil Cooler**  imm2_19.jpg  **Fig** **2.1** **9**    **NOTE** : unscrewing the cartridge holder cover makes the oil in support 7 flow towards the oil sump by means of the drain duct 4. | |
| **Tab 2.24**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Oil arriving from the pump | | 2 | Oil cooling | | 3 | Oil filtering | | 4 | Oil drain duct (oil sump return) | | 5 | Oil returning into the circuit | | 6 | Outgoing fitting from filter | | 7 | Oil filter support | | 8 | Cartridge holder cover | | 9 | Oil filter cartridge | | 10 | Oil Cooler | | 11 | Crankcase | | 12 | Oil directly from the cartridge | | 13 | Coolant | | 14 | Oil drain duct closure gasket | | 15 | Oil filtering chamber closure gasket | | 16 | Cartridge holder cover gasket |   **Tab 2.25** ***Cartridge characteristics.***   |  |  | | --- | --- | | **DESCRIPTION** | **VALORE** | | Filtering surface | 2.300 cm 2 | | Degree of filtration | 2 µm | | Max operating pressure | 4.0 Bar | | Max flow rate | 190 litres/hour | | 2.19.jpg   **Fig 2.20** |

## Cooling circuit

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.11.1 Cooling circuit diagram**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Tab 2.26**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Coolant pump | | 2 | Coolant intake | | 3 | Coolant, cylinder | | 4 | Coolant, cylinder head | | 5 | EGR gas coolant | | 6 | Coolant to radiator | | 7 | Coolant into radiator | | 8 | EGR valve coolant | | 9 | Coolant in the Oil Cooler | | 10 | Coolant input into the Oil Cooler | | 11 | Coolant output from the Oil Cooler | | 12 | Vent line from radiator (to 15) | | 13 | Vent line to expansion vase (to 15) | | 14 | Return from compensation tank | | 15 | Compensation tank | | 16 | Thermostatic valve | | imm2_21.jpg **Fig 2.21** |   2.21.jpg **Fig 2.22**     |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **2.11.2 Water pump  Tab 2.27**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Coolant pump control pulley | | 2 | Coolant intake fitting | | 3 | Coolant return hose from the Oil Cooler | | imm2_23.jpg **Fig 2.23** | | **2.11.3 Radiator with Intercooler (optional)  Tab 2.28**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Radiator with intercooler | | 2 | Coolant refill cap | | 3 | Radiator coolant vent tube or return | | 4 | Air hose (from Intercooler to manifold) | | 5 | Intercooler air delivery hose | | 6 | Coolant flow manifold | | 7 | Coolant intake manifold | | 8 | EGR Cooler coolant vent tube or return | | 2.23.png **Fig 2.24** | | **2.11.4 Thermostatic valve  Tab 2.29**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Cylinder head | | 2 | Coolant outlet cover | | 3 | Thermostatic valve | | 4 | Gaskets | | 5 | Air bleeding hole |   Starting opening temperature of +79° ± 2°C. | imm2_25.jpg **Fig 2.25** | | **2.11.5 EGR gas circuit cooling (EGR Cooler)**    Device that cools exhaust gas    **Tab 2.30**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | EGR valve | | 2 | EGR gas passage tubes | | 3 | Coolant outlet hose | | 4 | EGR Cooler | | 5 | Coolant draining union | | 6 | Coolant delivery hose | | 7 | Intake manifold | | imm2_26.jpg **Fig 2.26** | |

## Intake and exhaust circuit

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.12.1 Turbocharger** The turbocharger is controlled by means of exhaust gas that activates the turbine.    Z_importante.jpg **Important**       * See [**Par 2.18**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=113&parent=1000) .   **Tab 2.31**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Air intake hose | | 2 | Air compression volute | | 3 | Turbo charger central body | | 4 | Turbine housing with Waste Gate valve | | 5 | Gas exhaust flange | | 6 | Waste Gate control valve hose | | 7 | Waste Gate valve control actuator | | 8 | Waste Gate control valve linkage | | 9 | Engine crankcase breather | | 10 | Air compressed flow hose to intercooler | | 11 | Oil drain pipe | | 12 | Turbo charger lubrication pipe | | 2.26.png **Fig 2.27** |
| **2.12.2** **ATS device**  **2.12.2.1 DOC**  The DOC is a device to filter exhaust gas by means of its oxidation.    Internally, it is composed of hundreds of small ducts that enable the passage of exhaust gas.    It contains precious metals (platinum, palladium, iridium).      **NOTE:** The image is indicative only. The installation of the catalyst must be approved by KOHLER, for each application. In order to prevent breakage on the connection flange, the catalyst is normally connected via a hose.    Z_importante.jpg **Important**       * In order to prevent breakage on the connection flange, the catalyst must be connected via a flexible exhaust tube.   **Tab 2.32a**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 4 | Turbocharger | | 5 | Gas exhaust flange | | 13 | DOC | | 14 | Flexible exhaust tube | | 2.27.png **Fig 2.28** |
| **2.12.2.2 Intake and exhaust circuit diagram with DOC**   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  | Air in intake |  | Gas in recycle |  | Gas in exhaust |   imm2_29.jpg **Fig 2.29**imm2_30.jpg **Fig 2.30** | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Z_importante.jpg **Important**         * The diagrams in **Fig. 2.29 and Fig. 2.30** do not have an air filter, which must always be present and connected by means of an intake hose to the turbocharger. * The air temperature inside the intake manifold must never exceed that of the environment by 10°C.   Filtered air is sucked by the turbocharger, which compresses and sends it to the intercooler (as a consequence of compression, the air increases the temperature - the Intercooler cools it - this process enables better performance during combustion inside the cylinders). From the Intercooler, it is sent to the    intake manifold and, via ducts in the cylinder head, enters the cylinders. Compressed air inside the cylinders and mixed with the fuel transforms into Gas after combustion. The gas is expelled from the cylinders and sent to the exhaust manifold. The exhaust manifold sends the Gases to 2 ducts:     * **1st duct** : to the turbocharger body (the expelled Gases activate the turbine), the Gases then proceed towards the catalyst, which break down the pollutants contained in them before being definitely expelled. * **2nd duct** : to the EGR circuit, which takes care of recovering a part of the Gases that return to intake (this process burns less oxygen when power is not requested, thus breaking down pollutants further).   The EGR circuit is managed by ECU, which controls the EGR valve that provides for the recovery of Gases when the engine does not require power. The EGR circuit is furnished with a heat exchanger (EGR Cooler), which cools the recovered Gases (this process enables better performance during combustion inside the cylinders). | **Tab 2.32b**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Air in intake from air filter | | 2 | Air in compression | | 3 | Air in intercooler flow | | 4 | Air cooling | | 5 | Air in intake manifold flow | | 6 | Air in head intake | | 7 | Air in cylinder intake | | 8 | Gas in cylinder outlet | | 9 | Gas in head outlet | | 10 | Gas in outlet towards DOC | | 11 | Gas in oxidation | | 12 | Gas in recycle towards EGR valve | | 13 | Gas in EGR valve outlet | | 14 | Gas cooling (in EGR Cooler) | | 15 | Exhaust gas recirculation into intake manifold | | A | Intake manifold | | B | Exhaust manifold | | C | Upper crankcase | | D | Lower crankcase | | E | Oil sump | | F | Catalyst | | G | Radiator/intercooler | |
| **2.12.2.3 DOC+DPF**  The DOC+DPF system reduces emissions because the DPF eliminates the particulate generated by Diesel fuel combustion. The system triggers automatic DPF regeneration cycles depending on the degree of clogging.  The smell of the gases out of the exhaust line is different than the traditional one of gases from Diesel engines. Moreover, during regeneration stages, the exhaust gases could temporarily be white.    **NOTE:**  During regeneration, engine idling will increase.    2_12_2_3.png  **Fig 2.30a** | |
| **Tab 2.32c**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | turbocharger | | 2 | exhaust pipe from turbine | | 3 | DOC | | 4 | DPF | | 5 | ETB | | 6 | EGTS (Black) | | 7 | EGTS (Yellow) | | 8 | Delta-P (Delta Pressure) | | |
| **2.12.2.4** **DPF regeneration strategy**  You can intervene on the machine control panel for the DPF regeneration operations "only if requested by means of specific warning lights or messages on the control panel".  **Tab. 2.32d**  describes the level of particulate accumulation, the relationship with the warning lights that will light up on the panel, the performance limitations of the engine and the operator’s options intervention.  Forced regeneration must be executed in accordance with the machine instructions.  **Tab 2.32d**   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **SOOT LEVEL** | **WARNING LAMPS \*1** | **ENGINE DE-RATE** | **OPERATOR POSSIBLE ACTIONS** | **OPERATING CONDITIONS** | | **Level 0** |  |  |  | * No condition | | **Level** **1** | | **Level** **2** | | **Level** **3** | DPF_high_soot.png  Fixed | Forced Regeneration is Necessary | * Coolant temperature at 60 °C * Do not switch the engine off * Stationary vehicle * No load applied to the engine \*2 | | **Level** **4** | DPF_high_soot.png  Flashing | Engine de-rate | Forced Regeneration is Necessary | * Coolant temperature at 60 °C * Do not switch the engine off * Stationary vehicle * No load applied to the engine \*2 | | **Level** **5** | DPF_STOP.png  Flashing | Strong Engine de-rate | Contact an authorized KOHLER workshop.  Service Regeneration Required | REGENERATION via **KOHLER** software |   **\*1:**  The warning lights be different – consult the machine manual.  **\*2:**  Unless stated otherwise in the machine manual.  Z_Avvertenza.jpg      **Warning**     * Forced regenerations must only be executed if required by the ECU when the "HIGH SOOT" warning light goes on (due to a Level 3 - 5 particulate accumulation). * Do NOT execute the forced regenerations if not required by the ECU (due to a Level 0 - 2 particulate accumulation). * The minimum engine speed increases during the forced regeneration phases. * Repeated forced regenerations cause significant engine oil contamination by the fuel. * The oil level check must be executed after every forced regeneration. * If the regeneration inhibition function is misused, the particulate accumulation level will increase within a short time. * The engine oil filter and oil must be changed after a Service Regeneration is completed via KOHLER software * (Level 5 Particulate accumulation). * Fuel contamination allowed in the engine oil is 3% MAX. * Any engine load must be eliminated during forced regeneration so as to prevent damaging the ATS \*2 system. * Do not switch the engine off during level 3, 4 and 5 regeneration so as to prevent damaging the ATS system. | |
| **2.12.2.5** **Intake and exhaust circuit diagram with** **DOC+DPF**  2_12_2_5.png  **Tab 2.32e**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION  (pos. For DPF components only)** | | 1 | Air in intake from air filter | | 2 | Air in compression | | 10 | Gas in outlet towards DOC | | 11 | Gas in oxidation | | 12 | Gas in recycle towards EGR valve | | 16 | DPF | | F | DOC | | G | Radiator/intercooler | | H | ATS | | |
| **2.12.3 Air filter**  **NOTE:** Component not necessarily supplied by **KOHLER** .    Z_importante.jpg **Important**       * The air filter is a dry type of filter with a paper filtering element; element **s H and L** are replaceable (refer to **Tab. 2.8 and Tab.2.9** for procedure frequency on components). * Filter suction must be positioned in a cool place. * Should a hose be used, the length must not exceed **400** **mm** and is to be as straight as possible.   2.30.png **Fig 2.31** | **Tab 2.33**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | H | Air filter cartridge | | L | Air filter safety cartridge | | M | Filter cover | | N | Filter support | | Q | Dust exhaust valve | | R | Filter cover hook | |

## Electric system

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.13.1 ECU input and output signals diagram**   |  |  |  | | --- | --- | --- | | **SENSOR/SWITCH (INPUT)** |  | **DEVICES (OUTPUT)** | | Power relay | **ECU** | Electronic injector 1 | | Engine Revolution Sensor | Electronic injector 2 | | Engine phase sensor | Electronic injector 3 | | Coolant temperature sensor | Electronic injector 4 | | Common Rail pressure sensor | EGR valve control | | Oil pressure switch | Fuel intake adjustment valve | | EGR valve position | Revolution indicator | | Fuel temperature sensor | Heater relay | | T-MAP sensor | Diagnosis indicator lights | | ACACT Sensor | Throttle body adjustment | | Main accelerator pedal (double track) | Electric fan control (1-2 speeds or variable speed) | | Secondary accelerator pedal (optional) | CAN 1 (ISO15765 diagnostics) | | Hydraulic oil pressure sensor (optional) | CAN 2 (Vehicle SAE J1939) | | Fuel level sensor (optional) |  | | Air filter clogging sensor (optional) | | Sensor to detect water in the fuel | | Throttle body position | | EGTS (black) Sensor | | EGTS (yellow) Sensor | | Delta-P Sensor | | |
| **2.13.2** **Control unit (ECU)**  The ECU is a central processor, which monitors and controls engine operation.    The electronic control unit is responsible for engine management.    It is fitted on the frame of the vehicle, or in the cab (refer to the technical documentation of the vehicle).    Z_importante.jpg **Important**       * The ECU must only be used with the configuration defined by **KOHLER** , for each individual engine. * To look up ECU errors, refer to the Help File manual | **2.13.2.1 T** **echnical features**   * Operating temperature: -40°C - +100°C. * Storage temperature: -40°C - +100°C. |
| **Fig 2.32 -** **Fig  2.33**imm2_32_e_33.jpg  **Tab. 2.35**   |  |  | | --- | --- | | **ECU AND ENGINE IDENTIFICATION PLATES** | | | **POS.** | **DESCRIPTION** | | 1 | Engine model | | 2 | Validation code | | 3 | Engine specifications | | 4 | Bar Code of the engine chassis number | | 5 | Engine chassis number | | 6 | ECU identification code | | A | Connector A (ECU A) | | B | Connector B (ECU B) | | C | Barometric capsule | | D | Fastening points |      * Do **NOT** mount or replace the control unit with that of another engine. * Although externally each ECU seems to be identical, internally they are specifically configured only for use on the engine that they are supplied with. * To install a new control unit, is required to recharge on it's the original configuration relating to that specific engine . * **The control units are not interchangeable nor modifiable.** * **Each control unit is accompanied by its adhesive identification plate.** | |
| **2.13.3 Engine electrical wiring**  Tab_2_36___2186_493_cablaggio.png  Tab_2_36___2186_489_briglia_DPF.png  **Fig 2.34** | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tab. 2.36**   |  |  | | --- | --- | | **RIF.** | **DESCRIZIONE** | | 1 | Vehicle interface connector  **(Fig. 2.34a)** | | 2 | ECU Connector A  **(Fig. 2.34b)** | | 3 | ECU Connector B  **(Fig. 2.34b)** | | 4 | Fuel pressure regulating valve connector | | 5 | Fuel temperature sensor connector | | 6 | T-MAP sensor connector | | 7 | Common Rail pressure sensor connector | | 8 | Injectors connectors | | 9 | EGR valve connector | | 10 | Engine speed sensor connector | | 11 | Engine phase sensor connector | | 12 | Oil pressure switch connector | | 13 | Coolant temperature sensor connector | | 14 | D+ Connector Alternator | | 15 | Starter motor connector (50) | | 16 | Starter motor connector 3,2kW (50) | | 17 | Wiring support | | 18 | ETB connector (Stage V versions only) | | 19 | ACACT  connector (Stage V versions only) | | 20 | Ground | | 21 | CAN resistor | | 22 | ATS wiring connector (Stage V versions only) | | 23 | ATS interface wiring (Stage V versions only) | | 24 | Engine wiring connector | | 25 | DPF temperature connector (yellow) | | 26 | DPF temperature connector (black) | | 27 | Delta-P sensor connector | | imm2_34a.jpg **Fig 2.34a**imm2_34b.jpg **Fig 2.34b** |
| **NOTE:** Click by side to play the procedure. | <https://www.youtube.com/embed/6-0TbYG2EkY?rel=0> |
| **2.13.3.1 Wiring disconnection**  All sensor connectors and electronic control devices are sealed.  The connectors must be disconnected by means of pressure on tabs **A** or unblock the retainers **B** , as illustrated from **Fig. 2.34c to Fig. 2.34r.** | Fig._2.34c.jpg **Fig 2.34c** |
| imm2_34d.jpg **Fig 2.34d** | imm2_34e.jpg **Fig 2.34e** |
| imm2_34f.jpg **Fig 2.34f** | imm2_34g.jpg **Fig 2.34g** |
| imm2_34h.jpg **Fig 2.34h** | imm2_34i.jpg **Fig 2.34i** |
| imm2_34l.jpg **Fig 2.34l** | inn2_34m.jpg **Fig 2.34m** |
| imm2_34n.jpg **Fig 2.34n** | imm2_34o.jpg **Fig 2.34o** |
| imm2_34p.jpg **Fig 2.34p** | imm2_34q.jpg **Fig 2.34q** |
| imm2_34r.jpg **Fig 2.34r** |  |

## Sensors and switches

|  |  |
| --- | --- |
| **2.14.1 Revolution sensor on target wheel**    Speed sensor **A** is situated on the timing system carter.  The sensor detects the signal from the target wheel **B** (60 - 2teeth) situated on the crankshaft pulley. It sends it to the ECU as an analogical signal.  The sensor sends and analogue signal to the ECU.  The sensor produces a 5V square wave signal having a Hall effect while the crankshaft in rotation detects its position and speed.  The data sent by this sensor enables the ECU to pilot fuel anticipation injection for each piston.  For gap adjusting see [**Par. 9.15.1.5**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=171&parent=1000) . | imm2_35.jpg **Fig 2.35** |
| **2.14.2 Camshaft sensor**    Camshaft sensor **C** is situated on the timing system carter.    The purpose of the camshaft sensor **C** is to identify the position of the camshaft control gear **E** with respect to the engine shaft and consequently the position of the pistons with respect to the T.D.C.. The sensor produces a 5V square wave signal having a Hall effect while the camshaft in rotation detects the phases of the 4 strokes of the 1st cylinder. As a consequence, ECU by means of internal calculations, also recognises the phases of the other cylinders.    The data sent by this sensor enables the ECU to pilot fuel anticipation injection for each piston.  For gap adjusting see [**Par. 9.15.1.4**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=171&parent=1000) . | imm2_36.jpg **Fig 2.36** |
| **2.14.3 T-MAP sensor**  The T-MAP **F** sensor is situated on the intake manifold. It detects the input pressure in the intake manifold by means of electrical voltage variation and the air temperature by means of an electrical resistor.    The sensor sends signals to the ECU, which determines the values and modifies the injection strokes.    **Tab. 2.36** reports the electrical resistor values according to the intake air temperature.  **NOTE** : **R** indicates the pin where it is possible to measure electrical resistance.  **Tab 2.37**   |  |  | | --- | --- | | **°C (°F)** | **R ( Ω )** | | -30 (-22) | 23475 - 25945 | | 0 (32) | 5370 - 5935 | | 25 (77) | 1900 - 2100 | | 50 (122) | 772 - 854 | | 100 (212) | 177 - 195 | | 120 (248) | 107 - 119 | | 2.37.png **Fig 2.37** |
| **2.14.4 ACACT** **sensor (versions with DPF filter only)**  The ACACT sensor **J** is located on the intake manifold, before the T-Map sensor, and it measures the temperature of the air coming from the turbocharger.  **Tab. 2.37b** shows the electric resistance values based on the intake air temperature.  **Tab 2.37b**   |  |  | | --- | --- | | **°C (°F)** | **R (k Ω )** | | -40 (-40) | 130.3 | | 0 (32) | 33.87 | | 25 (77) | 17.17 | | 50 (122) | 9.603 | | 100 (212) | 3.739 | | 150 (302) | 1.796 | | 200 (392) | 1.000 | | 2_14_4.png  **Fig 2.37a** |
| **2.14.5** **EGTS sensor (yellow - black)**  The EGTS sensors **K1** and **K2** are placed on the ATS system, **K1** with black wire before the DOC, **K2** with yellow wire after the DOC.  They are both needed for the DPF filter regeneration strategies.  **Tab. 2.37b** shows the electric resistance values based on the intake air temperature.  **Tab 2.37c**   |  |  | | --- | --- | | **°C (°F)** | **R (k Ω )** | | -40 (-40) | 133,8 | | 0 (32) | 34,49 | | 50 (122) | 9,749 | | 100 (212) | 3,771 | | 150 (302) | 1,803 | | 200 (392) | 1,002 | | 250 (482) | 0,6173 | | 300 (572) | 0,4127 | | 350 (662) | 0,2934 | | 400 (752) | 0,2186 | | 450 (842) | 0,1690 | | 500 (932) | 0,1345 | | 550 (1022) | 0,1097 | | 600 (1112) | 0,0912 | | 650 (1202) | 0,0771 | | 700 (1292) | 0,0661 | | 750 (1382) | 0,0574 | | 800 (1472) | 0,0503 | | 850 (1562) | 0,0445 | | 2_14_5.png  **Fig 2.37b** |
| **2.14.6** **Delta-P sensor**  The Delta-P sensor **J** detects the clogging level of the DPF filter.  Operating temperature: -30°C - +120°C.    Z_importante.jpg    **Important**   * Connect the **J1** and **J2** pipes to the Delta-P sensor exclusively as shown in **Fig. 2.37d** . | 2_14_6.png  **Fig 2.37c**  2_14_6a.png  **Fig 2.37d** |
| **2.14.7 Common Rail pressure sensor**    Fuel pressure sensor **G** assembled on the Common Rail, detects the fuel pressure inside it by means of electrical voltage variation. Depending on the signal sent, ECU manages the fuel intake valve on the injection pump and, if necessary, modifies the injection strokes.    Z_importante.jpg **Important**       * Refer to [**Par. 2.9.5**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=103&parent=1000) | imm2_38.jpg **Fig 2.38** |
| **2.14.8 Fuel filter water detection sensor**    The water presence sensor **H** is situated in the fuel filter, which is there to indicate the presence of water in the fuel.    Water, if present in the fuel, because of its greater specific weight separates and settles in the lower part of the filter where there is a specific sensor that, by means of the ECU activates an alarm signal on the dashboard.  The butterfly valve nut **M** situated in the lower part of the body sensor enables the elimination of any water present in the fuel and prevent malfunctions on components of the injection circuit. | imm2_39.jpg **Fig 2.39** |
| **2.14.9 Fuel temperature sensor on the fuel injection pump**    The fuel temperature sensor **L** is situated on the high-pressure fuel injection pump. The fuel temperature sensor **L** , measures the temperature of the fuel entering the pump at high pressure. The signal sent to the ECU is analogue.    The resistance detected by the ECU is proportional to the fuel temperature.    Z_importante.jpg **Important**       * Refer to [**Par. 2.9.3**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=103&parent=1000) | imm2_40.jpg **Fig 2.40** |
| **2.14.10 Oil pressure switch**  Oil pressure switch **N** is assembled on the crankcase.  It is a N/C sensor, calibrated at 0.8 bar ± 0.1 bar.  With oil low pressure the sensor closes the electrical circuit and the warning lamp in the panel board switches on. | imm2_41.jpg **Fig 2.41** |
| **2.14.11 Coolant temperature sensor**  The **P** coolant temperature sensor of the coolant circuit is applied to the cylinder head on the side of the thermostatic valve.  It is used by the ECU to obtain information regarding the coolant temperature (via PIN **R** ) and control the warning light high-temperature signal and control the electric fan of the coolant radiator. Indicator light operation temperature +106°C / +108°C.  **NOTE** : **R** indicates the pin where it is possible to measure electrical resistance.    **Tab 2.38**   |  |  |  | | --- | --- | --- | | **CHARACTERISTICS** | | | | Temperature °C | R min Ω | R max Ω | | -40 | 38.313 | 52.926 | | 0 | 5.227 | 6.623 | | +140 | 0.067 | 0.076 | | 2.42.jpg **Fig 2.42** |
| **2.14.12 Air cleaner clogging switch**    **NOTE:** Component not necessarily supplied by **KOHLER.**  The switch is assembled on the air cleaner. When the filter is clogged, it sends a signal to the panel.    **Features** :   * Operating temperature: - **30 °C / +100°C** * Contact usually open. * Contact closed by vacuum: **-50 mbar.** | 2.43.png  **Fig. 2.42 a** |
| **2.14.13 ACAT** **Sensor (KDI 1903 TC model only)**  The ACAT **Q** sensor is placed on the air intake line and measures the temperature of the air coming from the turbocharger. **Tab. 2.38a** shows the electric resistance values based on the intake air temperature.  **Tab 2.38a**   |  |  | | --- | --- | | **°C (°F)** | **R (k Ω )** | | -40 (-40) | 130.3 | | 0 (32) | 33.87 | | 25 (77) | 17.17 | | 50 (122) | 9.603 | | 100 (212) | 3.739 | | 150 (302) | 1.796 | | 200 (392) | 1.000 | | 1903_TC_ACAT.png  **Fig. 2.42b** |
| **2.14.14 EGR-T** **Sensor (KDI 1903 TC model only)**  The EGR-T **R** sensor is placed on the air intake manifold after the EGR gas inlet and measures the temperature of the air mixed with EGR gas coming from the turbocharger. **Tab. 2.38b** shows the electric resistance values based on the intake air temperature.  **Tab 2.38b**   |  |  | | --- | --- | | **°C (°F)** | **R (k Ω )** | | -40 (-40) | 130.3 | | 0 (32) | 33.87 | | 25 (77) | 17.17 | | 50 (122) | 9.603 | | 100 (212) | 3.739 | | 150 (302) | 1.796 | | 200 (392) | 1.000 | | 1903_TC_EGR-T.png  **Fig. 2.42c** |

## Electrical components

|  |  |
| --- | --- |
| **2.15.1 Alternator (A)**    Externally controlled by the crankshaft by means of a belt.   * Ampere 80 A * Volt 12V | imm2_43.jpg **Fig 2.43** |
| **2.15.2 Alternator for Poly-V belt (optional) (B)**    Externally controlled by the crankshaft by means of a belt.   * Ampere 80 A * Volt 12V | imm2_44.jpg **Fig 2.44** |
| **2.15.3 Starter Motor (C)**     * Type Bosch 12 V * Power 2 kW * Anticlockwise rotation (seen from timing system side)      * Type Mahle 12 V * Power 3.2 kW * Anticlockwise rotation (seen from timing system side) | imm2_45.jpg **Fig 2.45a**  2_15_3b.png  **Fig 2.45b** |
| **2.15.4 EGR Valve (D)**    A device that provides for exhaust gas recovery that is controlled by ECU, which, according to acceleration parameters, RPM and power requested, varies the opening and closing of the valve.    The device has an integrated ECU, which, on each start-up of the control panel, executes an operation self-check.    In the event of a malfunction, it sends a signal to ECU, which, in turn, signals the anomaly on the control panel.    Characteristics:   * Type Dell'Orto EGV A16 * Operating/storage temperature: -30°C / +130°C. | imm2_46.jpg **Fig 2.46** |
| **2.15.5 Cold starting device (Heater)**  The cold starting device consists of a resistance, managed by the ECU, which is activated when the ambient temperature is ≤ -16° C.    The intake air is heated through the resistance and facilitates starting.      Characteristics:   * Type Hidria AET 12 V * Power 550 W | imm2_47.jpg **Fig 2.47** |
| **2.15.6 Fuel intake regulating valve (SCV)**    Valve E is situated on the high-pressure fuel injection pump.  It is managed by ECU, which regulates fuel intake by means of fuel pressure values inside the Common Rail, choking the input entrance of fuel in the injection pump. The digital signal varies the opening of the valve in proportion to the quantity of fuel required for the Common Rail.    Z_importante.jpg **Important**       * Refer to [**Par 2.9.3**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=103&parent=1000) | imm2_48.jpg **Fig 2.47 a** |
| **2.15.7 Electric fuel pump (optional)**  **NOTE:** Component not necessarily supplied by **KOHLER.**    The electric pump is located before the fuel filter. One of the following pumps can be assembled **A1 - A2 - A3 - A4.**    **Tab. 2.39** **(a-d)** indicates pump features.    **Tab. 2.39**   |  |  | | --- | --- | | **POS.** | **Description** | | **B** | Electrical connection | | **C** | Prefilter pump | | **IN** | Ingoing fitting (IN) from tank | | **OUT** | Outgoing fitting (out) to fuel filter |   **Tab. 2.39a**   |  |  | | --- | --- | | **A1** | **Value** | | Voltage | 12 V - 24 V | | Delivery | 100 L/h @ 0.44 - 0.56 bar |   **Tab. 2.39b**   |  |  | | --- | --- | | **A2** | **Value** | | Voltage | 12 V | | Delivery | 60.56 L/h @ 0.41 bar |   **Tab. 2.39c**   |  |  | | --- | --- | | **A3** | **Value** | | Voltage | 12 V | | Delivery | 24 L/h @ 0.1 bar |   **Tab. 2.39d**   |  |  | | --- | --- | | **A4** | **Value** | | Voltage | 12 V | | Delivery | 30 L/h @ 0.4 bar | | 2.50a.png  **Fig 2.48**  2.50b.png  **Fig 2.48a**  2.50c.png  **Fig 2.48b**  2.50d.png  **Fig 2.48c**  2.50e.png  **Fig 2.48d** |
| **2.15.8** **ETB (versions with DOC+DPF device - Stage V only)**  The ETB valve  **F**  is controlled by the ECU during the DPF filter regeneration strategies. | 2_15_8.png  **Fig 2.48e** |

## Timing system and tappets

|  |  |
| --- | --- |
| The timing system is equipped with hydraulic tappets that automatically recover the operation of the rocker rods assembly. No registration is therefore required.  **2.16.1 Components identification**imm2_49.jpg **Fig 2.49** | |
| **Tab 2.40**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Crankshaft | | 2 | Camshaft | | 3 | Camshaft tappets | | 4 | Rocker arm control rod | | 5 | Rocker arms | | 6 | Valves | | 7 | High-pressure fuel injection gear pump control | | 8 | Camshaft control gear | | 9 | Intermediate gear | | 10 | Intermediate gear pin | | 11 | Crankshaft gear | | 12 | Target wheel positioning reference pin on camshaft | | 13 | Camshaft target wheel | | 14 | Valve control bridge | | 15 | Articulation control valves | | 16 | Hydraulic tappets | | imm2_50.jpg **Fig 2.50**imm2_51.jpg **Fig 2.51** |
| **2.16.2 Timing system phasing angles**    Z_importante.jpg **Important**       * For information purposes, **Tab. 2.41**  reports the timing system diagram phasing angle values. * It should be noted that the said values may be verified by rotating the crankshaft **(Pos. 1 of Fig. 2.49)** , by means of handling the rocker arm control rod **(Pos. 4 of Fig. 2.49)** .   **NOTE:** Detecting the value by means of handling the rocker arm/valves may not be correct due to the hydraulic tappets, which may compress and create clearances that alters the actual value. **Tab 2.41**   |  |  |  | | --- | --- | --- | | **ENGINE** | **INTAKE** | **EXHAUST** | | 1903 TCR | opens 20° before TDC | opens 32° before BDC | | closes 32° after BDC | closes 16° after TDC | | 2504 TCR | opens 10° before TDC | opens 20° before BDC | | closes 14° after BDC | closes 4° after TDC | | 2.50EN.png **Fig 2.52** |
| **2.16.3 Rocker arm pin  Tab 2.42**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Rocker arm pin | | 2 | Rocker arm distancing spring | | 3 | Rocker arm pin support | | 4 | Exhaust rocker arm | | 5 | Intake rocker arm | | imm2_53.jpg **Fig 2.53** |
| **2.16.4 Rocker arms**  **Tab 2.43**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | **1** | Rocker arm body | | **2** | Hydraulic tappet oil refill line | | **3** | Valve tappet lubrication line | | **4** | Valve tappet | | **5** | Hydraulic tappet | | **6** | Oil flow line | | imm2_54.jpg **Fig 2.54** |
| **2.16.5 Hydraulic tappets  Tab 2.44**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | A | Hydraulic tappets | | B | Hight pressure chamber | | 1 | Hydraulic tappets oil refill pipe | | 2 | Retaining ring | | 3 | Piston | | 4 | Unidirectional valve | | 5 | Tappet body | | 6 | Spring |   **2.16.5.1 Hydraulic tappet operation**  The operating principle of the hydraulic tappet is based on the incompressibility of the liquids and on controlled leakage.  The oil under pressure enters the tappet chamber **A** , providing a constant supply of oil in the low-pressure chamber. Through the non-return valve, **4** the oil can only access the high-pressure chamber **B** and exit via the clearance between the piston **3** and the tappet body **5** (controlled leakage). The chamber **B** is filled when the rocker arm is on the base radius of the cam and the spring **6** keeps the piston **3** against the valve stem, thus eliminating any system play. Thanks to the spring extension, the tappet "extends", creating a small depression in the chamber **B** , making the non-return valve **4** open, and allowing the oil in the chamber **A** to pass to chamber **B** , restoring the proper amount of oil required to eliminate any play in the valves. | imm2_55.jpg **Fig 2.55** |

|  |
| --- |
| **2.16.5.2 Difficult operating conditions**  For proper operation on the hydraulic tappets it is essential that the low pressure chamber of the piston 3 is always full of oil.    In some conditions this may not occur (due to the fact that the oil leaks away when the engine is switched off, which can also partially drain the tappets). This situation will be the cause of clearances that will result in a characteristic noise similar toa ticking sound.   1. When the engine is cold, the tappet filling time could be very long if the oil used is not suitable for the specific environmental conditions ( [**Tab. 2.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=55&parent=1000) ) 2. If the engine is very hot: at idle speed, oil pressure may be low, and small air bubbles could form in the circuit. Because of this, this compressing the tappet slightly and producing valve play which is responsible for the ticking sound. On account of this, the tappet compresses slightly giving rise to a valve clearance, thus generating a slight ticking sound, which however disappears rapidly ( **MAX** 10 seconds) once normal operating conditions have been restored.     Anyway the duration of ticking Anyway the duration of ticking sound must be **MAX** 30 seconds. If not, the problem is surely due to the poor quality of the oil, wear or impurities that, transported by the oil, can infiltrate between the ball valve and its seat inside the piston, compromising the operation of the tappet itself; In these cases, the only solution is to replace the oil or hydraulic tappets.    The prolonged persistence of the ticking sound or abnormal noise must be investigating in order to prevent any malfunctions; if necessary, replace the hydraulic tappets and engine oil. |

