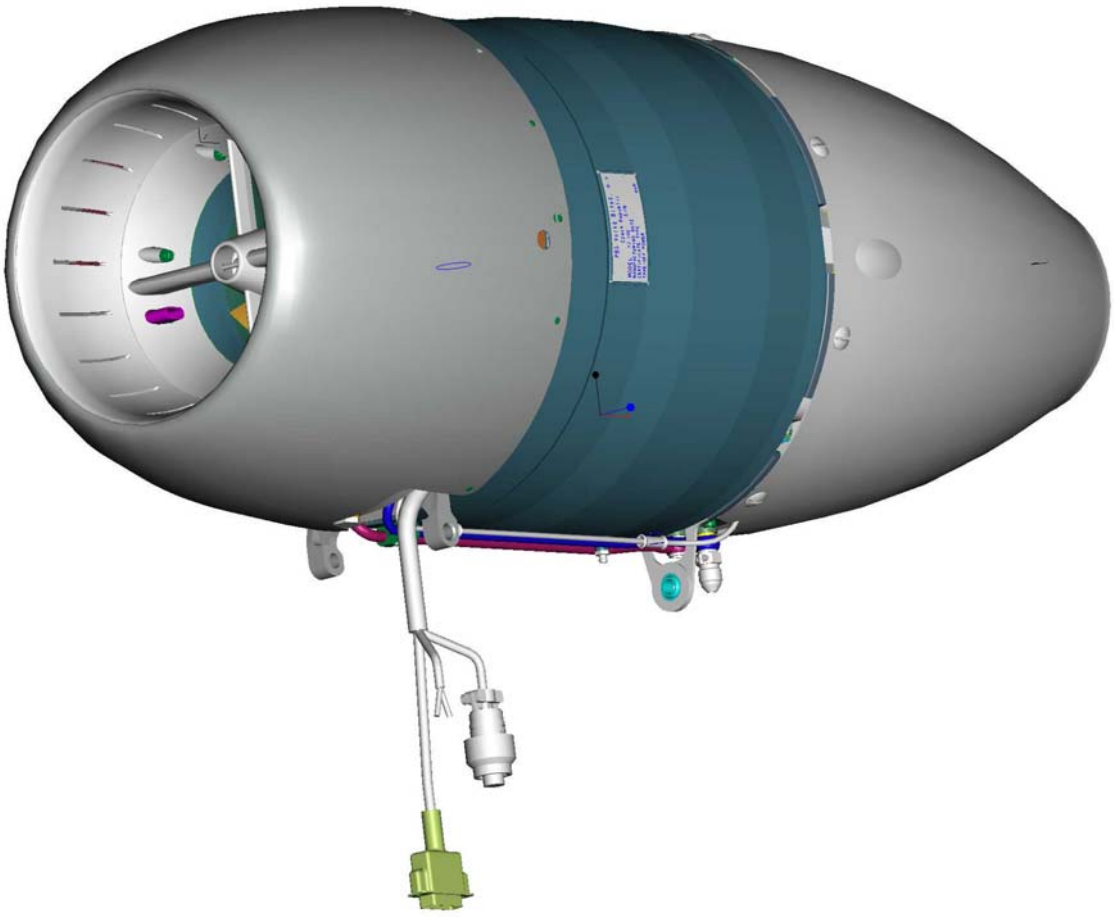
OPERATION AND MAINTENANCE MANUAL

TURBOJET ENGINE TJ 100



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SAFETY SUMMARY

DEFINITIONS
In this manual relevant steps are preceded by Warnings or Cautions. For WARNINGS and CAUTIONS contained herein the following definitions shall apply:

WARNING

Operating procedures or maintenance jobs, methods, circumstances or instructions, which non-observance could result in injury or death of personnel or represent a long-time health hazard.

CAUTION

Operating procedures or maintenance jobs, methods, circumstances or instructions, which non-observance could result in damage to or destruction of equipment.

General safety precautions

The following is the description of general safety precautions, which do not relate to any specific activity and therefore are not mentioned in other parts of this Manual. These are general recommendations, which should be understand and observed by the maintenance personnel in course of relevant phases of operation and maintenance.

Safety precautions

The TJ 100 operator must in engine testing and operation take into account the following safety risks:

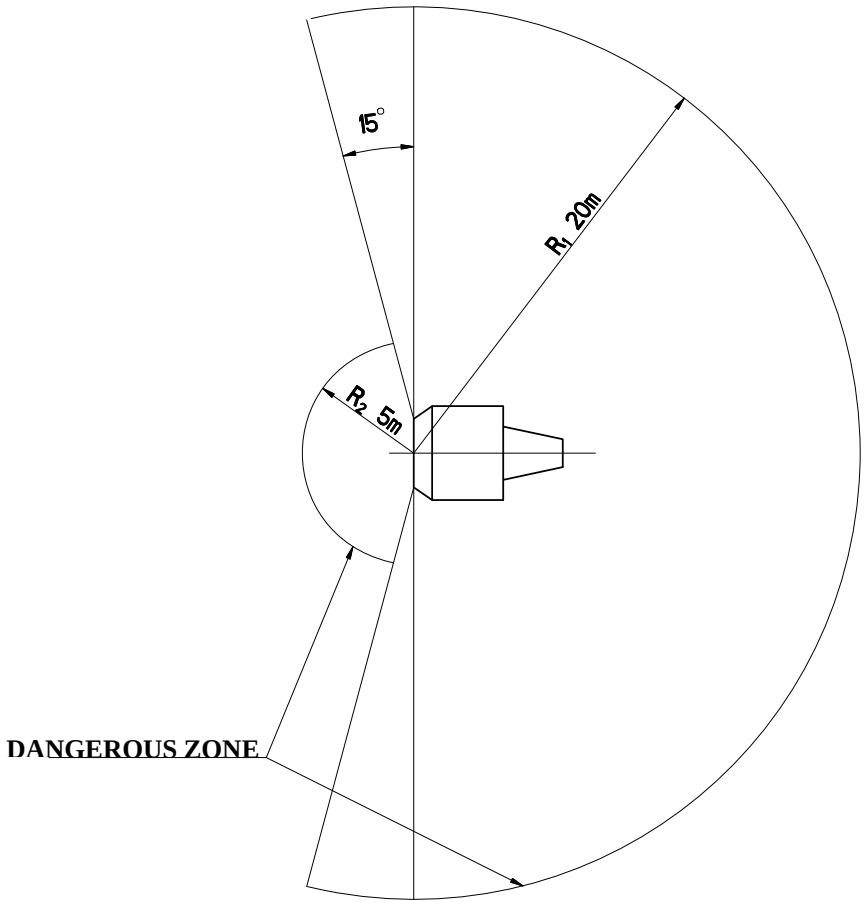
a) Aspiration of foreign objects
The engine needs a large amount of air for its function (approx. 1.7 kg/s at 100% speed), which may result in suction of foreign objects in the space of the compressor inlet, if these are not fixed sufficiently.

b) Forward thrust
The engine generates more than quintuple axial thrust in relation to its own weight; in tests it must be fixed sufficiently against motion.

c) Exhaust gas temperature
Exhaust gases exiting the engine with high speed have a temperature up to 770°C at the nozzle level, and approx. 100°C in the distance of approx. 4 m. The operator must take necessary precautions against risk of fire.

d) Noise level
The noise level of the operated engine is 134 dB (A) at the distance of 1 m from the exhaust nozzle. The operator must ensure appropriate sound protection equipment for the operating personnel.

e) Dangerous zones
For safety reasons presence of persons is forbidden in the zone of 20 m on sides and behind the engine and in the zone of 5 m in front of the engine, if the latter is operated without sufficient protective covers.



Dangerous materials

Warnings contained herein regarding dangerous materials should warn personnel against the danger that may be connected with such materials. For every dangerous material used there must be Material Safety Data Sheet (MSDS) or its equivalent available. All personnel must have access to MSDS (or their equivalent) for the materials he/she handles or is exposed to. Concerning dangerous chemicals, MSDS, required personal protective equipment, and the issues of proper method of handling and disposal of the dangerous materials and emergency procedures in their handling, please contact the personnel of a local OHS department.
Do not perform any maintenance without presence of another person.
The maintenance personnel must under no circumstances maintain the equipment without presence or assistance of another person, who is able to provide assistance and help any time.

Resuscitation

The personnel working with high voltage or dangerous materials or in their vicinity must be familiarized with the techniques of first aid and resuscitation. Appropriate information can be obtained from health service.

DESCRIPTION OF DANGEROUS MATERIALS

Aviation fuel according to paragraph 1.4:
The fuel according to paragraph 1.4 is a light yellowish flammable fluid, with explosive vapours. Long-time or recurrent contact with skin may result in dermatitis. Ingestion of a higher amount may cause indigestion. Inhalation damages the lungs. Vapours can irritate eyes, nose and throat. In contact with skin, wash the skin with soap water. In contact with eyes, rinse the eyes with plenty of water, and let them opened. In digestion, do not induce vomiting, and seek medical assistance. In inhalation, take the person from the room into fresh air and seek medical assistance.

Oil according to paragraph 1.4:
The oil according to paragraph 1.4 is produced by synthesis of hydrocarbons and additives. It is an amber fluid. Under normal conditions of use and with observance of the rules of personal hygiene, it has no adverse effect, and is not toxic. In contact with eyes, rinse the eyes with water; in irritation seek medical assistance. In contact with skin, wash the skin with soap water. Do not wear clothes contaminated with the oil. In inhalation, take the person from the room into fresh air. In irritation troubles in breathing, giddiness, nausea or unconsciousness, seek medical help.
In digestion, seek medical assistance, cause vomiting. Do not cause vomiting in unconsciousness.

WARNINGS AND CAUTIONS

- Hot oil can burn eyes and skin. Use protective goggles, isolated gloves and other protective equipment. In contact with eyes, seek medical treatment.
- In opening the engine tank, oil can splash out and get into eyes or on the skin. Use protective goggles, isolated gloves and other protective equipment. In contact with eyes, seek medical treatment.
- In use of compressed air for cleaning or drying, limit the pressure to maximum 200 kPa (29 PSI). Protect the eyes by protective goggles or protective shield.
- Use protective goggles when working with tying wire.
- Petrol 90/150 is deleterious and highly flammable. Do not inhale its vapours. Use the petrol in properly ventilated rooms, when it cannot get into contact with sparks, flame or hot surfaces. Use protective goggles, gloves resistant to solvents and other protective equipment. In contact with eyes, wash the eyes with plenty of water, and seek medical treatment. In contact with skin, wash the skin with soap water.

FOREWORD

PURPOSE AND SCOPE OF THE MANUAL

This manual has been prepared by PBS Velká Bíteš, a.s. Its purpose is to provide the user with the description of the design, function, technical parameters, installation and operation of the TJ 100 engine.
The manual cannot be distributed to third persons without the author's consent.

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CHAPTER 1
BASIC TECHNICAL PARAMETERS

1.1 Purpose

The turbojet engine has been designed and manufactured as a driving unit with the thrust up to 1100 N.

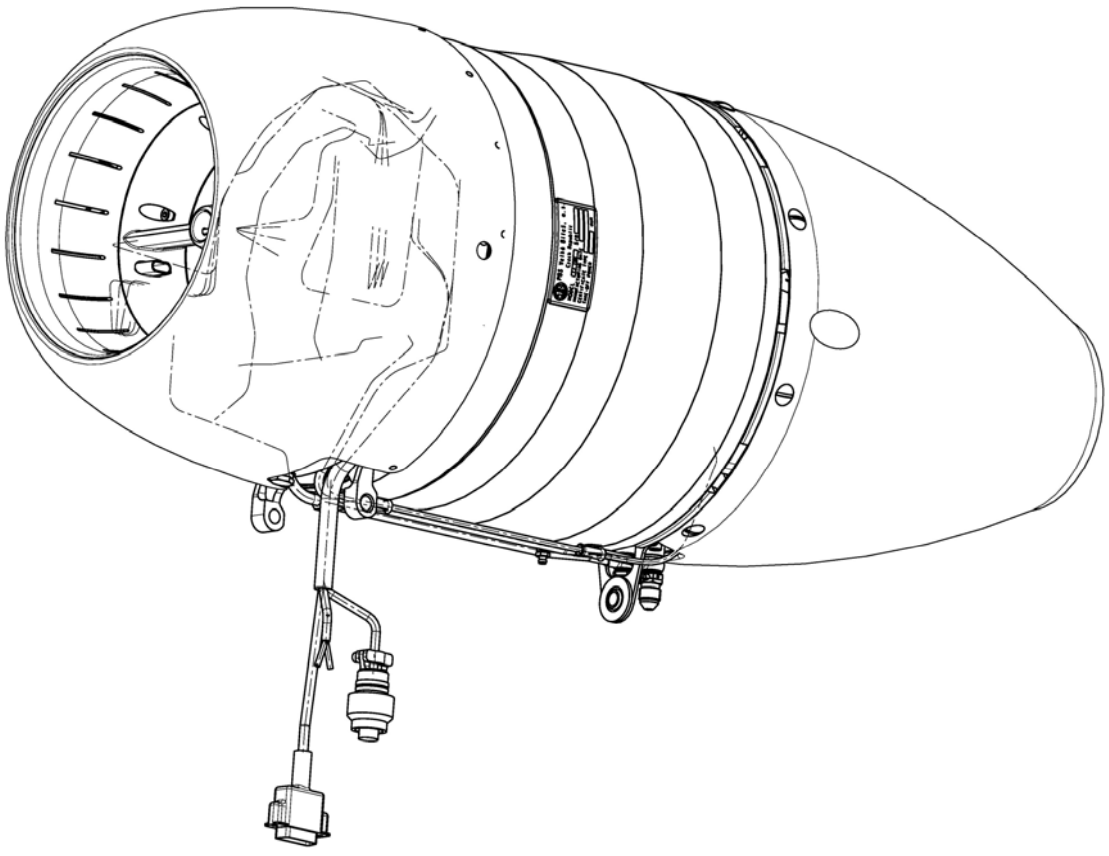


Figure 1-1 Turbojet Engine TJ 100

1.2 Basic technical parameter

With ISA conditions on the sea level, the engine shows the following static parameters in operating modes:

Parameter	Unit	Operating mode			
		Maximum take off	Nominal	Cruise	Idling
Speed of the engine	%	100	97	91	approx. 50
Thrust	N	≥ 1 100	≥ 950	≥ 710	< 160
SFC	kg/N/h	< 0.126	< 0.124	< 0.123	< 0.28
Run time	min	5	30	continuous	continuous
Exhaust gas temperature	°C	< 800	< 750	< 690	< 500

SFC is valid for the fuel with calorific value of 43.5 MJ/kg.

1.2.1 Intake air in maximum take-off mode in ISA conditions: approx. 1.7 kg/s

1.2.2 The above parameters are valid for the inlet nozzle of inside ∅ 98 mm and zero losses at the compressor inlet.

1.3 Other data

1.3.1 Operating speed of the engine - idling 30 000 rpm
- maximum (100%) 57 000 - 60 000 rpm

Permitted tolerance in steady modes ± 300 rpm
Minimum speed of the engine approx. 30 000 rpm
Overspeed of the engine approx. 61 200 rpm

1.3.2 Time necessary for the engine start
- from the START command to operating mode signalling ≤ 35 s

1.3.3 Parameters of the engine at starting from battery 24 V – 12 Ah:
- peak current consumption (10 s) approx. 100 A
- mean consumption per 1 start approx. 0.3 Ah

1.3.4 Parameters of built-in generator, rectifier and DC-DC converter:
- output voltage 28 VDC ± 1V
- total power output 1 000 W
- power output delivered into the network (incl. battery) max. 750 W

1.3.5 Acceleration time from 75% to 95 % speed ≤ 10 s

1.3.6 Oil tank capacity to mark MAX 390 ml
MIN 300 ml
Total capacity of the tank 430 ml

1.3.7 Oil consumption in the whole range of operating conditions max. 50 ml/hour

1.3.8 Minimum pressure of oil at the bearing inlet in the operating mode 65 kPa

1.3.9 Tightness of the fuel and oil system must be observed under all operating conditions. In the space of the air inlet from the oil separator condensation of oil vapours is permissible.

1.3.10 Maximum pressure of fuel in the fuel system of the engine < 15 bar

1.3.11 Weigh data (dry weight):

- the engine itself including the control unit and internal cabling	max.19,3 kg
- ignition source	max. 0.5 kg
- interconnecting wire	max. 0.3 kg
- weight of the engine incl. operating fluids	max.19.7 kg

1.3.12 Basic outside dimensions of the engine:

- biggest diameter of the engine casing	272 ± 0.5 mm
- engine length	625 ± 1.5 mm

1.4 Operating fluids

1.4.1 Fuel – jet fuel TS-1, T2, RT according to GOST 10227 - 86
JET A, JET A-1, JET B according to DERD 2494
Fuel cleanness must correspond to Class 10-11 according to GOST 17216-71 or 7-8 according to NAS 1638.

Oil – turbine oil 5cSt - MOBIL JET OIL II, AEROSHELL TURBINE OIL 560 according to MIL-L-23699
3cSt - AEROSHELL TURBINEOIL 390
Oil cleanness must correspond to Class 14 according to GOST 17216-71 or 10 according to NAS 1638.

1.5 Operating conditions

1.5.1 Engine startup is guaranteed at:

- intake air temperatures	-40°C to + 45°C
- altitudes	0 to 4 000 m
- flight speed	0 to 0.3 M

1.5.2 Engine function is guaranteed at:

- intake air temperatures	-40°C to +45°C
- altitudes	0 to 8 000 m
- flight speed according aircraft	0 to 0.3 M

1.5.3 Operating temperature of fluids at the engine inlet:

- oil	5cSt	-20°C to +145°C
	3cSt	-35°C to +135°C
- fuel		-40°C to + 60°C

1.5.5 Fuel pressure and flow

- airframe installation must ensure sufficient supply of the fuel at the engine inlet, pressure p_{p1} must be in the range between –20 kPa and +50 kPa
- flow of fuel at the engine inlet corresponds to immediate consumption, max. flow rate reaches 160 l/h

1.5.6 Power supply

For reliable function it is necessary to ensure:

- board battery capacity	min. 12 Ah
- board battery voltage	24 ÷ 29 V
- permissible voltage range for the engine function	21 ÷ 31 V
- at start the voltage must not drop under	18 V

1.6 Operating limitations

1.6.1 Start of the engine

1.6.1.1 **Restarting**

Permitted are maximum 3 restarts (including cold start) with a 1-minute dwell between them. Next start can be tried after 5 minutes of cooling.

1.6.1.2 **Failed start**

In case of failed start (fuel not ignited), the fuel is, after the completion of the STOP mode, drained from the valve on the bottom side of the engine casing. Prior to next attempt it is necessary to remove the causes of the failed start of the engine.