## Components handling

|  |  |
| --- | --- |
| **2.17.1 High-pressure fuel injection pump**  - Only handle by means of the points marked by **Y** . - It is forbidden to handle using the points marked by **N** . | imm2_57.jpg **Fig 2.56** |
| **2.17.2 Electronic injector**  - Only handle by means of the points marked by **Y** . -It is forbidden to handle using the points marked by **N** . | imm2_58.jpg **Fig 2.57** |
| **2.17.3 Common Rail**  - Only handle by means of the points marked by **Y** . - It is forbidden to handle using the points marked by **N** . | imm2_59.jpg **Fig 2.58** |
| **2.17.4 Turbocharger**    - Only handle by means of the points marked by **Y** . - It is forbidden to handle using the points marked by **N** .    Z_importante.jpg **Important**       * Refer to [**Par. 2.18**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=113&parent=1000) . | imm2_60.jpg **Fig 2.59** |
| **2.17.5** **ACACT** **(versions with DOC+DPF device - Stage V only)**  - Only handle by means of the points marked by  **Y** . - It is forbidden to handle using the points marked by  **N** .  **NOTE:** The sensor includes ceramic material.  - Do not install sensors which suffered impacts or falls.  - Do not install sensors in case of external contamination  - Do not install visibly damaged sensors  - Use exclusively the socket wrench to install the sensor | 2_17_5.png  **Fig 2.59a** |
| **2.17.6** **EGTS (** **versions with DOC+DPF device - Stage V only** **)**  - Only handle by means of the points marked by  **Y** . - It is forbidden to handle using the points marked by  **N** .  **NOTE:** The sensor includes ceramic material.  - Do not install sensors which suffered impacts or falls.  - Do not install visibly damaged sensors  - Do not install sensors in case of external contamination  - Do not apply any force on the cable or the metal elbow | 2_17_6a.png  **Fig 2.59b**  2_17_6b.png  **Fig 2.59c** |

## Turbocharger

|  |  |
| --- | --- |
| **2.18.1 What to do and what not to do**  **What to do:**   * Before assembling the turbocharger, make sure that the protection caps are fitted on all openings of the turbo. * Ensure pre-lubrication of the turbocharger. * Periodically check that the joints are sealed against oil and air. * Use lubricating oil according to the specifications described in [**Par. 2.4**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=55&parent=1000) . * Check the engine oil level. * Before switching it off after it has been used, make the engine run idle, or without a load, for approximately 1 minute. * Ensure that controls and maintenance intervals of the engine are observed as specified in [**Tab. 2.8 and 2.9** .](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=102&parent=1000) * Make sure that the engine and equipment are used correctly so as not to compromise the life of the turbocharger. | **What not to do:**   * Do not store turbocharges in damp, wet places if they are not in their original packaging. * Do not expose the turbocharger to dust and dirt if it is not in its original packaging. * Do not lift of hold the turbocharger from the actuator rod if it is not in its original packaging. * Do not apply additives to the lubricating oil and fuel, unless instructed to do so by Kohler. * Do not increase engine speed, or apply loads, immediately after start-up. * Do not intervene on the actuator settings  **A (Fig. 2.61)** . * Do not let the vehicle / engine run at idle speed for more than 20-30 minutes at a time. |
| **2.18.2 Practical operating rules**  Users can help to maximise the duration of their turbocharger by following the rules described below.   1. **Start-up** Start the engine at idle speed, or without a load, for approximately one minute. Oil operating pressure is reached within a few seconds and enables the moving parts to warm up and be lubricated.     Immediately increasing the engine speed upon start-up means making the turbocharger run at high speed with suboptimal lubrication, which may compromise the life of the turbocharger.   1. **After maintenance or a new installation** Proceed with pre-lubrication by filling new oil into the oil supply duct **B** until filling it completely. Start the engine at idle speed, or without a load, for a few minutes in order to ensure that the oil and bearings system operate satisfactorily. 2. **Low temperature air or engine inactivity** If the engine has been inactive for some time, or the air temperature is very low, start the engine at idle speed or without a load for a few minutes. 3. **Engine shutdown** Before switching the engine off after intense activity, one must allow the turbocharger to cool down. One must therefore let the engine run at idle speed or without a load for at least 2 minutes, thus allowing the turbocharger to cool. 4. **Engine at idle speed** Avoid using the engine at idle speed or without a load for long periods (more than 20-30 minutes). When operating at idle speed or without a load, the turbocharger is at low pressure in the exhaust chamber **C** and air supply **D** ; this may cause oil leaks from seals **E** to the extremity of the shaft. Even if this does not cause damage, it can cause blue smoke from the exhaust when the engine speed and load are increased. | imm2_61.jpg **Fig 2.60**imm2_62.jpg **Fig 2.61** |
| **2.18.3 Before installing a new turbocharger**    Z_importante.jpg **Important**       * Do not lift the turbocharger with one hand from the  box. * Do not lift turbocharger from Comp hsg side. * Lift the turbocharger with both hands from box. * Make sure to use clean gloves. * Handle the turbocharger as indicated in [**Par. 2.17.4.**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=112&parent=1000) | imm2_63.jpg **Fig 2.62** |
| 1. Avoid lifting from the intake side **G** . 2. Remove cap guard **F** and check that there is no excessive shaft axial and radial clearances. | imm2_64.jpg **Fig 2.63** |
| 1. Check for any signs of friction of the turbine on the turbocharger body. 2. Check for any traces of oil leaks on the turbocharger body. 3. After having check everything, reapply cap **F** on intake opening **H** of the turbocharger and do not remove it until assembly has been completed. | 2.65.jpg **Fig 2.64** |
| 1. Check the correct assembly of the capscrews and the presence of paint on them. | imm2_67.jpg **Fig 2.65** |
| **2.18.4 Installation instructions**   1. **Remove the cap guards with care only when assembling.** Handle carefully avoiding erratic movements. | imm2_65.jpg **Fig 2.66** |
| **2.18.5 Replacement instructions**    Always understand the cause of the breakage of the turbocharger before replacing it.    Correct the cause of the breakage before replacing it with a new turbocharger.    If in doubt, contact **KOHLER** service department.    Z_importante.jpg **Important**       * Failure to comply with these instructions can cause damage to the turbocharger and void the warranty. * Modifying the calibration of the turbocharger damages the turbocharger/engine. * Always use the correct gaskets, and fit carefully to avoid blocking holes when mounting. * Refer to the manual of the engine / vehicle, for: the correct type and quantity of oil, the correct tightening of components, instructions and installation. * It is forbidden to use liquid gaskets or sealants, particularly for the oil inlet/outlet. * Avoid dirt / debris while installing the turbocharger. * Before mounting the turbocharger, check that the code of the component is correct for the type of engine, as mounting the wrong turbocharger can damage the turbo / engine and void the warranty. | |

# Safety information

## Before start-up

|  |
| --- |
| * Read the manual carefully and carry out the operations described below in compliance with the instructions specified. * Periodic inspection and maintenance operations must be carried out as indicated in this manual and under the user's responsibility.     Z_importante.jpg **Important**       * Only use original spare parts and accessories. * The use of non-original parts, as well as voiding the warranty, affects the life and performance of the engine, and may be dangerous. * Non compliance with the operations described in the following pages may result damage to the engine and vehicle on which it is installed, as well as to people and/or property. |

## Safety precautions

|  |
| --- |
| * The intended use of the engine is in conformity with the machine on which it is mounted. * Any use of the machine other than that described cannot be considered as complying with its intended purpose as specified by **KOHLER** . * **KOHLER** declines all responsibility for any change to the engine not described in this manual made by unauthorized **KOHLER** personnel. * A proper use of the engine, a strict observance of the rules listed below and the rigorous application of all these precautions will avoid the risk of accidents or injuries. * Those who carry out the use and maintenance on the engine must wear the safety equipment and the accident-prevention guards [**(Par 3.4.3)**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=199&parent=1000) **.** * **KOHLER** declines all direct and indirect liability for failure to comply with the standards of conduct contained in this manual. * **KOHLER** cannot consider every reasonably unforeseeable misuse that may cause a potential danger. |

## General remarks

|  |
| --- |
| **3.3.1 Note for OEM**   * When installing the **KDI** engines, always bear in mind that any variation to the functional systems may involve serious failures to the engine. * Any improvement must be verified at **KOHLER** testing laboratories before application of the engine. * In the event KOHLER does not approve the type of modification, **KOHLER** shall not be held responsible for any consequential operation anomalies that the engine may undergo and any damage the engine may cause to persons and things. * The engine may only be assembled on a machine by personnel specifically trained by **KOHLER** and who work in compliance with the existing documentation. * The engine has been built to the specifications of a machine manufacturer, and it is his responsibility to ensure that all necessary action is taken to meet the essential and legally prescribed health and safety requirements. Any use of the machine other than that described cannot be considered as complying with its intended purpose as specified by **KOHLER** , which therefore declines all responsibility for accidents caused by such operations.   **3.3.2 Note for end user**   * The following indications are dedicated to the user of the machine in order to reduce or eliminate risks concerning engine operation and the relative routine maintenance work. * The user must read these instructions carefully. Failure to do this could lead to serious danger for his personal safety and health and that of any persons who may be in the vicinity of the machine. * On starting, make sure that the engine is as horizontal as possible, unless the machine specifications differ. * Make sure that the machine is stable to prevent the risk of overturning. * The engine must not operate in places containing inflammable materials, in explosive atmospheres, where there is dust that can easily catch fire unless specific, adequate and clearly indicated precautions have been taken and have been certified for the machine. * To prevent fire hazards, always keep the machine at least one meter from buildings or from other machinery. * Children and animals must be kept at a due distance from operating machines in order to prevent hazards deriving from their operation. * Thoroughly wash and clean all the external parts of the engine before performing any operation, in order to avoid the accidental introduction of impurities/foreign bodies. Use only water and/or appropriate products to clean the engine. If cleaning engine with a pressure washer or steam cleaner, it is important to maintain a minimum distance of at least 200mm between the surface to be washed and the nozzle. Avoid directing the nozzle on electrical components, cable connections and sealed rings (oil seals etc). Thoroughly wash and clean the area surrounding the engine following the instructions provided by machine manufacturer. * Fuel vapour is highly toxic. Only refuel outdoors or in a well ventilated place. * Make sure that no soundproofing panels and the ground or floor on which the machine is standing have not soaked up any fuel. * The engine may only be assembled on a machine by personnel specifically trained by **KOHLER** and who work in compliance with the existing documentation. * The engine has been built to the specifications of a machine manufacturer, and it is his responsibility to ensure that all necessary action is taken to meet the essential and legally prescribed health and safety requirements. Any use of the machine other than that described cannot be considered as complying with its intended purpose as specified by **KOHLER** , which therefore declines all responsibility for accidents caused by such operations. * Fuel vapour is highly toxic. Only refuel outdoors or in a well ventilated place. * Do not smoke or use open flames when refuelling. * During operation, the surface of the engine can become dangerously hot. Avoid touching the exhaust system in particular. * Before proceeding with any operation on the engine, stop it and allow it to cool. * Always open the radiator plug or expansion chamber with the utmost caution, wearing protective garments and goggles. * The coolant fluid is under pressure. Never carry out any inspections until the engine has cooled. * If there is an electric fan, do not approach the engine when it is still hot as the fan could also start operating when the engine is at a standstill. * The oil must be drained whilst the engine is hot. Particular care is required to prevent burns. Do not allow oil to come into contact with the skin because of the health hazards involved. It is recommended to use an oil intake pump. * During operations that involve access to moving parts of the engine and/or removal of rotating guards, disconnect and insulate the negative wire (-) of the battery to prevent accidental short-circuits and to stop the starter motor from being energized. * Check belt tension only when the engine is off. * Fully tighten the tank cap each time after refuelling. Do not fill the tank right to the top but leave an adequate space for the fuel to expand. * To start the engine follow the specific instructions provided in the engine and/or machine operating manual. Do not use auxiliary starting devices not originally installed on the machine (e.g. Startpilot). * Before starting, remove any tools that were used to service the engine and/or machine. Make sure that all guards have been refitted. * Do not mix fuel with elements such as oil or kerosene. Failure to comply with this prohibition will cause the non-operation of the catalyst and non-observance of the emissions declared by **KOHLER** . * Pay attention to the temperature of the oil filter when the filter itself is replaced. * Only check, top up and change the coolant fluid when the engine is off and reached the ambient temperature. Coolant fluid is polluting, it must therefore be disposed of in the correct way. * Do not use jets of air and water at high pressure on the cables, connectors and electronic injectors. * For engines equipped with ATS device, it is necessary to inhibit regeneration if using the engine in environments featuring risk of fire (e.g.: woods, areas containing flammable materials, areas containing flammable gas or liquids and any type of combustible material - if this function is available).   Z_importante.jpg **Important**       * Only use the eyebolts **A** installed by **KOHLER** to move the engine **(Fig. 3.1).** * The angle between each lifting chain and the eyebolts shall not exceed 15° inwards. * The correct tightening of the lifting brace capscrews is **25 Nm** . * Do not interpose spacers or washers between the eyebolts and engine head.   note_generali_1.jpg **Fig 3.1** |

## Safety signal description

* To ensure safe operation please read the following statements and understand their meaning.
* Also refer to your equipment manufacturer's manual for other important safety information.
* This manual contains safety precautions which are explained below.
* Please read them carefully.

|  |  |
| --- | --- |
| **3.4.1 Adhesive safety plates**  The following is a list of the adhesive safety plates that may be found on the engine, which indicate potential points of danger to the operator. | |
| Pittogrammi_LIBRO.jpg | Read the Operation and Maintenance handbook before performing any operation on the engine. |
| Pittogrammi_PARTI-CALDE-.jpg | Hot Parts. Danger of burns. |
| Pittogrammi-_PARTI-ROTANTI.jpg | Presence of rotating parts. Danger of jamming or cutting. |
| Pittogrammi_INCENDIO-ESPLOS.jpg | Presence of explosive fuel. Danger of fire or explosion. |
| Pittogrammi_USTIONE.jpg | Presence of steam and pressurized coolant. Danger of burns. |
| **3.4.2** **Warnings** Hereunder is a list of safety warnings that may be found in the manual, which advise you to pay attention when carrying out particular procedures that may be potentially dangerous to the operator or things. | |
| Pericolo.png | **Danger** This indicates situations of grave danger which, if ignored, may seriously threaten the health and safety of individuals. |
| Importante.png | **Important** This indicates particularly important technical information that should not be ignored. |
| Avvertenza.png | **Warning** This indicates that failure to comply with it can cause minor damage or injury. |
| **3.4.3** **Safety guards** Hereunder is a list of safety guards that must be worn prior to carrying out any type of operation and to avoid potential  harm to the operator. | |
| Pittogrammi_GUANTI.jpg | Use suitable protective gloves before carrying out any type of operation. |
| Pittogrammi_OCCHIALI.jpg | Use protective goggles before carrying out any type of operation. |
| Pittogrammi_CUFFIE.jpg | Use earmuffs before carrying out any type of operation. |

## Information and safety signals

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  | | --- | --- | | Z_Pericolo.jpg  **ACCIDENTAL START** | | | Z_Avv-accidentale-1.jpg Z_Avv-accidentale-2.jpg Z_Avv-accidentale-3.jpg | **Accidental Starts can cause severe injury or death.** | | Before working on the engine or equipment, disconnect the battery negative (-) wire. | | | Z_Pericolo.jpg  **HOT PARTS** | | | Z_Alta-temperatura.jpg | **Hot Parts can cause severe burns.** | | Engine components can get extremely hot from operation. Do not touch engine while operating or just after stopping.  Never operate the engine with heat shields or guards removed. | | | Z_Pericolo.jpg  **ROTATING PARTS** | | | Z_Parti-rotanti.jpg | **Rotating Parts can cause severe injury.** | | Stay away while engine is in operation. Keep hands, feet, hair, and clothing away from all moving parts to prevent injury. Never operate the engine with covers, shrouds, or guards removed. | | | Z_Pericolo.jpg  **LETHAL EXHAUST GASES** | | | Z_Carbon.jpg | **Carbon Monoxide can cause severe nausea, fainting or death.** | | Avoid inhaling exhaust fumes and never run the engine in a closed building or confined area. Carbon monoxide is toxic, odorless, colorless, and can cause death if inhaled. | | | Z_Pericolo.jpg  **ELECTRICAL SHOCK** | | | Z_Elecshock.jpg | **Electrical Shock can cause injury.** | | Do not touch wires while engine is running. | | | |  |  | | --- | --- | | Z_Pericolo.jpg  **HIGH PRESSURE FLUID RISK OF PUNCTURE** | | | Z_Fluidi.jpg | **High Pressure Fluids can puncture skin and cause severe injury or death.** | | Work on the injection system must be carried out by suitably trained staff wearing protection equipment. Injuries caused by fluid penetration are highly toxic and dangerous. **If an injury occurs, seek immediate medical attention.** | | | Z_Pericolo.jpg  **EXPLOSIVE FUEL** | | | Z_Comb-esplosivo.jpg | **Explosive fuel can cause fires and severe burns.** | | Fuel is flammable and its vapours can ignite. Store fuel only in approved containers, in well ventilated, unoccupied buildings. Do not fill the fuel tank while the engine is hot or running, since spilled fuel could ignite if it comes in contact with hot parts or sparks from ignition. Do not start the engine near spilled fuel. Never use fuel as a cleaning agent. | | | Z_Pericolo.jpg  **EXPLOSIVE GAS** | | | Z_Gas-esplosivi.jpg | **Explosive Gas can cause fires and severe acid burns.** | | Charge battery only in a well ventilated area. Keep sparks, open flames, and other sources of ignition away from the battery at all times. Batteries produce explosive hydrogen gas while being charged.    Keep batteries out of the reach of children. Remove all jewelry when servicing batteries. Before    disconnecting the negative (-) ground cable, make sure all switches are OFF. If ON, a spark will occur at the ground cable terminal which could cause an explosion. | | | Z_Pericolo.jpg  **CALIFORNIA WARNING - DECLARATION 65** | | | Engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm. | | |

## Safety and environmental impact

Every organisation has a duty to implement procedures to identify, assess and monitor the influence of its own activities (products, services, etc.) on the environment. Procedures for identifying the extent of the impact on the environment must consider the following factors: - Disposal of liquids.

- Waste management.

- Soil contamination.

- Atmospheric emissions.

- Use of raw materials and natural resources.

- Regulations and directives regarding environmental impact.

In order to minimise the impact on the environment, **KOHLER** provides some indications to be followed by all those handling the engine, for any reason, during its expected lifetime. - All components and fluids must be disposed of in accordance with the laws of the country in which disposal is taking place.

- Keep the injection system as well as engine management and exhaust pipes in efficient working order to limit environmental and noise pollution.

- When decommissioning the engine, select all components according to their chemical characteristics and dispose of them separately.

## Location of safety signals on engine



# Storage information

## Product preservation

Z_importante.jpg   **Important**

* If the engines are not to be used for 6 months, they must be protected by carrying out the operations described in Engine storage (up to 6 months) [**(Par. 4.2)**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=117&parent=1000) .
* If the engine is still not in use after the first 6 months, it is necessary to carry out a further procedure to extend the protection period (more than 6 months) [**(Par. 4.3)**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=118&parent=1000) .
* If the engine is not to be used for an extended period, the protective treatment procedure must be repeated within 24 months of the previous one.

## Engine storage (up to 6 months)

**Before storing the engine check that:**

* The environments are not humid or exposed to bad weather. Cover the engine with a proper protective sheet against dampness and atmospheric contaminants.
* The place is not near electric panel.
* Avoid storing the engine in direct contact with the ground.

## Engine storage (over 6 months)

**Follow the steps described in Par. 4.2.**

1. Pour protective oil in the carter up to the MAX level.
2. Refuel with fuel additives for long storage.The following additives are recommended: DEFA Fluid Plus (Pakelo Lubricants),

Diesel Treatment (Green Star),

Top Diesel (Bardhal),

STP® Diesel Fuel Injector Treatment.

1. With expansion tank:  
   make sure that the coolant is up to the **maximum** level.
2. Without expansion tank: Top liquid up until the pipes inside the radiator are covered by about 5 mm.

Do not overfill the radiator, but leave room for the fuel to expand.

1. Start the engine and run it at idle speed for around 2 minutes.
2. Bring the engine to 75% of **maximum** rated speed for 5 to 10 minutes.
3. Turn off the engine.
4. Empty out completely the fuel tank.
5. Spray SAE 10W-40 on the exhaust and intake manifolds.
6. Seal the exhaust and intake ducts to prevent foreign bodies from entering.
7. When cleaning the engine, if using a pressure washer or steam cleaning device, avoid directing the nozzle on electrical components, cable connections and sealed rings (oil seals etc).  
   If cleaning engine with a pressure washer or steam cleaner, it is important to maintain a minimum distance of at least 200mm between the surface to be washed and the nozzle - avoiding absolutely electrical components such as alternators, starter motors and engine control units (ECU).
8. Treat non-painted parts with protective products.
9. Loosen the alternator belt  [**Par. 7.3 point 1 and 2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=136&parent=1000)

**NOTA:** For Poly-V belt [**Par. 11.3 from points 1 to 3**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=178&parent=1000) .

If the engine protection is performed according to the suggestions indicated no corrosion damage will be found.

## Engine starting after storage

1. Remove the protective sheet.
2. Use a cloth soaked in degreasing product to remove the protective treatment from the external parts.
3. Inject lubricating oil (no more than 2 cm3) into the intake ducts.
4. Adjust the alternator belt tension ( [**Par. 9.15.2 from points 7 to 10**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=171&parent=1000) ) - for a Poly-V belt ( [**Par. 11.3 from point 5 to 8**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=178&parent=1000) )or replace if there are signs of deterioration.
5. Refill the tank with fresh fuel.

Z_Avvertenza.jpg **Warning**

* Over time, lubricants and filters lose their properties, so itis important to consider whether they need replacing, also based on the criteria described in [**Tab. 2.9**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=102&parent=1000) .

1. Make sure that the oil and the coolant are up to the **maximum** level.
2. Start the engine and run it at idle speed for around 2 minutes.
3. Bring the engine to 75% of **maximum** rated speed for 5 to 10 minutes.
4. Stop the engine and while the oil still hot, perform the operation in [**Par. 5.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=121&parent=1000) .
5. Replace the filters (air, oil, fuel) with original spare parts.
6. Perform the operations described in [**Par. 10.1**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=174&parent=1000) .
7. Perform the operations described in  [**Par. 5.1**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=120&parent=1000) and [**Par. 10.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=175&parent=1000) .

# Information regarding discharge of liquids

## Coolant

|  |  |
| --- | --- |
| Z_importante.jpg  **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) .   **NOTE:** Component not necessarily supplied by **KOHLER** . The representation of the radiator is purely indicative.    Z_Avvertenza.jpg **Warning**       * Presence of steam pressurized coolant danger of burns.      1. Undo the cap **A** carefully (circuit under pressure). | 5.1.png **Fig 5.1** |
| 1. Loosen clamp **G** and remove cap **B** from exhaust pipe **C** , draining the liquid into an appropriate container and refer to ( [**Par. 3.6**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=203&parent=1000) ). | 5.2.png **Fig 5.2** |
| 1. Undo cap **F** to drain all liquid from the system contained in the engine crankcase ducts into an appropriate container and refer to ( [**Par. 3.6**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=203&parent=1000) ). | 5.3.png **Fig 5.3**  5.4.png **Fig 5.4** |
| **NOTE** : Click by side to play the procedure. | <https://www.youtube.com/embed/_s_qNZuOqQU?rel=0> |

## Engine oil

|  |  |
| --- | --- |
| Z_Avvertenza.jpg **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) . * This operation should be carried out with vacuum pump. The oil must be drained whilst the engine is hot, which requires particular care to prevent burns. Do not allow oil to come into contact with the skin because of the health hazards involved. It is recommended to use an oil intake pump via the oil dipstick hole **B.** * Electric/pneumatic screwdrivers are forbidden.      1. Undo the cartridge holder cover **C** by performing three complete turns and wait 1 minute.   **NOTE** : this operation will allow to oil contained in the support **G** to flow into the oil sump in the correct way.   1. Unscrew cartridge holder cover **C** and check that the oil in the lub. oil filter bracket **G** has flowed towards the oil sump (refer to **NOTE** in [**Par. 2.10.3**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=104&parent=1000) ). 2. Undo the oil filler cap **A (Fig. 5.5)** . 3. Remove the oil dipstick **B** . 4. Remove the oil drain plug **D** and the gasket **E** (the oil drain plug is on both sides of the oil sump). 5. Drain oil in to an appropriate container. (For used oil disposal refer to the [**Par. 3.6**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=203&parent=1000) ). 6. Replace gasket **E** . 7. Tighten the drain oil plug **D** (tightening torque at **35** **Nm** ). 8. Perform the operations described in [**Par. 6.10.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=132&parent=1000) and the operation 5 [**Par. 6.10.3.**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=132&parent=1000) | 5.4.jpg   **Fig 5.5**  5.6.png **Fig 5.6** |
| **NOTE** : Click by side to play the procedure. | <https://www.youtube.com/embed/7T2NNBQqPpU?rel=0> |

# Information for replacing the functional units

## Electronic injector replacement

|  |  |
| --- | --- |
| Z_importante.jpg **Important**         * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) . * In the event of the electronic injectors being disassembled (not necessarily replaced) their position with respect to individual cylinders must not be changed when re-assembled. Refer to the reference between each injector and respective cylinder number. * Seal all injection component unions as illustrated in [**Par. 2.9.8**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=103&parent=1000&txts=2.9.8) during disassembly. * Handle the components as described in [**Par. 2.17**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=112&parent=1000&txts=2.9.8) . * Replace all seal gaskets after each assembly for all components on which they are provided. * The high pressure pipes must be replaced every time they are disassembled. * Before disassembling the electronic injectors, make sure the new high pressure pipes are available. * If a new (or different) electronic injector is fitted on the engine, the new calibration data must be entered in the ECU through a specific instrument **(** [**ST\_01**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **)** . * Electronic injectors are not repairable. * This procedure may be performed on one or more electronic injectors.     **NOTE:**   In the event of a leak upon replacement (oil - coolant - fuel - air), do not intervene with the engine running, but stop it and wait for 5/10 minutes before checking and solving the problem. | imm6_01.jpg **Fig 6.1** |
| **6.1.1 Fuel return pipes disassembly (Common Rail/electronic injectors)**     1. Disconnect the connector **C** . | imm6_02.jpg **Fig 6.2** |
| 1. Remove clips **E** from the electronic injector **F** . 2. Disconnect the junction **G** from the electronic injector **F** .       Z_Avvertenza.jpg **Warning**       * After removing the fittings, the clips **E** must automatically return to their initial position; otherwise they must be replaced.  1. Seal all injection component unions as illustrated in [**Par. 2.9.8**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=103&parent=1088) ***.*** | imm6_03.jpg **Fig 6.3** |
| **6.1.2 High pressure fuel pipes disassembly (Common Rail/electronic injectors)**    Z_Pericolo.jpg **Danger**       * The fuel injection circuit is under high pressure, use safety protections as described in [**Par 3.4.3**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=199&parent=1000) . * Ensure that the Common Rail is not under pressure by slowly and carefully unscrewing one of the nuts **H** .      1. Undo the nut **H** on the Common Rail **L** and then the nut **M** on the electronic injector **F** and remove the pipe **N** .       Z_importante.jpg **Important**       * In the event that the electronic injectors are disassembled (not necessarily replaced), mark them with the relevant cylinder number from which they originate so as not to confuse them during re-assembly. * Seal all injection component unions as illustrated in [**Par. 2.9.8**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=103&parent=1000&txts=2.9.8) . | imm6_04.jpg **Fig 6.4** |
| **6.1.3 Electronic injectors disassembly**   1. Undo and remove the screw **P** with the washer **R** e and then the bracket **Q** .     Z_importante.jpg **Important**       * Be careful not to damage the gaskets **X** . * Replace rings **X** , if damaged.   2. Pull out the electronic injector **F** . **NOTE:** Should you be unable to remove the electronic injector (acting only on point **BC** ), use an open-ended spanner (Ø 34 mm), by applying small rotations to unblock the component.  3. Seal all injection component unions as illustrated in [**Par. 2.9.8**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=103&parent=1000) . 4. Ensure that gasket **S** has remained in the correct position **(Fig. 6.6)** . Otherwise, recover the gasket from inside the electronic injector **T** manifold. | imm6_05.jpg **Fig 6.5**6.6.jpg **Fig 6.6** |
| **NOTE:** Click by side to play the procedure. | <https://www.youtube.com/embed/QQZtx2i75AY?rel=0> |
| **6.1.4 Electronic injector assembly**    Z_importante.jpg **Important**       * Always replace and lubricate the gaskets **AA** and **S** of the electronic injectors **F** with fuel, every time they are replaced. * Reposition the electronic injectors (not replaced) by following the references made for disassembly, as indicated in **Par.** **6.1.2.** * If the engine is painted or protected with clear paint, clean the paint off the diesel injector  **F  near to the part in contact with the gasket AB .**      1. Insert the gasket **S** on the electronic injectors **F (Fig. 6.7)** . 2. Insert electronic injector **F** into manifold **T** , being extra careful not to damage gasket **AB** and direct it as indicated in **Fig. 6.7** . | imm6_07.jpg **Fig 6.7** |
| **6.1.5 High pressure fuel pipes assembly**    Z_importante.jpg **Important**       * Always replace the pipes **N** after each assembly. * If the engine is painted or protected with clear paint, replace the fastening screws  **P**  to ensure the gaskets are sealed properly.  1. Position tube **N** in the Common Rail seat of the electronic injector; correct the position of the electronic injector by means of the entrance of the electronic injector unions **F** and Common Rail **L** . 2. Apply the nuts **H** and **M** by hand without tightening them. 3. Position the fastening brace of electronic injectors **Q** on capscrew surface **AD** , insert capscrews **P** in brace **Q** inserting washer **R** . | imm6_08.jpg **Fig 6.8** |
| Z_importante.jpg **Important**       * Ensure that brace **S** is perfectly positioned onto the electronic injector.     4.  Tighten the fixing screws **P** of the electronic injector bracket (tightening torque at **20 Nm** ). 5.  Tighten the nut **M** (tightening torque at **25 Nm** ). 6.  Tighten the nut **H** (tightening torque at **30 Nm** ). | imm6_09.jpg **Fig 6.9** |
| **6.1.6 Fuel return pipes assembly**   1. Check the condition of the gaskets **AE** . | imm6_10.jpg **Fig 6.10** |
| 1. Insert unions **AF** onto electronic injectors **F** and block them with clips **E** . 2. Mount the connectors **C** on the electronic injectors **F** .     Z_Avvertenza.jpg **Warning**       * Slightly move the wiring support to check that the electrical wire of connector **C** is not strained in correspondence with the outlet hole   **AF** . | 6.11.png **Fig 6.11** |
| **NOTE:** Click by side to play the procedure. | <https://www.youtube.com/embed/ArOgFV739EU?rel=0> |