1.6.2 Run time

Maximum run time of the engine is not limited by the control unit, but is limited by oil consumption and by the capacity of the oil tank. In standard conditions with oil tank filled to MAX, the run time of the engine is at least 2.5 hours.

1.6.3 Limitation of power take-off

Power take-off is possible from the engine at operating speed in the whole range of temperatures of ambient air and altitudes. Maximum current consumption is limited by the value of approx. 28 A.

1.6.4 Regulation of the temperature of exhaust gases

The control unit of the engine monitors in the operating mode the temperature of exhaust gases, and by regulation of fuel supply, prevents from the exhaust gas temperature getting above 770 °C.

1.6.5 Permitted rolling of the engine

Reliable work of the engine is guaranteed:

- in the range of longitudinal rolling motion ± 60°
- in the range of cross rolling motion ± 50°

} in relation to gravity axis

1.6.6 Permitted temperature limits of exhaust gases

The control unit of the engine is preset to automatic switching the engine off in case of exhaust gas temperature exceeding the following values:

a) At engine start 1000 °C for a time longer than 3 seconds
b) In operating mode of the engine 800 °C for a time longer than 3 seconds

1.6.7 Permitted overspeed of the engine

The control unit switches the engine automatically off at speed 61200 rpm.

1.7 Completion list

1.7.1 The manufacturer delivers the engine with the following items:

- Engine
- Ignition source
- Interconnecting wire
- Set of sealing

1.7.2 Documentation

- List of equipment delivered within the complete engine
- Operation and Maintenance Manual
- Engine Logbook

1.8 Product ordering

In ordering the TJ 100 it is always necessary to put down the following data:

- Product name : Turbojet engine TJ 100E3-110
- Number of units
- Method of preservation or warranty period of storage
- Language version of the accompanying documents
- Special requirements

1.9 Operating periods, service life

1.9.1 Operating periods

Initial operating period to GO:

- 100 operating hours; or
- 600 starts; or
- 5 years, whichever happens first

1.9.2 Service life

Engine life is given by triple operating periods as per p. 1.9.1. provided two general overhauls will be carried out. The time between individual GO must not exceed the terms specified in p.1.9.1. Operating period between GO is equal to the operating period to the first GO.

The service life is as a maximum:
- 300 hours; or
- 1 800 starts; or
- 15 years, whichever happens first

Service life of main components of the engine

Component name	Part number	Drawing no.	Service life – cycles
turbine wheel	470 111.11	B2-0470-10498	1 800
compressor impeller	470 112.13	B2-0470-11121	1 000

CHAPTER 2
ENGINE DESCRIPTION

2.1 Description

The engine is a single-shaft turbojet engine with a single-stage radial compressor, annular combustion chamber, single-stage axial turbine and exhaust nozzle. The rotor of the engine is mounted on 2 ball bearings lubricated with pressure oil. In the compressor suction, there is a brush-less starter generator, which makes it possible to start the engine from the board network and to generate energy during the engine run.
The engine consists of the following independent assembly groups:
- engine
- ignition source
- interconnecting wire

The engine is equipped with an autonomous oils system, electric starter generator, digital control unit and fuel system. It is fastened to the airframe by means of three fastening points with internal thread M 10x1.
See Figure 2-1 for equipment layout on the engine.

The engine cabling ensures interconnection of the control unit with the devices and sensors on the engine as well as with external devices:
- ignition source
- superior control system
- electromagnetic fuel valve
- board battery 24 V

} are not a part of the engine supply

Electric diagram of the engine connection is shown in Figure 2-2

Interconnecting wire is used for interconnection of the low-voltage ignition source with the engine spark plug.
For the engine function, it is necessary to ensure interconnection with the airframe fuel tank via the electromagnetic valve and fuel filter.

2.2 Engine equipment

2.2.1 Oil system

Lubricating system is autonomous, and consists of the following components:
- oil tank
- oil gear pump driven by electric motor
- oil – air cooler
- oil filter
- pressure switch
- lubricating nozzles
- fuel-oil exchanger
- safety valve (a part of the oil tank)
- oil separator driven by electric motor
- interconnecting piping

Oil is drawn by the pump from the tank. It is cooled down, filtered, and delivered through the piping to the injection nozzles of the bearings. The mixture of oil and air goes from the

bearing space through the exchanger into the centrifugal separator; the oil returns into the tank; the air and oil vapours are taken in by the engine.
A part of the filtered oil is led through the safety valve back into the tank; the valve maintains approximately constant oil pressure approx. 100 kPa at the lubricating nozzle inlet.
See Figure 2-5 for the joint diagram of the oil and fuel system.

2.2.2 Fuel system

Fuel installation of the engine consists of the following components:

- gear pump driven by electric motor
- fuel-oil exchanger
- bypass governor
- fuel ramp
- 12 fuel nozzles
- interconnecting piping
- drainage valve

Fuel is drawn in from the external tank through approx.50 μm fuel filter and the fuel valve, which are not accessories of the engine. The fuel is delivered into the fuel nozzles by electric gear pump fed from the electronic control of the engine. The speed of the fuel pump determines the fuel amount and thus also the work mode of the engine. A part of the fuel delivered into the nozzles returns via bypass governor back into the suction side of the fuel pump. The amount of the return fuel is regulated dependent on inlet pressure of the fuel upstream of the fuel nozzles.
The exchanger installed between the fuel pump and bypass governor provides for the cooling of the oil returned from the space of the engine bearings.
All devices of both the fuel and oil systems are mounted on the engine itself; the inlet fitting for the fuel is located on the front left bottom side.

2.2.3 Electrical system

Electric installation of the engine has been designed for nominal voltage 24 V. Electric system consists of the following parts:

- control unit (FADEC) with a rectifier and DC-DC converter
- starter generator (which at the same time performs the function of a speed sensor)
- electromotor of the fuel pump
- electromotor of the oil separator
- exhaust gas temperature sensor
- intake air temperature sensor
- minimum oil pressure switch
- interconnecting cabling
- ignition device
- electromagnetic fuel valve (is not a part of the engine)

2.2.4 Power supply unit

Power supply unit consists of a built-in three-phase generator, a rectifier, and a switched power source. With the engine speed range from approx. 50% to 100%, sufficient voltage and power is induced in the generator winding for self consumption of the engine; excess power can be used for the needs of the network. Generator output voltage is rectified by 6 diodes and conditioned to 28V by the switched STEP-DOWN source.
The power supply maintains the voltage of 28 V up to the power of 1000 W. If the current consumption exceeds 28A, the output voltage decreases.
The generator is situated in the suction space of the compressor. The rectifier and the switched source are parts of the control unit fastened on the suction branch of the engine.

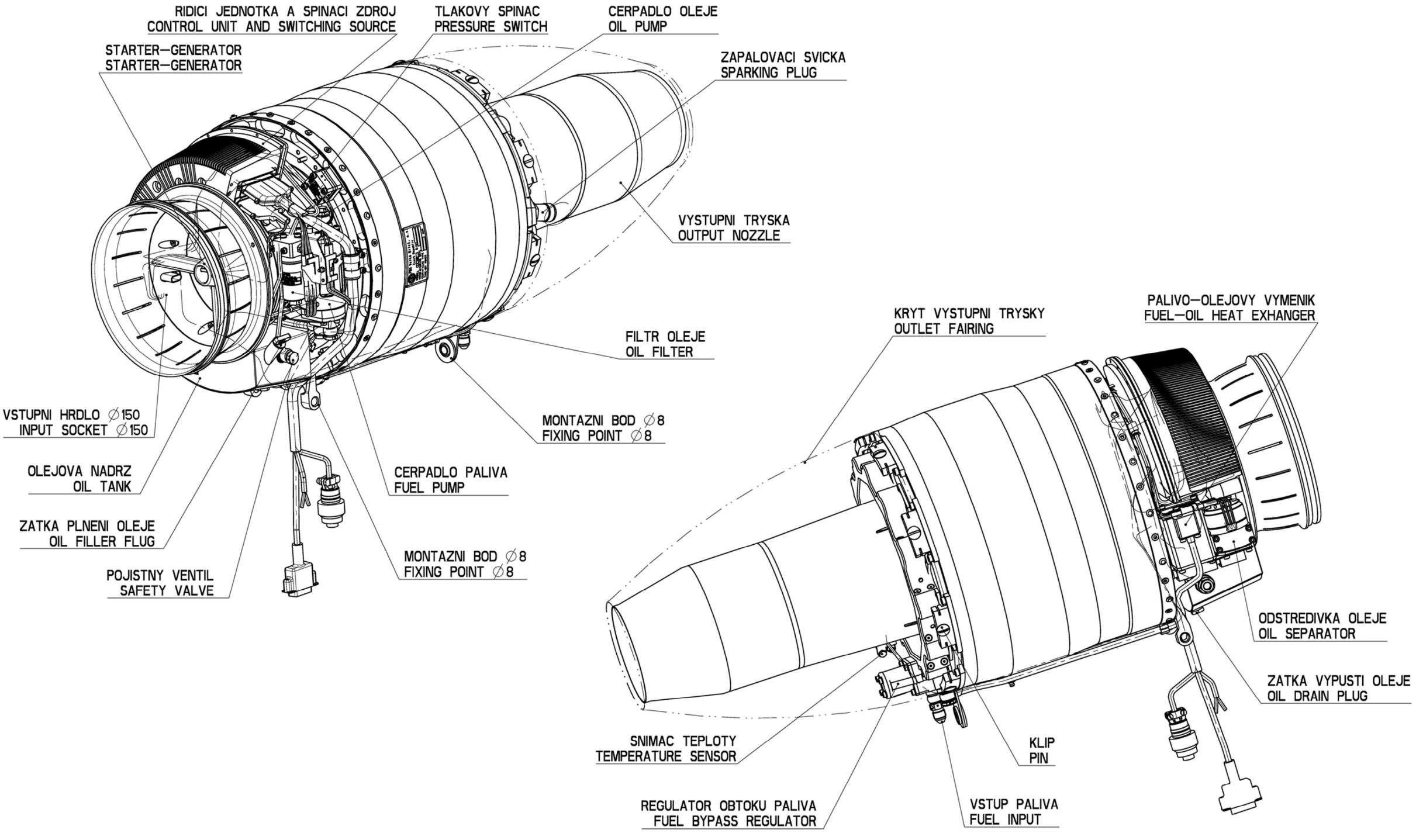
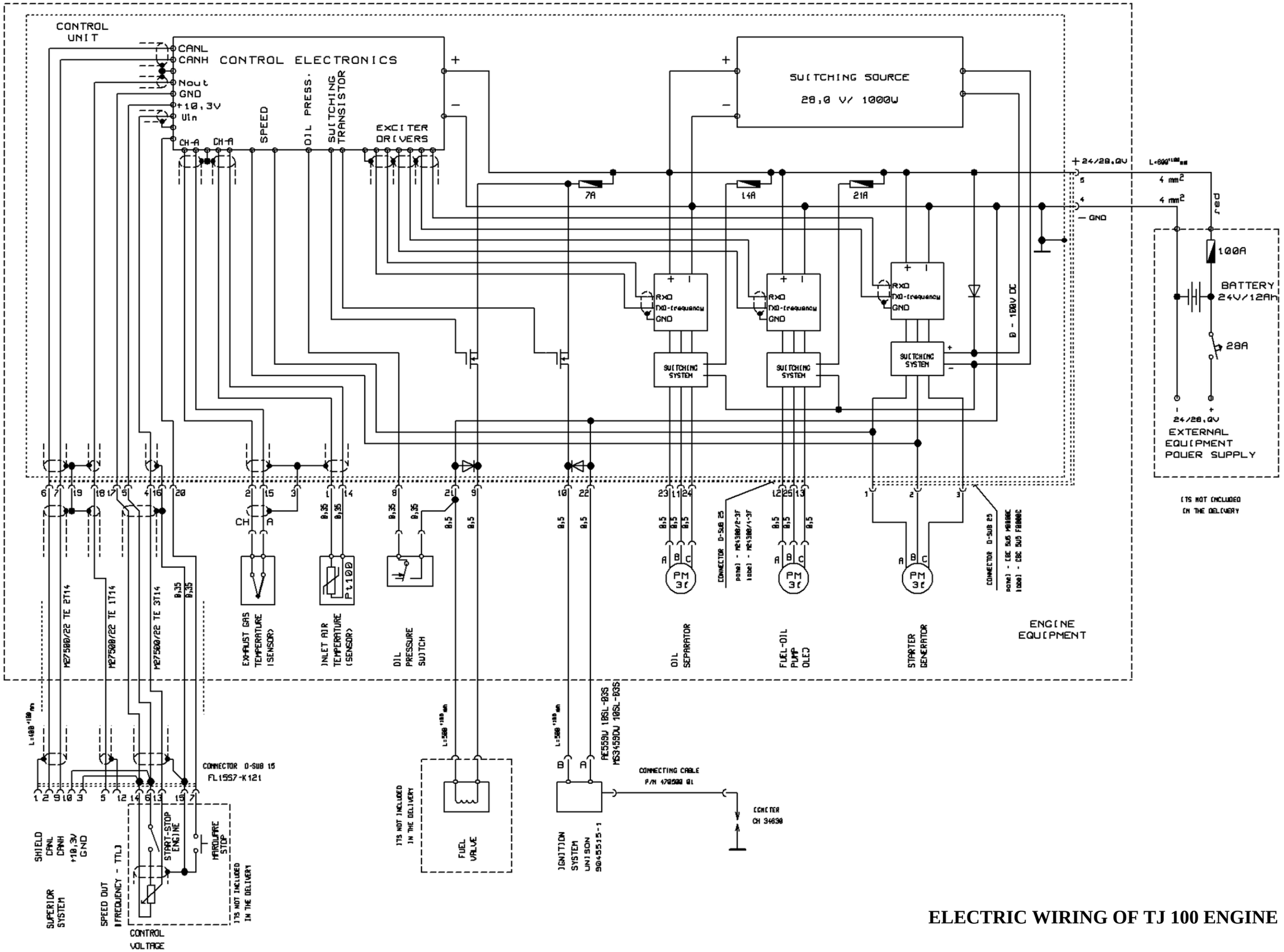


Figure 2-1 Turbojet engine TJ 100 (without inlet and outlet fairings)



ELECTRIC WIRING OF TJ 100 ENGINE

Figure 2-2 Wiring diagram

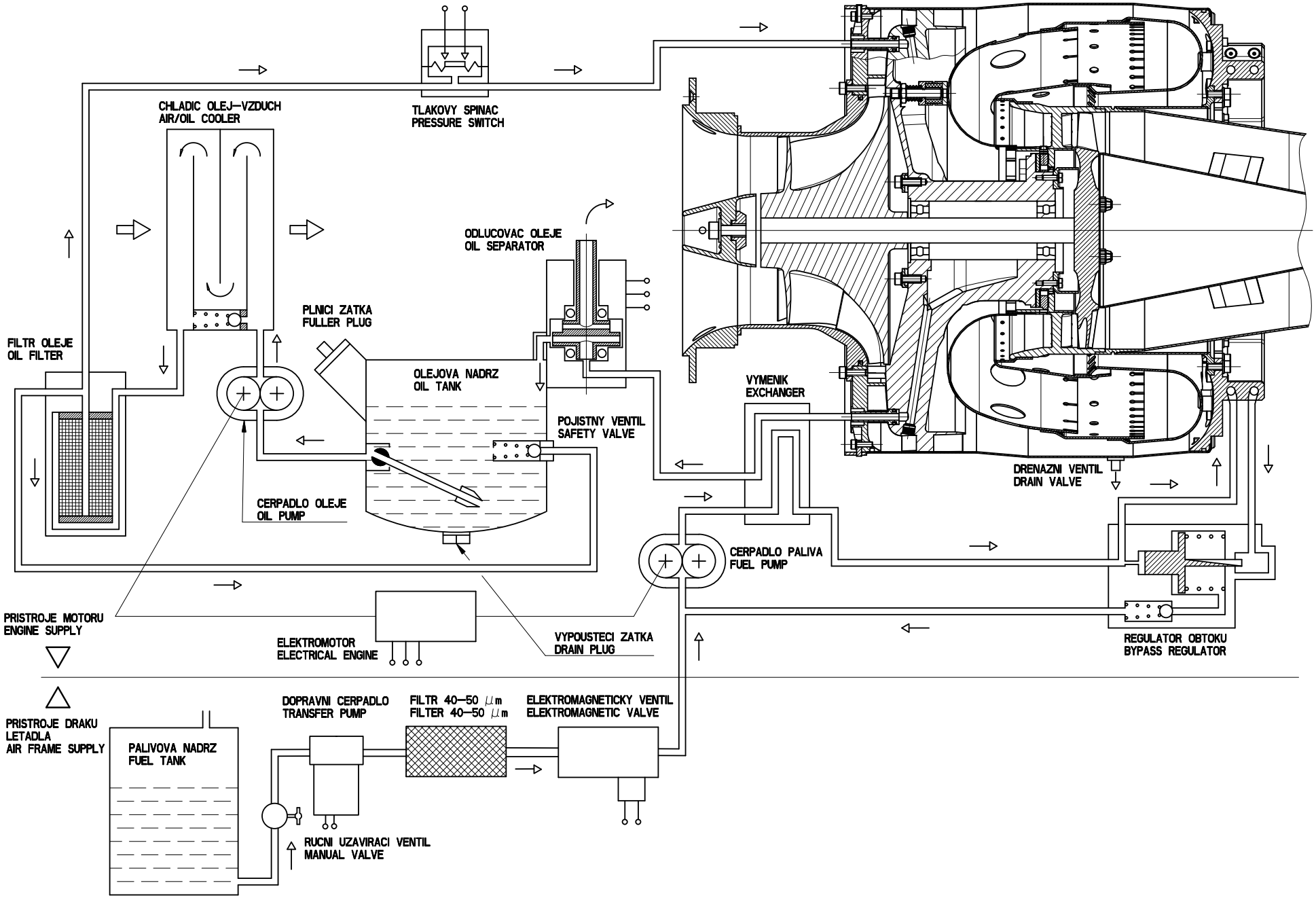


Figure 2-3 Fuel-oil system diagram

CHAPTER 3
PREPARATION FOR USE AND INSTALLATION

3.1 Unpacking

Internal preservation of the engine is performed with the approved types of fuel and oil during the engine testing by the manufacturer. External preservation is carried out by application of a preservative oil onto the engine. The engine is packed in foamy PE, overwrapped by extensible foil and inserted into a PE bag, after which the bag is sealed. Such packed engine is inserted into the foamed bottom of the heavy cardboard shipping box. The parts packed in the same way are attached to the engine in accordance with the completion list, and the space over the engine is filled with foam as well. Accompanying documents sealed in PE bag is attached into the package. The cardboard box is pasted over with an adhesive tape, and fastened by a draw band in two points. On the cover of the box there is a packing list with relevant data on it.

3.1.1 Procedure. The following steps describe instructions for engine unpacking from the shipping box:

a) Remove the draw bands, cut the adhesive tape, and open the shipping box cover.
b) Remove the documentation from the box.
c) Remove the upper foamy part.
d) Remove the components and check them according to the completion list.

CAUTION

In lifting, do not hold the engine by its external devices or piping. Otherwise it could be damaged.

a) Remove the engine from the shipping box and put it on a rubber pad.
b) Slit the PE bag, and remove the engine.
c) Remove the foamed polyethylene.

NOTE

Do not throw off the packaging material; leave it for further use in engine storage or transport.

3.2 Preparation for use

Prior to engine installation, perform the following procedure:

3.2.1 Preparation

a) Remove the engine from the shipping or storage box, as need be.
b) Check it visually for eventual mechanical damage.

WARNING

Petrol is harmful for health and highly flammable. Do not inhale its vapours. Use it only in well ventilated rooms, where it cannot get into contact with sparks, flame or hot surfaces. Use protective goggles, gloves resistant to solvents, and other protective equipment. In contact with eyes, wash the eyes with plenty of water and seek medical advice. In contact with skin, wash the skin with water and soap.

c) Wipe the preserved external surfaces with a cloth wetted in clean petrol or cleaning petrol, and let them dry in air. In cleaning, protect rubber parts and wiring components. No other dewaxing is needed.
d) Make a record on removal of preserving agents in the Engine Logbook.

3.2.2 Installation

NOTE

Pay special attention to cleanness during installation. Do not leave the caps and plugs removed unreasonably; after their removals install relevant pipes or components immediately.

a. Install the engine pursuant to paragraph 3.3.

b. Connect fuel system pursuant to paragraph 3.4.

c. Connect electrical equipment pursuant to paragraph 3.5.

d. Check whether all cap nuts and the other fastening items are properly tightened, and eventually secured in a prescribed way.

e. Fill the oil tank of the engine with prescribed type of oil, see p.1.4.1, up to MAX. No adjustment is needed after the installation.

3.3 Engine fastening

The engine mounting by engine brackets on the engine upper side – see dimensional drawing. Front bracket with two fixative openings ∅8 cushioning operation engine load at all directions, rear bracket with one opening ∅8 cushioning side loads only. The airframe construction must enable to dilatation moving of rear bracket (by engine warming).
The axis of the engine should be parallel to the oil tank downward orientation. .
The engine must be centred on the branch ∅ 150 $^{-0.05}_{-0.15}$ in the length of 4 mm. Recommended toleration of the counterpiece is ∅ 150 H8..

3.4 Fuel system

The engine is equipped with complete fuel system ensuring its operation. The engine user must ensure sufficient supply of fuel to the engine inlet – fitting M12x1- 6 g see Figure 3-1. Dimensional drawing.
The fuel delivered into the engine must not contain impurities higher than 50 μm; in supply piping to the engine there must be installed a protective filter 40÷50 μm and a stop valve controlled by the voltage from the control unit of the engine (it is opened under voltage).

3.5 Electrical equipment of the engine

The engine is equipped with a digital control system, a rectifier and a switched source fastened on the intake branch of the engine, which provides its cooling with the intake air. The engine is further equipped with an electric starter generator, internal and external cabling. Internal cabling of the engine ensures the connection of the control system with sensors and actuators.

External cabling is designed for:

+ wire AWG 10
- wire AWG 10

} - connection to 24 V network

- connector AE 559 W-500 SL–03S - connection of ignition system
- connector D-SUB 15 - connection of superior system
  control potentiometer 250÷1000Ω-LIN
  speed counter
- free wires - connection of the fuel stop valve (I max = 1.5 A)

External protective elements:
- fuse 100 A
- circuit breaker 28 A

3.6 Maintenance points

Figure 3-1. Dimensional drawing.

For maintenance of the engine it is necessary to provide access to:
- oil filter
- filling neck on the oil tank
- drain plug on the oil tank
- spark plug
- connector for control connection (connecting cabling)

3.7 Installation of the ignition source

The engine is supplied with the ignition source, which is mounted by the operator outside the space of the engine build-up. The ignition system is fastened by means of 4 screws M5 going through the bottom flanges (Figure 3.2). The spatial position of the ignition system can be arbitrary; the output connector (shorter) must be oriented to the engine.

Interconnection between the engine (spark plug) and the ignition source is made by the interconnecting wire, which is a part of the engine installation.

The power supply of the ignition source is ensured from the control unit of the engine via the connector AE 559 W – 500 SL – 03S. Ambient temperature of the ignition source must not exceed 85 °C.

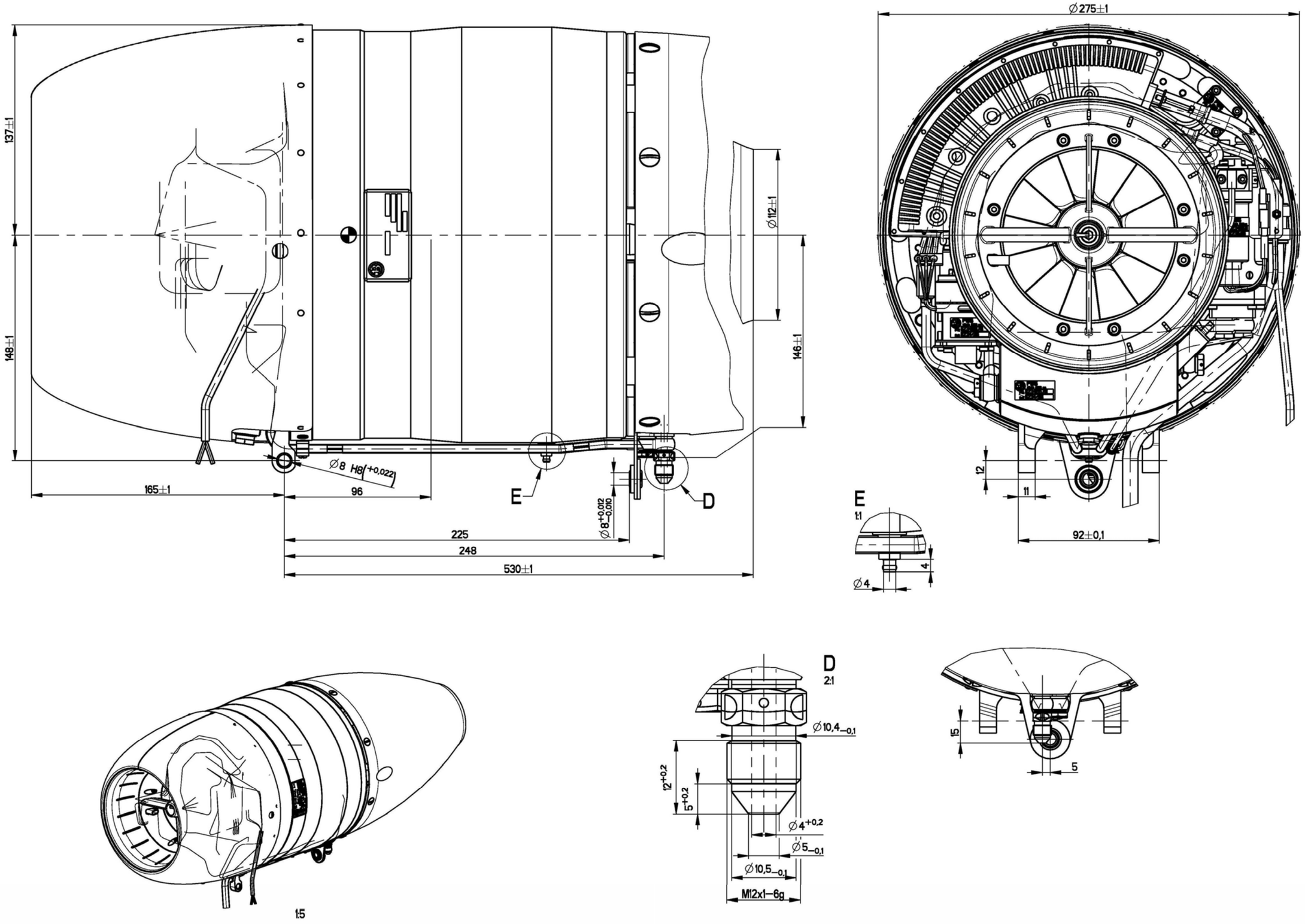


Figure 3-1 Dimensional drawing

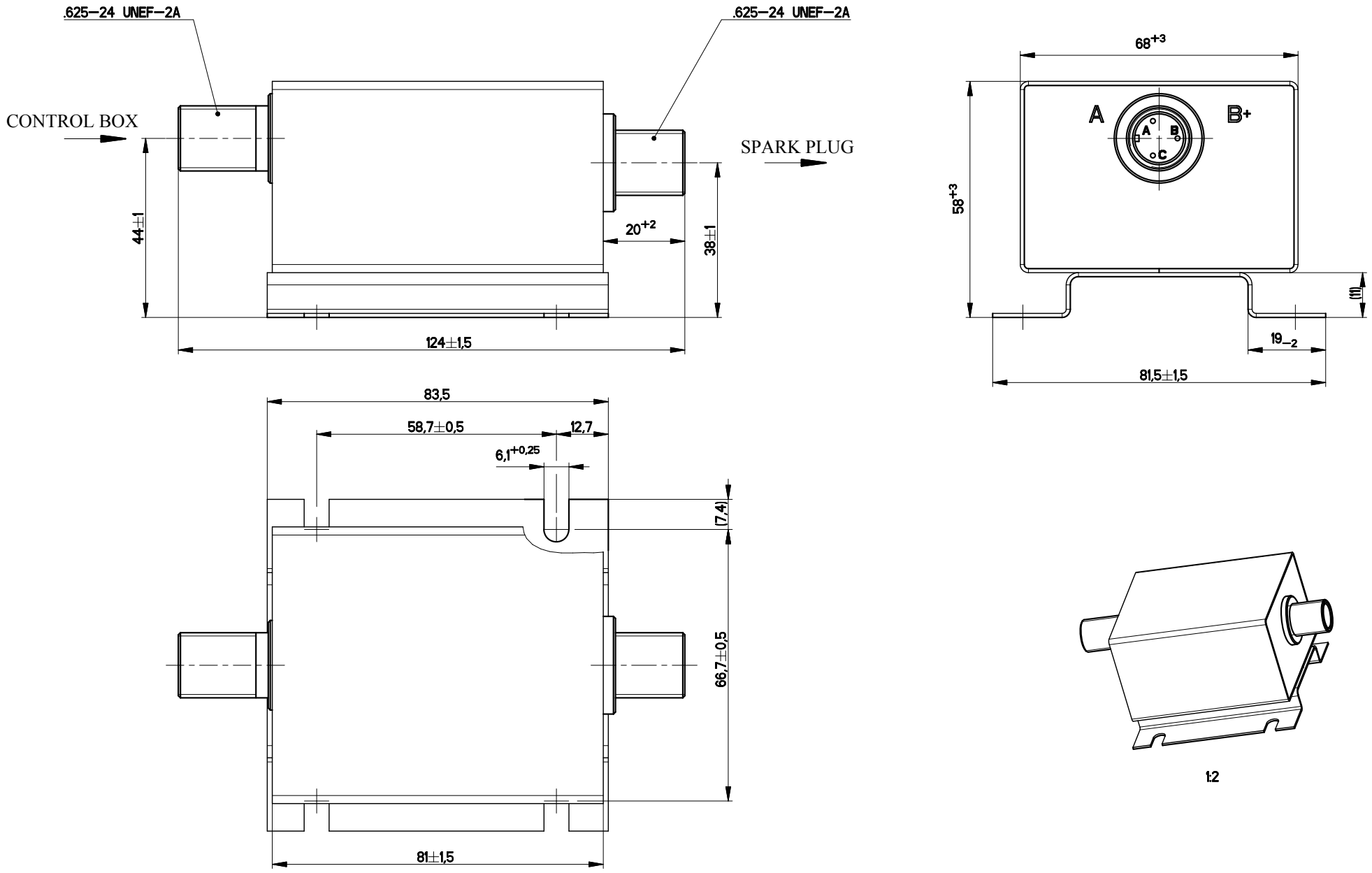


Figure 3-2 Ignition. Dimensional drawing

CHAPTER 4
OPERATION INSTRUCTIONS

4.1 Starting - START

The control unit, after receipt of the start signal (by putting the control voltage to an input higher than 4 V) begins the starting process:

- by control of the speed governor of the oil separator, sets the required speed of the separator, and checks its function
- by means of the starter governor, it ensures smooth starting up of the engine rotor

After the reach of approx. 7% speed:

- it switches on the ignition device power supply
- switches on the relay for the power supply of the fuel valve
- sets the fuel pump speed suitable for ignition of the mixture in the combustion chamber
- after ignition of the mixture, increase in the exhaust gas temperature above the stated value approx. 200°C and the reach of approx. 25% engine speed, it interrupts the starter power supply, and the engine itself accelerates to idling speed. If approx. 48% speed is reached, the ignition device is disconnected.
- In case that the mixture is not ignited in the combustion chamber (speed is not reached in the set time), the control system terminates the starting process

4.2 Engine run - FUNCTION

The control unit regulates the speed of the engine according to the value of the control voltage 5 ÷ 10 V or by the request from the superior control system, while:

- controlling acceleration and deceleration
- checking the exhaust gas temperature
- It is rectifying the engine speed according to input air temperature – measured by Pt 100 sensor placed in compressor intake - and also limits the max. engine speed at exhaust gases limit temperatures
- checking the switching of the pressure oil switch
- checking permitted speed range

4.3 Engine stopping - STOP

The control unit stops the engine if it receives a command:

- control voltage is in the interval 0 – 1 V, or a stop command
- by protection action

In engine stopping as well as in failed startup:

- the fuel and oil pumps stop
- power supply of the fuel valve is interrupted
- oil separator is stopped with a delay
- cooling of the engine turbine takes place – at the rotor speed decrease to approx. 3000 rpm, the starter function resets, and the speed is maintained at approx. 3000 rpm by means of the governor. The cooling is active for at least 20 seconds, or until the exhaust gas temperature decreases to a preset limit.

4.4 Cold start

Cold start is used for the removal of the unburned fuel from the combustion chamber, or for the turbine cooling.

The cold start is stated by the control voltage of 3-4 V or by a command from the superior control system; the function time is limited to approx. 13 seconds.

In cold start:
- the oil separator starts
- the starter is connected to the governor

The engine will turn up to approx. 13 % speed, and remains running for a limited time. Fuel supply and ignition function are blocked.
After the termination of the starter function, the oil separator runs for approx. 20 seconds, and after it will stop.

4.5 Cooling

The control unit sets the cooling mode either automatically following previous start or at:
- input control voltage 2 -3 V or on the command from the superior control system

The cooling mode ensures smooth cooling of hot parts of the engine and removes residual heat off the engine.
The cooling mode is terminated after approx. 20 seconds or later, as soon as the exhaust gas temperature drops below a stated limit.

4.6 Automatic protections

The control unit of the engine together with the built-in sensors of pressure, temperature and speed ensures automatic stopping of the engine in the following cases:

Engine start mode
- separator failure
- insufficient or no speed of the engine rotor
- exhaust gas temperature (t_4) has not be increased and underspeed was not reached in prescribed time
- temperature of exhaust gases has exceeded a permitted limit
- speed of the engine has got over overspeed

Operating mode
- separator failure
- speed of the engine decreased under underspeed (chamber extinguished etc.)
- speed of the engine exceeded overspeed
- temperature of exhaust gases exceeded permitted limit
- oil pressure dropped below min. limit for a time longer than 10 seconds.

Furthermore, the control unit of the engine is equipped with speed protection, which provides for the engine shutdown in case of the reach of 108% speed.

4.7 Correction of maximum speed

The control unit of the engine automatically reduces (corrects) maximum speed of the engine at low temperature of the intake air.
The purpose of the speed correction is to ensure stable operation of the engine compressor in the whole range of the intake air temperatures.

4.8 Limitation of exhaust gas temperature

The control unit of the engine ensures engine speed decrease in the case when the temperature of the gases downstream of the turbine reached the value of T_{max} –30°C and is kept constant.
The purpose of this limitation is to protect the hot parts of the engine against damage.

4.9 The limitation of fuel supply

The engine control box is checking the max. speed of fuel pump and protect possible engine overloading at extreme operation conditions

4.10 Description of the engine control

The engine can be controlled in two ways – by means of a serial communication link or by means of a control voltage – external potentiometer (250Ω ÷1000Ω), connected to the connector D-SUB 15 (pins 6-13-14). The control by means of the control voltage takes priority over the control via the communication link.

4.10.1 Control by means of external potentiometer

The potentiometer is connected between the internal source of the control unit (+10.3 V) and GND; it enables to set the following modes of the engine:

0 – 1	V	Stop
1 – 2	V	Run of oil separator
2 – 3	V	Oil separator and turning-out of the starter generator at the speed for cooling
3 – 4	V	Cold start of the engine
4 – 5	V	Start of the engine and run at minimum speed
5 – 10	V	Engine function at the speed in the range between 50% and 100 %

4.10.2 Control by means of serial communication interface

The control unit of the engine is equipped with serial interface of CAN type, and communicates via the protocol CANAerospace V 1.6. The connection to the series line is implemented in the cable connector of the engine D-SUB15. By means of this interface it is possible to set variable parameters, read default values or error messages. It is also possible to send the following commands:

- Start
- Stop
- Separator run
- Separator run and turning-out of the starter generator at speed for cooling
- Cold start

The Start command causes automatic execution of the Start function and engine speed control at required revolutions.

4.11 Check of the engine function

The check of the engine function can be carried out by means of monitoring software delivered by the engine manufacturer. The software has been designed for the use on common PC, and for its function it is necessary to use the converter of the bus CAN-RS 232. The converter must meet the specification stated in p. 4.11.1.
The converter is not a part of the supply, and can be ordered separately.

4.11.1 Converter specification

- bit rate 115200 bps
- data bits 7
- stop bits 2
- parity even

Data frame transferred on RS232 interface.
Each byte is sent as two characters in BCD format. Hexadecimal value C0 is then sent as the characters „C“ and „0“. If a frame size is 8 bytes, physically 16 characters is transmitted via the serial interface. Data block begins with CAN ID of the transferred value, followed by the length of the transferred frame, and a standard frame of the CANAerospace protocol. Each data block is terminated by character „#“.

4.12 Putting the engine into service for the first time

CAUTION

Before putting the engine into service, read thoroughly the safety precautions in the safety summary on page iii.