## High-pressure fuel injection pump replacement

|  |  |
| --- | --- |
| Z_Pericolo.jpg **Danger**       * The fuel injection circuit undergoes high pressure, use safety protections as described in [**Par 3.4.3**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=199&parent=1000) . * Ensure that the Common Rail is not under pressure by slowly and carefully unscrewing nut **A** .       Z_importante.jpg **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) . * Always replace the high pressure pipes after each disassembly. * Before disassembling the injection pump, make sure the new high-pressure pipe is available. * The injection pump is not repairable. * Should the fuel feeding pump need to be replaced, after assembly, it is necessary to perform the Pump Learning procedure by means of instrument [**ST\_01**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) . * Seal all injection component unions as illustrated in [**Par. 2.9.8.**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=103&parent=1000&txts=2.9.8) * To handling components refer to [**Par. 2.17.**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=112&parent=1000&txts=2.9.8) * Always replace the gaskets (where are provided) after each disassembly. | imm6_12.jpg **Fig 6.12** |
| **6.2.1 High-pressure fuel line disassembly (from the injection pump to the Common Rail).**   1. Undo the nut **A** . | imm6_13.jpg **Fig 6.13** |
| 1. Undo nut **D** from Common Rail **E** . | imm6_14.jpg **Fig 6.14** |
| 1. Undo the nut **B** on the intake manifold **C** and remove the pipe **F** . | imm6_15.jpg **Fig 6.15** |
| **6.2.2 Timing system carter oil filling flange disassembly**   1. Remove starter motor **(** [**Par. 7.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=136&parent=1000) **)** and assemble special tool [**ST\_34**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **(** [**Par. 7.7 point 2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=140&parent=1000) **)** . 2. Undo the screws **G (** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **)** ,remove the clamp **E** and the flange **H** . | imm6_16.jpg **Fig 6.16** |
| **6.2.3 High-pressure fuel injection pump disassembly**   1. Undo and remove nut **L** fixing the fuel feeding pump control gear **M** .     Z_importante.jpg **Important**       * Be careful that the nut **L** does not fall into the timing cover.  1. Tighten tool [**ST\_04**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) on the gear **M** . | imm6_17.jpg **Fig 6.17** |
| Z_importante.jpg **Important**       * Do **NOT** use the cylinder connection pipe **W** as a handle, to prevent damage or fuel leaks. * Before disassembling, carefully read [**Par. 2.17**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=112&parent=1000) . * Seal all injection component unions as illustrated in [**Par. 2.9.8.**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=103&parent=1000&txts=2.9.8)  1. Release the clamps **N** on the return pipe **P** and on the fuel inlet pipe **Q** . 2. Disconnect tubes **P** and **Q** from fuel feeding pump **R** . 3. Disconnect connectors **S** and **T** . 4. Loosen the screws **U** . 5. Redo the capscrew of tool [**ST\_04**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) to disconnect injection pump **R** from gear **M** . 6. Undo capscrews **U** and extract injection pump **R** with the relevant gasket **V** . 7. Undo and remove the tool [**ST\_04**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) . | imm6_18.jpg **Fig 6.18**imm6_19.jpg **Fig 6.19** |
| **NOTE:** Click by side to play the procedure. | <https://www.youtube.com/embed/UaZgKyWrP48?rel=0> |
| **6.2.4 High-pressure fuel injection pump assembly**    Z_importante.jpg **Important**       * Before assembling, carefully read [**Par. 2.17**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=112&parent=1000) * Always replace the gasket **V** after each assembly. The gasket **V** can only be fitted in one direction. * Remove the tool [**ST\_04**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) from the pump control gear ( **Ref. M** **of Par. 6.2.3** ) if applicable. * Do **NOT** use the cylinder connection pipe W as a handle, to prevent damage or fuel leaks. * Remove the protection caps only when reconnecting the hoses. | imm6_20.jpg **Fig 6.20** |
| 1. Check that the contact surfaces **AA** are free from impurities. 2. Insert the reference key **K** in the seat of the shaft **Z** . 3. Assemble the new gasket **V** on injection pump **R** . Insert injection pump **R** in its housing on crankcase **AA** making key **K** coincide with key seat **AH** of gear **M** . | imm6_21.jpg **Fig 6.21** |
| 1. Fully tighten the nut **L** on the shaft **Z** of the injection pump.       Z_importante.jpg **Important**       * Apply nut **L** by hand, but do not tighten. | imm6_22.jpg **Fig 6.22** |
| Z_importante.jpg **Important**         * It is mandatory to replace the screws **U** or apply a few drops of **Loctite 270** .      1. Clamp the screws **U** on the crankcase **AB** (tightening torque at **25 Nm** ). 2. Clamp the nut **L (Fig. 6.22)** (tightening torque at  **65  Nm** ). | imm6_23.jpg **Fig 6.23** |
| 1. Fit the connector **T** on the sensor **J** . 2. Fit the connector **S** on the sensor **Y** . 3. Remove the protection caps. 4. Fit the pipe **Q** on the fitting **AA** . 5. Fit the pipe **P** on the fitting **AB** . 6. Hook the clamps **N** on the hoses **Q** and **P** . | imm6_24.jpg **Fig 6.24** |
| **6.2.5 High-pressure line assembly (injection pump / Common Rail)**   1. Remove the protection cap. 2. Position the pipe **F** .       Z_importante.jpg **Important**       * Manually tighten the nut **A** . | imm6_25.jpg **Fig 6.25** |
| 1. Manually tighten the nut **D** . 2. Fix clamp **AC** by means of capscrew **B** on intake manifold **C** (tightening torque **10** **Nm -** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). 3. Clamp nut **D** (tightening torque at **30 Nm** ) and **A** (tightening torque at **25 Nm** ) in sequence. | imm6_26.jpg **Fig 6.26** |
| **6.2.6 Timing system carter oil filling flange assembly**    **NOTE:** Always replace the gasket **AE** after each assembly.   1. Position the gasket **AE** in the set on the flange **H** . 2. Fix the flange H on the crankcase **AF** with the screws **AG** (tightening torque at **10 Nm -** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). 3. Fit the clamp **E** on the flange **H** . 4. Disassemble the special tool [**ST\_34**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) and assemble the starter motor (tightening torque **45 Nm** ). | imm6_27.jpg **Fig 6.27** |
| **NOTE:** Click by side to play the procedure. | <https://www.youtube.com/embed/o3h6Say9sc4?rel=0> |

## Unit EGR Cooler replacement

|  |  |
| --- | --- |
| **6.3.1 Disassembly**    Z_importante.jpg **Important**         * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) . * To handling components refer to [**Par. 2.17.**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=112&parent=1088) * Always replace the gaskets (where are provided) after each disassembly.     **NOTE:** Perform the operations described in [**Par. 5.1**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=120&parent=1000) .     1. Undo the screws **B** of pipe **C** . | imm6_28.jpg **Fig 6.28** |
| 1. Undo screws **D** and **E** . 2. Remove pipe **F** and the relevant metal gaskets. 3. Release the clamps **G** and remove the sleeve **M** . | imm6_29.jpg **Fig 6.29** |
| 1. Undo the screws **H** and remove the EGR Cooler **L** from the sleeve **N** ( [**ST\_05**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). 2. Should the passage ducts of the gas exhaust be clogged by soot or carbon, replace EGR Cooler **L** . | imm6_30.jpg **Fig 6.30** |
| **NOTE:** Click by side to play the procedure. | <https://www.youtube.com/embed/xGWUnc-V1YY?rel=0> |
| **6.3.2 Assembly**   1. Insert the fitting **U** in the manifold **M** of the EGR valve unit. 2. Fit the EGR Cooler **L** with the screws **H** on the intake manifold **S** (tightening torque at **22 Nm -** [**ST\_05** ***)***](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) 3. Insert the hose **G** on the fitting **V** . 4. Secure the clamps **F** . | imm6_31.jpg **Fig 6.31** |
| 1. Insert the gasket **N** between the hose **B** and the EGR Cooler **L** and fix the screws **A** (tightening torque at **25 Nm** ) | imm6_32.jpg **Fig 6.32** |
| 1. Insert the hose **E** in its housing on the manifold **S** inserting the gasket **R** . 2. Insert the gasket **T** between the hose **E** and the EGR Cooler **L** and fit the screws **C** (tightening torque at **25 Nm** ). 3. Fit the screws **D** (tightening torque at **22 Nm -** [**ST\_05**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ).     **NOTE:** Perform the operations described in [**Par. 10.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=175&parent=1000) . | imm6_33.jpg **Fig 6.33** |
| **NOTE:** Click by side to play the procedure. | <https://www.youtube.com/embed/XSTfzyJa-9Q?rel=0> |

## EGR valve replacement

|  |  |
| --- | --- |
| **6.4.1 Disassembly**    Z_importante.jpg  **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) .   **NOTE:** Perform the operations described in [**Par. 5.1**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=120&parent=1000) .   1. Disconnect the connector **A** from the valve **C** . 2. Undo the screws **B** and remove the EGR valve **C** with the relevant gasket. | imm6_34.jpg **Fig 6.34** |
| **NOTE:** Click by side to play the procedure. | <https://www.youtube.com/embed/lZlk78GFzsg?rel=0> |
| **6.4.2 Assembly**    Z_importante.jpg **Important**         * Always replace gasket **D** after each assembly. * The EGR valve is not a serviceable item, and if faulty / worn out, should be replaced with a new one. * Movimentare i componenti come descritto nel [**Par. 2.17**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=112&parent=1000&txts=2.9.8) .      1. Mount the new gasket **D** on the valve **C** . 2. Fit the valve **C** on the flange **E** with screws **B** (tightening torque at **10 Nm** ). | imm6_35.jpg **Fig 6.35** |
| 1. Fit the connector **A** on the valve **C** .     **NOTE:** Perform the operations described in [**Par. 10.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=175&parent=1000) | imm6_36.jpg **Fig 6.36** |
| **NOTE:** Click by side to play the procedure. | <https://www.youtube.com/embed/KGHm0dnsQdc?rel=0> |

## Coolant pump replacement

|  |  |
| --- | --- |
| **6.5.1 Disassembly  NOTE:** Perform the operations described in [**Par. 5.1**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=120&parent=1000) .    Z_importante.jpg **Important**         * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=283&parent=1136) . * If the engine is fitted with the Poly-V belt, perform the operations described in [**Par. 11.3**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=178&parent=1000) .  1. Loosen the screws **A** and **B** . 2. Push the alternator **C** in the direction of the arrow **D** and remove the belt **E** . 3. Release clamp **F** and disconnect tube **G** from the coolant pump **N** .   **NOTE** : If union **R** , is disassembled, replace it or alternatively apply **Loctite 2701** on the thread when assembling on pump **G** (tightening torque of **20 Nm** ). | imm6_37.jpg **Fig 6.37**6.38.jpg **Fig 6.38** |
| 1. Release the clamp **M** from the coolant pump **N** . 2. Undo the screws **H** and remove the pump **N** with the relevant gasket **L** . | imm6_39.jpg **Fig 6.39** |
| **NOTE:** Click by side to play the procedure. | <https://www.youtube.com/embed/_QESHZf50PU?rel=0> |
| **6.5.2 Assembly**    Z_importante.jpg **Important**         * Always replace the gaskets **L** , after each disassembly. * Always replace the belt **E** after each assembly. * If the engine is fitted with the Poly-V belt, perform the operations described in [**Par. 11.3**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=178&parent=1000) . * To handling components refer to [**Par. 2.17.**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=112&parent=1088) * Always replace the gaskets (where are provided) after each disassembly  1. Fit the coolant pump **N** with the screws **H** interposing the new gasket **L** (tightening torque at **25 Nm** ). | imm6_40.jpg **Fig 6.40** |
| 1. Reinsert the pipe **G** and hook the clamp **F** ( **Fig. 6.38** ). 2. Rehook the clamp **M** on the pump **N** **(Fig. 6.39)** . 3. Push the alternator **C** in the direction of the arrow **D** . 4. Insert the belt **E** on the pulleys **P** . | imm6_41.jpg **Fig 6.41** |
| 1. Pull the alternator **C** in the direction of the arrow **Q** . 2. While tensioning the alternator **C** , first clamp screw **A** (tightening torque at **25 Nm** ) and then screw **B** (tightening torque at **69 Nm [thread M10] - 40 Nm** **[thread M8]** ). 3. Check the tension of the belt **E** with the instrument ( **DENSO BTG-2** ), positioning it in point **P** (the tension must be between **350 and 450 Nm** ). 4. If the tension values do not correspond, tighten screws **A** and **B** , then repeat operations **6, 7** and **8** . | imm6_42.jpg **Fig 6.42** |
| **NOTE:** Click by side to play the procedure. | <https://www.youtube.com/embed/GbvNS15R9SQ?rel=0> |

## Target wheel replacement

|  |  |
| --- | --- |
| **6.6.1 Disassembly**    Z_importante.jpg  **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) .  1. Position the crankshaft with the 1st cylinder in TDC, reference **A** upwards. 2. Remove the alternator belt following steps **1 and 2 (** [**Par. 6.5.1**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=127&parent=1000) **)** . | imm6_43.jpg **Fig 6.43** |
| 1. Disassemble the starting motor. 2. Mount the tool [**ST\_34**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) in the seat of the starter motor **C** and fit it with the two starter motor fixing screws. | 6.6.jpg **Fig 6.44** |
| 1. Disconnect the connector **L** . 2. Undo the screw **M** and remove the revolution sensor **N** and its respective spacer. | imm6_45.jpg **Fig 6.45** |
| 1. Undo the screw **P** (clockwise) and remove the pulley/targetwheel unit **Q** . | imm6_46.jpg **Fig 6.46** |
| 1. Undo the screws **R** and remove the target wheel **S** with the relevant sound-absorption disk **T** . | imm6_47.jpg **Fig 6.47** |
| **6.6.2 Assembly**   1. Check that the pin **U** is mounted properly on the pulley **V** . 2. Insert the disk **T** on the pulley **V** respecting the reference of the pin **U** . 3. Position the target wheel **S** on the pulley **V** respecting the reference of the pin **U** . 4. Fit the target wheel **S** with the screws **W** (tightening torque **10 Nm** ). 5. Perform the operations described in [**Par. 6.7.7**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=129&parent=1000) and then the operations between point **2 and 9** of [**Par. 6.5.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=127&parent=1000) . | imm6_48.jpg **Fig 6.48** |

## Oil pump replacement

Z_importante.jpg **Important**

* Before proceeding with operations, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) .
* The oil pump is not repairable.

|  |  |
| --- | --- |
| **6.7.1 Refrigerant pump disassembly**   1. Perform the operations described in [**Par 6.5.1**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=127&parent=1000) .     **6.7.2 Crankshaft and target wheel pulley disassembly**   1. Perform the operations described in [**Par 6.6.1**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=128&parent=1000) . 2. Disconnect the connector **AE** from the sensor **S** . | imm6_49.jpg **Fig 6.49** |
| **6.7.3 Timing system crankcase disassembly**    Z_importante.jpg **Important**       * Perform the operations described in [**Par. 5.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=121&parent=1000) **.**  1. Make sure that the reference pin **A** is facing upwards. 2. Undo the screw **H (** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **)** and remove the sensor **S** . 3. Undo the screws **B** and remove the timing system crankcase **C** . | imm6_50.jpg **Fig 6.50** |
| **6.7.4 Oil pump disassembly**   1. Undo the screws **D (** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **)** and remove the group pump **E** from the timing system crankcase **C** . 2. Remove the rotors **F** and **G** from the oil pump crankcase **E** . | imm6_51.jpg **Fig 6.51**  imm6_52.jpg  **Fig 6.52** |
| **6.7.5 Oil pump assembly**    **NOTE:** Carry out the checks described in [**Par. 8.7**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=157&parent=1000) prior to assembly.   1. Check that all surfaces in contact between **F, G, H, E and C** are free from impurities - scratches - dents. 2. When assembling, do not use any type of gasket between **E and C** . 3. Thoroughly lubricate the seat of the rotors **H** on the oil pump crankcase **E** and the two rotors **F and G** . 4. Within housing **H** insert the 2 rotors (in sequence) **G and F** , observing the references **BP** as described in figure (or refer to [**Par. 2.10.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=104&parent=1000) ). 5. Check that the 2 pins **L** are inserted properly in the timing system crankcase **C** . 6. Position the oil pump carter **E** using the reference pins **L** . 7. Clamp the oil pump carter **E** with the screws **D** (tightening torque **10 Nm - (** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **)** ). | imm6_53.jpg **Fig 6.53**imm6_54.jpg **Fig 6.54** |
| **6.7.6 Timing system crankcase assembly**    Z_importante.jpg **Important**       * Always replace the oil seal **J** after each assembly. * Always replace the gasket **P** after each assembly.      1. Lubricate the lip of the oil seal **J** . 2. Apply a coating of **Loctite 5188** around **1mm** thick on the surfaces **K** of the crankcase **C** . 3. Make sure that the key **M (Fig. 6.56)** is inserted properly on the crankshaft and that it is facing upwards. 4. Check that the 2 pins **N** are inserted properly in the timing system crankcase **C** . | imm6_55.jpg **Fig 6.55** |
| 1. Lubricate and insert the gasket **P** in the seat of the oil pump **Q** . 2. Tighten the tool [**ST\_10**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) on the crankshaft. 3. Position the crankcase **C** on the base, using the reference pins **N** , inserting the oil pump **Q** on the crankshaft. | imm6_56.jpg **Fig 6.56** |
| 1. Fit the timing system crankcase **C** with the screws **R** observing the indicated clamping sequence (tightening torque at **25 Nm** ). | imm6_57.jpg **Fig 6.57** |
| 1. Assemble sensor **S** by means of capscrew **T** on carter **C** inserting gasket U (tightening torque at **10 Nm** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). | imm6_58.jpg **Fig 6.58** |
| **6.7.7 Crankshaft and target wheel pulley assembly**   1. Leave the tool [**ST\_34**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) mounted **(** [**Fig. 6.44**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=128&parent=1000) **)** . 2. Check that the pin **A** is mounted properly on the crankshaft **Z** . 3. Position the pulley unit **W** on the crankshaft **Z** respecting the reference with the pin **A** . 4. Apply **Molyslip** grease on the screw thread **Y** . 5. Clamp the pulley unit **W** with the screw **Y** (tightening torque at **360 Nm** ). 6. Remove the special tool [**ST\_34**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **(** [**Fig. 6.44**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=128&parent=1000) **)** . | imm6_59.jpg **Fig 6.59** |
| 1. Mount the bracket **Z** with the screws **AA** (tightening torque at **10 Nm** ). 2. Perform the operations described in [**Par. 9.12**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=168&parent=1000) . 3. Insert the shim **AB** on the sensor **AC** . 4. Clamp the sensor **AC** on the bracket **Z** with the screw **AD** (tightening torque at **10 Nm** ).   **6.7.8 Coolant pump assembly**   1. Perform the operations described in [**Par 6.5.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=127&parent=1088) *.* | imm6_60.jpg **Fig 6.60** |

## Oil pressure valve replacement

|  |  |
| --- | --- |
| **6.8.1 Disassembly**    Z_importante.jpg  **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) .  1. Undo cap **A** . 2. Remove spring **B** , check its condition and replace it if broken. 3. Remove the valve piston **C** using a magnet. | imm6_61.jpg **Fig 6.61** |
| **6.8.2 Assembly**   1. Lubricate the piston **C** and fully insert it in the seat **E** . 2. Insert the spring **B** in the piston.     **NOTE:** Always replace the gasket **F** after each assembly.     1. Mount the gasket **F** on cap **A** . 2. Clamp the cap **A** on the crankcase **D** (tightening torque at **50 Nm** ). | imm6_62.jpg **Fig 6.62** |

## Oil vapour separator replacement

|  |  |
| --- | --- |
| **6.9.1 Disassembly**    Z_importante.jpg  **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) .  1. Release the clamp **AA** and remove the pipe **D** . 2. Release the clamps **F** . 3. Remove the clamp **P** cutting it in the point indicated and remove the separator body **C** removing it from the hose **AG** and **G** . | imm6_63.jpg **Fig 6.63** |
| 1. Release the clamp **F** . 2. Remove the pipes **G and AG** . 3. Remove the clamp **J** . 4. Undo the screws **B** . 5. Release the clamp **S** from the sleeve **K** . 6. Pull the flange **H** out of the manifold **K** and remove the relevant gasket, being careful not to bend the pipe **E** . | imm6_64.jpg **Fig 6.64** |
| **6.9.2 Assembly**    Z_Avvertenza.jpg **Warning**       * Always carefully inspect the condition of the tubes, and replace them if there is any doubt regarding their integrity. * Always replace the gasket **M** after each assembly.      1. Check that the contact surface **L** is free from impurities. 2. Position flange **H** inserting hose **K** onto the flange union **H** , being careful not to bend tube **E** . 3. Insert the gasket **M** between the flange **H** and the crankcase **N** . 4. Secure the flange **H** using the screws **B** on the crankcase **N** (tightening torque at **10 Nm** ). 5. Secure the clamp **S** on the manifold **K** . 6. Fit the pipes **G** and **AG** on the flange **H** . 7. Fit the breather body **C** on the pipes **G and** **D** and fit the pipe **G** with the clamps **F** and the pipe **D** with the clamp **AA** . 8. Fit the breather body **C** on the support flange **H** with the new clamp **P** . | imm6_65.jpg **Fig 6.65**Fig._6.66.jpg **Fig 6.66** |

## Oil cooler unit and oil filter replacement

|  |  |
| --- | --- |
| **6.10.1 Oil Cooler unit disassembly**    Z_importante.jpg **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) . * Perform the operations described in [**Par 5.1**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=120&parent=1000) **and** [**Par 5.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=121&parent=1000) **.** * Oil Cooler unit **E** is not repairable.  1. Release the clamps **A** . 2. Remove the pipes **B** out of the Oil Cooler unit **E** . | imm6_67.jpg **Fig 6.67** |
| Z_Avvertenza.jpg **Warning**       * Electric/pneumatic screwdrivers are forbidden. * Use a suitable container to recover any residue oil.  1. Unscrew cartridge holder cover **H** by performing three complete turns and wait 1 minute.   **NOTE** : this operation allows to oil contained in the support **E** to flow into the oil sump in the correct way.   1. Unscrew cartridge holder cover **H** and check that the oil in the lub. oil filter support **E** has flowed towards the oil sump. 2. Undo the screws **C and D** and remove the Oil Cooler unit **E** . | imm6_68.jpg **Fig 6.68** |
| 1. Remove the gaskets **F and G** from the Oil Cooler unit **E** . | imm6_69.jpg **Fig 6.69** |
| **6.10.2** **Oil filter cartridge replacement**   1. Remove gaskets **L, M and N** from element holder cover **H** . 2. Remove cartridge **P** from element holder cover **H** . | 2.jpg **Fig 6.70** |
| 1. Lubricate and insert gaskets **L, M and N** in the **L1, M1 and N1** seats of element holder cover **H** . 2. Insert element **P** into element holder cover  **H** . | 3.jpg **Fig 6.71** |
| **6.10.3 Oil Cooler unit assembly**    Z_importante.jpg **Important**       * In the event of assembly of union **U** on crankcase **S** , manual tightening torque with **Loctite 2701** on the thread).      1. Check that the surface **Q** on the support **E** and on the crankcase **S** are free from impurities. 2. Lubricate and insert the gasket **T** on the fitting **U** . 3. Lubricate and insert the gaskets on the support **E** : **F** in seat **F1** ; **G** in seat **G1** . 4. Fit the support **R** with the screws **C and D** (tightening torque at **10** **Nm** ). 5. Insert and tighten the cartridge support **H** on the filter support **E** (tightening torque at **25** **Nm** ). 6. Fit the pipes **B** on the support **E** and secure the pipes **B** with the clamps **A** . | 4.jpg **Fig 6.72**5.jpg **Fig 6.73** |

## Fuel filter replacement

|  |  |
| --- | --- |
| **6.11.1 Disassembly**    Z_importante.jpg  **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) .     Z_Avvertenza.jpg **Warning**       * The fuel filter is not always mounted in the engine. * When disassembling the sensor **E** , use a suitable container to recover the fuel contained in the cartridge **F** .  1. Release the clamps **A** and pull the pipes **B** out of the support **H** . 2. Unscrew the sensor **E** from the cartridge **F** . 3. Unscrew the cartridge **F** from the support **H** . 4. Undo the screws **C** and remove the support **H** . | imm6_74.jpg **Fig 6.74**imm6_75.jpg **Fig 6.75** |
| **6.11.2 Assembly**   1. Clamp the fuel filter support **H** with the screws **C** on the crankcase **M** (tightening torque at **25 Nm** ). 2. Fit the pipes **B** on the support **H** . 3. Secure the pipes **B** with the clamps **A** . | imm6_76.jpg **Fig 6.76** |
| 1. Lubricate the gasket **N** with fuel. 2. Tighten the cartridge **F** on the support **H** (tightening torque at **17 Nm** ). 3. Assemble gasket **J** onto sensor **E** and lubricate with fuel. 4. Tighten the sensor **E** on the cartridge **F** (tightening torque at **5 Nm** ). | imm6_77.jpg **Fig 6.77** |

## Replacement of SCV valve

|  |  |
| --- | --- |
| Z_importante.jpg **Important**       * Before starting any replacement operations, make sure the work area is free from dust (part **X** of valve **B** is extremely sensitive to micro-dust). * Pay the utmost attention to cleaning in order to prevent any type of contamination during replacement operations * - Before proceeding with the replacement, clean the outer part of pump **A** thoroughly - Avoid any type of contact with part **X** of the valve during replacement. * Lubricate part **X** of valve **B** with oil spray. * Before starting any replacement operations, make sure that the key on the vehicle’s panel is **OFF** . * Assemble the new valve in the same position as the previous one. | 6.70.jpg  **Fig. 6.78** |
| **6.12.1 Disassembly**    **1 -** Disconnect connector **C** from valve **B** .    **2 -** Loosen screws **D** .    **3 -** Remove valve **B** from pump **A** . | 6.71.jpg  **Fig. 6.79** |
| **6.12.2 Assembly**    **1 -** Insert studs **E** supplied with valve **B** in the fastening holes of pump **A** and insert gasket **F** in the seat of pump **A** .    **2 -** Assemble valve **B** on pump **A** using studs **E** as positioning guides.    **3 -** Remove studs **E** and secure valve **B** with screws **D** (tightening torque of 6 Nm).    **4 -** Fasten valve **B** by means of screws **D** (tightening torque of 10 Nm). | 6.72.jpg  **Fig. 6.80** |
| 6.73.jpg  **Fig. 6.81** | 6.74.jpg  **Fig. 6.82** |

# Information for disassembly

## Recommendations for disassembly

Z_importante.jpg **Important**

* The mark ( operazione_utile.gif ) after the title of a paragraph, indicates that the procedure is not required in order to disassemble the engine, however the procedures are featured in order to illustrate the disassembly of components.
* The operator should prepare all equipment and tools in order to enable him to carry out the operations correctly and safely.
* Before disassembly, perform the operation described in [**Chap. 5**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=120&parent=1000) .
* Before proceeding with operation, carefully read [**Chap. 3**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=114&parent=1000) .
* In order to operate safely and easily, we recommend positioning the engine on a rotating stand for engine overhauling.
* Seal all injection component unions as illustrated in [**Par. 2.9.8**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=103&parent=1000) during assembly.
* Protect all disassembled components and coupling surfaces subject to oxidation with lubricant.
* Where necessary, reference to special tools to use during disassembly operations is indicated (es. [**ST\_05**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ), identified in [**Tab. 13.1 - 13.2 - 13.3**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) .

## EGR circuit disassembly

|  |  |
| --- | --- |
| **7.2.1 EGR cooler unit**   1. Undo the screws **A** **(** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **) and B** and remove the pipe **C** with the relative gaskets. | imm_01.jpg **Fig 7.1** |
| 1. Undo the screws **D, E** **(** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **)** and remove pipe **F** and the relevant gaskets. | imm_02.jpg **Fig 7.2** |
| 1. Release the clamp **M** and remove pipe **N** . 2. Release the clamp **L** . 3. Undo capscrews **G** and remove EGR Cooler **H** from hose **X (** [**ST\_05**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **)** . | imm_03.jpg **Fig 7.3** |
| **7.2.2 EGR Valve**   1. Disconnect the connector **P** . 2. Undo the screws **Q** and remove the EGR valve **R** with the relevant gasket.     **NOTE:** The EGR valve is not a serviceable item, and if damaged/worn, it should be replaced with a new one. | imm_04.jpg **Fig 7.4** |
| 1. Undo capscrews **S** and remove flange **T** with the relative gasket. | imm_05.jpg **Fig 7.5** |

## Electric components disassembly

|  |  |
| --- | --- |
| **7.3.1 Electric wiring**    Z_importante.jpg **Important**       * Refer to [**Par. 2.13**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=107&parent=1000) prior to proceeding with disassembly.  1. Disconnect the connectors  **A, B and C** . 2. Release the clamp **D** . | imm_06.jpg **Fig 7.6** |
| 1. Disconnect the connectors **E, F and G** . 2. Release the clamps **J and H** . | imm_07.jpg **Fig 7.7** |
| 1. Disconnect the connectors **K and L** . | imm_08.jpg **Fig 7.8** |
| 1. Disconnect the connectors **M and P** . 2. Release the clamp **Q** . | imm_09.jpg **Fig 7.9** |
| 1. Disconnect the connectors **R** . 2. Undo the screws **S** and remove the wiring support **T** **(** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **)** . | imm_10.jpg **Fig 7.10** |
| **7.3.2 Starter motor**    Z_importante.jpg **Important**       * The motor is not repairable.  1. Undo the screws **U** and remove the starter motor **V** . | 7.3.jpg **Fig 7.11** |
| **7.3.3 Belt and alternator**   1. Loosen the screws **Z and W** . 2. Push the alternator **AA** in the direction of the arrow **AB** . 3. Remove the belt **AC** from the pulleys **AR** . 4. Undo the screws **Z and W** and remove the alternator **AA** .     Z_importante.jpg **Important**       * The belt must always be replaced every time it is disassembled, even if it has not reached the scheduled hours for replacement. | imm_12.jpg **Fig 7.12** |
| **7.3.4 Sensors and switches**    Z_importante.jpg **Important**       * After disassembly, protect the sensors suitably against knocks, dampness and any high temperature sources. * The sensors and switches cannot be repaired, therefore they must be replaced in the event of anomalies.     **7.3.4.1 Oil pressure switch** ( operazione_utile.gif )   1. Unscrew and remove the oil pressure switch **AD** . | imm_13.jpg **Fig 7.13** |
| **7.3.4.2 Coolant temperature sensor** ( operazione_utile.gif )   1. Unscrew and remove the coolant temperature sensor **AE** . | imm_14.jpg **Fig 7.14** |
| **7.3.4.3 Speed sensor** ( operazione_utile.gif )   1. Undo the screw **AF** and remove the sensor **AG** with the relative spacer **(** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **)** . 2. Undo the screws **AH** and remove the sensor **(** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **)** . | imm_15.jpg **Fig 7.15** |
| **7.3.4.4 Camshaft phase sensor**   1. Undo the screw **AM** and remove the sensor **AN** with the relative spacer ( [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). | imm_16.jpg **Fig 7.16** |
| **7.3.4.5 T-MAP Sensor** ( operazione_utile.gif )   1. Undo the screw **AP** and remove the sensor **AQ (** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **).** | imm_17.jpg **Fig 7.17** |
| **7.3.4.6 Fuel filter water detection sensor** ( operazione_utile.gif )    Z_Avvertenza.jpg **Warning**       * The fuel filter is not always mounted on the engine. * When disassembling the sensor **A** , use a suitable container to recover the fuel contained in the cartridge **B** .      1. Unscrew the sensor **A** from the cartridge **B** . | imm_18.jpg **Fig 7.18** |

## Turbocharger disassembly

|  |  |
| --- | --- |
| 1. Release the clamps **A and B** and remove the manifold **C** . | imm_19.jpg **Fig 7.19** |
| 1. Unscrew the fittings **D** and remove the pipe **E** with the relative gaskets **G** . 2. Undo the screws **F** . 3. Release clamp **M** . | imm_20.jpg **Fig 7.20** |
| 1. Undo the nuts **L** . 2. Remove tube **N** . | imm_21.jpg **Fig 7.21** |

## Exhaust manifold disassembly

|  |  |
| --- | --- |
| 1. Undo the nuts **A** and remove the manifold **B** and the gaskets **C** . 2. Close the openings and manifolds to prevent foreign bodies from entering. | imm_22.jpg **Fig 7.22** |

## Coolant recirculation components disassembly

|  |  |
| --- | --- |
| **7.6.1 Oil Cooler manifold**   1. Release the clamps **Z** . 2. Undo the screw **W** and remove hoses **J (** [**ST\_05**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **)** . | imm_23.jpg **Fig 7.23** |
| 1. Release the clamp **K** and remove hoses **AA** . | imm_24.jpg **Fig 7.24** |
| **7.6.2** **Coolant pump**    Z_importante.jpg **Important**       * The pump **B** is not repairable.  1. Undo the screws **A** and remove the water pump unit **B** with its gasket **C** . | imm_25.jpg **Fig 7.25** |
| **7.6.3 Thermostatic valve**   1. Undo the screws **A** and remove the thermostatic valve cover **B** . 2. Remove the thermostatic valve **C** and its gasket.         Z_importante.jpg **Important**       * Always replace the gasket **D** every time it is disassembled.  1. Check that the air bleeding hole is not clogged or blocked ( [**Par. 2.11.4**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=105&parent=1000) ). | imm_26.jpg **Fig 7.26** |