4.12.1 Check free turning of the engine rotor and cleanness of the suction space.

4.12.2 Remove the locking wire from the plug in the branch on the fuel-oil pump (see pos. 5, Figure 5-2, Chapter 5), remove the plug and inject approx. 20 ccm of clean lubricating oil in the hole (the oil must be identical to that in the oil tank). Replace the plug and secure it by the locking wire.

4.12.3 Check the fuel level in the fuel tank and oil tank.

4.12.4 Connect the battery.

4.12.5 Set the mode SEPARATOR RUN (1-2 V) and check the run.

4.12.6 Set the mode COOLING (2 – 3 V) and check the starter function.

4.12.7 Set the mode COLD START and check the starter function with maximum power.

4.12.8 Disconnected the power supply from the ignition source and perform ENGINE START for approx. 10 seconds in order to flood the fuel system. Fuel presence in the engine is indicated by a mist in the exhaust and by fuel flowing from the drain valve.

4.12.9 Connect the power supply to the ignition source, check all installations for tightness.

4.12.10 Check all precautions necessary in engine operation, and set the mode ENGINE START (4 – 5 V). The engine must reach idling speed within 35 seconds. Let the engine run idling for 3 to 5 minutes, set the mode STOP (0-1 V), and check the engine installation.

4.12.11 Make a record in the Engine Logbook on putting the engine into service.

CHAPTER 5
MAINTENANCE TECHNOLOGY

Inspection and maintenance of the devices specified in the following paragraphs shall be performed in prescribed maintenance intervals.

NOTE

All maintenance activities can only be performed by duly semi-skilled personnel.

WARNING

1) If possible, let the engine cool down before replacement of any its components.
2) It is not permitted to disassemble the engine beyond the permitted extent.

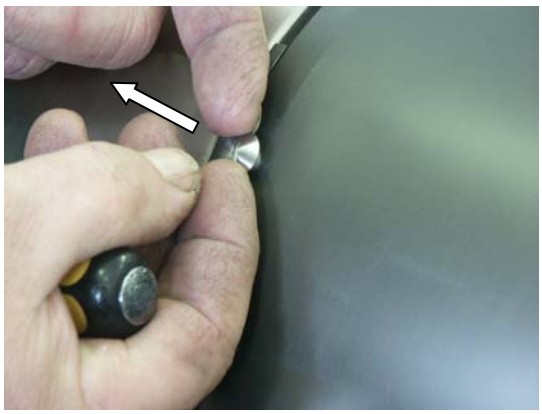
5.1 Maintenance technology content :

- Inspection of the engine before starting up
- Cleaning the oil filter
- Refilling the oil in the oil tank
- Oil exchange after 10 hours of operation
- Oil change

5.2 Engine fairings dismounting and mounting (Figure 5-1)

5.2.1 Outlet fairing dismounting

5.2.1.1 Put the screwdriver to the pin groove (2) and slightly turn 90° CCW (counter-clockwise). Take out the pin by hand.



5.2.1.2 Other 7 pins (2) release and take out by the same way.

5.2.1.3 Span the outlet fairing (1) by both hands opposite. Remove the fairing by use of axial traction.

5.2.2 Outlet fairing mounting

5.2.2.1 Outlet fairing (1) overthrust to engine exhaust cone. Orientation: Larger cut out to fixing point.

5.2.2.2 Turn fairing to centering exactly the opening for pins at fixing point.

5.2.2.3 Put in 2 pins (2) at fixing point and turn slightly push 90° CW by screwdriver.

5.2.2.4 Other 6 pins (2) secure by the same way.

5.2.3 Inlet fairing dismounting

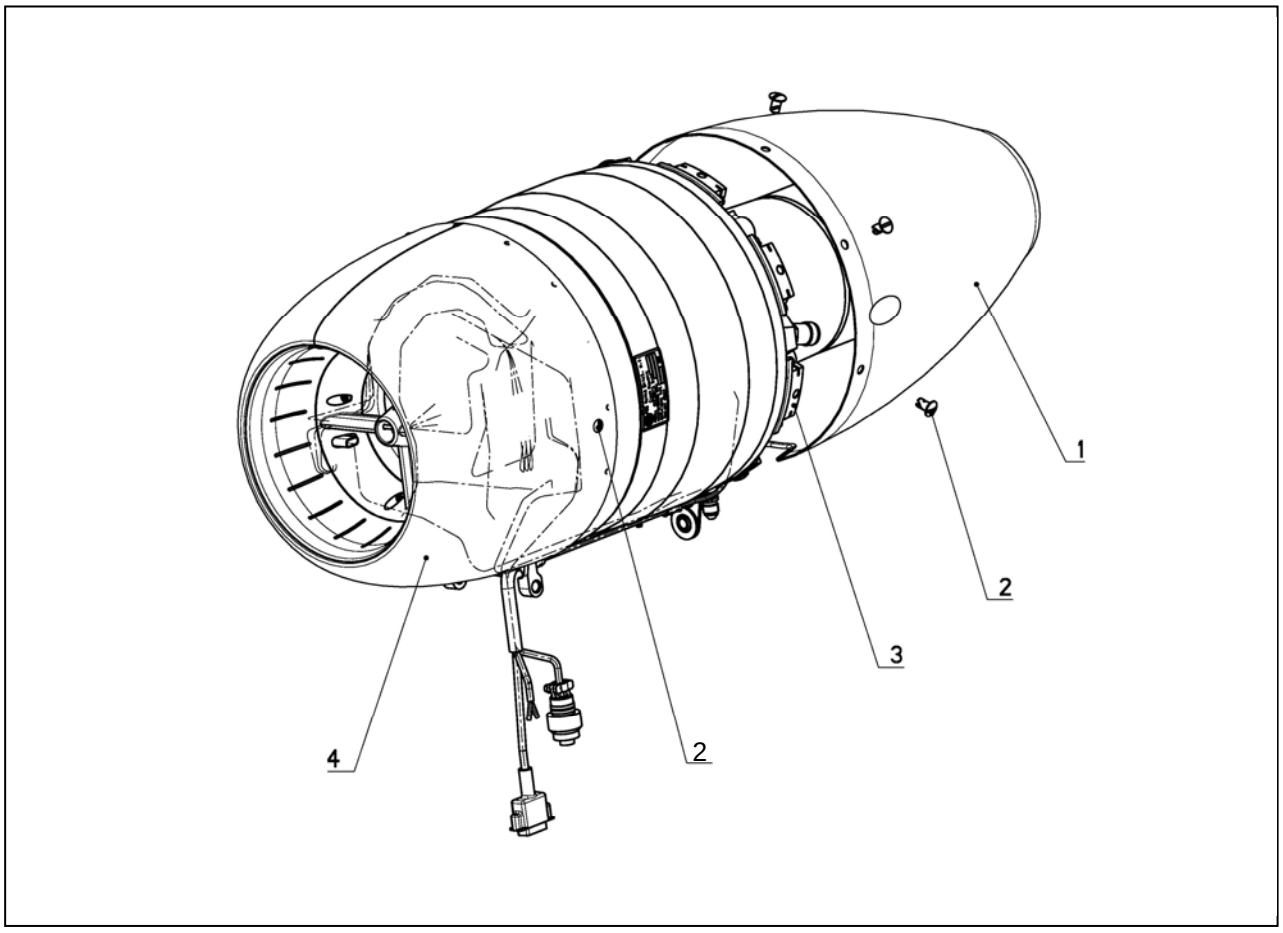
5.2.3.1 Put the screwdriver to the pin groove (2) and slightly turn 90° CCW (counter-clockwise). Take out the pin by hand.

5.2.3.2 Span the inlet fairing (4) by both hands opposite. Remove the fairing by use of axial traction from inlet.

5.2.4 Inlet fairing mounting

5.2.4.1 Inlet fairing (4) overthrust to input part. Let check the symmetrical setting of inlet and fairing cut out for foot inlet fairing pin (2).

5.2.4.2 Put in 2 pins (2) at fixing point and turn slightly push 90° CW by screwdriver.



1. Outlet fairing
2. Pin
3. Foot outlet fairing
4. Inlet fairing

Figure 5-1 Fairings

5.3 Inspection of the engine before starting up

5.3.1 Inspection of the engine fastening in suspensions.

5.3.2 Turn the rotor of the engine manually to check whether it turns out freely.

5.3.3 Check the oil level in the oil tank whether the oil level is at MAX.

5.3.4 Check by hand whether some screws or cap nuts are not loosened.

5.3.5 Check visually whether fuel or oil drops do not create on the piping, on the devices of the fuel or oil system.

5.4 Cleaning the oil filter (Figure 5-2)

NOTE

The oil cleaner filter is cleaned at regular maintenance intervals or low oil pressure case.

5.4.1 Using the wrench no. 12, unscrew and remove the filter cover (4) with the filter (2). Discharge oil from the filter cover. The amount of the discharged oil is approx. 50 ml.

5.4.2 Remove the filter (2) and split lock washer (6). Dismantle sealing rings (3, 5) from filter (2) and filter cover (4) .

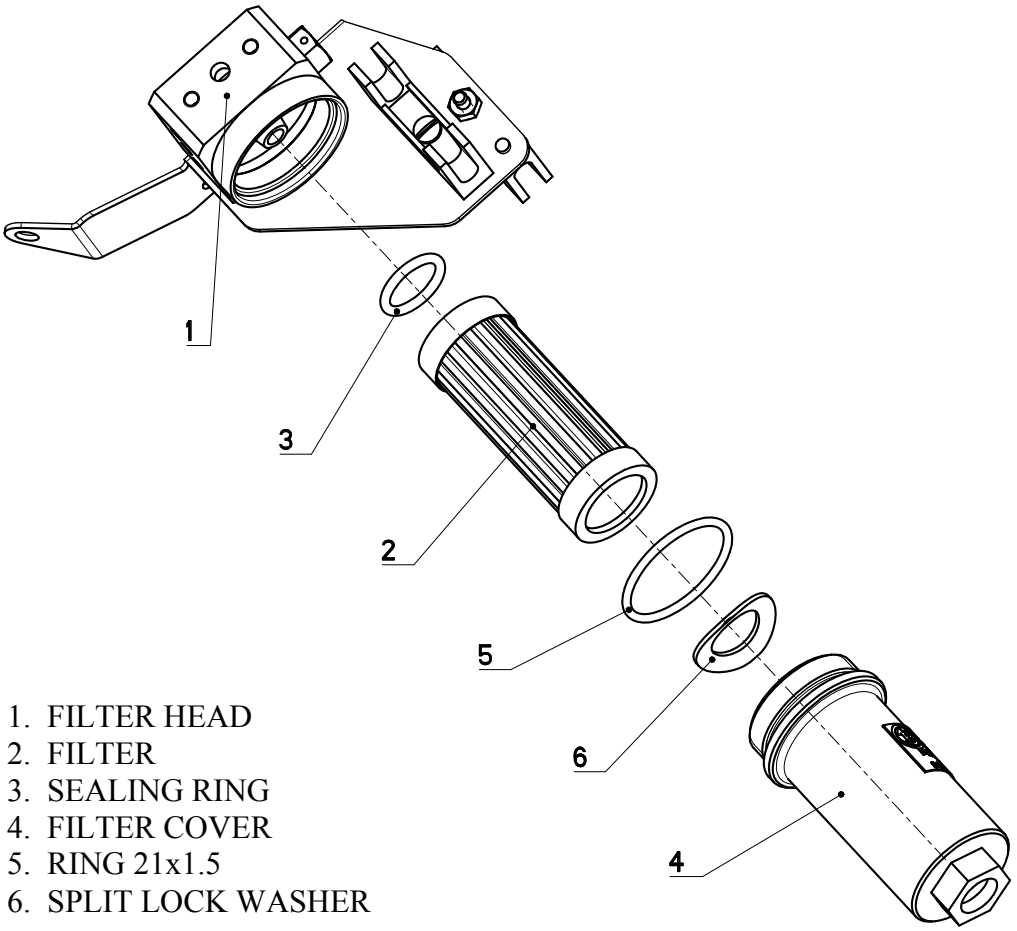
5.4.3 Wash the filter cover (1), filter (2) and the sealing rings (6) in petrol using a soft brush and dry by pressure air. Using of ultrasonic washing machine of filter (2) is recommended.

5.4.4 Lubricate the sealing rings (3, 5) with prescribed oil. Replace damaged rings.

5.4.5 Split lock washer (6) and clean filter (2) insert back into the filter cover (4), put on the sealing rings (3, 5) and screw the filter cover (4) into the filter head (1), and secure it by tying wire.

NOTE

When handling the device be careful not to contaminate internal space of the device.
Record the performed work in the Engine Book.



1. FILTER HEAD
2. FILTER
3. SEALING RING
4. FILTER COVER
5. RING 21x1.5
6. SPLIT LOCK WASHER

Figure 5-2 Oil filter cleaning

5.5 Refilling the oil in the oil tank (Figure 5-3)

WARNING

If possible, let the engine cool down before refilling the oil. Hot oil may burn eyes or skin. Use protective goggles, insulated goggles and other protective equipment. In case of contact with eyes or skin, seek medical advice immediately.

WARNING

At work with locking wire use protective goggles.

5.5.1 Remove locking wire from the TJ plug.

5.5.2 Unscrew the TJ plug (1, Figure 5-3) from the oil tank.

5.5.3 Check the oil level on the TJ plug rod.

5.5.4 If the oil level is closed to the bottom part of the range between MIN and MAX, refill the tank with clean oil to get the MAX mark after screwing in the plug.

5.5.5 Check whether the ring (2, Figure 5-3) in the TJ plug groove is not damaged. Replace the damaged ring and screw in the plug.

5.5.6 Wipe off all oil that got outside the TJ plug by a clean cloth.

WARNING

At work with locking wire use protective goggles.

5.5.7 Secure the TJ plug by means of the tying wire to the filter - tank piping

5.5.8 Record the performed work in the Engine Book.

5.6 Oil exchange after 10 hours of operation (Figure 5-3)

WARNING

If possible, let the engine cool down before refilling the oil. Hot oil may burn eyes or skin. Use protective goggles, insulated goggles and other protective equipment. In case of contact with eyes or skin, seek medical advice immediately.

WARNING

At work with locking wire use protective goggles.

5.6.1 Remove locking wire from the plugs (1,3, Figure 5-3) on the oil tank.

5.6.2 Unscrew the TJ plug (1, Figure 5-3) from the oil tank.

5.6.3 Unscrew the plug (3, Figure 5-3) from the oil tank an oil catch to the set vessel (min. volume 500 ml).

5.6.4 Check whether the ring (4, Figure 5-3) in the plug (3) groove is not damaged. Replace the damaged ring and screw in the plug and secure by means of the tying wire.

5.6.5 Refill the tank with clean oil to get the MAX mark after screwing in the plug.

5.6.6 Check whether the ring (2, Figure 5-3) in the TJ plug groove is not damaged. Replace the damaged ring and screw in the plug.

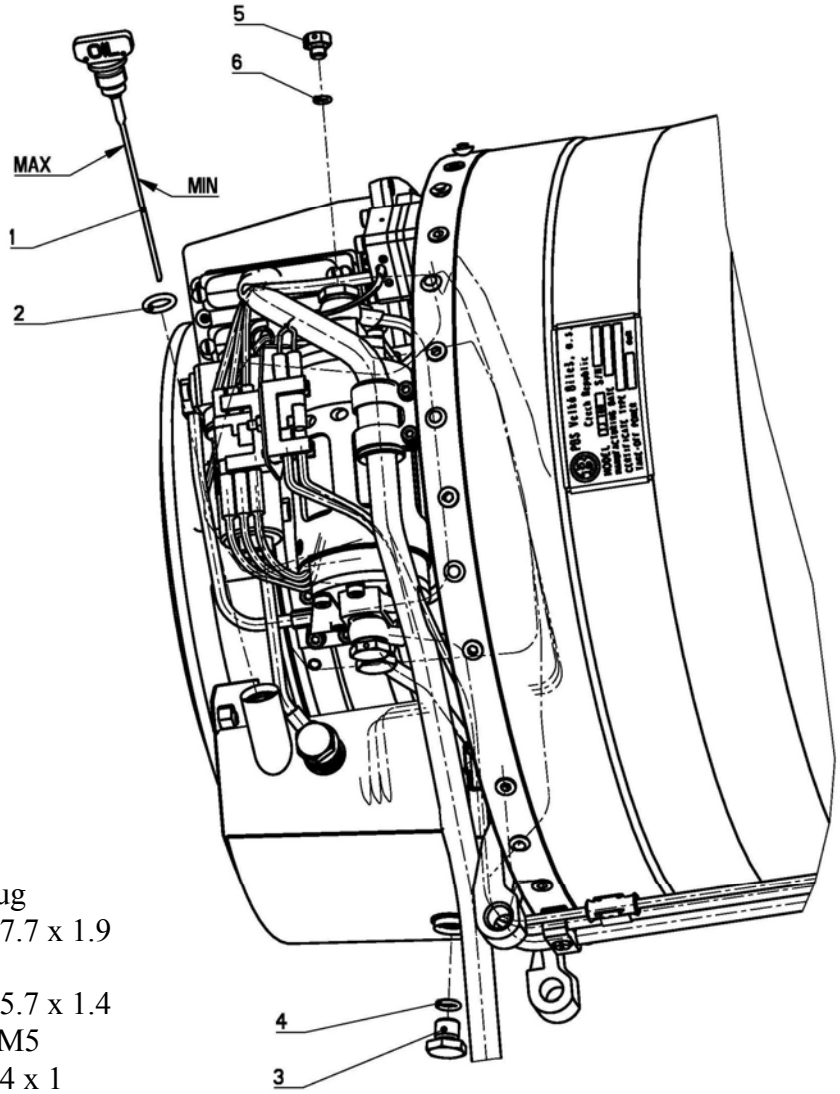
5.6.7 Wipe off all oil that got outside the TJ plug by a clean cloth.

WARNING

At work with locking wire use protective goggles.

5.6.8 Secure the TJ plug by means of the tying wire to the filter - tank piping

5.6.9 Record the performed work in the Engine Book.



1. TJ plug
2. Ring 7.7 x 1.9
3. Plug
4. Ring 5.7 x 1.4
5. Plug M5
6. Ring 4 x 1

Figure 5-3 Oil refilling

5.7 Oil change

5.7.1 Keep following conditions whether change of one kind of used oil to other:

- Use entirely oil listed in paragraph 1.4. only. Engine approval is necessary whether using of different substitute oil
- Don't mix different oil types
- Carry out complete oil sew from oil tank, clean filter according to paragraph 5.4 if change of oil type.
- Refill the tank with clean oil to get the MAX mark
- Start engine to idle speed. Turn-off after 2 – 3 minutes of running.
- Release the oil from oil tank, clean oil filter according to paragraph 5.4
- Refill the tank with clean oil to get the MAX mark
- Start engine to idle speed. Turn –off engine after 2-3 minutes and check tightness of oil system.
- Let the engine cool down before refilling the oil in oil tank to MAX mark according to paragraph 5.5
- Record the oil type change in the Engine Book.

5.8 Troubleshooting

5.8.1 General

The following paragraphs describe some indications of faults of the engine, which may occur in its starting or running. These indications are illustrated in form of simplified technological troubleshooting diagrams.

5.8.2 Description of possible faults and method of their removal

WARNING

The $\mathbf{n_{100}}$ register value of control box must be set to speed at which the engine operate at 100% thrust if the replacement of CPSJ control box is necessary for removal of fault. This setting can be provided by engine producer only and therefore is possible to use control box adjusted for concrete engine only.

Faults at starting up

Tab.1	After applying control voltage 4 ÷ 5V on the input U_{ctrl} or after sending the start command from the superior system – the startup cycle will not begin (the engine rotor does not turn up)
Tab.2	After applying control voltage 4 ÷ 5V on the input U_{ctrl} or after sending the start command from the superior system – the engine runs for a period shorter than 18 seconds
Tab.3	After applying control voltage 4 ÷ 5V on the input U_{ctrl} or after sending the start command from the superior system – the engine runs only 18 seconds (at ambient temperature below –10°C for 23 seconds)
Tab.4	After applying control voltage 4 ÷ 5V on the input U_{ctrl} or after sending the start command from the superior system – the engine runs only 35 seconds
Tab.5	After applying control voltage 3 ÷ 4V on the input U_{ctrl} or after sending the cold start command from the superior system – the cold start time of 13 seconds is not reached

Faults in operating mode

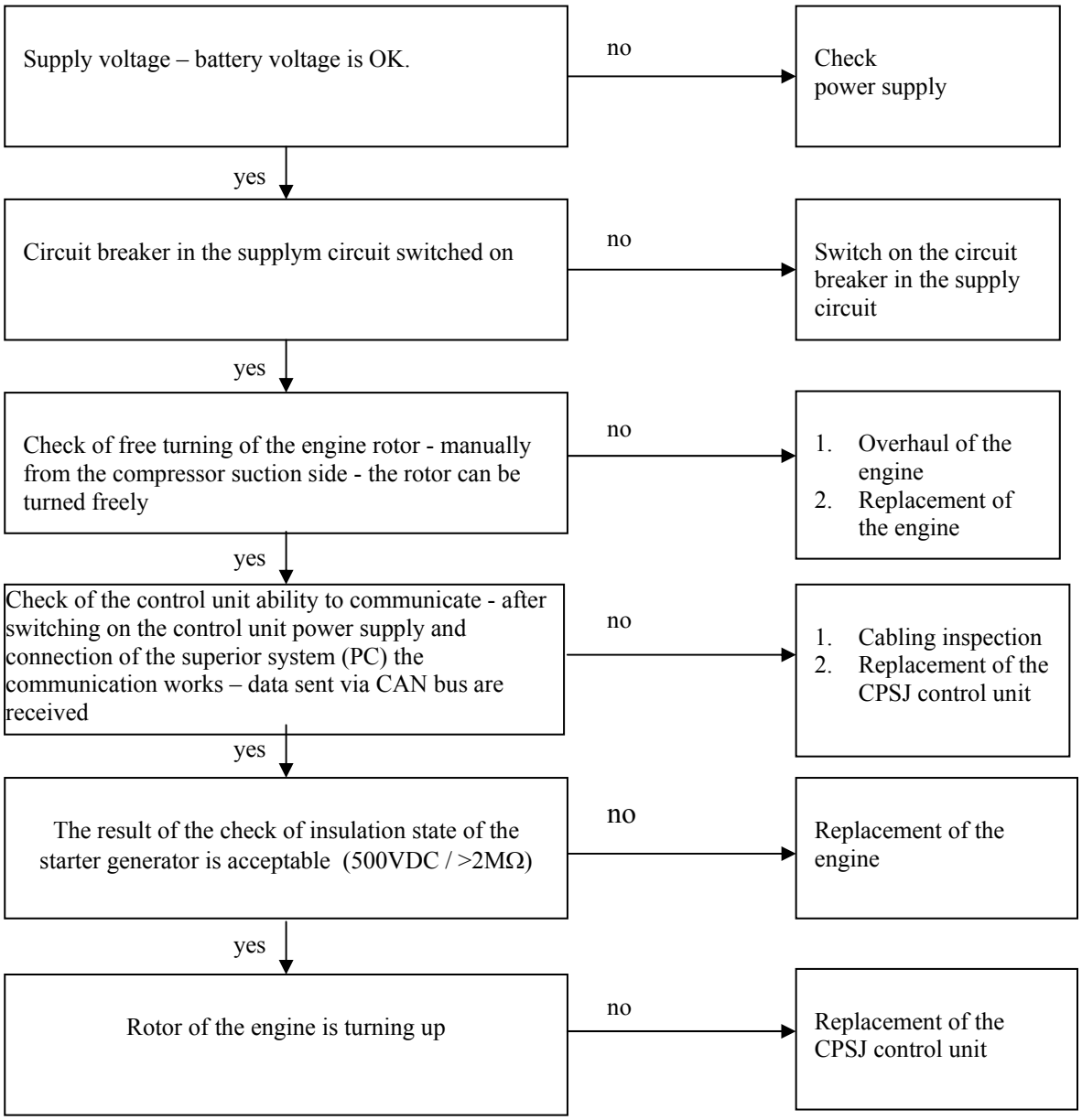
Tab.6	After the startup of the engine – after the reach of idling speed the engine was switched off – control voltage on the input $U_{ctrl} = 4 \div 5V$
Tab.7	After the startup of the engine – after the reach of idling speed the voltage generated by the switched power supply U_{sup} does not reach 28±1V (battery voltage in charging mode)
Tab.8	After the startup of the engine– after the reach of idling speed the engine does not react or react only partly to the request for higher speed (U_{ctrl} > 5V]

Tab.1	**After applying control voltage 4 ÷ 5V on the input U_{ctrl} or after sending the start command from the superior system – the startup cycle will not begin (the engine rotor does not turn up)**

Probable causes:

1. Circuit breaker of the engine power supply switched off
2. Faulty CPSJ control unit
3. Faulty starter generator

Fault removal:

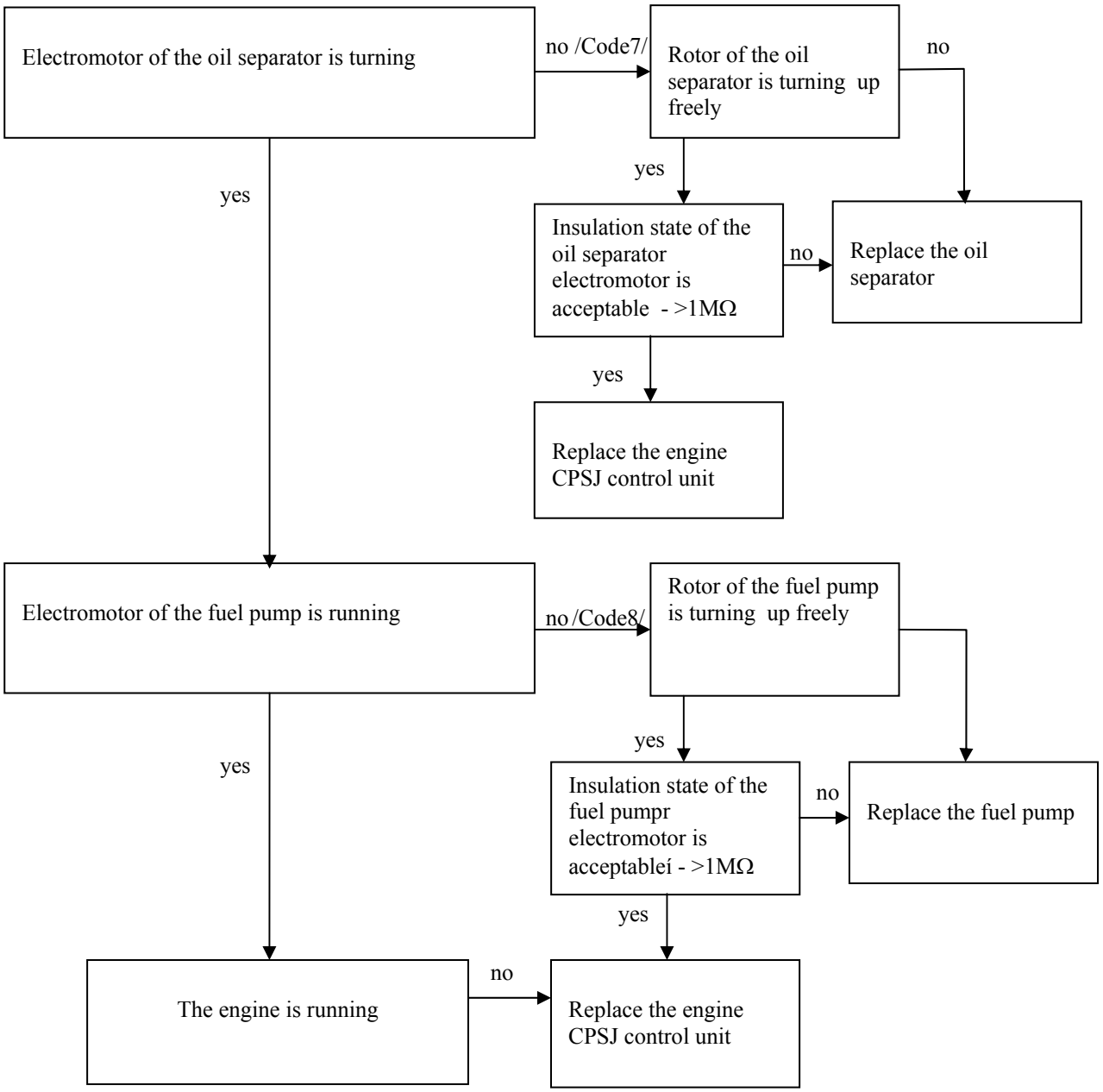


Tab.2	**After applying control voltage 4 ÷ 5V on the input U_{ctrl} or after sending the start command from the superior system – the engine runs for a period shorter than 18 seconds (switched off by the oil separator error /Code 7/)**

Probable causes:

1. Faulty electromotor of the oil separator
2. Faulty CPSJ control unit

Fault removal:

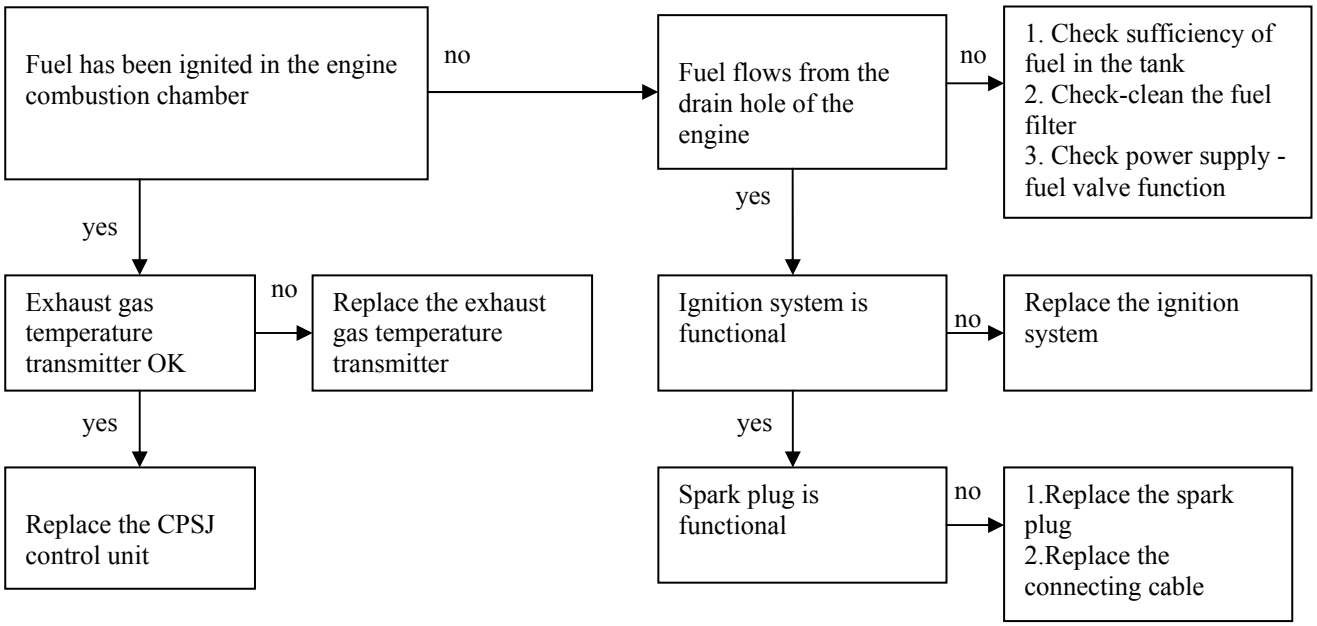


Tab.3	**After applying control voltage 4 ÷ 5V on the input U_{ctrl} or after sending the start command from the superior system – the engine runs only 18 seconds (at ambient temperature below –10°C for 23 seconds (switched off by the underspeed protection)**

Probable causes:

1. Lack of fuel at the engine inlet, clogged fuel filter
2. Faulty fuel valve or error in fuel valve power supply
3. Faulty ignition system or fault in ignition system power supply
4. Faulty spark plug or spark plug connecting cable
5. Faulty exhaust gas temperature transmitter
6. Faulty CPSJ control unit

Fault removal:

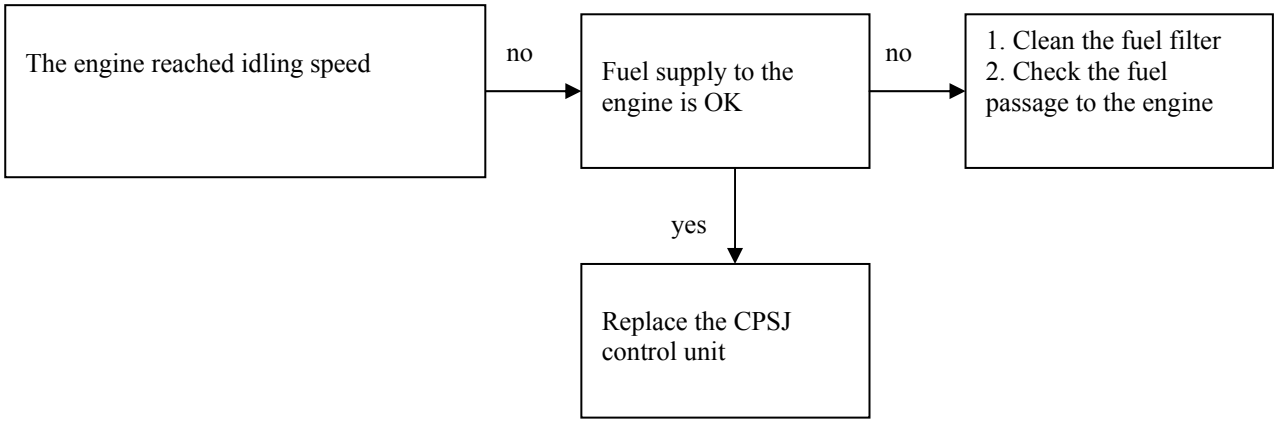


Tab.4	**After applying control voltage 4 ÷ 5V on the input U_{ctrl} or after sending the start command from the superior system – the engine runs only 35 seconds (switched off by the minimum speed protection)**

Probable causes:

1. Lack of fuel at the engine inlet, clogged fuel filter
2. Faulty CPSJ control unit

Fault removal:

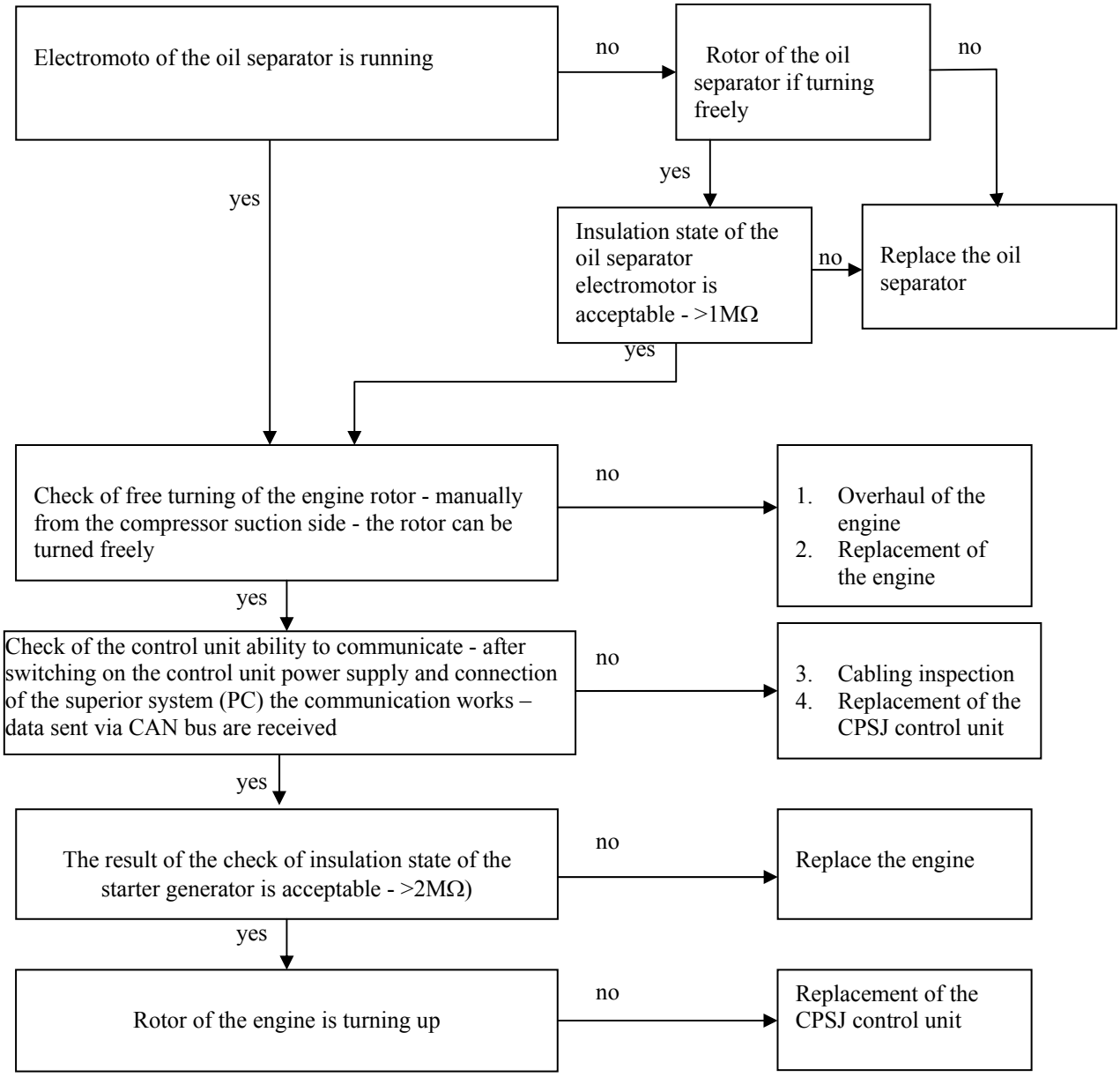


Tab.5	**After applying control voltage 3 ÷ 4V on the input U_{ctrl} or after sending the cold start command from the superior system – the cold start time of 13 seconds is not reached (switched off by the starter generator error protection or oil separator electromotor error protection)**