## Crankshaft and target wheel pulley disassembly

|  |  |
| --- | --- |
| 1. Position the crankshaft with the 1st cylinder at TDC,reference **H** . 2. Undo the screw **C** clockwise. 3. Remove the drive pulley unit and the target wheel **D** . | imm_28.jpg **Fig 7.27** |

## Lubrication circuit disassembly

|  |  |
| --- | --- |
| 7.8.1 Oil pressure valve( operazione_utile.gif **)**   1. Undo the cap **A** . 2. Remove the spring **B** , check its condition and replace it if broken. 3. Remove the valve piston **C** using a magnet. | imm_29.jpg **Fig 7.28** |
| **7.8.2 Timing system carter oil filling flange** ( operazione_utile.gif **)**   1. Undo the screws **D** and remove the oil filling flange **E (** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **)** . 2. Remove the gasket **F** . | imm_30.jpg **Fig 7.29** |
| **7.8.3 Timing system carter**   1. Ensure that the crankshaft with the 1st cylinder is at the TDC (taper pin **W** must be facing upwards). 2. Undo the screws **G** . 3. Remove the timing system semi-crankcase **H** . | imm_31.jpg **Fig 7.30** |
| **7.8.4 Oil pump**    Z_importante.jpg **Important**         * The oil pump is not repairable.      1. Undo the screws **L** and remove the pump unit **M** from the timing system carter **H** **(** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **)** . | imm_32.jpg **Fig 7.31** |
| 1. Remove the rotors **N and P** from oil pump carter **M** . | imm_33.jpg **Fig 7.32** |
| **7.8.5 Oil Cooler unit and lub. oil filter**   1. Screw the lid cartridge holder **V** . 2. Undo the screws **Q, R** and remove Oil Cooler group **S** .       Z_Avvertenza.jpg **Warning**       * Use a suitable container to recover any residue oil. * Oil Cooler unit **S** is not repairable. | imm_34.jpg **Fig 7.33** |
| 1. Remove the gaskets **T and U** .     **NOTE:** To replace the oil cartridge, refer to [**Par. 6.10.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=132&parent=1000) . | imm_35.jpg **Fig 7.34** |
| **7.8.6 Oil vapour separator unit**   1. Release the clamps **AA** . 2. Remove the manifolds **AB, AC and** **AD** . 3. Remove the clamp **AE** by carefully cutting it at the point indicated and remove the oil separator **AF** . | imm_36.jpg **Fig 7.35** |
| 1. Undo the screws **AG** . 2. Remove la flangia di supportoRemove flange support **AH** and the gasket seal **AL** . | imm_37.jpg **Fig 7.36** |

## Intake manifold disassembly

|  |  |
| --- | --- |
| 1. Undo the screws **A** and remove the semi-manifold **B (** [**ST\_05**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **)** . 2. Remove the separation plate **C** and the gaskets **H** . | imm_38.jpg **Fig 7.37** |
| 1. Undo the screws **D (** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **)** **and E** . 2. Remove the semi-manifold **F** and the gasket **G** . | imm_39.jpg **Fig 7.38** |

## Fuel system disassembly

|  |  |
| --- | --- |
| **7.10.1 Fuel return pipes**   1. Release the clip **A** .       Z_Avvertenza.jpg **Warning**       * After removing the union, the clip **A** must automatically return to its initial position; otherwise it must be replaced.  1. Undo the **B** distributor return fixing capscrew. 2. Release the clamp **D** . 3. Disconnect the pipe **E** from the fuel return fitting. 4. Undo and remove the screw **G** with the relative gaskets and put the cap on the Common Rail pressure relief valve **AA** . 5. Disconnect unions **M** from electronic injectors **N** . 6. Remove the fuel return pipes. | imm_40.jpg **Fig 7.39**imm_41.jpg **Fig 7.40** |
| **7.10.2 Fuel flow pipes**    Z_importante.jpg **Important**         * Seal all openings of the inlet and return unions on the injection pump **D** with the relevant caps, in order to prevent impurities from entering.      1. Loosen the clamps **P** . 2. Remove the pipes **Q and R** . | imm_42.jpg **Fig 7.41** |
| **7.10.3 High pressure fuel pipes**    Z_Pericolo.jpg **Danger**       * The fuel injection circuit undergoes high pressure, use safety protections as described in [**Par 3.4.3**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=199&parent=1000) . * Ensure that the Common Rail is not under pressure by slowly and carefully unscrewing one of the nuts **S** .      1. Loosen the nuts **S and T** in sequence. 2. Fully undo the nuts **S and T** in sequence, and remove the high pressure pipes **U and** **V** . | imm_43.jpg **Fig 7.42** |
| **7.10.4 Common Rail**   1. Undo the screws **AB** and remove the Common Rail **AC** .     **NOTE:** Take care to protect te sensor **AD** from knocks, moisture and any high temperature source. The internal parts of the rail cannot be repaired.    Z_importante.jpg **Important**       * Seal all injection component unions as illustrated in [**Par. 2.9.8**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=103&parent=1000) . * Common rail cannot be repaired. | imm_44.jpg **Fig 7.43** |
| **7.10.5 Electronic injectors**    Z_importante.jpg **Important**       * In the event that the electronic injectors are disassembled (not necessarily replaced), mark them with the relevant cylinder number from which they originate so as not to confuse them during re-assembly **(Fig. 7.45)** . * The electronic injectors cannot be repaired. * If one or more electronic injectors are to be replaced, the new calibration data must be inserted in the ECU via a specific instrument ( [**ST\_01**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). * Be careful not to damage the gaskets **X** .      1. Undo capscrews **AE** and remove them together with the relative washers **AF** and then brace **AG** . 2. Pull out the electronic injector **AH** .     **NOTE:** Should you be unable to remove the electronic injector (acting only on point **BC** ), use an open-ended spanner (Ø 34 mm), by applying small rotations to unblock the component.     1. Seal all injection component unions as illustrated in [**Par. 2.9.8**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=103&parent=1000) . 2. Ensure that gasket **AL** has remained in the correct position **(Fig. 7.46)** . Otherwise, recover the gasket from inside the electronic injector **AM** . | imm_45.jpg **Fig 7.44**imm_46.jpg **Fig 7.45** |
| 7.10.6 Fuel filter ( operazione_utile.gif )   1. Undo the fuel cartridge **AW** from support **AP** . 2. Undo the screws **AN** and remove the filter support **AP** . | imm_47.jpg **Fig 7.46** |
| **7.10.7 High-pressure fuel injection pump**    Z_importante.jpg **Important**       * Before disassembling, carefully read [**Par. 2.17**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=112&parent=1000) . * The injection pump is not repairable * Should the fuel feeding pump need to be replaced, after assembly, it is necessary to perform the Pump Learning procedure by means of instrument [**ST\_01**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) .      1. Undo the nut **AQ** . 2. Loosen the screws **AR** of the injection pump. 3. Screw the tool [**ST\_04**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) on the thread of the gear **AS** . 4. Tighten the screw **AT** on the puller to disconnect the gear **AS** from the injection pump and remove the injection pump control gear **AS** . 5. Undo the screws **AR** . 6. Remove injection pump **AU**   and the relative gasket **AV** . 7. Seal all injection component unions as illustrated in [**Par. 2.9.8**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=103&parent=1000) . | imm_48.jpg **Fig 7.47**imm_49.jpg **Fig 7.48** |

## Timing system gear disassembly

|  |  |
| --- | --- |
| 1. Unscrew screws **H** and remove target wheel **G** . 2. Unscrew screws **D** and remove camshaft gear **E** . 3. Remove retainer ring **A** and the shoulder ring **B** . 4. Remove the intermediate gear **C** . | imm_50.jpg **Fig 7.49** |
| 1. Remove the shoulder ring **F** . 2. Unscrew the screws L and remove the intermediate gear support **M** . | imm_51.jpg **Fig 7.50** |

## Flange unit disassembly

|  |  |
| --- | --- |
| **7.12.1 Flywheel**    Z_importante.jpg **Important**       * Leave the special tool [**ST\_34**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) for blocking the flywheel **(** [**Par. 7.7**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=140&parent=1000) **)** .  1. Only undo the screw **C** located uppermost. 2. Insert the tool [**ST\_09**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) in the seat of the screw **C** tightening it all the way. 3. Undo the remaining screws **D** .       Z_Pericolo.jpg **Danger**       * The flywheel **E** is very heavy. Pay the utmost attention while removing it in order to prevent it dropping or falling, as this may have serious consequences for the operative.  1. Remove the flywheel **E** . 2. Remove the tool [**ST\_09**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) . 3. Remove the tool [**ST\_34**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) shown in [**Fig. 7.11**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=136&parent=1000) **.** | imm_52.jpg **Fig 7.51** |
| **7.12.2 Flange housing**   1. Undo the screws **A** and remove the engine housing **B** .       Z_Pericolo.jpg **Danger**       * The flange housing is very heavy. Pay the utmost attention while removing it in order to prevent it dropping or falling, as this may have serious consequences for the operative. | imm_53.jpg **Fig 7.52** |

## Cylinder head unit disassembly

|  |  |
| --- | --- |
| **7.13.1 Rocker arms cover**   1. Undo the screws **A** . 2. Remove the rocker arms cover **B** . 3. Remove the gasket **C** . | imm_54.jpg **Fig 7.53** |
| **7.13.2 Rocker arm pin**   1. Undo the screws **D** . 2. Remove the rocker arm pin unit **E** . | imm_55.jpg **Fig 7.54** |
| 7.13.2.1 Rocker arm ( operazione_utile.gif )   1. Remove the retainer ring **F** . 2. Remove the shoulder rings **G** . 3. Remove the rocker arms **H** . | imm_56.jpg **Fig 7.55** |
| **7.13.3 Valve rods and bridges**   1. Remove the valve control U-bolts **M** . 2. Remove the rocker arm control rods **N** . | imm_58.jpg **Fig 7.57** |
| **7.13.4 Cylinder head**    Z_importante.jpg **Important**       * The cylinder head fastening bolts **P** must be replaced every time they are disassembled.  1. Undo the bolts **P** .         Z_importante.jpg **Important**       * To lift cylinder head **Q** , only use both eyebolts **AE** provided by **KOHLER** (refer to **Fig. 7.66** ). * When removing the cylinder head **Q** and subsequent disassembly, control, and assembly operations, it is necessary to protect the contact surface **W** of cylinder head **Q** and crankcase **J** against impacts.  1. Remove the cylinder head **Q** . 2. Remove the head gasket **R** . | imm_59.jpg **Fig 7.58**imm_60.jpg **Fig 7.59** |
| **7.13.4.1 Valves** ( operazione_utile.gif )   1. Mount the tool [**ST\_07**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) on the head **AF** fixing it on one of the holes for fixing the rocker arm cover.     **NOTE:** Change the fixing hole according to the position of the valves to be removed.     1. Position the tool [**ST\_07**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) on the valve as shown in the figure. | imm_61.jpg **Fig 7.60** |
| 1. Push the lever of the tool [**ST\_07**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) downwards, in order to lower the valve plates **S** in the direction of the arrow **T** , remove cotters **U** using a magnet.   **NOTE:** Repeat all the operations for all the valves concerned. | imm_62.jpg **Fig 7.61** |
| Z_importante.jpg **Important**       * Before removing the valves, make some marks to record their original position, in order to avoid confusing them when reassembling (if they are not replaced).  1. Remove the valves **V** . | imm_63.jpg **Fig 7.62** |
| **7.13.4.2 Electronic injector sleeves** ( operazione_utile.gif )   1. Unscrew and remove the sleeves **Z** from the head **Q** . 2. Remove the gaskets **AA and AB** . | imm_64.jpg **Fig 7.63** |
| **7.13.4.3 Valve stem gasket** ( operazione_utile.gif )   1. Remove the gaskets **AC** . | imm_65.jpg **Fig 7.64** |
| **7.13.4.4 Lifting eyebolts** ( operazione_utile.gif )   1. Undo the screws **AD** and remove the eyebolts **AE** . 2. Thoroughly wash the cylinder head **Q** . | imm_66.jpg **Fig 7.65** |

## Oil sump unit disassembly

|  |  |
| --- | --- |
| **7.14.1 Oil sump**   1. Undo the screws **A** . 2. Remove the oil sump **B** by inserting a plate in the areas indicated by the arrow **AA** . | imm_67.jpg **Fig 7.66** |
| **7.14.2 Oil suction pipe**   1. Undo the screws **C** and remove the oil pipe **D** . | imm_68.jpg **Fig 7.67** |
| 7.14.3 Oil vapour pipes ( operazione_utile.gif )   1. Unscrew and remove the pipes **E** . | imm_69.jpg **Fig 7.68** |

## Engine block disassembly

|  |  |
| --- | --- |
| **7.15.1 Crankshaft gasket flange**   1. Undo the screws **A** . 2. Remove the flange **B** and the gasket **C** . | imm_70.jpg **Fig 7.69** |
| **7.15.2 Piston unit/connecting rod**    Z_importante.jpg **Important**       * Mark some numerical references (cylinder n°) on the connecting rods, connecting rod caps **F1** , pistons and gudgeon pins to prevent unintentionally confusing the components not replaced during assembly. Failure to do this may result in engine malfunctions. * References on connecting rod **M** and cap **F1** must only be carried out on a side in correspondence with **K1** and **K2** , as illustrated in **Fig. 7.70a** .  1. Screw the bolt **AM** temporarily. 2. Unsrew bolts **E1** and remove the connecting rod caps **F1** . | imm_71.jpg **Fig 7.70** |
| **NOTE** : coupling cap **F1** on the connecting rod can be carried out with centring taper pins **(Fig. 7.70b)** or broken ( **Fig. 7.70c** - without centring taper pins).    7.72.png  **Fig. 7.70b**  7.72b.png  **Fig. 7.70c** | 7.71.png  **Fig 7.70a** |
| 1. Pull out the connecting rod - piston assembly from position **2 and 3** by manually applying pressure on the connecting rod big end **L** in the direction of arrow **AK** . 2. Couple the connecting rod big end caps **L** with the relevant piston and connecting rod unit **M** . 3. Turn capscrew **AM** and rotate the crankshaft by 180°. 4. Repeat points **2 to 5** to disassemble the connecting rod-piston assembly to position **1 and 4** . | imm_72.jpg  **Fig 7.71** |
| Z_Avvertenza.jpg **Warning**       * The connecting rod half-bearings **Z** are made of special material. Therefore, they must be replaced every time they are removed to prevent seizures. | imm_73.jpg **Fig 7.72** |
| **7.15.3 Lower semi-crankcase  3 CYLINDERS**   1. Undo capscrews **E and F** by following the order indicated in the figure. 2. Remove the lower semi-crankcase **D** and store it in a suitable container for washing. | ***3 Cylinders***  Fig._7.74.jpg **Fig 7.73** |
| **4 CYLINDERS**   1. Undo capscrews **E and F** by following the order indicated in the figure. 2. Remove the lower semi-crankcase **D** and store it in a suitable container for washing. | ***4 Cylinders***  Fig._7.75.jpg **Fig 7.74** |
| **7.15.4 Crankshaft**   Remove:   1. Crankshaft **G** . 2. The shoulder semi-rings **H** . | imm_76.jpg **Fig 7.75** |
| 7.15.5 7.15.5 Piston ( operazione_utile.gif )   1. Remove the retainer ring **N** . 2. Remove the pin **P** to separate the piston **Q** from the connecting rod **R** .       Z_importante.jpg **Important**       * If they are not replaced, keep the components together (connecting rod - piston - gudgeon pin) by using references in order to prevent them from getting mixed up during assembly. | imm_77.jpg **Fig 7.76** |
| **7.15.5.1 Rings** ( operazione_utile.gif )   1. Remove the rings **S** . | imm_78.jpg **Fig 7.77** |
| **7.15.6 Oil spray nozzles** ( operazione_utile.gif )   1. Undo the screws **T** and remove the spray nozzles **U** from the upper semi-crankcase **AB** . | imm_79.jpg **Fig 7.78** |
| **7.15.7 Camshaft**   1. Remove the lock ring **V** . 2. Extract the camshaft **W** from the upper semi-crankcase **AB** . | imm_80.jpg **Fig 7.79** |
| **7.15.8 Camshaft tappets**   1. With a magnet, remove the tappets AA from the upper semi-crankcase **AB** . | imm_81.jpg **Fig 7.80** |
| **7.15.9 Crankshaft bushings**   1. Remove the crankshaft bushings **AC** from the upper crankcase **AB** .     Z_importante.jpg **Important**         * The crankshaft half-bearings **AC** are made of special material. Therefore, they must be replaced every time they are removed to prevent seizures. | imm_82.jpg **Fig 7.81** |
| 1. Remove the crankshaft bushings **AF** from the lower semicrankcase **AE** . | imm_83.jpg **Fig 7.82** |
| **7.15.10** Cover 3 th PTO ( operazione_utile.gif )   1. Undo the screws **AG** . 2. Remove the cover **AH** and the gasket **AL** from the semicrankcase top. | imm_84.jpg **Fig 7.83** |

# Information about overhauling

## Recommendations for overhauls and tuning

* The information is laid out in sequence, according to operational requirements, and the intervention methods have been selected, tested and approved by the manufacturer's  
  technicians.
* This chapter describes procedures for checking, overhauling and tuning units and/or individual components.

**NOT** **E** : To easily locate specific topics, the reader should refer to the analytical index or chapter index.

* Before any intervention, the operator should lay out all equipment and tools in such a way as to enable him to carry out operations correctly and safely.
* The operator must comply with the specific measures described in order to avoid errors that might cause damage to the engine.
* Before carrying out any operation, clean the units and/or components thoroughly and eliminate any deposits.
* Do not wash the components with steam or hot water. Use suitable products only.
* Do not use flammable products (petrol, diesel, etc.) to degrease or wash components. Use suitable products only.
* Dry all washed surfaces and components thoroughly with a jet of air or special cloths before reassembling them.
* Apply a layer of lubricant over all surfaces of all disassembled components to protect them against oxidation.
* Check the integrity and state of wear of all disassembled components in order to ensure good working condition of the engine.
* When indicated, some components are to be replaced in pairs or together with other parts (e.g. crankshaft half-bearings/connecting rod, piston complete with rings and gudgeon pin, etc.).
* When indicated, some grinding operations are to be carried out in series (e.g. grinding of cylinders, crankpins, journals, etc.).

## Crankcase

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **8.2.1 Oil line check**  Use a pipe cleaner in access points **A, B, C, D, E** to clean the oil ducts of crankcase **G** . Use compressed air to eliminate any residues.    Replace and assemble the conical cap in hole **B** ( **B1** if present - tightening torque at **30 Nm** ) and caps in holes **D** , after having performed cleaning operations.    imm8_1.jpg **Fig 8.1**    **8.2.2** **Cylinder check**  Position crankcase G onto a workbench.    With a dial gauge, measure the diameter in correspondence to points **J-M-N (Fig. 8.2)** lengthwise and diagonally with regard to axis **H** of the crankshaft. If ovalisation or wear detected in a single point in **J-M-N** is greater than +0.05 mm with regard to the value in **Tab. 8.1a** , you are required to perform grinding operations on all cylinders F. Refer to **Tab. 8.1a**    to establish the clearance value of cylinders subjected to grinding operations.  Z_importante.jpg **Important**       * Grinding is prohibited before **10000 h** of operation on all engines provided with an EPA name plate (refer to [**Par. 1.3**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=51&parent=1088) ). * The grinding involved is of **+0.20, +0.50 e + 1 mm** . * Cylinder grinding operations must observe **KOHLER SPECIFICATIONS - cod. ED0035612500.** * Grinding must be strictly performed on all cylinders **F** .   **Tab. 8.1a** details the dimensional values of new components only.   * (1) The increase of **+0.20 mm** , may already be present on the engine.   **Tab 8.1a *Grinding values***   |  |  |  |  | | --- | --- | --- | --- | | **PISTON** | **Ø CILINDER (± 0.007 mm)** | **Ø PISTON (± 0.007 mm)** | **CLEARANCE VALUE (mm)** | | STD | 88.010 | 87.950 | 0.046 - 0.074 | | +0.20 (1) | 88.210 | 88.150 | | +0.50 | 88.510 | 88.450 | | +1.00 | 89.010 | 88.950 |   imm8_2.jpg **Fig 8.2** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **8.2.3 4-cylinder camshaft housing check**    The camshaft housings only contain the timing system side bushing **Q** . Use an internal dial gauge to measure the diameters of housings **X - W - K - Y - Z** . With a micrometer, measure the diameters of gudgeon pins **X1 - W1 - K1 - Y1 - Z1 (Fig. 8.4)** . According to the values measured, calculate the clearance between the housing and gudgeon, which is to observe the    values in **Tab. 8.2a** . The **MAX** value of wear allowed is **0.120 mm**    Z_importante.jpg **Important**       * **Tab. 8.2a** details the dimensional values of new components only. | **Tab 8.2a *Housing and camshaft gudgeon dimensions.***   |  |  |  | | --- | --- | --- | | **REF.** | **DIMENSIONS (mm)** | **CLEARANCE VALUE (mm)** | | **X** | 44.000 - 44.025 | 0.040 - 0.085 | | **X1** | 43.940 - 43.960 | | **W** | 43.000 - 43.025 | 0.060 - 0.105 | | **W1** | 42.920 - 42.940 | | **K** | 42.000 - 42.025 | 0.060 - 0.105 | | **K1** | 41.920 - 41.940 | | **Y** | 41.000 - 41.025 | 0.060 - 0.105 | | **Y1** | 40.920 - 40.940 | | **Z** | 36.000 - 36.025 | 0.060 - 0.105 | | **Z1** | 35.920 - 35.940 | |
| imm8_3.jpg **Fig 8.3** | |
| **8.2.3.1** **Block Surface Flatness**    Use a dial gauge to check if the cylinder head surface  **A1**  is level.  The  **MAX**  value of allowable irregularity of surface  **A1**  is:   * 0.10 mm on the entire area; * 0.03 mm on an area of 100x100 mm.   Grinding of surface  **A1**  is not permitted | 8.2.jpg  **Fig 8.3a** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **8.2.4 Camshaft control for 4 cylinder engine**  With a micrometer, measure the maximum dimensions of intake camshaft **R** and exhaust camshaft **S (Tab. 8.2b)** . The **MAX** value of wear allowed is **0.1 mm** .    Z_importante.jpg **Important**         * **Tab. 8.2b** details the dimensional values of new components only. | **Tab 8.2b *Camshaft dimensions.***   |  |  | | --- | --- | | **REF.** | **DIMENSIONS (mm)** | | **R** | 32.638 - 32.700 | | **S** | 32.998 - 32.060 | |
| imm8_4.jpg **Fig 8.4** | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **8.2.5 3** **-cylinder camshaft housing check**  The camshaft housings only contain the timing system side bushing **Q** . Use an internal dial gauge to measure the diameters of housings **X - W - K - Z** . Use an internal dial gauge to measure the diameters of housings **X1 - W1 - K1 - Z1 (Fig. 8.5)** . According to the values measured, calculate the clearance between the housing and gudgeon, which is to observe the    values in **Tab. 8.2a** . The **MAX** value of wear allowed is **0.120 mm**    Z_importante.jpg **Important**       * **Tab. 8.3a** details the dimensional values of new components only. | **Tab 8.3a *Housing and camshaft gudgeon dimensions.***   |  |  |  | | --- | --- | --- | | **REF.** | **DIMENSIONS (mm)** | **CLEARANCE VALUE (mm)** | | **X** | 44.000 - 44.025 | 0.040 - 0.085 | | **X1** | 43.940 - 43.960 | | **W** | 43.000 - 43.025 | 0.060 - 0.105 | | **W1** | 42.920 - 42.940 | | **K** | 42.000 - 42.025 | 0.060 - 0.105 | | **K1** | 41.920 - 41.940 | | **Z** | 36.000 - 36.025 | 0.060 - 0.105 | | **Z1** | 35.920 - 35.940 | |
| imm8_5.jpg **Fig 8.5** | |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **8.2.6 Camshaft control for 3 cylinder engine**  With a micrometer, measure the maximum dimensions of intake camshaft **R** and exhaust camshaft **S (Tab. 8.3b)** . The **MAX** value of wear allowed is **0.1 mm** .    Z_importante.jpg **Important**         * **Tab. 8.3b** details the dimensional values of new components only. | **Tab 8.3b *Camshaft dimensions***   |  |  | | --- | --- | | **REF.** | **DIMENSIONS (mm)** | | **R** | 32.834 - 32.896 | | **S** | 33.335 - 33.397 | |
| imm8_6.jpg **Fig 8.6** | |

## Tappets and tappet housings

|  |  |
| --- | --- |
| **8.3.1 Tappets check**  Use a surface plate and a dial gauge as shown in **Fig. 8.7** . Check the perpendicularity of the plate **C** , making the tappet **D** rotate in the direction of the arrow. The **MAX** value of wear allowed is **0.02 mm** .  With a gauge, check the length of value **A and B (Tab. 8.4)** . The **MAX** value of wear allowed is **0.08 mm** . | imm8_7.jpg **Fig 8.7** |
| **8.3.2 Tappet housing check**  Use an internal dial gauge to measure the diameter of the tappet housings **X** . Use value of **A** detected **(Par. 8.3.1)** to calculate the clearance value ( **Tab. 8.4** ). If the clearance values are not observed, replace the worn component.    Z_importante.jpg **Important**          **Tab. 8.4 *T*** ***appets and t*** ***appet housing size.***   |  |  |  | | --- | --- | --- | | **REF.** | **DIMENSIONS (mm)** | **CLEARANCE VALUE (mm)** | | A | 11.966 - 11.984 | 0.060 - 0.105 | | X | 12.000 - 12.018 | | B | 46.5 ± 0.2 | --- | | imm8_8.jpg **Fig 8.8** |

## Crankshaft

**8.4.1 Dimensional check and overhauling**

Wash the crankshaft thoroughly using suitable detergent.

Insert the pipe cleaner into all lubrication ducts **B** and blow compressed air to free them completely from any dirt residues.  
Check the state of wear and integrity of journals **C** and connecting rod **D** .

Perform the operations described in [**Par. 9.3.1**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=160&parent=1000) , perform the operations described in [**Par. 9.3.6**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=160&parent=1000) - except Points **2, 4, 9 and 10** .  
Measure the crank pins **A1** with a micrometer, and using a dial gauge measure the internal diameter of the connecting rod half-bearings **A2** .  
Measure the main journals **B1** , with a micrometer, and using a dial gauge measure the internal diameter of the crankshaft half-bearings **B2** .  
If the values described in **Tab. 8.5** do not correspond, proceed with grinding all gudgeon pins **A1 and B1** .

Gear **A** on the crankshaft is timed by a key, assembly of gear **A** on the shaft occurs after heating at a stabilized temperature of +180° C for 5 mins.

 **Fig 8.9**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Z_importante.jpg **Important**         * The crankshaft and connecting rod must be replaced every time they are assembled to prevent seizure, as they are made of special lead-free material. * The **MAX** allowed value of wear for **A1 and A2** is 0.120 mm. * The **MAX** allowed value of wear for **B1 and B2** is 0.120 mm. * To grind the crankshaft, a decrease in diameter of the halfbearings and connecting rod is provided for at 0.25 mm and 0.50 mm, to grind gudgeon pins **A1 and B1** , measure the values of diameters **A2 and B2** by assembling the decreased half-bearings, define the diameter to grind of pins **A1 and B1** , observing the clearance indicated in **Tab. 8.5.** * La **Tab. 8.5** riporta i valori dimensionali solo per i componenti nuovi. | **Tab 8.5 *Connecting rod and journal diameter***   |  |  |  | | --- | --- | --- | | **REF.** | **DIMENSIONS**  **(mm)** | **CLEARANCE VALUE (mm)** | | **A1** | 53.981 - 54.000 | 0.035 - 0.085 | | **A2** | 54.035 - 54.066 | | **B1** | 63.981 - 64.000 | 0.035 - 0.102 | | **B2** | 64.035 - 64.083 | |
| **8.4.2 Checking the axial clearance of the crankshaft**  Perform the operations described in [**Par. 9.3.5 and 9.3.6**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=160&parent=1000) .    Using a dial gauge, measure the axial shift of crankshaft **E** . Axial shift must be a **MIN** of 0.18 mm and **MAX** 0.38 mm.. If the values measured do not correspond, replace shoulder rings **D** . | imm8_10.jpg **Fig 8.10** |

## Connecting rod - piston assembly

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **8.5.1 Connecting rod dimensions check**    Z_importante.jpg **Important**         * Before assembling the connecting rod and pistons ( [**Par. 9.3.7 e 9.3.8**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=160&parent=1000) ), check that the difference in weight between the complete connecting rod and piston units do not exceed 8 gr to prevent weight imbalances during rotation of the crankshaft and consequent damage. * Mark some references on the connecting rods, caps **Q** , pistons and gudgeon pins to prevent unintentionally confusing the components during assembly. Failure to do this may result in engine malfunctions. * Connecting rod half-bearings **S** must be there with each assembly.   Check that the contact surfaces are perfectly clean and intact.  Assemble the connecting rod cap **Q** to the connecting rod with the half-bearings **S** and tighten capscrews **P** (tightening torque at **25 Nm** ). With a dial gauge, measure diameters **B and D** . The **MAX** allowed value of wear for **B and D** is **0.06 mm.  Tab 8.6**   |  |  |  | | --- | --- | --- | | **REF.** | **DIMENSIONS (mm)** | **CLEARANCE VALUE (mm)** | | **A** | 169.980 - 170.020 |  | | **B** | 30.020 - 30.030 | 0.025 - 0.030 | | **C** | 29.995 - 30.000 | | **D** | 54.035 - 54.066 |  | | **E** | 67.700 - 68.000 |  | | **F** | 29.750 - 29.790 |  |     Z_importante.jpg **Important**       * **Tab. 8.6** details the dimensional values of new components only. * Check that the connecting rod and crankshaft half-bearings are coupled properly. * Refer to the warnings in [**Par. 8.4.1**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=154&parent=1000) for value **D** decreased. * If the clearance value between **B and C** is not observed, you are required to replace bearing **R (Fig. 8.12)** .     Measure value **A, C, D, E and F** and confront them with those described in **Tab.8.6** . If the measured values do not follow those described in **Tab.8.6** , replace connecting rod **T** . | imm8_11.jpg **Fig 8.11**imm8_12.jpg **Fig 8.12**imm8_13.jpg **Fig 8.13** |
| **8.5.2 Checking the gudgeon pin-pin axes are parallel**    Lubricate gudgeon pin **A** and bearing **R (Fig. 8.12)** . Insert the gudgeon pin into bearing **R** . Use a dial gauge to check the axis parallelism of the connecting rod big end and small end.    Parallel deviation (value **V** ) measured at the tip of the gudgeonpin, must be a **MIN** of 0,015 and **MAX** of 0,030 mm. If the parallelism values do not comply with the specified ones,replace the connecting rod with a new one.  **8.5.3** **Piston rings check**  Insert ring **U** into the cylinder, measure value H (distance between the points of ring **U** ). Repeat for all the seal rings.    If the measured value **H** does not correspond to the values indicated in the table **(Tab. 8.7)** , replace the seal rings **U** .  Z_importante.jpg **Important**       * Seal rings cannot be replaced separately.     **NOTE:** refer to **Fig. 8.19** to locate the rings.  **Tab. 8.7**   |  |  | | --- | --- | | **RINGS** | **H (mm)** | | U1 | 0.100 - 0.300 | | U2 | 0.250 - 0.500 | | U3 | 0.250 - 0.400 | | imm8_14.jpg **Fig 8.14**imm8_15.jpg **Fig 8.15** |
| **8.5.4 Piston dimension check**  Clean the piston thoroughly. Measure the diameter of the piston at 12 mm (quota **L** ) from the base of the skirt in correspondence with the graphite lubrication windows **M** .  Refer to **Tab. 8.1b** to establish the clearance value of the pistons with a decreased diameter. In correspondence with point **W** , there are: 3 digits for the STD piston;    3 digits followed by **R** for a piston with an increased diameter of 0.20 mm; +0.5 for a piston with an increased diameter of 0.50 mm;    +1 for a piston with an increased diameter of 1.00 mm;  If clearance between cylinder and piston is greater than 0,074 mm, the piston and seal rings must be replaced.  Z_importante.jpg **Important**       * **Tab. 8.1b** details the dimensional values of new components only.   **Tab. 8.1b**   |  |  |  |  | | --- | --- | --- | --- | | **PISTON** | **Ø CYLINDERS**  **(± 0.007 mm)** | **Ø PISTON (± 0.007 mm)** | **CLEARANCE VALUE**  **(mm)** | | STD | 88.010 | 87.950 | 0.046 + 0.074 | | +0.20 | 88.210 | 88.150 | | +0.50 | 88.510 | 88.450 | | +1.00 | 89.010 | 88.950 | | imm8_16.jpg **Fig 8.16**imm8_17.jpg **Fig 8.17** |
| Z_importante.jpg **Important**       * With a feeler gauge, measure the clearance of the seal ring in the respective seat (value **L1, L2 e L3** ). * If the clearance does not comply with the values shown in the **Tab. 8.8** , replace the seal rings and the piston.   **Tab 8.8**   |  |  | | --- | --- | | **SEAL RINGS** | **CLEARANCE VALUE (mm)** | | **U1 (L1)** | 0.110 - 0.150 | | **U2 (L2)** | 0.070 - 0.115 | | **U3 (L3)** | 0.030 - 0.065 | | imm8_18_8_19.jpg **Fig 8.18 e 8.19** |