Probable causes:

1. Faulty electromotor of the oil separator
2. Faulty starter generator
3. Faulty CPSJ control unit

Fault removal:

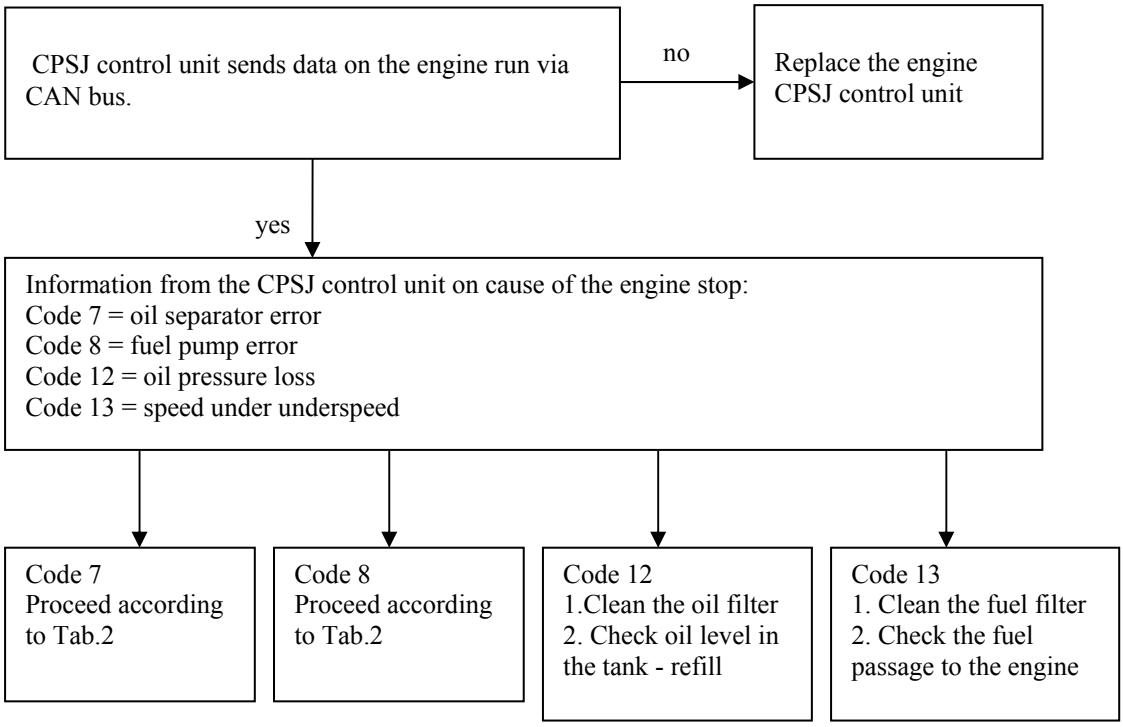


Tab.6	**After the startup of the engine – after the reach of idling speed the engine was switched off – control voltage on the input U_{ctrl} = 4 ÷ 5V**

Probable causes:

1. Faulty CPSJ control unit
2. Fault of fuel pump or oil separator
3. Insufficient oil pressure (lack of oil in the oil tank)
4. Lack of fuel at the engine inlet, clogged fuel filter

Fault removal:

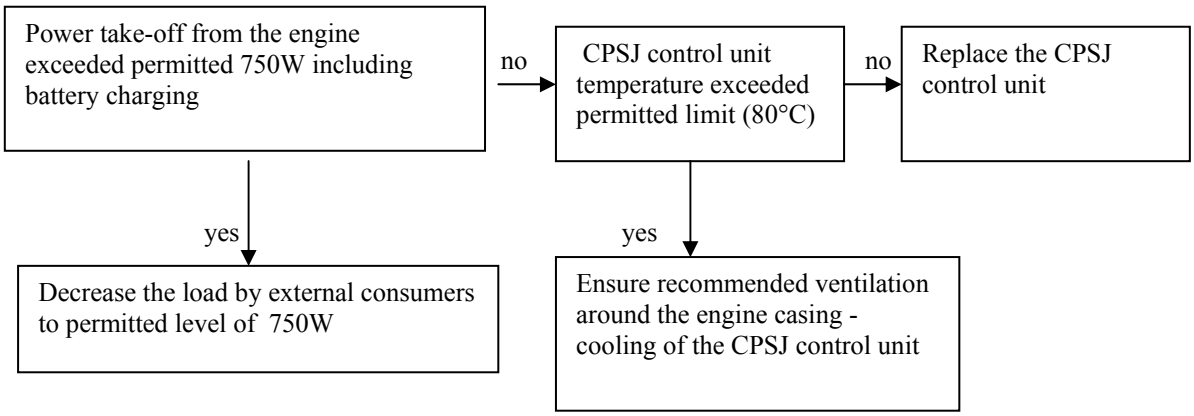


Tab.7	**After the startup of the engine – after the reach of idling speed the voltage generated by the switched power supply U_{sup} does not reach 28±1V (battery voltage in charging mode**

Probable causes:

1. Maximum current take-off from CPSJ exceeded
2. Small or bad venting of the space around the engine casing
3. Faulty CPSJ control unit

Fault removal:

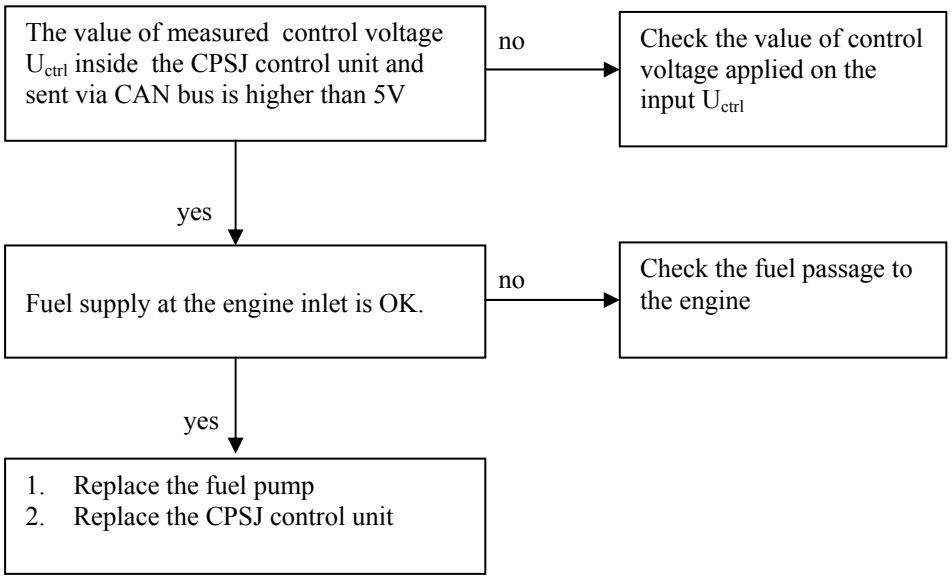


Tab.8	**After the startup of the engine– after the reach of idling speed the engine does not react or react only partly to the request for higher speed (U_{ctrl} > 5V)**

Probable causes:

1. Lack of fuel at the engine inlet, clogged fuel filter
2. Faulty CPSJ control unit
3. Faulty fuel pump

Fault removal:



CHAPTER 6
REPLACEMENT OF DEVICES OF THE ENGINE

WARNING

- The replacement of the devices specified in this chapter can only by performed by semi-skilled personnel.
- Before replacement of any device let the engine cool down..
- It is not permitted to disassemble the engine and its devices beyond the permitted extent.

NOTE

- Record the replacement of any devices in this chapter in the Engine Book.
The inlet and outlet fairings dismantling and subsequent mounting according to point 5.2 must be performed before device exchange according this chapter.

6.1 Replacement of the control unit (Figure 6-1)

Dismantling:

WARNING

Is necessary to carry out changes of register setting $\mathbf{n_{max}}$ of control box to value corresponding to 100% thrust speed – the value from Engine book - by the help of supplied monitoring software if is necessary to change CPSJ control unit for faulty removal. Is strictly prohibited to pass the speed n_{max} value.

NOTE

The engine must be removed from airplane.

WARNING

Before any work on electric equipment, interrupt power supply from the accumulator

6.1.1 Remove locking wire from connectors screws
6.1.2 Using screwdriver no. 5, unscrew 4 screws M3 on 2 connectors and disconnect both connectors.
6.1.3 Unscrew 4 screws M4 (2) on the inlet part flange using the screwdriver no. 7, and remove the control unit.

Mounting:

6.1.4 Spread screws (2) thread by LOCTITE 242 – fixation against stripping
6.1.5 Insert the control unit in its original place, and screw in 4 screws M4 (2) using the torque wrench. The tightening torque is 4.0 Nm.
6.1.6 Connect both connectors, and using special screwdriver no. 5 screw in the screws M3.
6.1.7 Secure the connector screws by means of the tying wire

6.2 Replacement of pressure switch (Figure 6-1)

Dismantling:

6.2.1 Take out the connector from the mounting clip (7) and disconnect it by pull.
6.2.2 Using the Allen wrench 2.5, unscrew 4 screws (6) from the pressure switch (3)
6.2.3 Remove the ring 11.6 x1.9 (4) from the counterpart of the pressure switch.

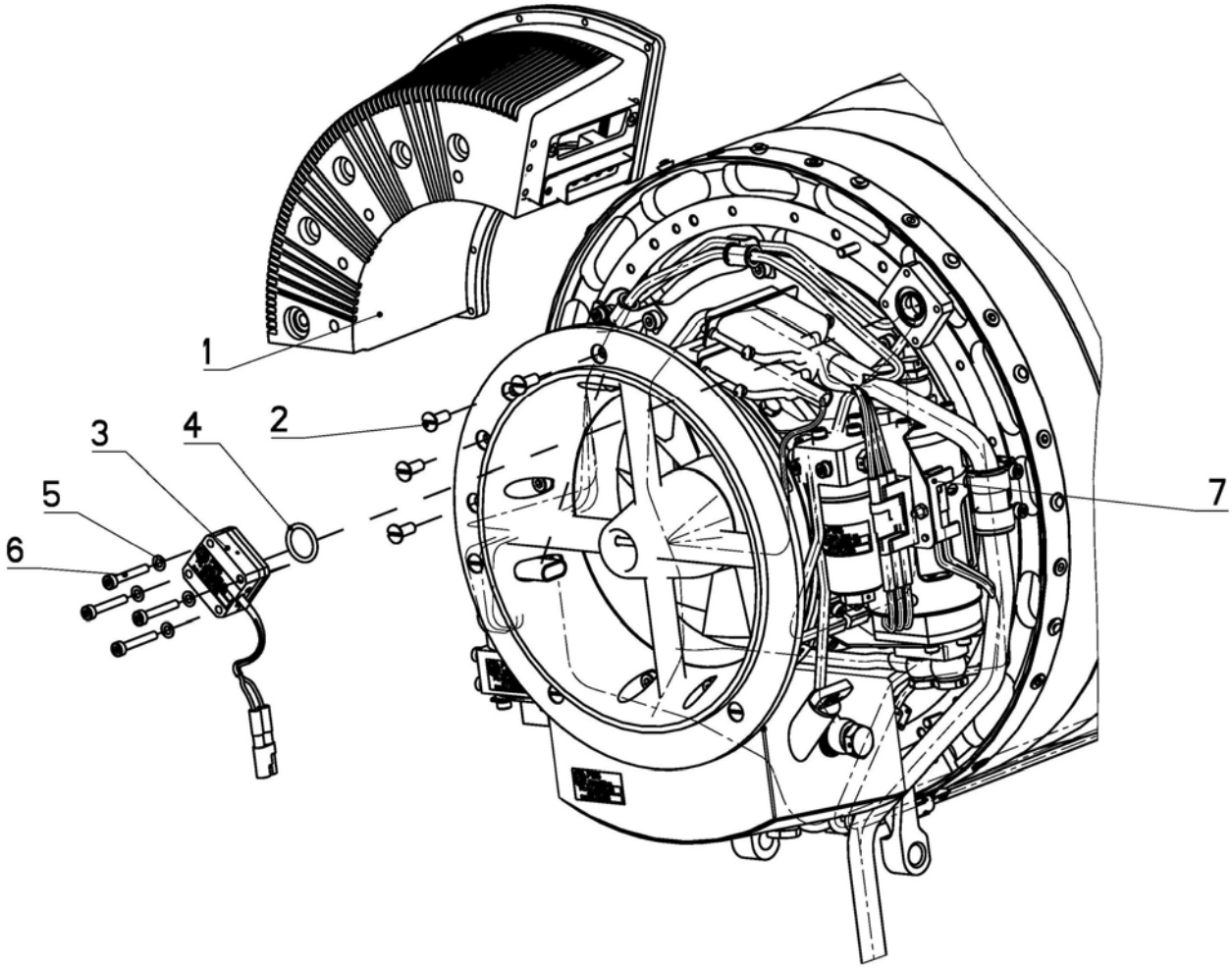
Mounting:

6.2.4 Insert new ring 11.6 x1.9 (4) from the counterpart of the pressure switch, and attach the pressure switch (3)

6.2.5 Spread screws (6) thread by LOCTITE 242 – fixation against stripping

6.2.6 Screw in 4 screws (6) with washers (5). The tightening torque is 2.3 Nm

6.2.7 Connect the connector, and insert it into the mounting clip (7)



1. Control unit
2. Screw M4
3. Pressure switch
4. Ring 12,42x1,78
5. Washer 3
6. Screw M3
7. Mounting clip

Figure 6-1. Control Unit and Pressure Switch

6.3 Replacement of spark plug (Figure 6-2)

Dismantling:

6.3.1 Remove locking wire from spark plug and connecting wire

6.3.2 Using open-end wrench no. 22, unscrew the connecting wire from the spark plug.

6.3.3 Using the ring spanner no. 17, unscrew the spark plug (1) with sealing

Mounting:

6.3.4 Screw in the spark plug (1) with sealing. The tightening torque is 12 Nm.

6.3.5 Attach the connecting wire, and tighten it carefully by the wrench.

6.3.6 Secure the spark plug and connecting wire by means of the tying wire

6.4 Replacement of the exhaust gas temperature transmitter (Figure 6-2)

Dismantling:

WARNING

Before any work on electric equipment, interrupt power supply from the accumulator

6.4.1 Using the wrench no. 8 and the wrench no. 7, unscrew the leading-in cables from the exhaust gas temperature transmitter (2)

6.4.2 Using open-end wrench no. 12 unscrew the exhaust gas temperature transmitter (2)

Mounting:

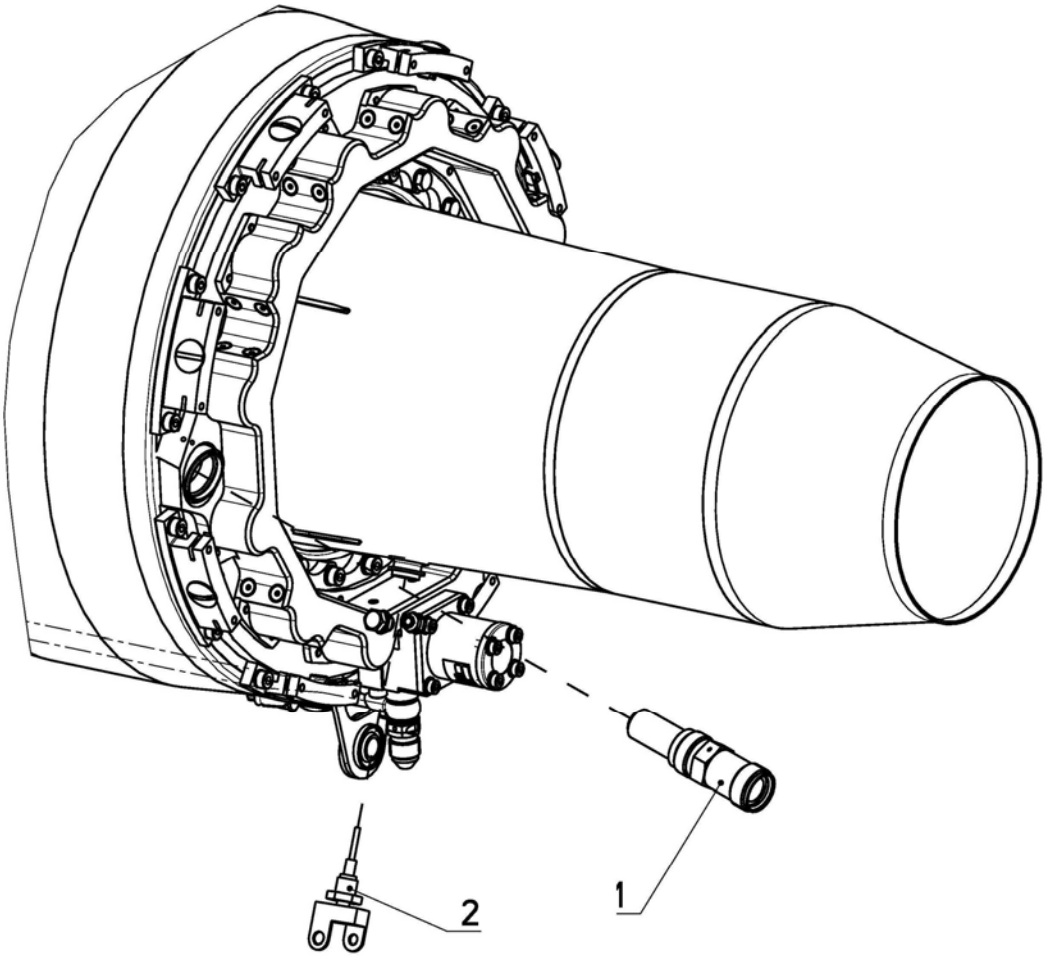
6.4.3 Screw in the new exhaust gas temperature transmitter and tighten it. The tightening torque is 5 Nm.

6.4.4 Secure the exhaust gas temperature transmitter by means of the tying wire

NOTE

To prevent unwanted connection of the exhaust gas temperature transmitter, the leading-in cables have different connecting diameters.

6.4.5 Using the screws M4 and M5 with self-lock nuts, connect the leading-in cables. The tightening torque is 3Nm.



1. Spark plug
2. Exhaust gas temperature transmitter

Figure 6-2, Spark Plug and Exhaust Gas Temperature Transmitter

6.5 <u>Replacement of fuel - oil pump</u> (Figure 6 – 3)

<u>Dismantling:</u>

6.5.1 Before dismantling the fuel oil pump (1), close the main fuel cap and release oil from oil tank according to paragraph 5.5.1 – 5.5.3

6.5.2 Using the wrench no. 17, unscrew the cap nut of the fuel supply from the inlet branch (7)

6.5.3 Catch the flowing out fuel into a prepared vessel.

6.5.4 Remove locking wire from branches (6, 7, 15)

6.5.5 Using the ring spanner no. 12, unscrew the branches (6, 15) and inlet branch (7) from the connected piping

6.5.6 Catch the flowing out fluids into the prepared vessel or rag.

6.5.7 Remove locking wire from screws M3 (19) on the cable clip (17) on the cable pack. Unscrew screws and cable bend out

6.5.8 Withdraw the connector from the clip (12), and disconnect it.

6.5.9 Using the Allen wrench no. 2.5, unscrew 2 screws (16) from lower bracket (20) and 2 screws (13) from upper bracket. Remove the pump.

Mounting:

6.5.10 Spread screws (13, 16) thread by LOCTITE 242 – fixation against stripping

6.5.11 Insert the new pump into the original place, and by means of 2 screws (13) with washers (14) and 2 screws (16) with washers (14), screw it in. The tightening torque is 2.3 Nm

6.5.12 Put in sealing (8) to branches (6, 7, 15) and screw in the branches. You must not mistake of branches (6,7,15) placing. The tightening torque is 6 Nm

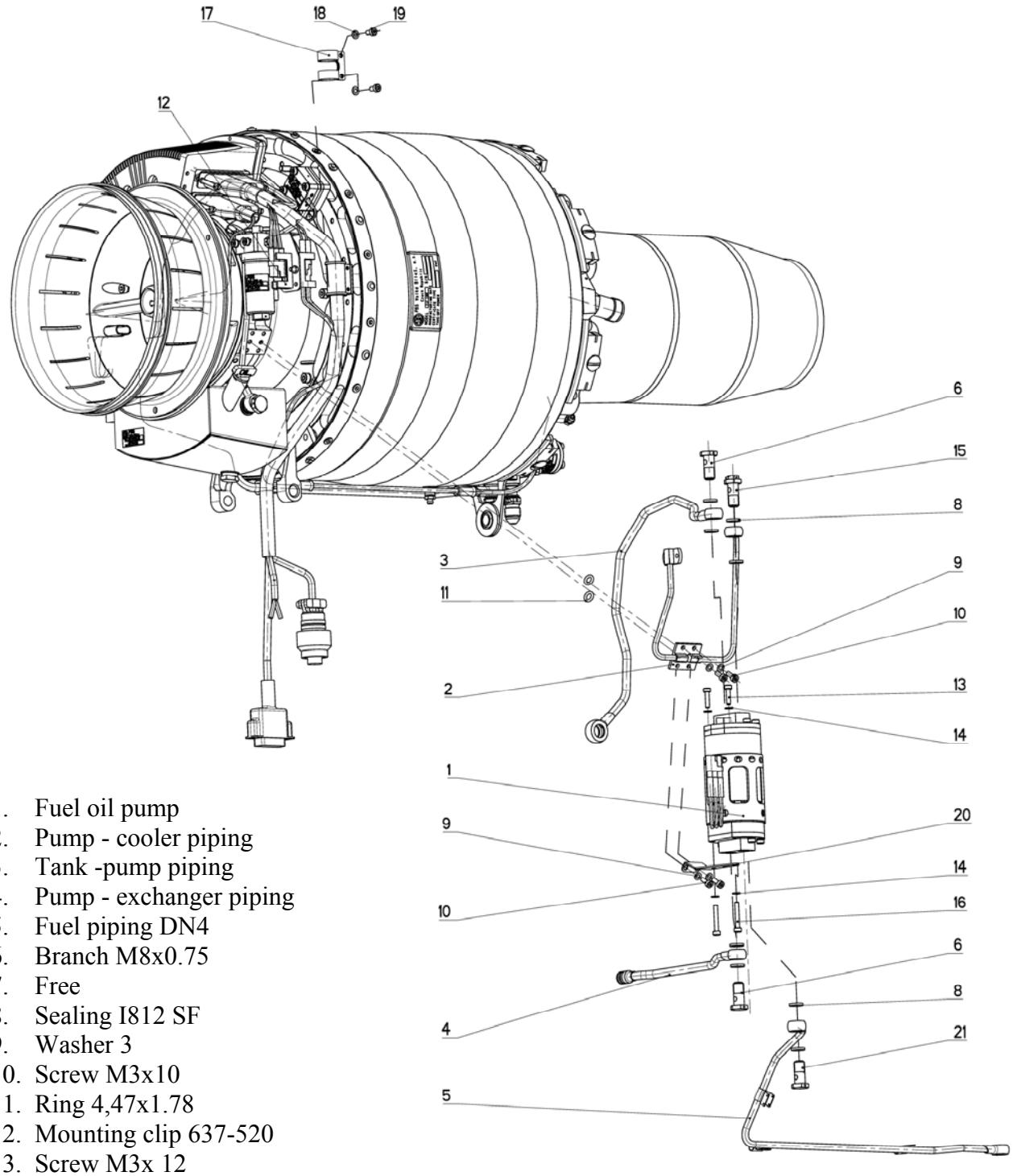
6.5.13 Secure the branches (6, 7, 15) by means of the tying wire

6.5.14 Screw the mounting clip (17) by screws M3 (19) with washers (18) on cable pack and secure by means of tying wire

6.5.15 Screw the cap nut on the inlet branch of the fuel supply piping, and tighten it.

6.5.16 Connect the connector and insert it into the clip (12).

6.5.17 Refill the tank with clean oil to get the MAX mark after screwing in the plug.



1. Fuel oil pump
2. Pump - cooler piping
3. Tank -pump piping
4. Pump - exchanger piping
5. Fuel piping DN4
6. Branch M8x0.75
7. Free
8. Sealing I812 SF
9. Washer 3
10. Screw M3x10
11. Ring 4,47x1.78
12. Mounting clip 637-520
13. Screw M3x 12
14. Washer 3
15. Filling branch
16. Screw M3x20
17. Cable clip
18. Washer 3
19. Screw M3x6
20. Lower bracket
21. Screw M8x0.75

Figure 6-3, Fuel Oil Pump

6.6 Replacement exchanger and oil separator (Figure 6-4)

Dismantling:

NOTE

The engine must be removed from airplane if necessary to dismantle of exchanger or oil separator If it is requested to replace one of the devices, both the devices must be dismantled

WARNING

Before any work on electric equipment, interrupt power supply from the accumulator

6.6.1 Release oil from oil tank according to paragraphs 5.5.1 – 5.5.3 before dismantling of exchanger and oil separator (1, 2)

6.6.2 Remove 4 screws M4 (2, Figure 6-1) for releasing of control unit on input branch.

6.6.3 Remove exchanger bracket for better access

6.6.4 Release the connector from the mounting clip (16) and disconnect it.

6.6.5 Using Allen wrench no. 3, unscrew the screw M4 (8)

6.6.6 Using Allen wrench no. 2.5, unscrew 4 screws M3 (13)

6.6.7 Using Allen wrench no. 2.5 unscrew 2 screws M3 (10) from the fuel piping (3)

6.6.8 Catch the flowing out fluids into the prepared vessel.

6.6.9 Remove locking wire from fuel piping branch

6.6.10 Using the ring spanner no. 12, release the branch on the bypass governor fuel piping (3) and withdraw the piping from the exchanger body.

6.6.11 Slacken the screw M4(17) to release the suction (18)

6.6.12 By turning tension, withdraw the exchanger and oil separator from the pump - exchanger piping (4) and from the outlet branch (5)

6.6.13 Remove the ring (12) from the flange on the oil tank.

6.6.14 Unscrew the screw M3 (10) and by pull separate the exchanger (1) from the oil separator (2)

Mounting:

6.6.15 Check whether the rings(15) on the coupling 10(7), spacer coupling (6) and fuel piping (3) are not damaged. Replace the damaged rings and apply used oil on them before mounting.

6.6.16 Slide the coupling 10 (7) into the exchanger (1), and slide the oil separator (2) onto the coupling.

6.6.17 Spread screws (10) thread by LOCTITE 242 – fixation against stripping

6.6.18 Screw the oil separator (2) to the exchanger (1) by the screw (10) with washer (11). The tightening torque is 2.3 Nm

6.6.19 If the spacer coupling (6) has been withdrawn from the exchanger (1), insert it into the exchanger.

6.6.20 Insert new ring (12) into the flange on the oil tank, and apply used oil on it.

6.6.21 Insert carefully the oil separator (2) with the exchanger (1) together by the spacer coupling (6) into the outlet branch (5), and by the exchanger onto the pump exchanger piping (4)

6.6.22 By hand, uplift the released suction (18), and slide it onto the oil separator inlet (2)

6.6.23 Spread screws (13) thread by LOCTITE 242 – fixation against stripping

6.6.24 Screw the oil separator (2) by the screws (13) with washers (11) to the oil tank flange. The tightening torque is 2.3 Nm

6.6.25 Check whether the pump exchanger piping (4) and spacer coupling (6) are correctly put into the outlet branch (5).

6.6.26 Spread screws (8) thread by LOCTITE 242 – fixation against stripping

6.6.27 By the screw (8) with washer (9) screw in the exchanger (1) The tightening torque is 4 Nm

6.6.28 Insert the fuel piping into the exchanger (1) and screw in the screws (10) with washers (11) The tightening torque is 4 Nm

6.6.29 Tighten the branch on the fuel piping (3).The tightening torque is 6 Nm

6.6.30 Secure the fuel branch by means of the tying wire

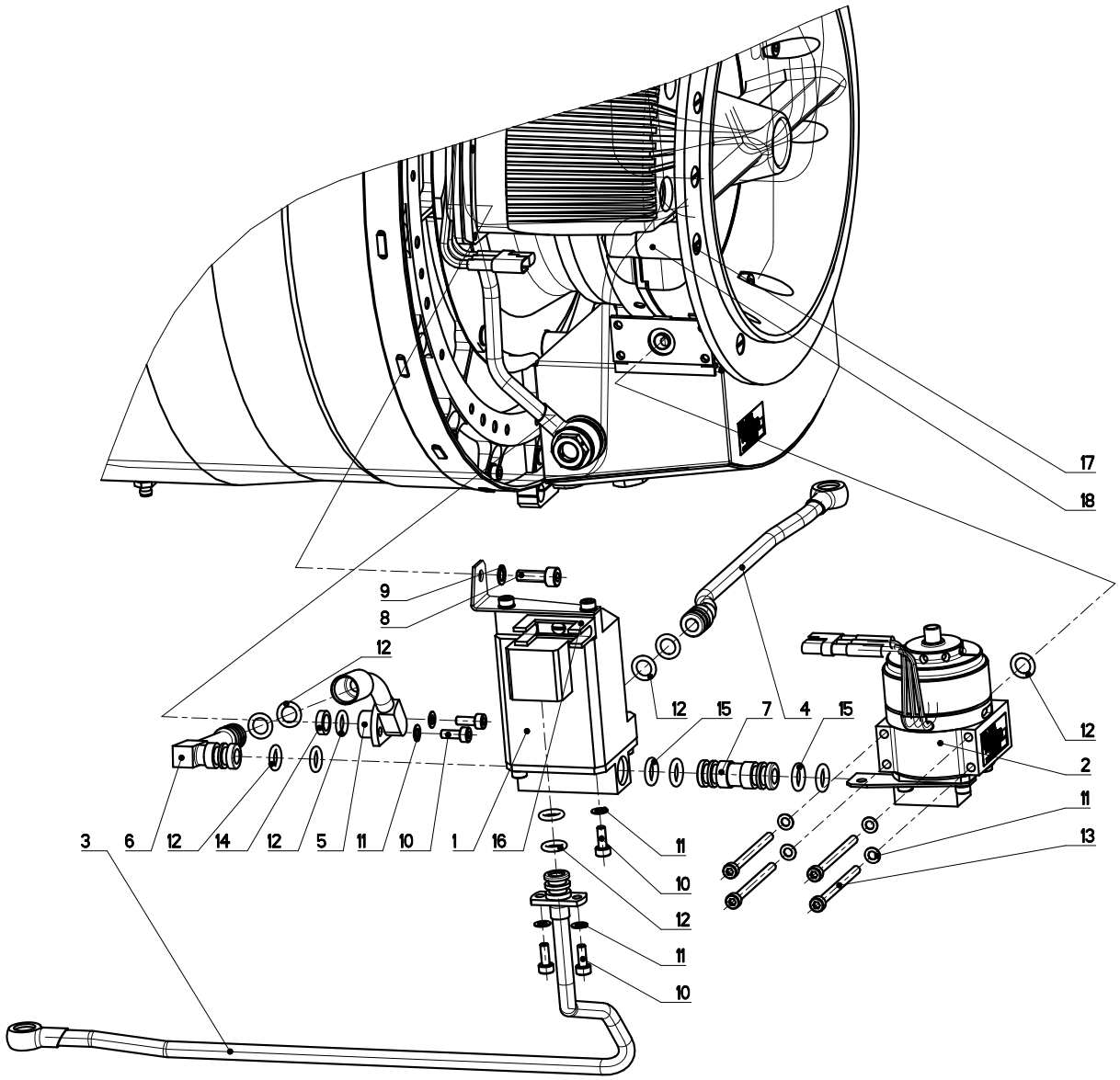
6.6.31 Unscrew screw (17) and spread screw thread by LOCTITE 242 and tighten the suction (18). The tightening torque is 2.3 Nm

6.6.32 Connect the connector and insert it into the mounting clip (16)

6.6.33 Insert the control unit in its original place, and screw in 4 screws M4 (2, Figure 6-1) using the torque wrench. Spread screws thread by LOCTITE 242 – fixation against stripping The tightening torque is 4.0 Nm

6.6.34 Screw upper exchanger bracket

6.6.35 Refill the tank with clean oil to get the MAX mark after screwing in the plug



1. Exchanger
2. Oil separator
3. Fuel piping DN5
4. Pump exchanger piping
5. Outlet branch
6. Spacer coupling
7. Coupling 10
8. Screw M4x12
9. Washer 4
10. Screw M3x8
11. Washer 3
12. Ring 6.07x1.78
13. Screw M3x40
14. Spacer ring
15. Ring 6.5x2
16. Mounting clip 637-520
17. Screw M4x10
18. Suction

Figure 6-4, Exchanger and Oil Separator

6.7 Replacement of bypass governor III (Figure 6-5)

Dismantling:

6.7.1 Remove locking wire from fuel piping branches (6, 7)

6.7.2 Using the ring spanner no.12, unscrew 2 branches M8 x 0.75 (9) from the fuel piping (6, 7) on the bypass governor III

6.7.3 Catch the flowing out fluids into the prepared vessel

6.7.4 Remove 4 sealing washers (8) from the branches M8 x 0.75 (9)

6.7.5 Using the Allen wrench no. 3, unscrew 2 screws M4 (5)

6.7.6 Remove the bypass governor III from the fuel ramp.

Mounting:

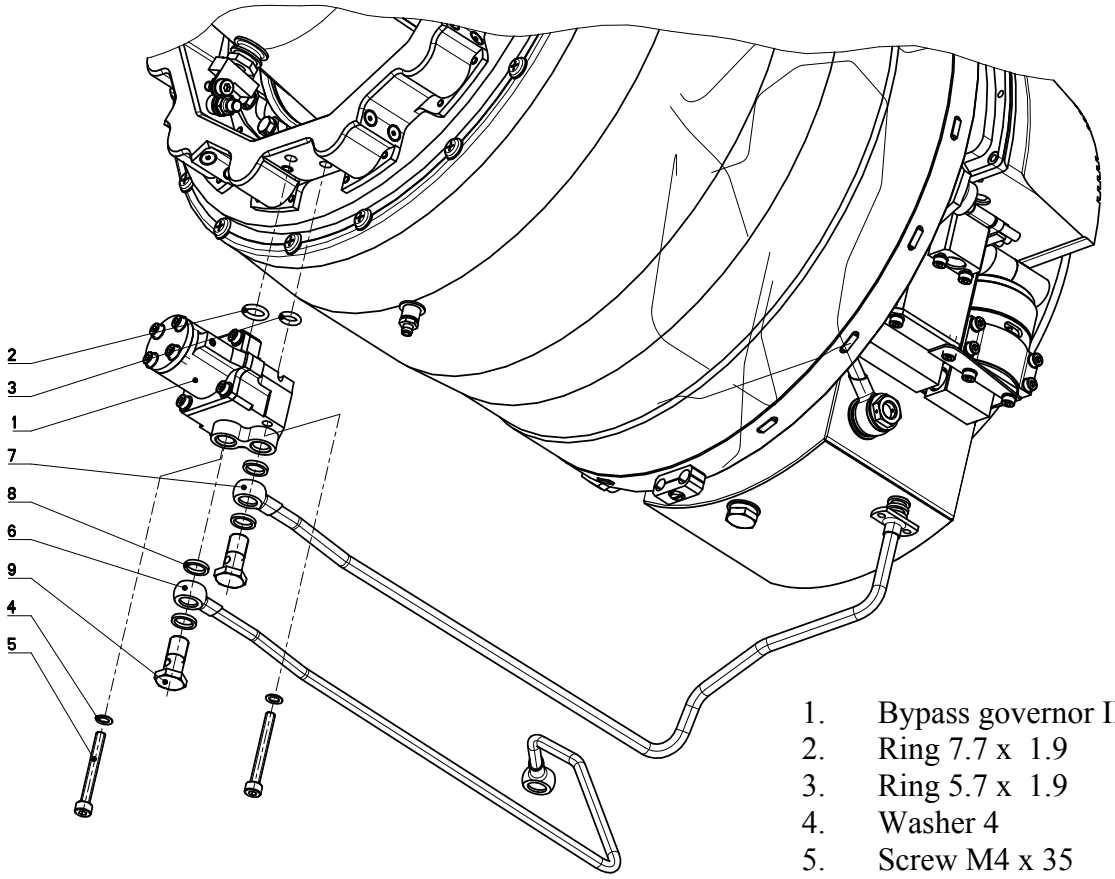
6.7.7 Insert new rings 7.7x1.9 and 5.7x1.9 (2,3) into grooves of the bypass governor III

6.7.8 Spread screws (5) thread by LOCTITE 242 – fixation against stripping

6.7.9 Screw in the bypass governor III by means of 2 screws M4 (5) with washers 4 (4). The tightening torque is 4Nm

6.7.10 Put the sealing washers (8) on the branch (9) and fuel piping (6,7), and screw it in the bypass governor III. The tightening torque is 6 Nm.