## Cylinder head

|  |  |
| --- | --- |
| **8.6.1 Flatness check**  Put the cylinder head on a surface plate and, with a dial gauge, check the flatness of surface **C** .  The **MAX** value of allowable irregularity of surface **C** is 0.10mm. If the value is not observed, you are required to grind surface **C** . The **MAX** removal allowed is 0.20 mm.    Z_importante.jpg **Important**       * Grinding is to be performed with sleeves **A** of the electronic injectors assembled. * Grinding is prohibited on all engines provided with an EPA name plate (refer to [**Par. 1.3**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=51&parent=1000) ). | imm8_20.jpg **Fig 8.20a -** **Fig 8.20b** |
| **8.6.2 Valve seats check**  Measure indentation **B** of each valve with regard to the cylinder head surface **C** , which is to be a **MIN** of 0.60 mm and **MAX** of 0.85 mm. The **B MAX** indentation allowed on worn components is 1.10 mm.    If the measured value does not correspond with the values indicated, replace the worn component.    Z_importante.jpg **Important**       * The seats must be worked after driving to reach value **B** , go to a rectification workshop for such operations.   **8.6.3 Valve springs**    Using a dynamometer, subject the spring to two different forces **(in Tab. 8.9)** and check that the length of the spring corresponds to the values indicated in the table.  (\*1) The code **ED0057551850-S** is installed from **S/N 4418801760**    **Tab 8.9**   |  |  |  |  | | --- | --- | --- | --- | | **WEIGHT (kg)** | | **LENGHT (mm)** | | | **ED0057552810-S** | **ED0057551850-S (\*1)** | | 0 | 0 | **Z** | 48.34 | | 13.5 | 20.4 | **Z1** | 30.00 | | 19.5 | 29.8 | **Z2** | 22.00 | | imm8_21.jpg **Fig 8.21**imm8_22.jpg **Fig 8.22** |
| **8.6.4 Valve guides check**  Measure the diameters **D** and **E** of the rods and guides valve **(Tab. 8.10)** . If the diameters don't correspond to the values indicated, replace the valves or guides.  The **MAX** allowed value of wear for **D and E** is 0.10 mm.    Observe values **G** from surface **F** when assembling guides **H (Tab. 8.10)** .    Z_importante.jpg **Important**       * Carry out the measurements in different points to detect any ovalisation and/or concentrated wear. * **Tab. 8.10** details the dimensional values of new components only.   **Tab 8.10 *Valve stem - valve guide dimensions***   |  |  |  | | --- | --- | --- | | **REF.** | **DIMENSIONS (mm)** | **CLEARANCE VALUE (mm)** | | **D** | 5.978 - 5.990 | 0.040 - 0.064 | | **E** | 6.030 - 6.042 | | **G** | 7.000 - 7.020 |  | | imm8_23.jpg **Fig 8.23** |
| **8.6.5 Valve guides replacement**  The intake and exhaust guides are both made out of grey iron with pearlitic phosphoric matrix and they have the same dimensions.    The guides are press-fit assembled; assembly is possible by cooling the guides with the aid of liquid nitrogen.      Before assembling a new guide, measure value **L and M** ,calculate the press-fit value, which must observe the values in **Tab. 8.11** .    Observe values **G** from surface **F** when assembling guides **H (Tab. 8.10 - Fig. 8.23)** .    Z_importante.jpg **Important**       * The guides must be worked for value **E (Tab. 8.10 - Fig.8.23)** after driving. Contact a rectification workshop for such operations.   **Tab 8.11 *valve guides - housing dimensions***   |  |  |  | | --- | --- | --- | | **REF.** | **DIMENSIONS (mm)** | **PRESS-FIT VALUE (mm)** | | **L** | 10.000 - 10.015 | 0.030 - 0.054 | | **M** | 10.045 - 10.054 | | imm8_24.jpg **Fig 8.24** |
| **8.6.6 Rocker arm check**  Measure values **W1** in correspondence with holes **M** located on rocker arm gudgeon **L** (seen from  **B** in **Fig. 8.25** ). Measure values **W2 (Fig. 8.27).** Based on the values measured, calculate the clearance between  **W1** and **W2** , which is to observe the values in **Tab. 8.12.** Check that all oil pipes **N** and **M** are free from impurities or obstructions.  **Tab 8. *12***   |  |  |  | | --- | --- | --- | | **REF.** | **DIMENSIONS (mm)** | **CLEARANCE VALUE (mm)** | | **W1** | 19.985 - 20.005 | 0.035 - 0.076 | | **W2** | 20.040 - 20.061 |   8.26.png  **Fig. 8.26** | 8.25.png  **Fig 8.25**  8.27.png  **Fig 8.27** |

## Oil pump check

|  |  |
| --- | --- |
| **8.7.1 Dimensional and visual check**  Perform the operations described in [**Par.7.8.1 and Par.7.8.4.**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=141&parent=1000)    Measure clearance value **B**  between the rotor teeth, the value of allowable wear is **MAX** 0.28 mm.    Clean all the components thoroughly, check that the work surfaces **C** of the rotors and pump body are not worn.    Z_importante.jpg **Important**         * Should the results from checks carried out not be in accordance with the conditions described, replace the timing system carter together with the oil pump.   On assembly, references **A** must be visible. | imm8_25.jpg **Fig 8.28**imm8_26.jpg **Fig 8.29** |
| **8.7.2** **R otors clearance check**    Z_importante.jpg **Important**    Replace carter **R** complete with its oil pump, if there are signs of wear in area **P** of surface **Q (Fig. 8.32 - 8.32a)** .  Measure values **G and H (Fig. 8.30)** . Measure values **L, M and N (Fig. 8.31)** . According to the values measured, calculate the clearance between **G and H, L and M and L and N** which are to observe the values in **Tab. 8.** **13** .    For assembly, carry out the operations described from [**Par. 9.11.3 to Par. 9.11.4**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=167&parent=1000) . | imm8_27.jpg **Fig 8.30** |
| **Tab 8.13**   |  |  |  | | --- | --- | --- | | **REF.** | **DIMENSIONS (mm)** | **CLEARANCE VALUE (mm)** | | **G** | 82.820 - 82.855 | 0.032 - 0.075 | | **H** | 82.500 - 82.540 | | **L** | 15.500 - 15.525 | 0.036 - 0.086 | | **M** | 15.464 - 15.489 | | **N** | | imm8_28.jpg **Fig 8.31** |
| 8.32.png **Fig 8.32** - **Fig 8.32a** | |
| **8.7.3 Oil pressure valve check**  Measure the free length **F** of spring **D** , which must be **47.91 mm** . If the measured value does not correspond to the value indicated, replace spring **D** .    **Tab 8.14**   |  |  | | --- | --- | | **POS** | **DESCRIPTION** | | **B** | Oil stopper | | **C** | Gasket | | **D** | Spring | | **E** | Piston | | imm8_30.jpg **Fig 8.33** |

# Assembly information

## Information on engine configuration

* In this chapter, the engine is represented as **"BASE CONFIGURATION"** (refer to [**Par 1.4**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=96&parent=1000) **-** [**Par.**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=97&parent=1000) [**1.5**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=97&parent=1000) ).
* For the assembly of components not described in this chapter refer to [**Chap. 11**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=176&parent=1000) .
* The following are the components described in [**Chap. 11**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=176&parent=1000) .

**11.1** [**Oil dipstick in cylinder head**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=176&parent=1000) **11.2** [**Heater (replacement)**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=177&parent=1000) **11.3** [**Poly-V alternator belt (replacement and adjustment)**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=178&parent=1000) **11.4** [**Tightening pulley and alternator for Poly-V belt**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=179&parent=1000) **11.5** [**Idler gear (for 3 rd / 4 th PTO)**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=180&parent=1000) **11.6** [**3 rd PTO (replacement)**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=181&parent=1000) **11.7** [**4 th PTO (replacement)**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=182&parent=1000) **11.8** [**3 rd + 4 th PTO (configurations)**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=364&parent=1000) **11.9** [**Balancer shafts (replacement)**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=183&parent=1000) **11.10** [**Air filter (cartridge replacement)**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=184&parent=1000) **11.11** [**Remote oil filter (disassembly and assembly)**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=185&parent=1000) **11.12** [**Oil sump with supporting structure**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=821&parent=1000)

**11.13** [**ETB (REPLACEMENT)**](https://iservice.lombardini.it/jsp/Template4/manuale.jsp?id=2663&parent=1088)

**11.14** [**ACACT (REPLACEMENT)**](https://iservice.lombardini.it/jsp/Template4/manuale.jsp?id=2665&parent=1088)

**11.15** [**EGTS (REPLACEMENT)**](https://iservice.lombardini.it/jsp/Template4/manuale.jsp?id=2666&parent=1088)

**11.16** [**DPF & DOC filter (REPLACEMENT)**](https://iservice.lombardini.it/jsp/Template4/manuale.jsp?id=2667&parent=1088)

**11.17** [**Oil dipstick on timing gear side**](https://iservice.lombardini.it/jsp/Template4/manuale.jsp?id=2675&parent=1088)

## Assembly recommendations

* The information is laid out in sequence, the intervention methods have been selected, tested and approved by the manufacturer's technicians.
* This chapter describes the installation procedures for the assemblies and/ or individual components which have already been checked, overhauled or possibly replaced with original spare parts.
* Where necessary, reference to special tools during assembly operations is indicated and identified in [**Tab. 13.1**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) , [**Tab. 13.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) and [**Tab. 13.3**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) hereinafter in **Tab. 9.1** an example of a special tool ( [**ST\_05**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ).

**Tab. 9.1**

|  |  |  |  |
| --- | --- | --- | --- |
| **SPECIAL TOOLS** | | | |
| **"ST" Code** | **Picture /draw** | **DESCRIPTION** | **PART NUMBER** |
| **ST\_05** | ST_05.jpg | Six nicks Key SN 8 | ED0014603650-S |

Z_importante.jpg **Important**

* Before proceeding with operations, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) .
* To easily locate specific topics, the reader should refer to the **analytical index** or **chapter index** .
* The operator must check that:
  + the components, the assemblies, the coupling surfaces of the parts are washed, clean and thoroughly dried;
  + the coupling surfaces are undamaged;
  + the equipment and tools are ready so that all work can be carried out correctly and safely;
  + ensure that the working environment is safe.
* The operator must:
  + carry out the procedures smoothly and safely. It is thus recommended to install the engine on a special rotating stand used when servicing engines to ensure the safety of the operator and the other individuals involved;
  + tighten the assemblies and / or components in a criss-cross or alternating pattern, initially with a value lower than that preset, and then subsequently, with the tightening torque specified in the procedure;
  + replace all seal gaskets after each assembly for all components on which they are provided.

## Engine block assembly

|  |  |
| --- | --- |
| **9.3.1 Crankshaft bushings**    Z_importante.jpg **Important**       * Execute the procedure in [**Par. 8.2.1 and 8.2.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=152&parent=1000) , before proceeding with assembly.. * The crankshaft half-bearings are made of special material. Therefore, they must be replaced every time they are assembled to prevent seizures.  1. Fit the new half-bearings **B** onto the crankcase upper half **E** adhering to the reference notches **C** .         Z_importante.jpg **Important**       * After the half-bearings are fitted, check that the lubrication holes **D** correspond with the crankcase grooves **E** . * The lower and upper half bearings **CANNOT** be singularly replaced, and both halves must be replaced together.  1. Fit the new half-bearings **S** onto the lower crankcase **F** using the reference notches **C** . 2. Lubricate the half-bearings **A and B** with oil. | imm9.1.jpg **Fig 9.1**imm9.2.jpg **Fig 9.2** |
| **9.3.2 Tappets**   1. Lubricate the tappets **G** with oil. 2. Insert the tappets **G** into the housings **H** of the upper crankcase. | imm9.3.jpg **Fig 9.3** |
| **9.3.3 Camshaft**   1. Check that the bushing **Q** is correctly fitted. 2. Lubricate the pins **L** , the cams **M** of the camshaft **N** , all the housing **P** and the bushing **Q** with oil. 3. Insert the camshaft **N** all the way into its housing **P** . 4. Fit the lock ring **R** on to the crankcase **E** to hold the position of the camshaft **N** . 5. Manually rotate the camshaft **N** ensuring that it is free. | imm9.4.jpg **Fig 9.4** |
| **9.3.4 Oil spray nozzles**   1. Insert the sprayers **V** onto the upper crankcase **E** manually screwing the screw fittings **U** . 2. Direct the sprayers **V** as shown **Z** and tighten the connecting screws **U** (tightening torque of **10 Nm** ). | imm9.5.jpg **Fig 9.5** |
| **9.3.5 Crankshaft**    Z_importante.jpg **Important**       * Carry out the checks described in [**Par. 8.4.1 and Par. 8.4.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=154&parent=1000) .  1. Check that the crankshaft half-bearings are mounted correctly on the upper crankcase **E** . 2. Lubricate the main journal and crankpin **J** , with oil. 3. Insert the crankshaft **W** into its seat on the upper crankcase **E** . 4. Insert the 2 shoulder half-rings **K** , between the crankshaft **W** and the upper crankcase **E** ( **AB** detail). | imm9.6.jpg **Fig 9.6** |
| **9.3.6 Lower crankcase**   1. Check that the crankshaft half-bearings are mounted correctly on the lower crankcase **F** ( **AC** detail). 2. Assemble the 2 shoulder half-rings **AD** onto the lower crankcase **F** applying two drops of grease to keep them in their seat. 3. Check that the coupling surfaces **AE** are free from dirt and grit. | imm9.7.jpg **Fig 9.7** |
| 1. Spread a bead of **Loctite 5660 (rif. AL)** of approx **1 mm** thickness on the surface **AM** of the upper crankshaft half **C** being careful not to block the oil feed grooves **AG** and the return oil sump **AH** . 2. Join the two crankshaft halves **E and F** observing the guide pins **AN** . | imm9.8.jpg **Fig 9.8** |
| Z_importante.jpg **Important**       * Failure to adhere to the bolt fixing procedures may compromise the functionality of the engine, and may also cause damage to persons and property.  1. Tighten the fastening screws strictly following the sequence and the tightening torque indicated. **Tightening sequence for 3 cylinders** Tightening Screws **Torx M12x1.25** (from the **n° 1** to the **n° 8** ): CYCLE 1 - with a torque of **40 Nm** ; CYCLE 2 - with a torque of **70 Nm** ; CYCLE 3 - with a torque of **120 Nm** .     Tightening Screws **M8x1.25** (from the **n° 9** to the **n° 21** ): CYCLE 4 - with a torque of **20Nm** ; CYCLE 5 - with a torque of **35** **Nm** ;   1. Perform the operations described in [**Par. 8.4.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=154&parent=1000) . 2. Check that crankshaft **W** rotates smoothly.     **NOTE:** In the next illustrations of **Par. 9.1** the coupled crankcase half will be indicated with the letter **E** . | ***3******Cylinders***  Fig._9.9.jpg   **Fig 9.9** |
| 1. **Tightening sequence for 3 cylinders** Tightening Screws **Torx M12x1,25** (from the **n° 1** to the **n° 10** ): CYCLE 1 - with a torque of **40 Nm** ; CYCLE 2 - with a torque of **70 Nm** ; CYCLE 3 - with a torque of **120 Nm** .     Tightening Screws **M8x1.25** (from the **n° 11** to the **n° 27** ): CYCLE 4 - with a torque of **20Nm** ; CYCLE 5 - with a torque of **35** **Nm** ;   1. Perform the operations described in  [**Par. 8.4.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=154&parent=1000) . 2. Check that crankshaft **W** rotates smoothly. | ***4******Cylinders***  Fig._9.10.jpg **Fig 9.10** |
| **9.3.7 Piston rings**   1. Perform the operations described in [**Par. 8.5.3**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=155&parent=1000) . 2. Put the scraper ring **AP** onto the piston **AQ** . 3. Put the 2° seal ring **AR** on the piston **AQ** . 4. Put the 1° seal ring **AS** onto the piston **AQ** . | imm9.11.jpg **Fig 9.11** |
| 1. Perform the operations described in [**Par. 8.5.4**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=155&parent=1000) . 2. Position the segment openings with a 120° angle between them ( **Y** ).   **NOTE:**  do not use the segment opening with the pin hole ( **N** )   1. Lubricate the piston skirt and piston rings with oil. | 9_3_7.png **Fig 9.12** |
| **9.3.8 Piston**    Z_importante.jpg **Important**       * Before proceeding to the assembly of the piston and connecting rod, carry out the checks described in [**Par. 8.5.1**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=155&parent=1000) . * Always replace the bearings **CE** after each assembly. * Mate components respecting references at [**Par. 7.15.5**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=160&parent=1000) .  1. Loosen the screws **AU** and remove the connecting rod cap **AV** . 2. Fit the new bearings **CE** . 3. Insert the connecting rod **AZ** into the piston **AQ** and align the seats **BA** . 4. Insert the gudgeon pin **BB** into the seat **BA** for the assembly of the connecting rod and piston unit. 5. Insert the lock rings **BD** inside the seat **BE** of the piston **AQ** to lock the gudgeon pin **BB** . | imm9.13_9.14.jpg **Fig 9.13**imm9.14_9.15.jpg **Fig 9.14 - Fig 9.15** |

|  |  |
| --- | --- |
| **9.3.9 Piston and connecting rod assembly**    Z_importante.jpg **Important**       * Before assembling the piston and connecting rod assemblies, execute the controls described in [**Par. 8.5.5**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=155&parent=1000) .  1. Rotate the crankshaft **W** by moving the crankpin **BG** to a TDC position of the affected cylinder. | imm9.16.jpg **Fig 9.16** |
| 1. Lubricate the piston skirt and rings **AQ** . 2. Check that the half-bearing **AS** is mounted correctly and lubricate it thoroughly. 3. Using the piston ring compression pliers, insert the piston inside the cylinder **BQ** by around 10mm (height **BM** ).       Z_importante.jpg **Important**       * Make sure you are at the stage described in **Point 1** . * The piston **AQ** must be mounted with the arrow **BN** (stamped on the piston crown) facing the timing system side.  1. Rotate the piston **AQ** by **10°** counter-clockwise with respect to its correct assembly position ( **Fig. 9.18** - height **BP** ).   **NOTE:** Doing this prevents the impact between the connecting rod **AZ** and the sprayer **V** . | imm9.17.jpg **Fig 9.17**imm9.18.jpg **Fig 9.18**imm9.19.jpg **Fig 9.19** |
| Z_importante.jpg **Important**         * Leave the ring compressor assembled on the piston  1. Push piston **AQ** downwards without introducing the segments in the cylinder, rotate piston **AQ** by **10°** in a clockwise direction (value **BR** – correct assembly position). | imm9.20.jpg **Fig 9.20** |

|  |  |
| --- | --- |
| 1. Push the piston **AQ** downwards by centering the crankpin **BG** with the connecting rod **AZ** . 2. Turn the crankcase on support to assemble the con rod capp on cylinder 1 and 4. 3. Check that the half-bearing **AS** is mounted correctly on the connecting rod cap **AV** .       Z_importante.jpg **Important**       * Check that the break levels of connecting rod cap AV coincide perfectly onto connecting rod AZ before screwing on and tightening capscrews AU.  1. Couple the connecting rod cap **AV** to the connecting rod **AZ** using the marks made at disassembly ( [**Par. 7.15.2 and 7.15.5**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=148&parent=1000) ). 2. Screw in the screws **AU** . 3. Repeat the operations from 1 to 10 for each cylinder.         Z_importante.jpg **Important**       * Failure to adhere to the assembly procedures may compromise the functionality of the engine, and also cause damage to persons and property.  1. Tighten the screws **AU** , alternately, strictly following the tightening torques indicated.     Tightening sequence of screws **Torx M10x1** : **1° CYCLE -** with a torque of **40 Nm; 2° CYCLE** - with a torque of **85 Nm** ;     1. Check that the connecting rods have axial play and the crankshaft **W** rotates smoothly.     **NOTE:** After the check carried out at point **14** , position the shaft **W** with the first cylinder to TDC. | imm9.21.jpg **Fig 9.21**imm9.22.jpg **Fig 9.22**imm9.23.jpg **Fig 9.23** |
| **NOTE:** Click by side to play the procedure. | <https://www.youtube.com/embed/Ba8qqxTx6wA?rel=0> |
| **9.3.10 Crankshaft gasket flange**      Z_importante.jpg **Important**       * Check that the contact surface between the flange and the crankcase is free of grit and dirt. * Always replace the gasket **BS** at each assembly.      1. Check that there are bushings **BT** on the crankcase **E** . 2. Lubricate the oil seal lip **BU** . 3. Position the gasket **BS** and flange **BV** on the crankcase **E** in correspondence with the bushings **BT** . 4. Put **Loctite 243** on the **2** screws **BW** matching the bushings **BT** . 5. Screw the fastening screws all the way in **BW** without tightening them. 6. Tighten all the screws **BW** strictly following the tightening sequence indicated (tightening torque to **10 Nm** ). | imm9.24.jpg **Fig 9.24**imm9.25.jpg **Fig 9.25** |
| **9.3.11 Cover 3 rd PTO**    Z_importante.jpg **Important**       * Replace capscrews **CA** with each assembly or alternatively apply **Loctite 2701** on the thread.  1. Secure the cover **CB** with the screws **CA** and **CC** inserting the gasket **CD** (tightening torque **25 Nm** ). | imm9.26.jpg **Fig 9.26** |

## Oil sump unit assembly

|  |  |
| --- | --- |
| **9.4.1 Oil vapour pipes**   1. Apply **Loctite 648** on the pipe threads **A** . 2. Screw and tighten the pipes **A** (tightening torque of **15 Nm** ). | imm9.27.jpg **Fig 9.27** |
| **9.4.2 Oil suction pipe**  Z_importante.jpg **Important**       * It is mandatory to replace the gasket **B** after each assembly. * Always replace capscrews **D** with new ones or alternatively apply **Loctite 2701** .      1. Insert the new gasket **B** in the seat of the oil suction hose flange **D** . 2. Secure the hose **C** on the crankcase **E** with the screws **D** (tightening torque **10 Nm** ). | imm9.28.jpg **Fig 9.28** |
| **9.4.3 Oil Sump**   1. Ensure that the contact surfaces **F** of the oil sump **G** and the crankcase **E** are completely clean. 2. Apply a bead of approx. **2.5 mm** of sealant **(Loctite 5660)** on the surface **F** of the oil sump **G** . | imm9.29.jpg **Fig 9.29** |
| Z_importante.jpg **Important**       * Tighten the screws **L** , strictly following the sequence and tightening torque indicated.      1. Tighten the screws **L** following the sequence indicated (tightening torque **25 Nm** ). 2. After tightening all of the screws, loosen screw **n°1** and retighten it to the torque value specified in step **4** . 3. Check that the oil drain plugs **M** are tight (tightening torque **35 Nm** ). | imm9.30.jpg **Fig 9.30** |

## Flange unit assembly

|  |  |
| --- | --- |
| **9.5.1 Bell housing**    Z_Pericolo.jpg **Danger**       * Bell **A** is very heavy; pay special attention during assembly operations to avoid dropping and causing serious risks to the operator.  1. Install the bell housing **A** in accordance with the reference pins **B** on the base **C** . | imm9.31.jpg **Fig 9.31** |
| Z_importante.jpg **Important**       * Failure to adhere to the assembly procedures may compromise the functionality of the engine, and also cause damage to persons and property.  1. Tighten the fastening screws strictly following the tightening sequence indicated (tightening torque **50 Nm** ). | imm9.32.jpg **Fig 9.32** |
| **9.5.2 Flywheel**    Z_Pericolo.jpg **Danger**       * Flywheel **F** is very heavy; pay special attention during assembly operations to avoid dropping and causing serious risks to the operator.  1. Screw the special tool [**ST\_09**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) on the crankshaft **E** instead of the screws **G** positioned higherup ( **Fig. 9.33** ). 2. Insert the flywheel F on the crankshaft **E** using the tool as a guide [**ST\_09**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) and manually tighten all the screws **G** , remove the tool [**ST\_09**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) and install the last screw **G.** 3. Mount the tool [**ST\_34**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) in the seat of the starter motor **H** and fit it with the two starter motor fixing screws. 4. Tighten the screws **G** (tightening torque at **140 Nm** ). | imm9.33.jpg **Fig 9.33** |

## Timing system gear assembly and injection pump

|  |  |
| --- | --- |
| **9.6.1 Timing system gear assembly**   1. Check that the key **A** is correctly fitted on the camshaft **B** . 2. Position the gear **C** on the camshaft B adhering to the key reference **A** . 3. Screw capscrew **D** until the end. 4. Insert the reference pin **E** on the gear **C** . 5. Screw the encoder **F** with the screws **G** on the gear **C** observing the plug **E** . 6. Tighten the middle gear pin **H** , in the housing **J** of the crankcase, with the screws **K** (tightening torque **25 Nm** ).       Z_importante.jpg **Important**       * The fitting of the middle gear pin **H** has only one position, the 4 screw holes **K** are not equally spaced. * Always replace the gasket **L** after each assembly.  1. Insert the shoulder ring **M** . 2. Check the integrity of the bushing **N** on the middle gear **P** , and ensure that it is free from impurities. 3. Thoroughly lubricate the pin **H** and the bushing **N** . 4. Position the gear **P** on the pin **H** observing all the marks **W** of the gears **C and S** , **(Fig. 9.37).**       Z_importante.jpg **Important**       * Failure to comply with the marks **W** on the gears **C, P and S** , causes engine malfunction and serious damage.  1. Insert the shoulder ring **Q** and the lock ring **R** . 2. Tighten the gear **C** with the screw **D** ( **Fig. 9.34** - tightening torque at **100 Nm** ). 3. Tighten the screws **G** on the gear **C** (tightening torque at **5 Nm** ). | imm9.34.jpg **Fig 9.34**imm9.35.jpg **Fig 9.35**imm9.36.jpg **Fig 9.36**imm9.37.jpg **Fig 9.37** |
| **9.6.2 High-pressure injection pump**   1. Check that the surface **V** is free from impurities ( **Fig. 9.38** ).       Z_importante.jpg **Important**       * Always replace gasket **U** with every assembly. * The seal gasket **U** can only be fitted in one direction( **Fig. 9.38** ). * Always replace capscrews **T** with new ones or alternatively apply **Loctite 2701 (Fig. 9.38)** .  1. Fit the new gasket **U** on the injection pump **Z** **(Fig. 9.38)** . 2. Fix the pump **Z** into the housing **V** together with the gasket **U** by the screws **T** ( **Fig. 9. 38** - tightening torque at **25 Nm** ). 3. Check the correct fitting of the key **AA** on the shaft **AB** of the injection pump ( **Fig. 9.39** ). 4. Place the gear **AC** on the shaft **AB** of the pump respecting the reference to the key **AA** and the reference **Q** of the gear **A** **E (Fig. 9.39)** . Serrare il dado **AD** (coppia di serraggio a **65 Nm** ). 5. Remove special tool [**ST\_34**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). | imm9.38.jpg **Fig 9.38**imm9.39.jpg **Fig 9.39**imm9.40.jpg **Fig 9.40** |

## Cylinder head unit assembly

|  |  |
| --- | --- |
| **9.7.1 Valve stem gasket**    Z_importante.jpg **Important**       * Carry out the checks described in [**Par. 8.6.4**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=680&parent=1000) before proceeding with the following operations. * Lubricate the oil seals **A** on the inside.      1. Fit the oil seals **A** on the valve guides **B** using the tool [**ST\_08**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) . | imm9.41.jpg **Fig 9.41** |
| **9.7.2 Electronic injector sleeves** ( operazione_utile.gif **)**   1. Insert the seals **C** in the seats of the sleeve **D** . 2. Insert the seal **E** with the convex side facing upward at the base of the sleeve **D** . 3. Lubricate the gaskets **C** . 4. Insert and carefully screw the sleeve **D** into the seat of the head **F** .     **NOTE:** The sleeve **D** must not protrude above the surface of the head **BF** .     1. Clamp the sleeve **D** (tightening torque at **30 Nm** ). | imm9.42.jpg **Fig 9.42** |
| **9.7.3 Electronic injectors projection**   1. Insert the electronic injector **G** inside the sleeve **H** . 2. Mount the rocker arm pin fixing screw **L** up to the stop. 3. Mount the electronic injector fixing bracket **M** and secure it with the screw **N** , without performing the calibration. 4. Check using [**ST\_03**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) tool **(Fig. 9.44)** , the projection of the injector, which must range between 1.68 ÷ 2.42 mm.     **NOTE** : if the value detected does not correspond, replace gasket **Q** with a different thickness. | imm9.43.jpg **Fig 9.43**imm9.44.jpg **Fig 9.44** |
| **9.7.4 Valves**   1. Pre-lubricate and insert the valves **X** into the head **F** taking care to fit them in the original positions as per the reference marks made in [**Par. 7.13.4.1**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=146&parent=1000) . 2. Position the spring **Y** on the seat of the head **F** . 3. Position the disk **S** on the spring **Y** centering the valve **X** . 4. Mount the tool [**ST\_07**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) on the head **F** fixing it on one of the holes for securing the rocker arm cover.     **NOTE:** Change the fixing hole according to the position of the valves to be fitted.     1. Position the tool [**ST\_07**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) on the valve as shown in the figure. 2. Push the lever of the tool [**ST\_07**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) downwards, in order to lower the valve disks **S** in the direction of the arrow **AK** , and insert the valve cotters **AJ** inside the disk **S** . 3. Check that the valve cotters **AJ** are properly mounted on the valve seats **X** and release the tool [**ST\_07**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) .     **NOTE:** repeat all the steps for the relevant valves and remove the tool [**ST\_07**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) . | imm9.45.jpg **Fig 9.45** |
| imm9.46.jpg **Fig 9.46** |
| imm9.47.jpg **Fig 9.47** |
| **9.7.5 Cylinder head**   1. Fix the eyebolts **AW** with the screws **AX** onto the head **F** (tightening torque of **25 Nm** ). 2. Position the piston **P** at the TDC. 3. Position the tool [**ST\_03**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) on the crankcase surface of the head and measure the piston protrusion **P** from head level **K** in 4 diametrically opposed points **R.** Repeat the operation for all pistons **P** and take note of the highest average value, determining valu **e S (Tab. 9.2)** .     **Tab. 9.2**   |  |  | | --- | --- | | **S (mm)** | **Hole number** | | 0.030 - 0.126 | 1 1foro.jpg | | 0.127 - 0.250 | 2 2fori.jpg | | 0.251 - 0.375 | 3 3fori.jpg |  1. Based on the value detected at point **3** , select the relevant gasket **T** as shown in the **Tab. 9.2 (Fig. 9.50** detail **U** ). 2. Check that the crankcase surface **K** and the gasket **T** are completely free of dirt and grit.       Z_importante.jpg **Important**       * The head gasket must be replaced for each assembly.  1. Position the gasket **T** on the surface **K** with reference to the centering bushings **J** . | imm9.48.jpg **Fig 9.48**imm9.49.jpg **Fig 9.49**imm9.50.jpg **Fig 9.50** |
| 1. Check that the surface head **W** is free from impurities. 2. Position the head **F** on the crankcase **Z** with reference to the centering bushings **J** .       Z_importante.jpg **Important**       * The fastening bolts **V** must be replaced every time they are assembled.  1. Secure the head **F** by tightening the screws **V** strictly following the sequence indicated in the **Fig. 9.52** or **Fig. 9.53** and the tightening torque indicated in the **Tab. 9.3** . | imm9.51.jpg **Fig 9.51** |
| Z_importante.jpg **Important**       * Failure to adhere to the bolt fixing procedures may compromise the functionality of the engine, and also may cause damage to persons and property. * Tighten capscrews **V** observing the cycles, tightening, and subsequent rotation as indicated in **Tab. 9.3** . * For engine **KDI 1903 TCR** : 8 screws **Torx M12x1,25 (Fig. 9.52)** . * For engine **KDI 2504 TCR** : 10 screws **Torx M12x1,25 (Fig. 9.53)** . | **3 CYLINDERS**  Fig._9.49.jpg **Fig 9.52** |
| **Tab. 9.3**   |  |  | | --- | --- | | **CYCLE** | **TORQUE** | | 1 | 40 Nm | | 2 | 70 Nm | | 3 | 100 Nm | | 4 | 90° | | 5 | 90° | | 6 | 90° | | **4 CYLINDERS**  Fig._9.50.jpg **Fig 9.53** |
| **9.7.6 Rods and valve bridges**   1. Insert the rocker control rods **AA** into the niches of the head **F** .     Z_importante.jpg **Important**       * Properly centre the rods **AA** into the spherical housing of the camshaft tappets **AB** .  1. Mount the valve bridge **AC** on to the pairs of discharge and suction valves. | imm9.54.jpg **Fig 9.54** |
| imm9.55.jpg **Fig 9.55** |
| **9.7.7 Rocker arms**    Z_importante.jpg **Important**       * To correctly position the rocker arms, turn the rocker arm pin **AH** with the lower height **AL** towards the timing system side as in **Fig.9.57** . * The discharge rocker arm **AT** is shorter than the suction arm **AR** .      1. Fit the lock ring **AM** into the seat **AN** of the rocker arm pin **AH** . 2. Position the pin **AH** with the screw support surface **AP** facing upwards and insert the 2 shoulder rings **AQ** . 3. Insert in sequence the suction rocker arm **AR** , the holder **AS** and the discharge rocker arm **AT** in the pin **AH .** 4. Insert the spring **AU** in the pin **AH** . 5. Repeat points **3, 4** for all the rocker arms. **NOTE:** The holder **AV** must be fitted with the last pair of rocker arms towards the flywheel. 6. Insert 2 shoulder rings **AQ** and the lock ring **AN** to lock all the components inserted in the pin **AH** . **NOTE** : The spring **AU** ensures that the supports **AS** and **AV** are kept in place. | imm9.57.jpg **Fig 9.57**imm9.58.jpg **Fig 9.58** |
| **9.7.8 Rocker arm pin assembly**    Z_importante.jpg **Important**       * Position the rocker arm pin assembly **BB** on a level to align all the support surfaces. * Check that the pistons are positioned half way between the TDC and BDC. Rotate the crankshaft 90° counterclockwise with regard to the 1st cylinder TDC, positioning the crankshaft pin **BP** as shown in Fig **9.60a** . If the crankshaft pulley and the timing gear cover have not been removed, rotate the crankshaft positioning the reference **BQ** located on the target wheel in correspondence of the speed sensor, as shown in **Fig. 9.60b** . * If the engine is painted or protected with clear paint, replace the fastening screws  **BE** .  1. Position the rocker arm pin assembly **BB** on the head **F** , respecting the plug **BC** on the head using the holder indicated **AV** . 2. Check the correct positioning of all the rocker arms and the u-bolt control valves (detail **BD** ). House the tappet in the seat of the rocker arms control rod. 3. Secure the rocker arm pin **BB** tightening the screws **BE** (tightening torque to **25 Nm** ). Adhere to the screw tightening sequence **BE** as shown in **Fig. 9.60** . | imm9.59.jpg **Fig 9.59**imm9.60.jpg **Fig 9.60** |
| imm9.60A.jpg **Fig 9.60a** | imm9.60B.jpg **Fig 9.60b** |
| **9.7.9 Assembly Rocker arm cover**    Z_importante.jpg **Important**       * Replace gasket **BF, BL and BM** with each assembly **(** [**ST\_11**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **-** [**ST\_12**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **)** . * Observe the order of tightening illustrated in **Fig. 9.62 - 9.63** .      1. Position tool [**ST\_17**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) onto the head in correspondence with the two fastening holes **5 and 6** . 2. Position gasket **BF** on cylinder head **F** using tool [**ST\_17**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) as a guide. 3. With vaseline lubricate the gaskets **BL** in the upper part, and the gaskets **BM** in the lower part. 4. Attach the rocker arm cover **BN** on the head **F** with the screw **BG** (tightening torque to **10 Nm** ). | imm9.61.jpg **Fig 9.61** |
| imm9.62.jpg **Fig 9.62** | imm9.63.jpg **Fig 9.63** |

## Fuel system assembly

|  |  |
| --- | --- |
| Z_importante.jpg **Important**       * Do NOT mount new or different injectors without the required tool ( [**Chap. 13**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). * Remove the protective caps from all the components of the fuel circuit just before assembly just before assembly.   **9.8.1** **Fuel filter**   1. Secure the fuel filter holder **R** with the screws **S** on the crankcase **T** (tightening torque of **25 Nm** ).     **NOTE:** For the assembly of the fuel cartridge, refer to operations **4** and **5** of [**Par. 6.11.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=133&parent=1000) . | imm9.64.jpg **Fig 9.64** |
| 1. Insert the tube **K** on the fitting coming out of the filter holder **R** and on the fuel inlet fitting of the injection pump **M** and secure it with the clamps **N** . | imm9.65.jpg **Fig 9.65** |
| **9.8.2 Common Rail**   1. Secure the rail **AA** on the head **AB** with the screws **AC** (tightening torque at **25 Nm** ). | imm9.66.jpg **Fig 9.66** |
| 1. Fit the gaskets **AD** and the fitting **AE** on the screw **AF** . 2. Tighten the parts so assembled on the Common Rail **AG** (tightening torque at **15 Nm** ) with the entrance of union **AE** facing upward. | imm9.67.jpg **Fig 9.67** |
| **9.8.3 Electronic injectors**    Z_importante.jpg **Important**       * Always replace and lubricate the gaskets **AH and** **AL** of the electronic injectors **AM** with fuel, every time they are assembled. * Pay attention when repositioning the electronic injectors, using the marks as described inl [**Par. 7.10.5**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=143&parent=1000) . * If a new (or different) electronic injector is fitted on the engine, you are required to prepare tool [**ST\_01**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) . * If the engine is painted or protected with clear paint, clean the paint off the diesel injector  **AM  near to the part in contact with the gasket ( BL  >  Fig. 9.61 ) .**  1. Insert the gasket **AL** inside the injector sleeve **BQ** . 2. Insert the electronic injectors **AM** inside the rocker arm cover **AN** and orientate them as per **Fig. 9.68** . | imm9.68.jpg **Fig 9.68** |
| **9.8.4 High pressure fuel pipes**    Z_importante.jpg **Important**       * Always replace the pipes **AQ** and tube **E** after each assembly.      1. Position the pipes **AQ** on the Common Rail **AA** and on the electronic injectors **AM** , adjust the position of electronic injectors **AM** via the fitting inlets with the pipes **AQ.**       Z_importante.jpg **Important**       * Tighten the nuts **AS** and **AT** manually, without clamping them. * If the engine is painted or protected with clear paint, replace the fastening screws  **AU** to ensure the gaskets **BQ** are sealed properly.  1. Position the injector fastening brackets **AV** and the screws **AU** , inserting the washer **AJ** .       Z_importante.jpg **Important**       * Replace the pipes **AQ (Fig. 9.69)** if the screws **AU** do not rotate freely.  1. Tighten all the nuts **AS** (tightening torque at **30 Nm** ). 2. Tighten the nuts **AT** (tightening torque at **25 Nm** ). 3. Make sure that the mounting brackets **AV** are positioned correctly on electroinjectors **BR** and on fixing screws of the rocker arm assembly **AM.** 4. Tighten the fixing screws of the injector mounting bracket (tightening torque of **20 Nm** ). 5. Position the pipe E screwing the screws **BA and BB** .       Z_importante.jpg **Important**       * Screw the nuts **BA** and **BB** manually without tightening them.  1. Tighten the nut **BA** (tightening torque of **30 Nm** ). 2. Tighten the nut **BB** (tightening torque of **25 Nm** ). 3. Tighten the Common Rail fastening screws **BC** (tightening torque of **25 Nm** ). | imm9.69.jpg **Fig 9.69**imm9.70.jpg **Fig 9.70**imm9.71.jpg **Fig 9.71** |
| **9.8.5 Fuel return pipes**   1. Check the gaskets **BD** on the fittings **BG** .     **NOTE:** Do not disconnect the pipes from the distributor. | imm9.72.jpg **Fig 9.72** |
| 1. Position the return pipes and fitting the distributor **BE** with the screw **BC** on the head **BF** ( **Fig. 9.72** - tightening torque of **10 Nm** ). 2. Mount the fittings **BG** ( **Fig. 9.74** ) on the injectors **AM** and lock them with the clips **BH** . 3. Insert the pipe **BL** on the fitting **BN** . 4. Insert the pipe **BM** on the fitting **BP** . | imm9.73.jpg **Fig 9.73** |
| Z_importante.jpg **Important**       * Pipes of a **"BASE CONFIGURATION"** (refer to [**Par. 1.5**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=97&parent=1000) ) engine are shown. Other return pipes can be missing or different. * The pipes can vary in quantity, size and dimensions depending on the engine version. | imm9.74.jpg **Fig 9.74** |

## Intake manifold assembly

|  |  |
| --- | --- |
| **9.9.1 Semi-collettor external**    Z_importante.jpg **Important**       * Check that the contact surfaces between the semi-collector **C** and the head **D** are free from impurities.      1. Insert the special tool [**ST\_18**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) into indicated point. 2. Insert the screws **A** and the gasket **B** on the semi-collector **C** . 3. Secure the semi-collector **C** with the screws **A** on the head **D** (tightening torque of **25 Nm** ). 4. Tighten the clamp **E** with the screw **F** on the semi-collector **C** (tightening torque of **10 Nm -** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). 5. Tighten the screw **G** and the holder **H** on the semi-collector **C** (tightening torque of **10 Nm -** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). | imm9.75.jpg **Fig 9.75**imm9.76.jpg **Fig 9.76** |
| **9.9.2 External half-manifold**    Z_importante.jpg **Important**       * Check that the contact surfaces between the two semi collectors **C** and **M** are free from impurities.      1. Fit the screws **L** on the semi-collector **M** freeing the holes **Q** indicated in **Fig. 9.78** . 2. Mount the gaskets **N** on the semi-collector by interposing the separation sheet **P** . 3. Fit the semi-collector **M** on the semi-collector **C** with the screws **L** (tightening torque of **22 Nm -** [**ST\_05**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). | imm9.77.jpg **Fig 9.77**imm9.78.jpg **Fig 9.78** |

## Exhaust manifold assembly

|  |  |
| --- | --- |
| Z_importante.jpg **Important**       * Replace the self-locking nuts **B** and the metal gaskets **D** between the manifold and the cylinder head every time they are disassembled. * In the event of mounting the studs **C** , fix ( **25 Nm** tightening torque) with **Loctite 2701** on the thread.  1. Check that the contact surfaces **F** are free from impurities. 2. Insert the gaskets **D** and **E** on the studs **C** . 3. Position the manifold **A** on the studs **C** . 4. Fix the manifold **A** on the cylinder head by tightening the self-locking nuts **B** (tightening torque of **25 Nm** ). | imm9.79.jpg **Fig 9.79** |

## Assembly lubrication circuit

|  |  |
| --- | --- |
| **9.11.1 Assembly oil mist separator unit**    Z_importante.jpg **Important**       * Always replace the gasket **B** after each assembly. * Always carefully inspect the condition of the pipes, and replace them if there is any doubt regarding the integrity of their seal.  1. Check that the contact surfaces **A** are free from impurities. 2. Mount the gasket **B** on the holder **C** . 3. Fix the separator body holder **C** on the crankcase **E** with the screws **D** (tightening torque of **12 Nm** ) fitting the gasket **B** . | imm9.80.jpg **Fig 9.80** |
| 1. Fit the pipes **F and G** on the holder **C** . 2. Insert the bleeder **H** attaching it to the pipes **F and G.** Secure the pipe **F** with the clamps **J** . 3. Secure the bleeder **H** onto the holder **C** with the clamp **K** . | imm9.81.jpg **Fig 9.81** |
| **9.** **11 .2 Oil Cooler and oil filter Unit Assembly**   1. Check that the surface **L** on the holder **V** and on the crankcase **E** are free from impurities. 2. Lubricate and insert the gasket **N** on the fitting **P** .       Z_importante.jpg **Important**       * Always replace the gaskets **Q and S** every time they are disassembled.  1. Lubricate and insert the gaskets **Q and S** respectively in the seats **R and T** of the holder **V** . 2. Secure the holder V with the screws AA and AB (tightening torque of **10 Nm** ).       Z_importante.jpg **Important**       * In the event of mounting the fitting **P** on the crankcase **E** (tightening torque of **15 Nm** with **Loctite 2701** on the thread). | imm9.82_9.83.jpg **Fig 9.83 e Fig 9.83** |
| **NOTE:** To assemble the oil cartridge refer to operations **5 and 6** of [**Par. 6.10.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=132&parent=1000) .    Z_importante.jpg **Important**       * Always replace the gaskets **BM and BN** every time they are assembled.  1. Insert and tighten the cartridge-holder cover **AC** on the filter holder **V** (tightening torque of **25 Nm** ). | imm9.84.jpg **Fig 9.84** |
| **9.** **11 .3 Oil pump**  **NOTE:** Carry out the checks described in [**Par. 8.7**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=157&parent=1000) before proceeding with the following operations.     1. Check that all contact surfaces between **AL, AH, AF, AG and AN** are free of impurities – scratches - dents. 2. When assembling, do not use any type of gasket between **AG and AN** . 3. Thoroughly lubricate the seat of the rotors **AF** on the oil pump crankcase **AG** and the two rotors **AH and AL** . 4. Insert, inside the seat **AF** , the 2 rotors (in sequence) **AH and AL** , respecting the reference **BP** as the picture (or refer to [**Par. 2.10.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=104&parent=1000) ). 5. Check that the 2 pins **AM** are inserted properly in the crankcase timing system **AN** . 6. Position the oil pump assembly **AG** using the pin marks **AM.** 7. Fasten the oil pump cover **AG** with the screws **AH** (tightening torque **10 Nm** ). | imm9.85.jpg **Fig 9.85**imm9.86.jpg **Fig 9.86** |
| **9.** **11 .4 Timing system carter**    Z_importante.jpg **Important**       * Always replace the the gasket **AP** after each assembly ( [**ST\_14**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). * Always replace the gasket **AU** after each assembly.  1. Distribute a bead of **Loctite 5188** , of about **1mm** thickness, on the surfaces **AQ** of the crankcase **AN.** 2. Make sure that the key **AS (Fig. 9.88)** is inserted properly on the crankshaft and that it is facing upwards. 3. Lubricate and insert the gasket **AU** in the seat of oil pump **AV** . 4. Apply the tool **ST\_10** onto the crankshaft. 5. Check that the 2 pins **AT** ( **Fig. 9.88** ) are properly insertedin the timing system crankcase **AN** . 6. Lubricate oil seal **AP** with oil and position the carter **AN** on the crankcase **E** , using the pins **AT** , inserting the oil pump **AV** on the crankshaft. 7. Fasten capscrews **AW** observing the indicated clamping sequence (tightening torque of **25 Nm** ). | imm9.87.jpg **Fig 9.87**imm9.88.jpg **Fig 9.88**imm9.89.jpg **Fig 9.89** |
| **9.** **11 .5 Crankcase oil filler flange Timing System**    Z_importante.jpg **Important**       * Always replace the gasket **BA** after each assembly.  1. Position the gasket **BA** in the seat on the flange **BB** . 2. Fasten the flange **BB** on the crankcase **BC** with the screws **BD** (tightening torque of **10 Nm -** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). | imm9.90.jpg **Fig 9.90** |
| **9.** **11 .6 Oil pressure relief valve**   1. Lubricate the piston **BE** and fully insert it in the seat **BF** . 2. Insert the spring **BG** in the piston.       Z_importante.jpg **Important**       * Always replace the gasket **BH** after each assembly.  1. Mount the gasket **BH** on cap **BL** . 2. Tighten the cap **BL** on the crankcase **AN** (tightening torque of **50 Nm** ). | imm9.91.jpg **Fig 9.91** |

## Crankshaft and phonic wheel pulley unit assembly

|  |  |
| --- | --- |
| **NOTE:** To fit the target wheel refer to the operations in [**Par. 6.6.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=128&parent=1000) .   1. Check that the pin **F** is mounted properly on the crankshaft **G** . 2. Position the pulley unit **H** on the crankshaft **G** using the pin mark **F** (detail **M** ). 3. Apply **Molyslip** grease on the screw thread **N** . 4. Fix the pulley **T** with the screw **Z** (tightening torque of **360 Nm** ) and remove special tool [**ST\_34**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000)  ( **Fig. 9.33** ). | imm9.92.jpg **Fig 9.92** |

## Coolant circuit assembly

|  |  |
| --- | --- |
| **9.3.1 Thermostatic valve**    Z_importante.jpg **Important**       * Always replace the gasket **A** after each assembly.      1. Check the condition of the seal gasket **A** and fit it on the thermostatic valve **B** . 2. Position the thermostatic valve **B** in the seat on the head **C** (detail **D** ). 3. Secure the cover **E** with the screws **F** on the head **C** (tightening torque of **10 Nm** ). | imm9.93.jpg **Fig 9.93** |
| **9.13.2 Coolant pump assembly**    Z_importante.jpg **Important**       * Always replace the gasket **L** every time it is assembled.      1. Fit the pump **G** with the screws **H** interposing the gasket **L** (tightening torque of **25 Nm** ). | imm9.94.jpg **Fig 9.94** |
| **9.13.3    Oil Cooler hoses**   1. Assemble the Oil Cooler hose behind the injection pump and connect to oil heat exchanger. 2. Insert hose **L** into clamp **N** . 3. Fasten hose **L** by means of clamp **P** on Oil Cooler **M** . | imm9.95.jpg  **Fig 9.95** |
| 4 **.** Secure the sleeve **Q** on Oil Cooler **M** and to the coolant pump **T** with the clamps **K** . 5. Fasten the clamp **Y** with the screw **S** (tightening torque of **22 Nm** - [**ST\_05**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). | imm9.96.jpg  **Fig 9.96** |

## Turbocharger Assembly

|  |  |
| --- | --- |
| Z_importante.jpg **Important**       * Before proceeding, perform the operation described in [**Par. 2.18**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=113&parent=1000) . * Ensure that tube **B** is not clogged.  1. Fasten the connecting sleeve **A** to the pipe **B** with the clamp **C** onto the flange fitting **D** .       Z_importante.jpg **Important**       * Always replace the gasket **F** after each assembly.  1. Lubricate and insert the gasket **F** into the seat of the pipe **G** .       Z_importante.jpg **Important**       * Remove the plastic or foam caps from the turbo compressor before assembling. * Replace nuts **M** with each assembly.  1. Check that the contact surfaces **E** are free from impurities deformations or cracks, otherwise replace exhaust manifold **L** . 2. Position the turbo-compressor **H** on the bolts on the manifold **L** . 3. Fasten the turbo-compressor **H** with the nuts **M** (tightening torque of **25 Nm** ). 4. Fasten the pipe **G** with the screws **N** to the turbo-compressor **H** .         Z_importante.jpg **Important**       * Always replace the gasket **P** after each assembly. * Before assembly of the tube **Q** , perform the operation described in [**Par. 2.19.2 - point 2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=113&parent=1000) . * Ensure that tube **Q** is not clogged.  1. Fasten the fuel outlet pipe **Q** with the fittings **R** on the turbocompressor **H** and on the crankcase **S** (tightening torque of **15 Nm** ).     Insert the gaskets **P** between: - **Q** and **R** ; - **Q** and **S** ; - **Q** and **H** .     1. Insert the sleeve **T** on the turbo-compressor **H** and secure it with the clamp **U** . 2. Insert the pipe **V** onto the sleeve **T** and onto the relief valve **Z** . Secure tube **V** with the clamps **W** . | imm9.97.jpg **Fig 9.97**imm9.98.jpg **Fig 9.98**imm9.99.jpg **Fig 9.99**imm9.100.jpg **Fig 9.100** |

## Electric component assembly

**9.15.1 Sensors and switches**

|  |  |
| --- | --- |
| **9.15.1.1 T-MAP Sensor**   1. Fasten the sensor **A** with the screws **B** on the manifold **C** (tightening torque of **10 Nm -** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). | imm9.101.jpg **Fig 9.101** |
| **9.15.1.2 Coolant temperature sensor**   1. Secure the sensor **D** onto the head **E** (tightening torque of **20 Nm** ). | imm9.102.jpg **Fig 9.102** |
| **9.15.1.3 Oil Pressure Switch**   1. Clamp the oil pressure switch **F** on the crankcase **G** (tightening torque at **35 Nm** ). | imm9.103.jpg **Fig 9.103** |
| **9.15.1.4 Camshaft phase sensor disassembly**   1. Rotate the crankshaft **H** posizioning a tooth **L** of the target wheel which is mounted on the camshaft at the center of hole **M** . 2. Carry out the steps described in points **5, 6 and 7** to insert the correct number of spacers **N** . 3. Fit the spacer **N** on the sensor **P** . 4. Fasten the phase sensor **P** on distribution guard **L** with the screw **Q** (tightening torque of **10 Nm -** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). | imm9.104.jpg **Fig 9.104** |
| 1. Measure the distance from the coupling surface **AD** to the tooth surface on the target wheel **(X1)** . 2. Measure the distance between the coupling surface **AD** and the sensor surface **R (Y1)** . 3. The difference between the 2 measurements determines the air gap value **(Z1)** . The value **(Z1)** permitted must be a minimum of **0.2 mm** and a maximum of **1.2 mm** . Insert one or two spacers **N (Fig. 9.104)** based on the value **(Z1)** detected.   **NOTE:** The calibrated spacers N have a thickness of **0.2 mm** . | imm9.105.jpg **Fig 9.105** |
| **9.15.1.5 Speed sensor**   1. Measure the distance from the coupling surface **AE** to the external diameter of the target wheel **(X2)** . 2. Measure the distance between the coupling surface **AE** and the sensor surface **V (Y2)** . 3. The difference between the 2 measurements determines the air gap value **(Z2)** . The value **(Z2)** permitted must be a minimum of **0.2 mm** and a maximum of **1.2 mm** . Insert one or two spacers **N (Fig. 9.104)** based on the value **(Z2)** detected.   **NOTE:** The calibrated spacers U have a thickness of **0.2 mm** .  Mount the bracket **S** with the screws **T** (tightening torque at **10 Nm -** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ).   1. Insert the shim **U** on the sensor **V** .   Clamp the sensor **V** on the bracket **S** with the screw **Z** (tightening torque at **10 Nm -** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). | imm9.106.jpg **Fig 9.106**imm9.107.jpg **Fig 9.107** |
| **9.15.1.6 Fuel filter water detection sensor**   1. Lubricate and insert the gasket **AA** on the fitting **AB** . 2. Tighten the sensor **AB** onto the cartridge **AC** (tightening torque of **5 Nm** ). | imm9.108.jpg **Fig 9.108** |

|  |  |
| --- | --- |
| **9.15.2 Alternator**   1. Insert the screw **BA** onto the alternator **BB** . 2. Insert the washer **BC** onto the screw **BA** . 3. Manually fit the screw **BA** all of the way onto the crankcase **BD** without tightening. 4. Manually fit the screw **BE** all of the way onto the head **BF** without tightening. | imm9.109.jpg **Fig 9.109** |
| 1. Pull out the dipstick **BB** in the direction of the arrow **BG** .         Z_importante.jpg **Important**       * The belt **BH** must always be replaced every time it is assembled, even if it has not reached the scheduled hours for replacement.  1. Insert the belt **BH** on the pulleys **BJ** . | imm9.110.jpg **Fig 9.110** |
| 1. Pull out the dipstick **BB** in the direction of the arrow **BK** . 2. While tensioning the alternator **BB** , first clamp screw **BE** (tightening torque at **25 Nm** ) and then screw **BA** (tightening torque at **69 Nm [thread M10] - 40 Nm** **[thread M8]** ). | imm9.111.jpg **Fig 9.111** |
| 1. Check the tension of the belt **BH** with a Clavis type instrument, positioning it in point (the tension must be between **350 and 450 Nm** ). 2. If the tension values do not correspond, tighten screws **BA and BE** , then repeat operations **7, 8 and 9** . | imm9.112.jpg **Fig 9.112** |
| **9.15.3 Starter Motor**    Z_importante.jpg **Important**       * Remove the [**ST\_34**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000)  tool if it remains in position on the engine  1. Fit the starter **BQ** with the screws **BR** on to the flange bell **BS** (tightening torque of **45 Nm** ). | imm9.113.jpg **Fig 9.113** |
| **9.15.4 Electric cabling**   1. Position the cable holder **BT** together with the cabling **BU** on the rocker cap **BV** . 2. Mount the connectors **C1** on the electronic injectors **S1** . 3. Screw the wiring holder BT on the rocker cap BV with the screws BW (tightening torque of **10 Nm -** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). | imm9.114.jpg **Fig 9.114** |
| 1. Fit the connector **C2** on the sensor **S2** . 2. Fit the connector **C3** on the sensor **S3** . 3. Insert the clamp **H1** on the collector **DA** . | imm9.115.jpg **Fig 9.115** |
| 1. Insert the connector **C4** on the fuel intake valve **S4** . 2. Insert the connector **C5** on fuel temperature sensor **S5** . | imm9.116.jpg **Fig 9.116** |
| 1. Fit the connector **C6** on the sensor **S6** . 2. Fit the connector **C7** on the sensor **S7** . 3. Insert the clamps **H2** on the thermostat cover **DB and H3** on the lateral oil intake flange **DC** . 4. Fit the connector **C8** on the sensor **S8** . | imm9.117.jpg **Fig 9.117** |
| 1. Fit the connector **C9** on switch **S9** . 2. Insert the terminal **C10** on the engine **S10** . 3. Insert the connector **C11** on the alternator cable **S11** . 4. Insert the clamp **H4** on the vent holder **DD** . | imm9.118.jpg **Fig 9.118** |

## EGR Circuit Assembly

|  |  |
| --- | --- |
| **9.16.1 EGR valve**    Z_importante.jpg **Important**       * Check that the contact surfaces between flange **B** and the head **D** are free from impurities. * Always replace the gasket **A** after each assembly.      1. Mount the gasket **A** on the flange **B** . 2. Secure the flange **B** with the screws **C** on the head **D** (tightening torque of **10 Nm** ). | imm9.119.jpg **Fig 9.119** |
| 1. Insert the screws **E** into the holder **F** . 2. Position the gasket **G** in correspondence with the screws **E** on the holder **F** . 3. Secure the EGR valve holder **F** with the screws **E** on the flange **B** (tightening torque of **10 Nm** ). | imm9.120.jpg **Fig 9.120** |
| 1. Fit the connector **H** on the valve **L** . 2. Tighten the clamp **J** with the screw **K** on the flange **B** . | imm9.121.jpg **Fig 9.121** |
| **9.16.2 EGR Cooler**   1. Insert the fitting **N** of EGR Cooler **M** in the sleeve **P** of the EGR valve unit. 2. Position EGR Cooler **M** on the intake manifold **Q** with the screws **R** **(** [**ST\_05**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **)** . 3. Secure the fitting **N** with the clamp **S** to the sleeve **P** . | imm9.122.jpg **Fig 9.122** |
| 1. Fasten the pipe **T** with the screws **U** on the EGR valve unit **V** inserting the gasket **W** (tightening torque of **10 Nm -** [**ST\_06**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). 2. Fasten the pipe **T** with the screws **AA** on EGR Cooler **M** inserting the gasket **AB** (tightening torque of **25 Nm ).** | imm9.123.jpg **Fig 9.123** |
| 1. Fasten the pipe **AC** on the intake manifold **AD** with the screws **AE** (tightening torque of **25 Nm** - [**ST\_05**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ) inserting the gasket **AF** . 2. Fasten the pipe **AC** on the EGR Cooler **M** with the screws **AG** (tightening torque of **25 Nm** ) inserting the gasket **AH** . 3. Fit the EGR Cooler **M** on the intake manifold **Q** with the screws **R** (tightening torque of **25 Nm -** [**ST\_05**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **- Fig. 9.122** ). 4. Connect hose **AL** on EGR Cooler **M** . | imm9.124.jpg **Fig 9.124** |

## Tightening torques and the use of sealants

**Tab. 9.4** - *\*Alternatively to the capscrew replacements, with "Dri-loc"*

|  |  |  |  |
| --- | --- | --- | --- |
| **BASE CONFIGURATION** | | | |
| **SHORT BLOCK** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Oil sprays fastening capscrew | M6x1 | 10 |  |
| **Lower crankcase fastening capscrew** | **M12x1.25** | **3 Torque cycles** |  |
| 1st Cycle |  | 40 |  |
| 2nd Cycle |  | 70 |  |
| 3rd Cycle |  | 120 |  |
| **Lower crankcase fastening capscrew** | **M8x1.25** | **2 Torque cycles** |  |
| 1st Cycle |  | 20 |  |
| 2nd Cycle |  | 35 |  |
| **Connetting road screw** | **M8x1** | **2 Torque cycles** |  |
| 1st Cycle |  | 40 |  |
| 2nd Cycle |  | 85 |  |
| Flange oil seal fastening capscrew | M6x1 | 10 |  |
| Closing cover fastening capscrew 3rd PTO | M8x1.25 | 25 | Loctite 2701\* |
| Idle gear lubr. hole cap closure | M14x1.5 | 30 | Loctite 2701\* |
| Coolant drain hole closing cap | M16x1.5 | 50 |  |
| **OIL SUMP ASSEMBLY** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Oil fumes tube | M12x1,5 | 15 | Loctite 648 |
| Oil suction hose fastening capscrew | M6x1 | 10 | Loctite 2701\* |
| Oil sump fastening capscrew | M8x1.25 | 25 |  |
| Oil drain cap | M18x1.5 | 35 |  |
| **FLANGE ASSEMBLY (1ST PTO)** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Flange bell fastening capscrew | M10x1,5 | 50 |  |
| Flywheel fastening capscrew | M12x1,25 | 140 |  |
| **GEAR DISTRIBUTION** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Intermediate gear gudgeon fastening screw | M8x1.25 | 25 |  |
| Camshaft gear control fastening capscrew | M10x1 | 100 |  |
| Gear fastening nut on high-pressure fuel injection pump | M14x1.5 | 65 |  |
| **ENGINE CYLINDER HEAD ASSEMBLY** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Air bleeding cap | M6x1 | 8 |  |
| Lifting brace fastening capscrew | M8x1.25 | 25 |  |
| Electronic injector manifold | M12x1 | 30 |  |
| **Cylinder head fastening capscrew** | **M12x1.25** | **6 Torque cycles** |  |
| 1st Cycle |  | 40 |  |
| 2st Cycle |  | 70 |  |
| 3st Cycle |  | 100 |  |
| 4st Cycle |  | 90° |  |
| 5st Cycle |  | 90° |  |
| 6st Cycle |  | 90° |  |
| Rocker arm gudgeon fastening capscrew | M8x1,25 | 25 |  |
| Rocker arm cover fastening capscrew | M6x1 | 10 |  |
| **INJECTION SYSTEM** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Fuel filter fastening capscrew | M8x1.25 | 25 |  |
| Fuel cartridge fastening | ... | 17 |  |
| Common rail fastening capscrew | M8x1.25 | 25 |  |
| Electronic injector brace fastening capscrew | M8x1.25 | 20 |  |
| Distributor fastening capscrew | M8x1.25 | 10 |  |
| Waste line fastening drilled capscrew on common rail | M10x1 | 15 |  |
| Electronic Injector side injection tube nuts | M12x1.5 | 25 |  |
| Injection pump side injection tubes nuts | M12x1.5 | 25 |  |
| Common Rail side injection tubes nuts | M14x1.5 | 30 |  |
| Injection pump fastening capscrew | M8x1.25 | 25 | Loctite 2701\* |
| **INTAKE MANIFOLD** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Internal semi-manifold fastening capscrew (on cylinder head) | M8x1.25 | 25 |  |
| External semi-manifold fastening capscrew | TG8 | 22 |  |
| Intake flange fastening capscrew | TG8 | 22 |  |
| **EXHAUST MANIFOLD** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Exhaust manifold fastening stud | M8x1.25 | 25 |  |
| Exhaust manifold fastening nut | M8x1.25 | 25 |  |
| Exhaust/manifold/muffler flange fastening nut | M8x1.25 | 25 |  |
| **LUBRICATION CIRCUIT** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Oil fumes support fastening capscrew (on crankcase) | M6x1 | 12 |  |
| Oil filter fastening union | M20x1.5 | 15 | Loctite 2701\* |
| Oil cooler fastening capscrew | M6x1 | 10 |  |
| Cartridge-holder cover | ... | 25 |  |
| Oil pump carter fastening capscrew | TG6 | 10 |  |
| Carter distribution fastening capscrew | M8x1.25 | 25 |  |
| Side oil load flange fastening capscrew (onto carter distribution) | TG6 | 10 |  |
| Pressure relief valve cap | M16x1.5 | 50 |  |
| **CRANKSHAFT AND TARGET WHEEL PULLEY ASSEMBLY (2 ND PTO)** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Phonic wheel fastening capscrew (on crankshaft pulley) | M6x1 | 10 |  |
| Crankshaft pulley fastening capscrew | M16x1.5 | 360 | Molyslip |
| **COOLANT CIRCUIT** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Coolant tube clamp fastening capscrew (Oil Cooler return) | TG6 | 10 |  |
| Thermostatic valve cover fastening capscrew | M6x1 | 10 |  |
| Coolant pump fastening capscrew | M8x1.25 | 25 |  |
| **TURBO COMPRESSOR** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Oil return tube fastening capscrew | M6x1 | 10 |  |
| Oil supply tube fastening capscrew | M10x1 | 15 |  |
| Turbine fastening stud (on manifold) | M8x1.25 | 25 |  |
| Exhaust flange fastening stud (on turbine) | M8x1.25 | 25 |  |
| Turbine fastening nut | M8x1.25 | 25 |  |
| Exhaust flange fastening nut (on turbine) | M8x1.25 | 25 |  |
| **ELECTRICAL COMPONENTS** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| MAP sensor fastening capscrew | TG6 | 10 |  |
| Coolant temperature sensor | M12x1.5 | 20 max. |  |
| Oil pressure switch | M12x1.5 | 35 |  |
| Phase sensor fastening capscrew | TG6 | 10 |  |
| Speed sensor fastening capscrew | TG6 | 10 |  |
| Sensor for water presence in fuel |  | 5 |  |
| Alternator bracket fastening capscrew | M8x1.25 | 25 |  |
| Alternator fastening capscrew | M8x1.25 | 25 |  |
| Alternator fastening capscrew | M10x1.5 | 69 |  |
| Starter motor fastening capscrew | M10x1.5 | 45 |  |
| Supply cable fastening nut (starter motor) | M8x1.25 | 10 |  |
| Cabling support fastening capscrew | TG6 | 10 |  |
| **EGR CIRCUIT** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Flange EGR valve fastening capscrew | M6x1 | 10 |  |
| EGR valve fastening capscrew | M6x1 | 10 |  |
| EGR Cooler tube fastening capscrew (on flange EGR valve) | TG6 | 10 |  |
| EGR Cooler fastening capscrew | TG8 | 22 |  |
| Tube fastening capscrew on EGR Cooler | M8x1.25 | 25 |  |
| Tube fastening capscrew on intake manifold | M8x1.25 | 25 |  |

*\* Alternatively to the capscrew replacements, with "Dri-loc"*

|  |  |  |  |
| --- | --- | --- | --- |
| **OPTIONAL COMPONENTS (CHAP. 11)** | | | |
| **OIL DIPSTICK ON CYLINDER HEAD** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Oil dipstick tube fastening capscrew | M6x1 | 10 |  |
| **HEATER** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Flange intake with heater fastening capscrew | M8x1.25 | 22 |  |
| **ALTERNATOR WITH POLY-V BELT** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Pulley fastening capscrew | M10x1.5 | 48 |  |
| Pulley positioning blocking nut capscrew | M10x1.5 | 45 |  |
| Alternator brace fastening capscrew | M8x1.25 | 25 |  |
| Alternator fastening capscrew (upper) | M8x1.25 | 25 |  |
| Alternator fastening capscrew (lower) | M8x1.25 | 40 |  |
| Pulley sliding plate fastening capscrew | M8x1.25 | 25 |  |
| **IDLE GEAR (FOR 3TH /4TH PTO)** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Gear drilled fastening capscrew | M14x1.5 | Consultare il Par. >> | Molyslip |
| **3 TH PTO** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Pump support fastening capscrew | M8x1.25 | 25 | Loctite 2701\* |
| Pump fastening capscrew | M8x1.25 | 25 |  |
| **4 TH PTO** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Grooved crankshaft support fastening capscrew | M8x1.25 | 25 | Loctite 2701\* |
| Cover fastening capscrew (3 rd PTO side) | M8x1.25 | 25 |  |
| Sump support fastening capscrew | TG6 | 10 |  |
| Pump fastening capscrew | M8x1.25 | 25 |  |
| **BALANCE DEVICE (4 CYLINDERS)** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Housing closing panel fastening capscrew | M6x1 | 8 |  |
| Shafts support fastening capscrew | M10x1.5 | 50 |  |
| **REMOTE OIL FILTER** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Head fastening and Oil Cooler union on crankcase | M20x1.5 | 25 | Loctite 2701\* |
| Crankcase head nipple and oil filter support | M14x1.5 | 40 |  |
| Tube union on crankcase head | G3/8 | 30 |  |
| Tube union on filter support | G3/8 | 35 |  |
| Oil filter | M20x1.5 | 20 |  |
| Filter support head air bleeding cap | M8x1.25 | 25 |  |
| **INTAKE CIRCUIT** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Air filter support plate fastening capscrew (on flange bell) | M8x1.25 | 25 |  |
| Air filter support fastening capscrew | M8x1.25 | 25 |  |
| **EXHAUST CIRCUIT** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Muffler brace support fastening capscrew | M8x1.25 | 25 |  |
| Muffler fastening capscrew on muffler | M8x1.25 | 25 |  |
| Muffler fastening nut | M8x1.25 | 25 |  |
| **COOLING CIRCUIT** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Blower fastening capscrew | M6x1 | 10 |  |
| Radiator support fastening capscrew | M16x1.5 | 150 |  |
| Shroud radiator fastening capscrew | M6x1 | 10 |  |
| Radiator lower brace fastening capscrew | M8x1.25 | 25 |  |
| Radiator on anti-vibrating | M8x1.25 | 25 |  |
| Anti-vibrating radiator fastening nut (on lower brace) | M8x1.25 | 25 |  |
| Anti-vibrating and brace fastening capscrew (upper) | M6x1 | 10 |  |
| Upper brace fastening capscrew (on engine cylinder head) | M8x1.25 | 25 |  |
| Side bulkheads fastening capscrew | M6x1 | 10 |  |
| **ENGINE SUPPORT** | | | |
| **Component** | **Thread (mm)** | **Torque (Nm)** | **Sealer** |
| Side feet fastening capscrew (on flange bell or crankcase) | M12x1.75 | 50 |  |
| Rear feet fastening capscrew | M16x1.5 | 200 |  |

# Fluids filling information

## Engine oil

|  |  |
| --- | --- |
| Z_importante.jpg  **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) . |  |
| 1. Loosen the oil filler cap **A** or the oil filler cap **C** if the cap **A** is not accessible. 2. Add the type and amount of oil recommended ( [**Tab. 2.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=55&parent=1000) ). | 10.1.png **Fig 10.1** |
| 1. Remove the oil dipstick **B** and check that the level is up to but does not exceed the **MAX** . 2. If the oil level is not at **MAX** , insert more oil until the **MAX** level is reached as indicated on the dipstick. 3. Re-tighten the cap **A or C** .     **NOTE:** See the [**Par. 11.1**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=176&parent=1000) for the various configurations of the oil dipstick. | 10.2.png **Fig 10.2** |
| **NOTE** : Click by side to play the procedure. | <https://www.youtube.com/embed/cVpoy_m253A?showinfo=0&rel=0> |

## Coolant

|  |  |
| --- | --- |
| Z_importante.jpg  **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) . |  |
| 1. Tighten the cap **G** , replacing the copper gasket (Tightening torque of **50 Nm** ). | 10.3.png **Fig 10.3** |
| **NOTE:** A sealing plug or connecting pipe to the expansion tank may be present on the junction **B** , both should be secured with a strap.   1. Reinsert on the junction **B** the sealing plug or a connecting pipe to the expansion tank. | 10.4.png **Fig 10.4** |
| Z_Avvertenza.jpg **Warning**     * Presence of steam pressurized coolant danger of burns.  1. Refill the radiator with coolant (refer to [**Par. 2.6**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=195&parent=1000) for the liquid specifications). 2. Top liquid up until the pipes inside the radiator are covered by about 5 mm. 3. For engines equipped with separate expansion tank, pour in fluid until reaching the max level mark. 4. Loosen the screw **F** on the head **H** , release any air and tighten the screw **F** (Tightening torque of **8 Nm - Fig. 10.7** ). 5. Start the engine without the radiator cap A or the expansion tank **(C)** cap **B.** 6. Keep the engine at idle speed or without a load until the coolant level goes down and becomes steady (the waiting times varies according to the ambient temperature). 7. Turn off the engine and allow it to cool. 8. If there is an expansion tank **(C)** top liquid up to the mark **MAX** . 9. Without expansion tank top liquid up until the pipes inside the radiator are covered by 5 mm. Do not overfill the radiator, but leave room for the coolant to expand. 10. Tighten the radiator cap A or the expansion tank **(C)** cap **B.**         Z_Avvertenza.jpg **Warning**       * Before starting make sure that the radiator cap and expansion tank cap, if present, are installed correctly to avoid loss of liquid or vapour at high temperatures.  1. After a few hours of operation stop the engine and allow it to cool. Check and top up the coolant. | 10.5.png **Fig 10.5**imm10.6.jpg **Fig 10.6** |
| 10.7.png  **Fig. 10.7** | |
| **NOTE** : Click by side to play the procedure. | <https://www.youtube.com/embed/S79xPhTZMps?showinfo=0&rel=0> |

# Information about optional components

## Oil dipstick in cylinder head

|  |  |
| --- | --- |
| Z_importante.jpg  **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) . |  |
| **11.1.1 Check**   1. Pull out the dipstick **B** in the direction of the arrow **A** . 2. Check that the mark left by the oil on the dipstick is between the **MIN and MAX** notches. | 11.1.png **Fig 11.1** |
| **11.1.2 Replacement**  **11.1.2.1 Disassembly**   1. Undo the screw **D** . 2. Pull out the oil dipstick hose **E** in the direction of the arrow **F** | imm11.2.jpg **Fig 11.2** |
| **11.1.2.2 Assembly**    Z_importante.jpg **Important**       * Always replace the gasket **G** every time it is disassembled.  1. Insert the gasket **G** in the seat **K** of the hose **E .** 2. Insert the hose **E** in the crankcase **H** . | imm11.3.jpg **Fig 11.3** |
| 1. Secure the oil dipstick hose **E** using the screw **D** on the manifold **L** (tightening torque at **10 Nm** ). | imm11.4.jpg **Fig 11.4** |
| **NOTE:** Check the integrity of the gaskets **J** .   1. Insert the dipstick **B** inside the hose **E** . | imm11.5.jpg **Fig 11.5** |

## Heater (replacement)

|  |  |
| --- | --- |
| Z_importante.jpg  **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) . |  |
| **11.2.1 Disassembly**   1. Undo the screws **A** and the relevant washers and remove the earth cable **B** . 2. Remove the flange **C** and the manifold **D** . 3. Remove the heater **E** and the relevant gaskets **F** . | 11.6.png **Fig 11.6** |
| **11.2.2 Assembly**    Z_importante.jpg **Important**       * Always replace gaskets **F** , with each assembly.      1. In sequence, fit the manifold **G** with the gasket **F** , the new heater **E** , the second gasket **F** , the flange **C** , the washers **H** , the screws **A** and the cable **B** . 2. Secure the flange **H** with the screws **A** (tightening torque at **22 Nm** ). 3. Secure the earth cable **B** with the nut **J** and the relevant washer on the heater **E** . | 11.7_TCR.jpg   **Fig 11.7** |

## Poly-V alternator belt (replacement and adjustment)

|  |  |
| --- | --- |
| Z_importante.jpg  **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) . |  |
| 1. Loosen the nut **B** and manually tighten the screw **C** until it just touches the pulley pin **D (Fig. 11.9)** . | CAP_11_POLY-V_prot_galoppino_01.png   **Fig 11.8** |
| 1. Untighten the screw **E** by around **32mm (A)** . 2. Untighten the screw **C** .     **NOTE:** The belt tensioner pulley **F** should move towards the arrow **G** . If it does not, please move it manually. | CAP_11_POLY-V_prot_galoppino_02.png  CAP_11_POLY-V_prot_galoppino_03.png **Fig 11.9** |
| 1. Remove the V-Belt **H** and install the new one.     **NOTE:** Ensure that the internal profile of belt **H** is properly inserted into the grooves of the pulley **A** (as illustrated in **D1 e D2** ). | CAP_11_POLY-V_prot_galoppino_04.png   **Fig 11.10** |
| 1. Tighten capscrew **C** , to shift gudgeon **D** fully to the bottom of the grooved guide. 2. Tighten capscrew **E** (tightening torque at **45Nm** ). 3. Hold the screw **C** still with a key, and tighten the screw **B** on the plate **L** to secure the screw **C** (tightening torque at **45Nm** ). 4. Check, in point **P (Fig. 11.8)** ,the tension of the belt. Check by the appropriate tool that at point **p** the tension value is between **149 and 196 Hz** .     **NOTE:** After the engine has been in operation for around 15 minutes, repeat point **8** . | CAP_11_POLY-V_prot_galoppino_05.png   **Fig 11.11** |

## Tightening pulley and alternator for Poly-V belt

|  |  |
| --- | --- |
| Z_importante.jpg  **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) . |  |
| **11.4.1 Disassembly**   1. Perform the operations from [**point 1 to 3 of**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=178&parent=1000) [**Par. 11.3**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=178&parent=1000) *.* 2. Remove the belt **H (** [**Fig. 11.10**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=178&parent=1000) **)** . 3. Undo and remove the screw **A** . 4. Fully undo the screw **B** and remove the tightening pulley **C** . | CAP_11_POLY-V_prot_galoppino_06.png   **Fig 11.12** |
| 1. Undo the screws **D** and remove the plate **E** and the pin **F** . | imm11.13.jpg **Fig 11.13** |
| 1. Undo the screws **G and H** remove the alternator **L** . | imm11.14.jpg **Fig 11.14** |
| 1. Undo the screws **M** and remove the bracket **N** . | imm11.15.jpg **Fig 11.15** |
| **11.4.2** **Assembly**   1. Secure the bracket **N** using the screws **M** on the cylinder head **P** (tightening torque at **25 Nm** ). | imm11.16.jpg **Fig 11.16** |
| 1. Insert the screw **H** into the fixing hole on the alternator **L** . 2. Insert the spacer **R** on the screw **H** (between the alternator and crankcase). 3. Tighten the screw manually **H** onto the crankcase **Q** . 4. Orientate the second fixing hole of the alternator **L** with the hole of the bracket **N** , secure the alternator **L** using the screw **G** (tightening torque at **25 Nm** ) onto the bracket **N** and then the screw **H** (tightening torque at **25 Nm** ). | imm11.17.jpg **Fig 11.17** |
| 1. Insert the pin **F** in the plate slot **E** . 2. Orientate the pin **F** with the surface **S** (support for screw **A** ) upwards. 3. Secure the plate **E** using the screws **D** on the bracket **N** (tightening torque at **25 Nm** ). | imm11.18.jpg **Fig 11.18** |
| 1. Insert the screw **B** in the plate **C1** and pulley **C** . 2. Manually tighten the screw **B** onto the pin **F** up to the stop; Undo the screw **B** again by one turn.     **NOTE:** The screw **B** must protrude by about 32 mm **(A)** from the surface of the tightening pulley **C** (see detail **X** ).     1. Install the new belt **H** **(Fig. 11.10)** . 2. Tighten the screw **A** onto the plate **E** up to the stop on the pin **F** . 3. Perform the operations from point **6 to 8** **of *Par. 11.3*** . | CAP_11_POLY-V_prot_galoppino_07.png   **Fig 11.19** |

## Idler gear (for 3rd / 4th PTO)

|  |  |
| --- | --- |
| Z_importante.jpg  **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) . |  |
| **11.5.1 Disassembly**   1. Undo the screw **A** and remove the gear unit **B** . | imm11.20.jpg **Fig 11.20** |
| 1. Remove the retainer ring **C** from the seat of the pin **D** . 2. Remove the shoulder washer **E** , the gear **B** , the shoulder ring **F** and the bushing **G** from the pin **G** .     **11.5.2 Assembly**   1. Insert gudgeon  **D** : - shoulder ring **F** (minimum shim) - gear **B** - shoulder ring **E** - retainer ring **C** . 2. Insert the bushing **G** on the crankcase **L** . | imm11.21.jpg **Fig 11.21**imm11.22.jpg **Fig 11.22** |
| Z_importante.jpg **Important**       * Always replace the washer **H** every time it is disassembled. **Modified component, see service letter 700019. \*** * Check that the perforated screw **A** is free from impurities inside it. * Lubricate the thread and under the head of the screw **A** with **Molyslip** .      1. Position the gear unit **B** on the hole **J** using the bushing **G** to centre. 2. Secure the gear unit **B** using the screw **A** inserting the washer **H** (tightening torque at **85 Nm** ). | imm11.23.jpg **Fig 11.23** |

## 3rd PTO (replacement)

|  |
| --- |
| imm11.24.jpg **Fig 11.12** |

|  |  |
| --- | --- |
| Z_importante.jpg  **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) . |  |
| **11.4.1 Disassembly**   1. Undo the screws **A** and remove the pump **B** . | imm11.25.jpg **Fig 11.13** |
| 1. Remove the centring ring **C** and the relative gaskets. 2. Undo the screws **N** . | imm11.26.jpg **Fig 11.14** |
| 1. Remove the flange **F** with the components **D, E, G and H** in the direction of the arrow **P** . 2. Remove the gasket **J** . | imm11.27.jpg **Fig 11.15** |
| 1. Remove the retainer ring **D** and the shoulder washer **E** . 2. Remove the gear **H** and the shoulder ring **G** from the flange **F** in the direction of the arrow **Q** . | imm11.28.jpg **Fig 11.16** |
| **11.4.2 Assembly**    Z_importante.jpg **Important**       * Always replace the gasket **J** after each assembly. * Lubricate the gear **H** with oil.  1. Insert the gear **H** in the flange **F** in the direction of the arrow **R** inserting the shoulder ring **G** . 2. Insert the shoulder ring **E** on the flange **F** and clamp the gear **H** using the retainer ring **D** . 3. Position flange **F** on the crankcase **K** inserting the gasket **J** , and inser gear **H** in crankcase **K** . | imm11.29.jpg **Fig 11.17**Fig._11.18.jpg **Fig 11.18** |
| 1. Secure the flange **F** using the screws **N** (tightening torque at **25 Nm** ). | Fig._11.19.jpg **Fig 1** |
| Z_importante.jpg **Important**       * Always replace rings **P and Q** after each assembly.   5. Insert the centring ring **C** in the flange **F** up to the stop. 6. Position the pump **B** on the flange **F** engaging the gear **H** . 7. Secure the pump **B** using the screws **A** on the flange **F** (tightening torque at **25 Nm** ). | Fig._11.20.jpg **Fig 11.20** |

## 4th PTO (replacement)

|  |
| --- |
| imm11.33.jpg **Fig 11.21** |

|  |  |
| --- | --- |
| Z_importante.jpg  **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) . |  |
| **11.7.1 Disassembly**   1. Undo the screws **A** and remove the pump **B** . | imm11.34.jpg **Fig 11.22** |
| 1. Undo the screws **C** and remove the flange **D** . | Fig._11.23.jpg **Fig 11.23** |
| 1. Undo the screws **E** and remove the cover **F** . | Fig._11.24.jpg **Fig 11.24** |
| 1. Undo the screws **G** and remove the flange **K** with the components **H, J, M, N and P** . | Fig._11.25.jpg **Fig 11.25** |
| 1. Remove the retainer ring **H** and the shoulder ring **J** from the flange **K** . 2. Remove the gear **N** and the shoulder ring **M** from the flange **K** . | imm11.38.jpg **Fig 11.26** |
| **11..2** **Assembly**    Z_importante.jpg **Important**       * Always replace the gasket **J** after each assembly. * Lubricate the gear **H** with oil.  1. Insert the gear **N** in the flange **K** in the direction of the arrow **W** inserting the shoulder ring **M** . 2. Insert the shoulder ring **J** on the flange **K** and clamp the gear **N** using the retainer ring **H** . | imm11.39.jpg **Fig 11.27** |
| 1. Position flange **K** onto crankcase **Q** inserting gasket **P** and insert gear **N** in crankcase **Q** .     Z_importante.jpg **Important**       * Always change capscrews **G** with new ones or alternatively apply **Loctite 2701** .  1. Secure the flange **K** using the screws **G** (tightening torque at **25 Nm** ). | Fig._11.28.jpg **Fig 11.28** |
| Z_importante.jpg **Important**       * Always replace the gasket **V** after each assembly.  1. Insert gasket **V** on cover **F** , insert and position the cover **F** on flange **K** . 2. Secure the cover **F** using the screws **E** (tightening torque at **25 Nm** ) on the flange **K** . | Fig._11.29.jpg **Fig 11.29** |
| Z_importante.jpg **Important**       * Always replace the gasket **T** after each assembly.  1. Position and tighten flange **D** by means of capscrews **C** on carter **S** (tightening torque **10 Nm -** [***ST\_06***](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). | Fig._11.30.jpg **Fig 11.30** |
| Z_importante.jpg **Important**       * Always replace the gasket **U** after each assembly.  1. Position the gasket **U** on the flange **D** . 2. Secure the pump **B** using the screws **A** (tightening torque at **25 Nm** ) on the flange **D** . | Fig._11.31.jpg **Fig 11.31** |

## 3rd + 4th PTO (configurations)



**Fig. 11.45**

|  |  |
| --- | --- |
| **11.8.1 Information**  Hydraulic pumps on the 3rd and 4th PTO can be installed at the same time. In some configurations, there is also the centering ring **C** on the 4th PTO.    Z_importante.jpg **Important**       * For disassembly or installation, refer to [**Par. 11.5**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=180&parent=1000) **,** [**Par. 11.6**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=181&parent=1000) **e** [**Par. 11.7**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=182&parent=1000) **.** * Always replace the gasket of the rings **B** and **C** and flanges **D** and **K** at each assembly. * Lubricate the gear **H** with oil. | Fig._11.33.jpg  **Fig. 11.46** |

## Balancer device (replacement)

|  |  |
| --- | --- |
| Z_importante.jpg  **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=283&parent=1136) . |  |
| **11.9.1 Disassembly**   1. Perform the operations described in [**Par. 5.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=121&parent=1000) . 2. Undo the screws **A** and remove the oil sump **B** . | imm11.45.jpg **Fig 11.47** |
| 1. Undo the screws **C** and remove the hose **D** . | imm11.46.jpg **Fig 11.48** |
| 1. Undo the screws **E** and remove the shaft support box **F** . | imm11.47.jpg **Fig 11.49** |
| 1. Undo the screws **G** and remove the plate **H** . | imm11.48.jpg **Fig 11.50** |
| 1. Remove the shafts **J and K** in the direction of the arrow **L** from box **F** . | imm11.49.jpg **Fig 11.51** |
| **11.9.2 Assembly**   1. Lubricate the bushings **V** with **Molikote** grease. 2. Insert the shafts **J and K** inside the box **F** in the direction of the arrow **M** . | imm11.50.jpg **Fig 11.52** |
| 1. Make sure that the shafts **J and K i** nside the box **F** observe the marks **N** and that the shaft **J** with the gear indicated by letter " **S** " stamped on it is on the left with respect to the box **F** . | imm11.51.jpg **Fig 11.53** |
| 1. Secure the plate **H** using the screws **G** on the box **F** (tightening torque at **8 Nm** ). | imm11.52.jpg **Fig 11.54** |
| 1. Manually tighten the retainer screw [**ST\_15**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=191&parent=1000) on the box **F** by slightly rotating the shaft **K** , centring the hole on it using the [**ST\_15**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=191&parent=1000) , to lock the device. | imm11.53.jpg **Fig 11.55** |
| 1. Rotate the crankshaft and clamp it on the TDC (Ref. **P** upwards) using the tool [**ST\_34**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000)  secured in place of the starter motor (detail **Q** ). | imm11.54.jpg **Fig 11.56** |
| 1. Position the box **F** on the surface of crankcase **R** observing the reference bushings. 2. Secure housing **F** using capscrews **E** and  insert washers **U** (tightening torque at **50 Nm** ). 3. Remove the retainer screw [**ST\_15**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) from the box **F** . | imm11.55.jpg **Fig 11.57** |
| Z_importante.jpg **Important**       * Check that the retainer capscrew  [**ST\_15**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) **(Fig. 11.55)** is not present in point **X** on housing **F** . * Always replace the gasket **W** after each assembly. * Lubricate the gasket **W** with oil before assembling it.      1. Insert the gasket **W** in the seat on the flange of the oil hose **D** . 2. Secure the oil intake hose **D** using the screws **C** . 3. Perform the operations described in [**Par. 9.4.3**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=161&parent=1000) to assemble the oil sump. | imm11.56.jpg **Fig 11.58** |

## Air filter (cartridge replacement)

|  |  |
| --- | --- |
| 1. Release the two hooks **A** and remove the cover **B** from the body **C** . 2. Remove the cartridges **D and E** .       Z_importante.jpg **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) . * The safety cartridge **E** (if present) must always be replaced if it is dirty or damaged.  1. Insert the new cartridge **E** inside the new cartridge **D** and both of them inside the filter body **C** . 2. Secure the cover **B** via the hooks **A** . | 11.59.png **Fig 11.59** |

## Remote oil filter (disassembly and assembly)

|  |  |
| --- | --- |
| **11.11.1 Option A**  **11.11.1.1 Disassembly**   1. Perform the operations described in [**Par. 5.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=121&parent=1000) **.**     Z_importante.jpg **Important**     * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=283&parent=1136) . * For the replace the cartridge, please refer to operation **n° 4 (Par. 11.11.1)** and operation **n° 7 (Par. 11.11.2)** . * For the disassembly of the pipes **B and C** , lock with a tool the fittings **K, H (Fig. 11.61) and L (Fig. 11.62)** in order to prevent their lose together with the nuts **A** , with the consequent of oil leakage. * The threads of unions **L** and **H** have different features - Before removing the unions **L** and **H** , apply a distinguishing mark on them in order to reposition them correctly on the support **M** or on the head **J** during the assembly phase. * The threads of nuts **A** have different features - Before removing the tubes **B** and **C,** apply a distinguishing mark on them in order to correctly screw the nuts **A** to the unions **L** and **H** during the assembly phase.  1. Undo the nuts **A** and remove the hoses **B and C** . 2. Unscrew the fittings **L** and remove the copper gaskets from the support **M** . 3. Unscrew the cartridge **N** with gasket from the support **M** . | imm11.58.jpg **Fig 11.60**imm11.59.jpg **Fig 11.61** |
| 1. Release the clamps **D** and remove the hoses **E and F** from Oil Cooler **G** . 2. Unscrew and remove the fitting **H** with its copper gasket from the oil filter head **J** . 3. Unscrew and remove: - the fitting **K** with the copper gasket; - Oil Cooler **G** and the relative gasketsi; - the oil filter head **J** . | imm11.60.jpg **Fig 11.62** |
| **11.11.1.2 Assembly**      Z_importante.jpg **Important**       * Always replace the gaskets **P, Q, R and U** at each assembly. * Lubricate the gaskets **P, Q and R** with oil before assembling them.      1. Insert the gasket **P** on the seat of the fitting **K** . 2. Insert flange head **J** on the fitting **K** and the gasket **Q** in the seat of head **J** . 3. Insert the Oil Cooler **G** on the fitting **K** and the gasket **R** in the seat of Oil Cooler **G** . 4. Onto crankcase **S** apply Oil Cooler **G** and flange **J** by means of union **K** (tightening torque at **25 Nm + Loctite 2701** on thread) as positioned in **Fig. 11.64.** 5. Clamp union **H** on flange **J** inserting gasket **U** (tightening torque at **40 Nm** ). | imm11.61.jpg **Fig 11.63**imm11.62.jpg **Fig 11.64** |
| Z_importante.jpg **Important**       * Always replace the gaskets **V** after each assembly.  1. Clamp unions **L** on support **M** inserting gasket **V** (tightening torque at **40 Nm** ). 2. Lubricate gasket **W** and clamp cartridge **N** on support **M** (tightening torque at **20 Nm** ). | imm11.63.jpg **Fig 11.65** |
| 8. Connect tube **B** to the central fitting of support **M** and of head **J** . 9. Connect tube **C** to the side fitting of support **M** and of head **J** . 10. Clamp the nuts **A** on the head **J** (tightening torque at **30 Nm** ). 11. Clamp the nuts **A** on support **M** (tightening torque at **35 Nm** ).    Z_importante.jpg **Important**       * Check the tightening of the fittings **K, H (Fig. 11.64) and L (Fig. 11.65)** (tightening torque at **40 Nm** ). | imm11.64.jpg **Fig 11.66** |
| **11.11.2** **Option B**  **11.11.2.1** **Disassembly**   1. Perform the operations described in [**Par. 5.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=121&parent=1000) **.** 2. Perform the operations indicated in point 1 of [**Par. 7.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=121&parent=1000) **.**     Z_importante.jpg **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=283&parent=1136) . * The oil filter cartridge may not be supplied by **KOHLER** (in such cases, refer to the machine’s documentation) * To replace only the cartridge, refer to operations **5** ( **Par. 11.11.1** ) and **7** ( **Par. 11.11.2** ). * to remove the tubes **B** and **C** , use a wrench to lock the unions **L** ( **Fig. 11.70** ) and **H** ( **Fig. 11.72** ) in order to prevent them from being loosened and removed together with the nuts **A** , with subsequent oil leaks. * The threads of unions **L** and **H** have different features - Before removing the unions **L** and **H** , apply a distinguishing mark on them in order to reposition them correctly on the support **M** or on the head **J** during the assembly phase. * The threads of nuts **A** have different features - Before removing the tubes **B** and **C** , apply a distinguishing mark on them in order to correctly screw the nuts **A** to the unions **L** and **H** during the assembly phase. | 11_67.png **Fig 11.67** |
| 1. Undo the nuts **A** and remove the hoses **B and C** . 2. Unscrew the fittings **L** and remove the copper gaskets from the support **M** . 3. Unscrew the cartridge **N** with gasket from the support **M** . | 11_68.png  **Fig 11.68**  11_69.png  **Fig 11.69**  11_70.png  **Fig 11.70** |
| 1. Release the clamps **D** and remove the hoses **E and F** from Oil Cooler **G** . 2. Unscrew and remove the unions **H** together with the relevant copper gasket from the head **J** . 3. Unscrew and remove: - the union **K** with its gasket; - the head **J** ; - the Oil Cooler **G** with relevant gaskets; - the screws **X** and **Y** ; - the support **T** ; | 11_71.png  **Fig 11.71**  11_72.png  **Fig 11.72** |
| **11.11.2.2** **Assembly**      Z_importante.jpg **Importante**       * Replace the gaskets **H1** , **J1** , **J2** , **K1** , **L1** , **T1** and **Z1** at every assembly. * Lubricate the gaskets **J1** , **J2** , **K1** , **T1** and **Z1** with oil before performing the assembly.      1. Insert the gasket **K1** on the seat of the union **K** . 2. Insert the gaskets **J1** and **J2** on the seats of the union **J** . 3. Assemble on the support **T** : Oil Cooler **G** head **J** 4. Fix the union **K** to the support **T** , aiming the Oil Cooler **G** and the head **J** correctly (tightening torque of **25 Nm** + **Loctite 2701** on the thread). | 11_73.png  **Fig 11.73** |
| 1. Insert the gasket **Z1** on the seat of the union **Z** . 2. Insert the gasket **T1** on the seat of the support **T** . 3. Assemble on the support **T** on the crankcase **S** and fix it using the screws **X** and **Y** (tightening torque of **10 Nm** ). 4. Fit the tubes **E** and **F** on the Oil Cooler **G** and fix them using the clamps **D** ( **Fig. 11.71** ). | 11_74.png  **Fig 11.74**  11_75.png  **Fig 11.75** |
| 1. Fix the unions **H** to the head **J** placing the gasket **H1** in-between (tightening torque of **40 Nm** ). | 11_76.png  **Fig 11.76** |
| 1. Fix the unions **L** to the support **M** placing the gaskets **L1** in-between (tightening torque of **40 Nm** ). 2. Lubricate the gasket **N1** and fix the cartridge **N** to the support **M** (tightening torque of **20 Nm** ). | 11_77.png  **Fig 11.77** |
| 1. Connect the tubes **B** and **C** onto the unions **L** of the support **M** and **H** of the head **J** . 2. hten the nuts **A** on the head **J** (tightening torque **30 Nm** ). 3. Tighten the nuts **A** on the support **M** (tightening torque **35 Nm** ). 4. Perform the operations indicated in point **1** of [**Par. 9.15.3**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=121&parent=1000) **.\*** | 11_68.png  **Fig 11.78**  11_69.png  **Fig 11.79** |

## Oil sump with supporting structure

|  |  |
| --- | --- |
| **11.12.1 Flywheel (J) disassembly**   1. Execute the operations described in [**Par. 7.12.1**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=145&parent=1000) .   **11.12.2 Plate/flange housing (L) disassembly**   1. Loosen supplementary capscrews **A** and **B** . 2. Execute the operations described in [**Par. 7.12.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=145&parent=1000) . 3. Remove housing or plate **L** . | 11_67.jpg  **Fig. 11.80** |

|  |  |
| --- | --- |
| **11.12.3 Oil sump disassembly**   1. Execute the operations described in [**Par. 5.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=121&parent=1000) . 2. Loosen capscrews **C** and remove bypass tube **D** . 3. Loosen capscrews **E** and remove oil sump **F** . | 11_68.jpg  **Fig. 11.81** |

|  |  |
| --- | --- |
| **11.12.4 Oil sump assembly**   1. Make sure contact surfaces **G** of oil sump **F** and crankcase **H** have no impurities. 2. Apply a sealing bead of approximately **2.5 mm** ( **Loctite 5660** ) onto surface **G** of crankcase **H** . 3. Place oil sump **F** onto crankcase **H** in correspondence with the fastening holes (use tool [**ST\_18**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). | 11_69.jpg  **Fig. 11.82** |

|  |  |
| --- | --- |
| 11_70.jpg  **Fig. 11.83** | |

|  |  |
| --- | --- |
| 1. Apply capscrews **E** into the fastening holes and use torque at **10 Nm** . 2. Loosen capscrews **E** , leaving approximately 1 mm leeway ( **position A** ) between the neck surface of capscrews **E** and oil sump **F** . 3. Place flange housing or plate **L** onto crankcase **H** , complying with centring tap pins **M** . 4. Using 2 capscrews **A** , fasten housing or plate **L** onto crankcase **H** (tightening torque at  **20 Nm** ). 5. Using 2 capscrews **A** , fasten housing or plate L onto oil sump **F** (tightening torque at **20 Nm** ). | 11_76.jpg  **Fig. 11.84** |

|  |  |
| --- | --- |
| 11_72.jpg    **Fig. 11.85** | |

|  |  |
| --- | --- |
| 1. Fasten oil sump **F** by tightening capscrews **E** and strictly following the order shown in **Fig. 11.73** (tightening torque at  **20 Nm** ). 2. Loosen capscrews **A** and remove housing or plate **L** ( **Fig. 11.72** ). 3. Fasten oil sump **F** by tightening capscrews **E** and strictly following the order shown in **Fig. 11.73** (tightening torque at  **47 Nm** ). Loosen the screw **1** again and tighten it to **47 Nm** . | 11_xx_coppa_portante_3cyl_ord_serr.png  11_78.jpg  **Fig. 11.86** |

|  |  |
| --- | --- |
| 1. Insert gaskets **N** into seats **P** of bypass tube **D** . 2. Fasten bypass tube **D** onto oil sump **F** using capscrews **C** (tightening torque at **10 Nm** ). | 11_74.jpg  **Fig. 11.87** |

|  |  |
| --- | --- |
| **11.12.5 Flange plate / housing assembly**   1. Execute the operations described in **point 6** of **Par. 11.12.4** . 2. Fasten housing or plate **L** by using capscrews **A** and strictly following the order shown in **Fig. 11.75** (tightening torque at **85 Nm** ). 3. Fasten housing or plate **L** by using capscrews **B** (tightening torque at **270 Nm** ).   **11.12.6 Flywheel assembly**   1. Execute the operations described in [**Par. 9.5.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=162&parent=1000) **.** | 11_80.jpg  **Fig. 11.88** |

## ETB (replacement)

|  |  |
| --- | --- |
| 1. Unscrew screws **A** and remove the ETB valve **B** with its gasket **C** .     Z_importante.jpg **Important**         * Always replace the gasket **C** at each assembly. | 11_13_1.png  **Fig. 11.89** |
| 1. Fix the ETB valve **B** and its gasket **C** by means of screws **A** (tightening torque **10 Nm** ) | 11_13_2.png  **Fig. 11.90** |

## ACACT (replacement)

|  |  |
| --- | --- |
| 1. Unscrew sensor **A** and its gasket **B** .     Z_importante.jpg **Important**         * Before assembling the new sensor, see **Par. 2.17.5** * Always replace the gasket **B**  at each assembly. | 11_14a.png  **Fig. 11.91** |
| 1. Fix sensor **A** and gasket **B** on their support **C** (tightening torque **20 Nm** ). | 11_14b.png  **Fig. 11.92** |

## EGTS (Black | Yellow - replacement)

|  |  |
| --- | --- |
| 1. Unscrew sensors **A** .     Z_importante.jpg **Important**         * Before assembling the new sensor, see **Par. 2.17.6** | 11_15a.png  **Fig. 11.93** |
| 1. Fix sensors **A** on the ATS **B** (tightening torque **30 Nm** ). | 11_15b.png  **Fig. 11.94** |

## DPF & DOC filter (replacement)

|  |  |
| --- | --- |
| 1. Obtain a new replacement KIT for the DPF filter or a replacement KIT with regenerated DPF filter from your spare parts service.       Z_importante.jpg **Important**         * Before disassembling/assembling any sensors, see **Par. 2.17.5** and **2.17.6** * Always replace the seal **P** upon every assembly.  1. Perform the operations indicated in **point 1** of **Par. 11.15** . 2. Open the package of the DPF replacement KIT, taking care not to damage it. 3. Unscrew screw **A** and loosen clamps **B** , then remove the Delta-P sensor **D** . 4. Disconnect pipes **C** from their unions **J** and remove the Delta-P sensor **D** . 5. Unscrew and remove unions **J** . | 11_16a.png  **Fig. 11.95** |
| 1. Loosen clamps **E** and remove manifold **N** . | 11_16b.png  **Fig. 11.96** |
| 1. Loosen clamp **G** and remove the DPF filter **H** .   **NOTE:**  do not remove clamp **G** .   1. Inspect the DPF filter to detect any visible signs of oil contamination. 2. Put the removed DPF filter in the plastic container supplied with the replacement KIT and send it to your spare parts service using the replacement KIT package.   **NOTE** **:** a residual value will be recognised depending on whether the used DPF is intact and recyclable or damaged and requiring a correct disposal. | 11_16c.png  **Fig. 11.97** |
| 1. Loosen the clamps **Q** and **S** and remove the manifold with DOC **M** from the flexible hose **R** . | 11_xx_Filtro_DOC_01.png  **Fig. 11.98** |
| 1. Fit the new manifold with the DOC filter **M** on the support **T** , inserting the flexible hose **R** inside the inlet of the manifold **M** . | 11_xx_Filtro_DOC_04.png  11_xx_Filtro_DOC_02.png  11_xx_Filtro_DOC_03.png  **Fig. 11.99** |
| Z_importante.jpg **Important**         * Do not apply any tension during the assembly of components.  1. Before fastening the manifold **M** , it must be oriented in the same position as the previously installed DOC filter. 2. Tighten the clamp Q (tightening torque of **10 Nm** ). 3. Tighten the clamp **S** (tightening torque of **12 Nm** ). | 11_xx_Filtro_DOC_01.png  **Fig. 11.100** |
| 1. Insert the gasket **P** on the manifold with DOC filter **M** . 2. Insert the new DPF filter **H** inside clamp **G** . 3. Insert the DPF filter **H** on manifold **M** until reaching the gasket **P** . | 11_16d.png  **Fig. 11.101** |
| Z_importante.jpg **Important**         * Before fastening the DPF filter **H** , it must be oriented in the same position as the previous filter. * Do not apply any tension during the assembly of components.  1. Fasten the DPF filter **H** with clamp **E** (tightening torque  **12   Nm** ). | 11_16e.png  **Fig. 11.102** |
| 1. Insert gasket **P** on the DPF filter **H** . 2. Insert manifold **N** on the DPF filter **H** until reaching the gasket **P** .     Z_importante.jpg **Important**         * Before fastening manifold **N** , it must be oriented in the original position.  1. Fasten manifold **N** with clamp **E** (tightening torque  **12   Nm** ). | 11_16f.png  **Fig. 11.103** |
| 1. Position support **K** in contact with support **K1** and fasten clamp **G** (tightening torque  **12  Nm** ). | 11_16fa.png  **Fig. 11.104** |
| 1. Screw unions **J** on the DPF filter **H** and position them about **20°** away from the centre line (as in  **Fig. 11.90** ). | 11_16g.png  **Fig. 11.105** |
| 1. Fix unions **J** (tightening torque **60 Nm** ). | 11_16h.png  **Fig. 11.106** |
| 1. Fit pipes **C** on unions **J** and fasten them with clamps **B** . 2. Fix the Delta-P sensor **D** on its support **K** by means of screw **A** (tightening torque **10 Nm** ). 3. Provide the machine owner with the warranty certificate of the new DPF filter KIT installed. 4. Perform the " **DPF replacement** " procedure to reset the ASH & SOOT through the relevant KOHLER diagnostic tool interfaced with the ECU. | 11_16l.png  **Fig. 11.107** |

## Oil sump 15L

|  |  |
| --- | --- |
| **11.17.1 Option A**  **11.17.1.1** **Disassembly**   1. Perform the operations indicated in [**Par. 5.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=121&parent=1000) . 2. Loosen the screws **A** and remove the oil sump **B** . 3. Loosen the screws **A1** and remove the oil sump **B1** flange. | 11_xx_coppa_Carrier_01.png  11_xx_coppa_Carrier_02.png  **Fig. 11.108** |

|  |  |
| --- | --- |
| **11.17.1.2** **Assembly**   1. Apply a bead of approx. **2.5 mm** of sealant ( **Loctite 5660** ) inside the channel **B2** of the oil sump **B1** flange. 2. Position the oil sump **B1** on the crankcase **H** at the fixing holes (use the tool [**ST\_18**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). 3. Screw the screws **A1** in the fixing holes. | 11_xx_coppa_Carrier_03.png  11_xx_coppa_Carrier_04.png  11_xx_coppa_Carrier_05.png  **Fig. 11.109** |
| 1. To fix the sump **B1** , tighten the screws **A1** by strictly following the order indicated in the **Fig. 11.110** (tightening torque of **25 Nm** ). 2. Loosen the screw **1** again and tighten it to **25 Nm** . | 11_xx_coppa_Carrier_06.png  **Fig. 11.110** |

|  |  |
| --- | --- |
| 1. Apply a bead of approx. **2.5 mm** of sealant ( **Loctite 5660** ) inside the channel **B3** of the oil sump **B** . 2. Position the oil sump **B** on the oil sump **B1** flange at the fixing holes (use the tool [**ST\_18**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). 3. Screw the screws **A** in the fixing holes. | 11_xx_coppa_Carrier_08.png  11_xx_coppa_Carrier_09.png  **Fig. 11.111** |
| 1. To fix the sump **B** , tighten the screws **A** by strictly following the order indicated in the **Fig. 11.112** (tightening torque of **25 Nm** ). 2. Loosen the screw **1** again and tighten it to **25 Nm** . | 11_xx_coppa_Carrier_10.png  **Fig. 11.112** |
| **11.17.2 Option B**  **11.17.2.1** **Disassembly**   1. Perform the operations indicated in [**Par. 5.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=121&parent=1000) . 2. Loosen the screws **A** and remove the oil sump **B** . 3. Loosen the screws **A1** and remove the oil sump **B1** flange. | 11_xx_coppa_Liebherr_01.png  11_xx_coppa_Liebherr_02.png  **Fig. 11.113** |
| **11.17.2.2** **Assembly**   1. Apply a bead of approx. **2.5 mm** of sealant ( **Loctite 5660** ) inside the channel **B2** of the oil sump **B1** flange. 2. Position the oil sump **B1** on the crankcase **H** at the fixing holes (use the tool [**ST\_18**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). 3. Screw the screws **A1** in the fixing holes. | 11_xx_coppa_Liebherr_03.png  11_xx_coppa_Liebherr_04.png  11_xx_coppa_Liebherr_05.png  **Fig. 11.114** |
| 1. To fix the sump **B1** , tighten the screws **A1** by strictly following the order indicated in the **Fig. 11.115** (tightening torque of **25 Nm** ). 2. Loosen the screw **1** again and tighten it to **25 Nm** . | 11_xx_coppa_Liebherr_06.png  **Fig. 11.115** |
| 1. Apply a bead of approx. **2.5 mm** of sealant ( **Loctite 5660** ) inside the channel **B3** of the oil sump **B** . 2. Position the oil sump **B** on the oil sump **B1** flange at the fixing holes (use the tool [**ST\_18**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) ). 3. Screw the screws **A** in the fixing holes. | 11_xx_coppa_Liebherr_08.png  11_xx_coppa_Liebherr_09.png  **Fig. 11.116** |
| 1. To fix the sump **B** , tighten the screws **A** by strictly following the order indicated in the **Fig. 11.117** (tightening torque of **25 Nm** ). 2. Loosen the screw **1** again and tighten it to **25 Nm** . | 11_xx_coppa_Liebherr_10.png  **Fig. 11.117** |

## Replacement of air intake components without Intercooler (KDI 1903 TC model only)

|  |  |
| --- | --- |
| **11.18.1 Disassembly**    **1 -** Loosen clamps **A** and **B** .    **2 -** Remove manifold **C** . | 1903_TC_cap_11_aspirazione_1.png  **Fig. 11.118** |
| **3 -** Loosen the screws **B** and remove the sensor **E** . | 1903_TC_cap_11_aspirazione_2.png  **Fig. 11.119** |
| **4 -** Unscrew and remove sensor **F** . | 1903_TC_cap_11_aspirazione_3.png  **Fig. 11.120** |
| **5 -** Loosen clamps **M** and **G** and disengage tube **H** and manifold **N** .  **6 -** Disengage elbow **P** from manifold **N** . | 1903_TC_cap_11_aspirazione_4.png  **Fig. 11.121** |
| **7 -** Unscrew and remove sensor **S** . | 1903_TC_cap_11_aspirazione_10.png  **Fig. 11.122** |
| **11.18.2 Assembly**  **1 -** Fit tube **H** on union **L** and fasten it with clamp **G** . | 1903_TC_cap_11_aspirazione_5.png  **Fig. 11.123** |
| **2 -** Fit manifold **N** on ETB **Q** and fasten it with clamp **M** . **3 -** Fit elbow **P** on manifold **N** and fasten it with clamp **M** . **4 -** Fit tube **H** on union **R** and fasten it with clamp **G** . | 1903_TC_cap_11_aspirazione_6.png  **Fig. 11.124** |
| **5 -** Fix sensor **F** on elbow **P** by placing gasket **F1** in-between (tightening torque of **20 Nm** ). | 1903_TC_cap_11_aspirazione_7.png  **Fig. 11.125** |
| **6 -** Place sensor **E** on elbow **P** . **7 -** Fix sensor **E** through screws **D** (tightening torque of **10 Nm** ). | 1903_TC_cap_11_aspirazione_8.png  **Fig. 11.126** |
| **8 -** Fit manifold **C** on elbow **P** and turbocharger **P1** . **9 -** Fix manifold **C** with clamps **A** and **B** . | 1903_TC_cap_11_aspirazione_9.png  **Fig. 11.127** |
| **10 -** Fix sensor **S** on manifold **J** by placing gasket **S1** in-between (tightening torque of **20 Nm** ). | 1903_TC_cap_11_aspirazione_11.png  **Fig. 11.128** |

# Information on adjustments

## 'Waste Gate' opening valve regulation

Z_importante.jpg **Important**

* Before proceeding with operation, read [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=814&parent=1545) .
* Regulation must not be carried out with the engine running.
* During the procedure in **point 5** , pay special attention not to bend rod **H** .

1. Disconnect the hose **A** from the turbocharger, and connect a pressure gauge **B** (scale from 0 to 5 bar).
2. Connect the gauge **B** to the network of compressed air, interposing a pressure reducer **C** .
3. Position dial gauge **D** in such a way that feeler **F** rests onthe Waste Gate rod control valve extremity **H** (point **E** ).
4. By using gradually the reduction gear C send the air to the Waste Gate actuator control L in order to move rod H forward by 1 mm (value M to check on dial gauge D). Pressure read on gauge B must be: 1350 mbar for engine model KDI 2504 TCR and 1250 mbar for engine model KDI 1903 TCR.
5. If pressure is less or more than the indicated value, proceed as follows: - Undo lock nut G from rod H.

- Remove the retainer cotter pin (point **E** ) and disconnect rod **H** from the Waste Gate control lever.  
- Tighten (to increase) / or loosen (to decrease) pressure of the ring nut of rod **H** until reaching the corrected calibration.  
- Redo lock nut **G** .  
- Reconnect rod **H** and assemble the cotter pin point **E** .

 **Fig 12.1**

## Air filter check

|  |  |
| --- | --- |
| Z_importante.jpg  **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=283&parent=1136) . * When the cartridge **G** is dirty, do not clean it but replace cartridges **B and G** . |  |
| 1. All manifolds connected to the turbo must be fully clean and not damaged. 2. Clean the inside components **A and D** with a damp cloth. 3. **Do not use compressed air** , repeatedly tap the front side **E** on a flat surface. | 12.2.png **Fig 12.2** |

## Oil steam separator check

|  |  |
| --- | --- |
| Z_importante.jpg  **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/man/jsp/Template2/manuale.jsp?id=198&parent=1000uale.jsp?id=283&parent=1136) . |  |
| 1. Loosen clamp **B** and remove hose **C** from hose **D** . 2. Start the engine at idle speed or without a load; check if air comes out of hose **C** .     **NOTE:** If what is described in **Point 2** does not occur, proceed with cleaning or replacing oil separator **A** and accurately clean support flange **F** , all connecting hoses, and repeat the operation from P **oint 2.** | 12.3.png **Fig 12.3** |

## Rubber hoses and manifolds check

|  |  |
| --- | --- |
| Z_importante.jpg  **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) . |  |
| The check is carried out by applying slight deflection or bending along the tube/hose and next to the hose clamps.   Components must be replaced if they have clear signs of cracks, tears, cuts, leaks, or do not retain a certain degree of elasticity.   1. Check the condition of all rubber hoses **A** . 2. Check whether there are any leakages of air, refrigerant, oil or fuel next to their connections. | 12.4.png **Fig 12.4**12.5.png **Fig 12.5** |

## Oil leak check

|  |  |
| --- | --- |
| Z_importante.jpg  **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) . |  |
| Check that there are no leakages next to area **A** .   1. Start the engine at idle speed or without a load and check whether there are any leakages next to area  **A.** 2. It is anyhow necessary to also check the seals of all main components and their surface contact, such as: - crankcase and gasket (side 1 a PTO) - oil sump and exhaust caps     - cylinder head and its assembled components    - rocker arm cover    - Timing system carter and gasket (side 2 a PTO) - oil dipstick housing or rod support tube.      **NOTE:** Perform the checks described in **Points 1 and 2** periodically and during maintenance procedures. It is also necessary to check for leakages on the components that are not listed.  If necessary, disassemble the components that have a leakage and investigate the possible cause.    The components must be replaced otherwise they do notguarantee their sealing. | 12.6.png **Fig 12.6**12.7.png **Fig 12.7** |

## Oil pressure check

|  |  |
| --- | --- |
| Z_importante.jpg  **Important**       * Before proceeding with operation, read  [**Par. 3.3.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=198&parent=1000) . | |
| 1. Insert a thermocouple instead of the oil dipstick **A** .      1. Unscrew and remove the oil pressure switch and screw on a 10 bar pressure gauge in its seat **(Fig. 12.10)** .      1. Start the engine at idle speed and without a load, check the oil pressure value according to the oil temperature **(Fig. 12.9** ).   **NOTE** : The graph in **Fig. 12.9** illustrates the pressure line with speed of 1000 Rpm.   1. If the pressure values are below the values indicated in **Fig. 12.9** , check to identify the cause of the problem.   12.9.png  **Fig. 12.9** | 12.8.png  **Fig. 12.8**  12.10.png  **Fig. 12.10** |

# Tools information

## Information regarding specific tools

In **Tab 13.1 - 13.2 - 13.3** there is a list of all the specific tools that are required and approved to carry out operations of disassembly - assembly - regulations - settings - repairs on engine series **KDI**

, correctly and safely.

Z_Avvertenza.jpg **Warning**

* **KOHLER** declines all responsibility for any damage to the engine, persons, or things caused by the use of different types of tools to those indicated in **Tab 13.1 - 13.2 - 13.3** , where referred to them in the manual.

|  |  |  |  |
| --- | --- | --- | --- |
| **Tab. 13.1** | | | |
| **SPECIAL TOOLS FOR DISASSEMBLY AND ASSEMBLY** | | | |
| **"ST"** | **Picture/Draw** | **DESCRIPTION** | **PART NUMBER** |
| **ST\_03** | immst_03.jpg | Piston protrusion - electronic injectors cylinder head surface control tool | ED0014602980-S |
| **ST\_04** | immst_04.jpg | High-pressure fuel injection pump puller gear | ED0014603680-S |
| **ST\_05** | immst_05.jpg | Spanner for capscrews Six nicks SN 8 | ED0014603650-S |
| **ST\_06** | immst_06.jpg | Spanner for capscrews Six nicks SN 5 | ED0014603640-S |
| **ST\_07** | immst_07.jpg | Tool for disassembling / reassembling valves | ED0014603720-S |
| **ST\_08** | immst_08.jpg | Tool for gasket valve stem | ED0014603660-S |
| **ST\_09** | immst_09.jpg | Tool for flywheel assembling / disassembling | ED0014603610-S |
| **ST\_10** | immst_10.jpg | Crankshaft gasket assembling tool | ED0014603670-S |
| **ST\_11** | immst_11.jpg | Rocker arm cover gasket assembling tool (electronic injector seat) | ED0014603620-S |
| **ST\_12** | immst_12.jpg | Rocker arm cover gasket assembling tool (rocker arm capscrew gudgeon seat - electronic injector fastening capscrew brace seat) | ED0014603630-S |
| **ST\_14** | immst_14.jpg | Buffer insertion of a crankshaft gasket onto a timing system carter | ED0014603750-S |
| **ST\_15** | immst_15.jpg | Locking screw balance shafts | ED0097301980-S |
| **ST\_17** | immst_17.jpg | Rocker arm cover mounting studs | ED0014603730-S |
| **ST\_18** | immst_18.jpg | Intake and oil sump manifold mounting studs | ED0014603740-S |
| **ST\_34** | Bloccaggio.png | Crankshaft blocking tool | ED0014604270-S |
| **Tab. 13.2** | | | |
| **SPECIFIC EQUIPMENT TO PROTECT COMPONENTS OF THE INJECTION CIRCUIT** | | | |
| **ST\_40** | immst_40a.jpgimmst_40b.jpg | Complete box with caps to close holes and unions for high-pressure injection circuit components. | ED0082051380-S |
| **Tab. 13.3** | | | |
| **SPECIAL TOOLS TO TEST THE ENGINE ON THE TEST BENCH - DIAGNOSTIC PROCEDURE** | | | |
| **ST\_01** | 3.png | Complete instrument Kit for diagnostics "POLAR XL" | ED0014603690-S |
| **ST\_49** | 1.png | Complete instrument Kit for diagnostics "DIAGBOX" | ED0014604210-S |
| **ST\_50** | 2.png | Complete instrument Kit for engines bench test | ED0014604110-S |

# Information about failures

## Possible causes and trouble shooting

**IMMEDIATELY STOP THE ENGINE WHEN:**

1. Engine rpm increases and decreases suddenly without being able to control them;
2. A sudden and unusual noise is heard;
3. The colour of the exhaust fumes suddenly darkens or turns white;
4. The oil pressure warning light or a Warning Lamp turns on during operation;
5. The coolant temperature warning light turns on during operation.

**Tab. 14.1** contains the possible causes of some failures, which may occur during operation.

Always perform these simple checks before removing or replacing any part.

Z_Avvertenza.jpg **Warning**

* Do not carry out any checks or operations on the engine when it is running.

**Tab. 14.1**



# Glossary

## Glossary

***A***

|  |  |
| --- | --- |
| **ACACT:** | After Charge Air Cooler Temperature |
| **Air gap:** | Distance to respect between a fixed component and one in movement. |
| **Alternator:** | A component that transforms mechanical energy into AC electrical energy. |
| **Authorised workshop:** | **KOHLER** authorised service centre. |
| **Authorised service station:** | **KOHLER** authorised workshop. |
| **ATS:** | After Treatment System - Post-treatment system, referred to the exhaust gases produced by the engine. |

***B***

|  |  |
| --- | --- |
| **Balancer device:** | A device that reduces vibrations caused by movement of the alternating weights (Crankshaft - Connecting rods - Pistons). |
| **Base configuration:** | Engine having components represented in **Par. 1.4 - 1.5** . |
| **BDC:** | Bottom Dead Centre; a moment in which the piston is at the start of its stroke. |
| **Bore:** | Internal diameter of the cylinder in combustion engines. |

***C***

|  |  |
| --- | --- |
| **CAN:** | "Controller Area Network" - also known as CAN-bus, is a data communication standard for ECUs. |
| **Catalyst:** | see " **DOC** " |
| **Combustion:** | Chemical reaction of a mixture composed of fuel and fuel (air) inside a combustion chamber. |
| **Common Rail:** | A high-pressure "Common Duct" that produces a constant supply of fuel directly to the Electronic injectors. |
| **Crankshaft:** | A component that transforms straight operation into rotary operation, and vice-versa. |

***D***

|  |  |
| --- | --- |
| **DOC** **:** | Diesel Oxidation Catalyst - Catalyst for diesel engines that reduces harmful exhaust gas emissions produced by the engine. |
| **DPF** **:** | Diesel Particulate Filter - A filter that captures particles of carbonaceous origin emitted by diesel engines. |

***E***

|  |  |
| --- | --- |
| **EC:** | "European Community". |
| **ECS:** | Emission Control System |
| **ECU:** | Electronic Control Unit; an electronic device in charge of electronically detecting and controlling other electronic control devices. |
| **EGR:** | Exhaust Gas Recirculation, in internal combustion engines; a system that enables recirculation of combusted gas by means of taking it in once again, which enables it to break down  a part of the pollutants present in the exhaust gas. |
| **EGR Cooler:** | Recirculated exhaust gas cooling; a system that is able to cool recirculated gas (EGR) from the exhaust. This enables the temperature to remain constant inside the intake manifold,  thus improving combustion inside the cylinders and breaking down pollutants further. |
| **EGR-T:** | "Exhaust Gas Recirculation Temperature" - temperature sensor for EGR |
| **EGTS:** | "Exhaust Gas Temperature Sensor" |
| **EGR valve:** | Electronically-controlled device that adjusts the entrance of exhaust gas recirculated inside the intake manifold. |
| **Electronic Injector:** | An electronically activated component able to inject jets of atomised fuel inside the cylinders. |
| **EPA:** | Environmental Protection Agency. The United States' authority that safeguards the environment; its duty is to govern and control polluting emissions. |
| **ETB:** | Electronic Throttle Body - This is controlled by the ECU upon request of the accelerator pedal, and its function is crucial for the correct regeneration of the ATS system. |

***F***

|  |  |
| --- | --- |
| **Fig.:** | Figure. |
| **Functional units:** | Component, or group of main components, able to carry out specific functions on the engine. |

***G***

|  |  |
| --- | --- |
| **Galvanised:** | Material that has undergone surface protection treatment. |
| **Grinding (valves and seats):** | Cleaning operation of the valves and seats carried out with an abrasive paste (refer to an authorised service station for this type of operation). |

***H***

|  |  |
| --- | --- |
| **Heater:** | A device that heats the intake air by means of an electrical resistor. |
| **Heavy conditions:** | Type of extreme condition referred to the work environment in which the engine is used (very dusty - dirty area, or in a contaminated environment due to various types of gas). |

***I***

|  |  |
| --- | --- |
| **Idle speed operation:** | Operation of a running engine with the vehicle stopped and on idle speed. |
| **Intercooler:** | Air-cooling element under pressure from the turbo situated between the turbine and intake manifold. |

***K***

|  |  |
| --- | --- |
| **KDI:** | "Kohler Direct Injection" |

***M***

|  |  |
| --- | --- |
| **Maintenance - periodic:** | A group of maintenance actions that have the sole objective to control and replace elements on their expiry, without modifying or improving the functions carried out by the system, neither increasing the value nor improving performance. |
| **MAX:** | Maximum. |
| **Methyl ester:** | It is a mixture of products by means of a chemical conversion of oils and animal and/or vegetable fat, which is used to produce Biofuel. |
| **Min.:** | Minutes. |
| **MIN:** | Minimum. |
| **Model:** | Model, engine identification plate, which indicates the engine's model. |

***N***

|  |  |
| --- | --- |
| **N/C:** | Normally Closed, referred to switches (oil-pressure switch). |

***O***

|  |  |
| --- | --- |
| **Oil Cooler:** | Small radiator used to cool the oil. |

***P***

|  |  |
| --- | --- |
| **Par.:** | Paragraph. |
| **Paraffin.:** | Fatty and solid substance that may form inside the diesel. |
| **Pipe cleaner:** | An instrument having a metal cylindrical body with bristles that jut outwards. It is similar to a brush and is used to clean areas that are not easily accessible manually (e.g. oil ducts inside an engine). |
| **Poly-V:** | Poly-V, the name associated with a service belt, which derives from the profile of its section that is constructed with joined Vs. |
| **Power operation:** | Operation of the engine at high speeds. |
| **PTO:** | Power Take Off - a point provided to take advantage of alternative operation transmission. |
| **Pump Learning:** | Automatic procedure carried out by **ECU** (by means of a diagnostics instrument - **ST\_01** ) to discover the operating characteristics of the fuel feeding pump (should the injection pump or **ECU** be replaced). |

***Q***

|  |  |
| --- | --- |
| **QR:** | Quick Response (code) - QR Code, a two-dimensional matrix bar code composed of black modules placed inside a squareshaped structure. |

***R***

|  |  |
| --- | --- |
| **Ref.:** | Reference. |
| **Rpm:** | Rounds per minute. |

***S***

|  |  |
| --- | --- |
| **s/n:** | Serial number (engine identification name plate) indicating the engine identification series/chassis number. |
| **SCV:** | Suction Control Valve - it is situated on the high-pressure injection pump and is directly controlled by the **ECU** adjusting the intake of fuel to send to the **Common Rail** . |
| **Spec.:** | Specification, (engine identification name plate) indicating the engine version. |
| **STD:** | (Standard), base configuration of a component, or a group of components. |

***T***

|  |  |
| --- | --- |
| **Tab.:** | Table. |
| **Target Wheel:** | A wheel that is a part of a device to control angular operation by means of teeth placed on the circumference, which enable to determine and transmit the speed and position of the crankshaft to a sensor. |
| **TCR:** | Turbo Common Rail. |
| **TDC:** | Top Dead Centre; a moment in which the piston is at the end of its stroke. |
| **Thermostatic valve:** | A valve that adjusts the flow of coolant liquid; it is able to operate by means of temperature variation. |
| **Tightening torque:** | A term indicated for installation of threaded components and which is determined by means of a unit of measurement **Nm** . |
| **T-MAP:** | T-MAP (sensor), measures the temperature and absolute pressure inside the intake collector. |
| **Torque:** | Force applied to an object that rotates on an idler shaft. |
| **Trochoid:** | Rounded toothed profile (also known as "lobes"). |
| **Turbocharger:** | Device that compresses air intake by sending it to the intake manifold by means of a turbine. |

***U***

|  |  |
| --- | --- |
| **Used oil:** | Oil altered by operation or time, which is no longer compliant for correct lubrication of the components. |

***W***

|  |  |
| --- | --- |
| **Waste-Gate valve:** | A device, which is directly or automatically controlled, used to limit the pressure of exhaust gas inside the turbine. |
| **Warning Lamp:** | A warning light (usually red) that indicates a serious anomaly during engine operation. |

|  |  |  |  |
| --- | --- | --- | --- |
| **SYMBOLS AND UNITS OF MEASUREMENT** | | | |
| **SYMBOL** | **UNIT OF MEASUREMENT** | **DESCRIPTION** | **EXAMPLE** |
| α | degree | Rotation/inclination angle | 1° |
| cm 2 | square centimetre | Area | 1 cm 2 |
| Ø | millimetre | Circumference | Ø 1 mm |
| Nm | newton-metre | Torque | 1 Nm |
| mm | millimetre | Length | 1 mm |
| µm | 1/1000 of a millimetre (micron) | 1 µm |
| H | hour | Time | 1 h |
| g/kW | grammes per kilowatt per hour | Specific consumption | 1 g/kWh |
| kg/h | kilogramme per hour | Max. flow rate | 1 kg/h |
| Lt./min. | litres per minute | Flow rate | 1 Lt./min. |
| Lt./h | litres per hour | 1 Lt./h |
| ppm | parts per million | Percentage | 1 ppm |
| N | newton | Force | 1 N |
| A | Ampere | Intensity of electrical current | 1 A |
| gr. | gramme | Weight | 1 gr. |
| kg | kilogramme | 1 kg |
| W | Watt | Power | 1 W. |
| kW | kiloWatt | 1 kW |
| pa | pascal | Pressure | 1 pa |
| KPa | Kilopascal | 1 KPa |
| bar | barometric pressure | 1 bar |
| mbar (1/1000 bar) | barometric pressure | 1 mbar |
| R | Resistance | Resistance to electrical current (referred to a component) | 1 Ω |
| Ω | ohm | Resistance of electrical current | 1 Ω |
| Rpm | revs per minute | Rotation of an axis | 1 Rpm |
| Ra | average roughness expressed in microns | Roughness | 1 Ra |
| °C | degree centigrade | Temperature | 1°C |
| V | Volt | Electrical voltage | 1 V |
| eagonale.png | millimetre | Hex-head capscrew | eagonale.png 1 mm |
| cm 3 | cubic centimetre | Volume | 1 cm 3 |
| Lt. | litre | 1 Lt. |