6.7.11 Secure the branch (9) by means of the tying wire



1. Bypass governor III
2. Ring 7.7 x 1.9
3. Ring 5.7 x 1.9
4. Washer 4
5. Screw M4 x 35
6. Fuel piping DN 4
7. Fuel piping DN 5
8. Sealing 1812 SF
9. Branch M8 x 0.75

Figure 6- 5, Bypass Governor III

6.8 Replacement of oil filter (Figure 6- 6)

Dismantling:

WARNING

Before any work on electric equipment, interrupt power supply from the accumulator

6.8.1 Remove connectors from control box according to paragraphs 6.1.1 and 6.1.2

6.8.2 Remove the connectors from the mounting clips (12)

6.8.3 Using the ring spanner no.12, unscrew the safety valve (13) from the filter tank piping (6) on the oil tank

6.8.4 Catch the flowing out oil into prepared vessel.

6.8.5 Using the Allen wrench no.2.5 unscrew the screws (11) from the pump - cooler piping (8)

6.8.6 Using the Allen wrench no.2.5, unscrew the screws (11) from the filter - switch - bearing piping (7)

6.8.7 Using the Allen wrench no.2.5, unscrew the screws (5) from the fuel oil pump (15)

6.8.8 Using the socket wrench no.7, unscrew the screw (3)

6.8.9 Remove the oil filter (1) and using the Allen wrench no. 2.5, unscrew the filter -tank piping (6) from it.

6.8.10 Remove the rings (9) from the piping (6), (7), (8), and replace them by new rings.

Mounting:

6.8.11 Spread screws (11, 3, 5) thread by LOCTITE 242 – fixation against stripping

6.8.12 Attach the filter - tank piping (6) with the ring (9) to the oil filter (1), and screw them with the screws (11) and washers (10). The tightening torque is 2.3 Nm

6.8.13 Put the oil filter (1) on the fuel oil pump (15), and screw it by the screw (3) with washer (2). The tightening torque is 4 Nm

6.8.14 By means of the screws (5) with washers (4) screw the fuel oil pump (15) to the oil filter (1). The tightening torque is 2.3 Nm

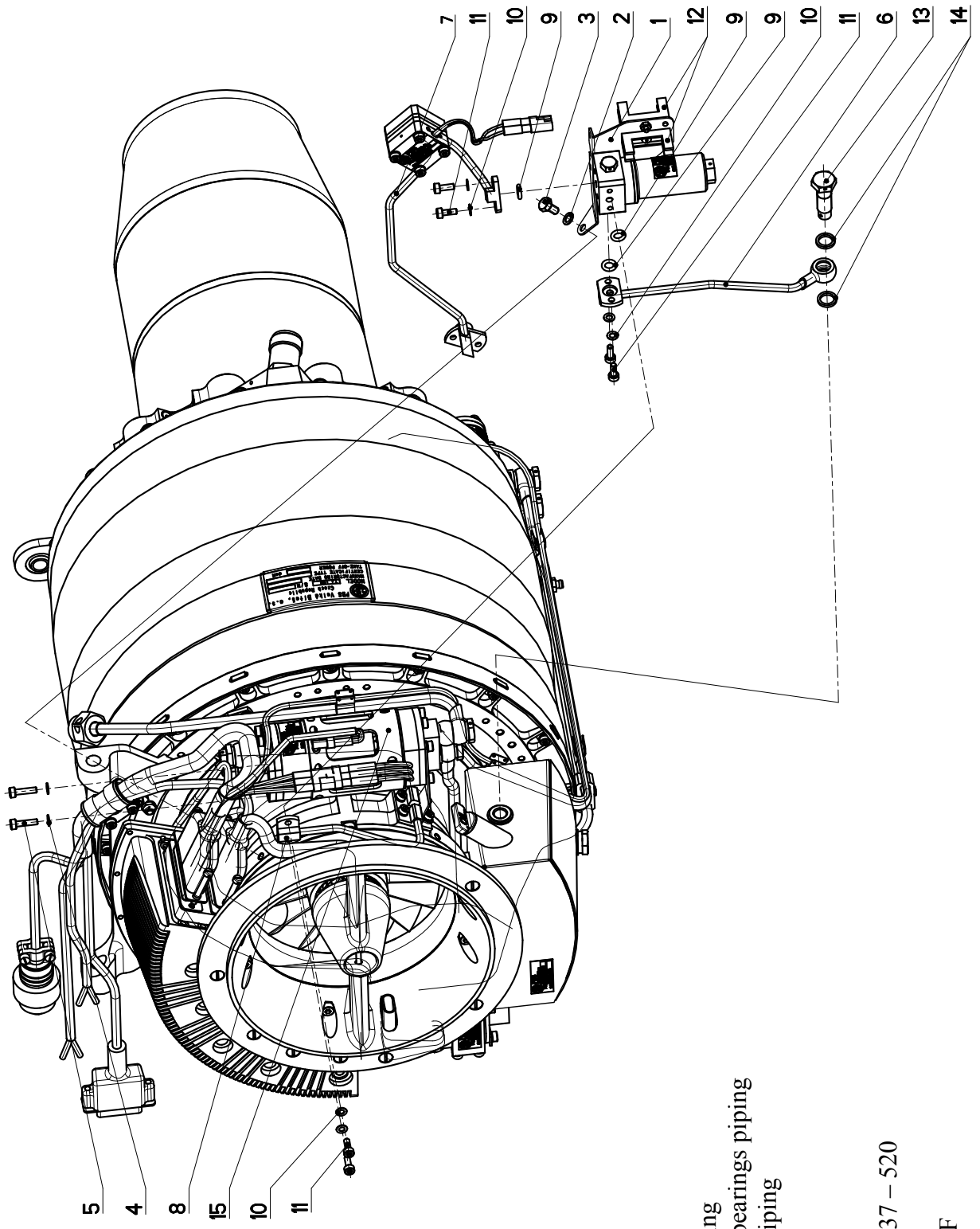
6.8.15 By means of the screws (11) with washers (10) screw the pump - cooler piping (8) with the ring (9) and the filter – switch – bearings piping (7) with the ring (9) to the filter. The tightening torque is 2.3 Nm

6.8.16 Insert the safety valve (13) with the sealing (14) in the filter - pump piping (6), put on the sealing (14) and screw it to the oil tank. The tightening torque is 6 Nm

6.8.17 Secure the safety valve (13) by means of the tying wire

6.8.18 Insert the connectors into the mounting clips (12)

6.8.19 Insert the connectors to the control box according to paragraphs 6.1.6 and 6.1.7



1. Oil filter
2. Washer 4
3. Screw M4x8
4. Washer 3
5. Screw M3x12
6. Filter - tank piping
7. Filter - switch -bearings piping
8. Pump - cooler piping
9. Ring 4.6x1.78
10. Washer 3
11. Screw 3x8
12. Mounting clip 637 – 520
13. Safety valve
14. Sealing I 812 SF
15. Fuel oil pump

Figure 6- 6, Oil Filter

6.9 Replacement of cable harness (Figure 6-7)

Dismantling:

NOTE

The engine must be dismantled from aircraft before any cable harness dismantling.

WARNING

Before any work on electric equipment, interrupt power supply from the accumulator.

6.9.1 Remove locking wire from screws on signal connector (1) and superior system connector (7)

6.9.2 Using the screwdriver, unscrew the screws on the control unit (Figure 6-1) from the signal connector (1, Figure 6-7), and disconnect the connector.

6.9.3 Unscrew the cap nut of the connector (9) on the ignition device, and disconnect the connector.

6.9.4 Using the screwdriver, unscrew the screws on the connector (7) of the superior system, and disconnect the connector.

6.9.5 Disconnect the cabling (8) from the fuel valve.

6.9.6 Remove the connector (2, 3) from the mounting clip on the oil filter (12, Figure 6-6)

6.9.7 Remove the connector (4) from the mounting clip on the fuel oil exchanger (16, Figure 6-4), and disconnect the connector.

6.9.8 Release the control unit according to paragraph 6.1.2, lift it slightly, and remove the thermometer T1 (5) from its input part and cable from grommet (11).

6.9.9 According to paragraph. 6.4.1, release the cables from the exhaust gas temperature transmitter.

6.9.10 Using the Allen wrench no. 2.5, release the sleeve on the grommet (10)

6.9.11 There is necessary dismantling and releasing of cable grommet (10) if are installed new battery cable shanks.

Mounting :

6.9.12 Put in the battery cable to grommet (10) and install cable shanks

6.9.13 Put the sleeve on the grommet (10) and screw it in.

6.9.14 Insert the thermometer T1 (5) in the grommet (11) input part, and screw in the control box according to p. 6.1.3.

6.9.15 Connect the connector (4) with the connector of the oil separator, and insert it into the mounting clip (Figure 6-4)

6.9.16 Insert signal connector (1) into the control box, and using the special screwdriver tighten the locking screws. Secure screws by means of the tying wire

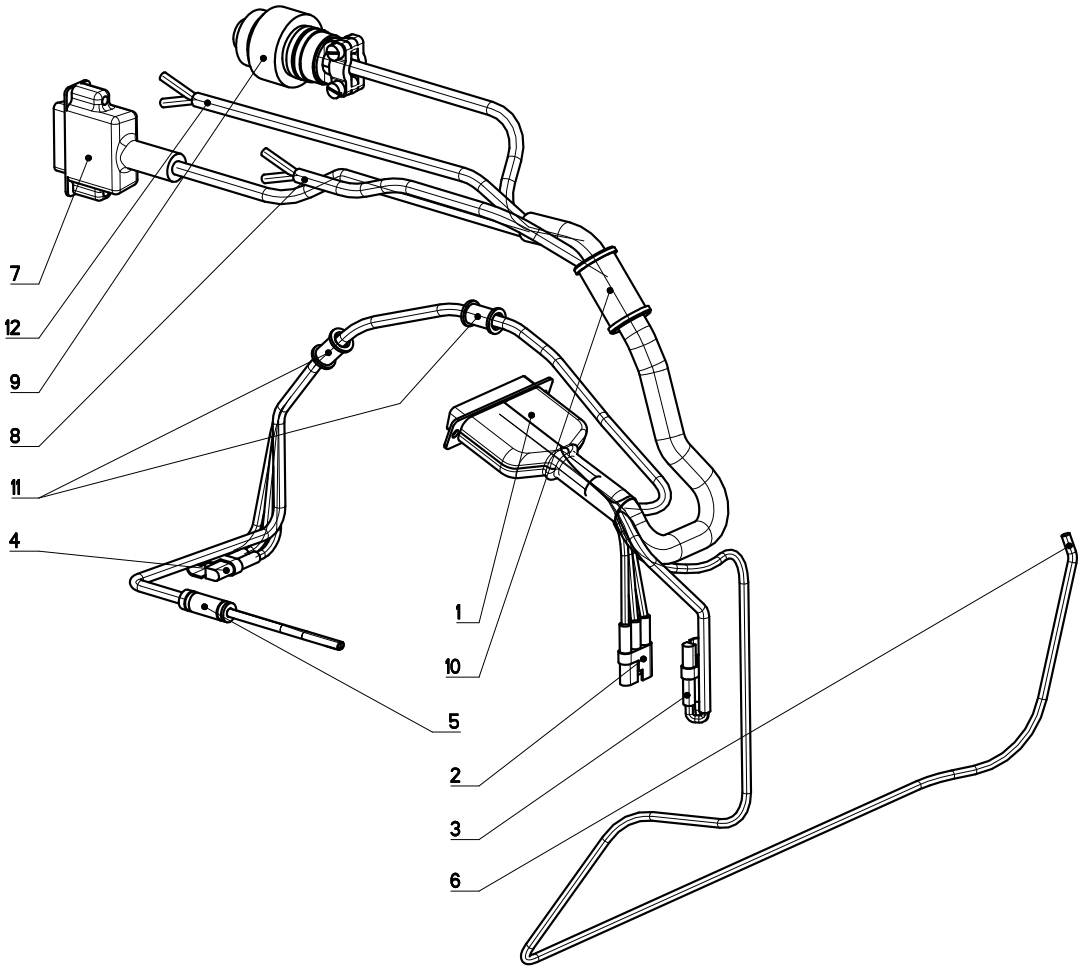
6.9.17 Connect the connector (2) with the fuel oil pump according to p. 6.5.14 and connector (3) with the pressure switch according to p. 6.2.6.

6.9.18 Connect the cabling (8) to the fuel valve.

6.9.19 Insert the connector (9) into the ignition device, and tighten the cap nut.

6.9.20 According to p. 6.4.5, connect the cabling (6) on the exhaust gas temperature transmitter.

6.9.21 Connect the connector (7) with the connector of the superior system, and screw in the locking screw by means of the screwdriver. Secure the screws by means of the tying wire



1. Signal connector
2. Fuel oil pump connector
3. Pressure switch connector
4. Oil separator connector
5. Thermometer T1
6. Connection to the exhaust gas temperature transmitter
7. Superior system connector
8. Connection to fuel valve
9. Ignition device connector
10. Grommet
11. Grommet

Figure 6- 7, Cable Harness

CHAPTER 7
ILLUSTRATED SPARE PARTS BREAKDOWN

7.1 General

In the Illustrated Parts Breakdown (IPB) there are parts, which provide logistic support to given equipment. The IPB is used in ordering, identification of parts and for the illustration of relations in dismounting and mounting.

7.2 Maintenance Parts List

The Maintenance Parts List (MPL) represents a hierarchical breakdown of assemblies and parts included in a final item/items or the items sold as a specific configured part, which can be dismantled, repaired, manufactured, installed, replaced or reassembled at various levels of maintenance.

7.2.1 Parts included. In the Maintenance Parts List (MPL) there are assemblies and parts that were installed in time, when the basic final item was made. If an assembly or component (including subcontractor's items) differs from the original one or is installed during production of subsequent final items, the MPL contains the UOC. If the original assembly or part have not been further used (due to a design change or modification), the IPB contains only the newly used assembly or component.

7.3 Figure Number, Index, Sheet Number

The first column of the IPB contains the figure number, an index and the number of the sheet, by means of which any part of assembly specified in MPL has assigned a number on the illustration. The indexes are assigned to each part to facilitate its right position and to make possible cross references between the figures and the MPL. For the items, which are not shown in the figures, there is a hyphen (-) inserted before the index. On each page there is a note explaining the meaning of this symbol. If more sheets are needed to illustrate all parts of an assembly or an assembly group, the number of relevant sheet separated by a slash (/) is shown after the index.

7.4 Part Number

In this column there is a numeric identification of each part: the number assigned by the manufacturer, subcontractor, or the number according to a national standard. If no numerical identification is available, there must be model number or type number shown instead of it.

7.5 CAGE (manufacturer or supplier identification code)

This column contains the CAGE code in the same line as the relevant numeric identification of the product. See the following table for CAGE code explanation.

CAGE	Address
2128G	První brněnská strojírna Velká Bíteš

7.6 Description

The purpose of the description column is to show mutual relations between individual assemblies, subassemblies and parts in the IPB as follows:

1 2 3 4 5 6 7

Assembly

- Assembly parts
- Subassembly
- Subassembly connecting material

xxx

- • Subassembly parts
- • Sub-subassembly
- • Sub-subassembly connecting material

xxx

- • • Sub-subassembly parts

etc.

7.7 Units per Assembly, UPA

This column shows the number of units contained in an assembly or subassembly. The quantity shown in this column is not necessary total quantity contained in the final item. If the item has already been specified above in the list, or if it is shown for reference purposes, it is designated by abbreviation REF. The abbreviation AR means "AS REQUIRED" and it is used in case, when it is not possible to specify concrete amount.

7.8 Usable on Code

The Usable on Code are defined at the end of the IPB for relevant figure. If no code is specified, it means that the part shown in the IPB is common for all configurations contained in the catalogue.

7.9 Symbols and Abbreviations

CAGE	Commercial And Government Entity (manufacturer or supplier code)
IPB	Illustrated Parts Breakdown
NP	Nonprocurable
UOC	Usable On Code
UPA	Units per Assembly

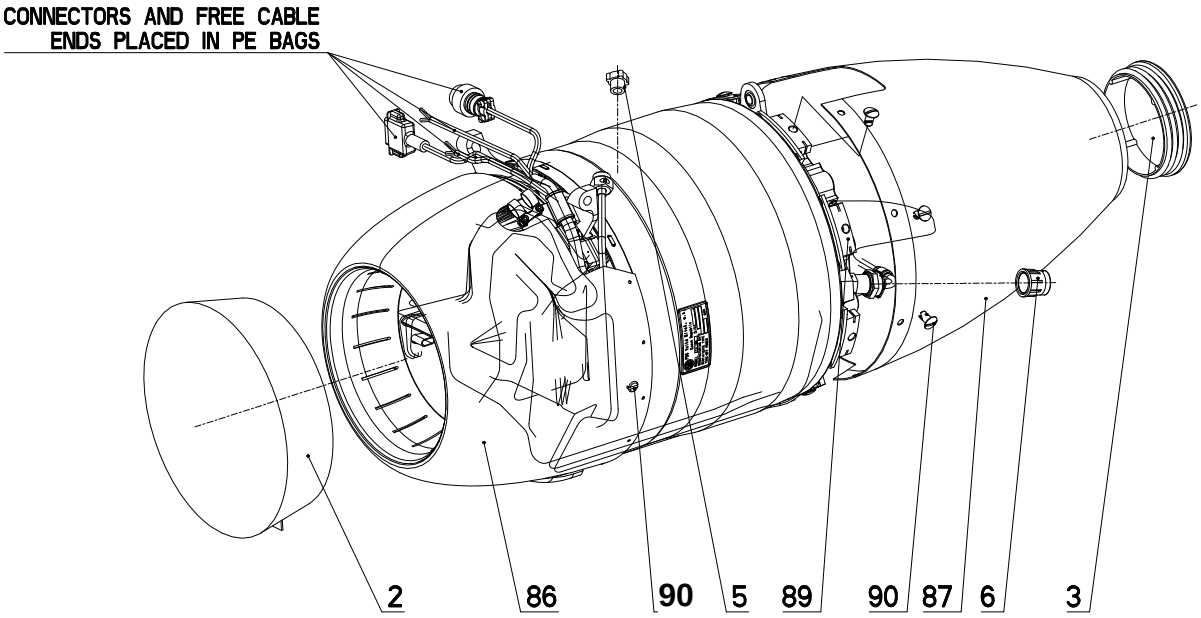


Figure 7-1/1 Turbojet engine

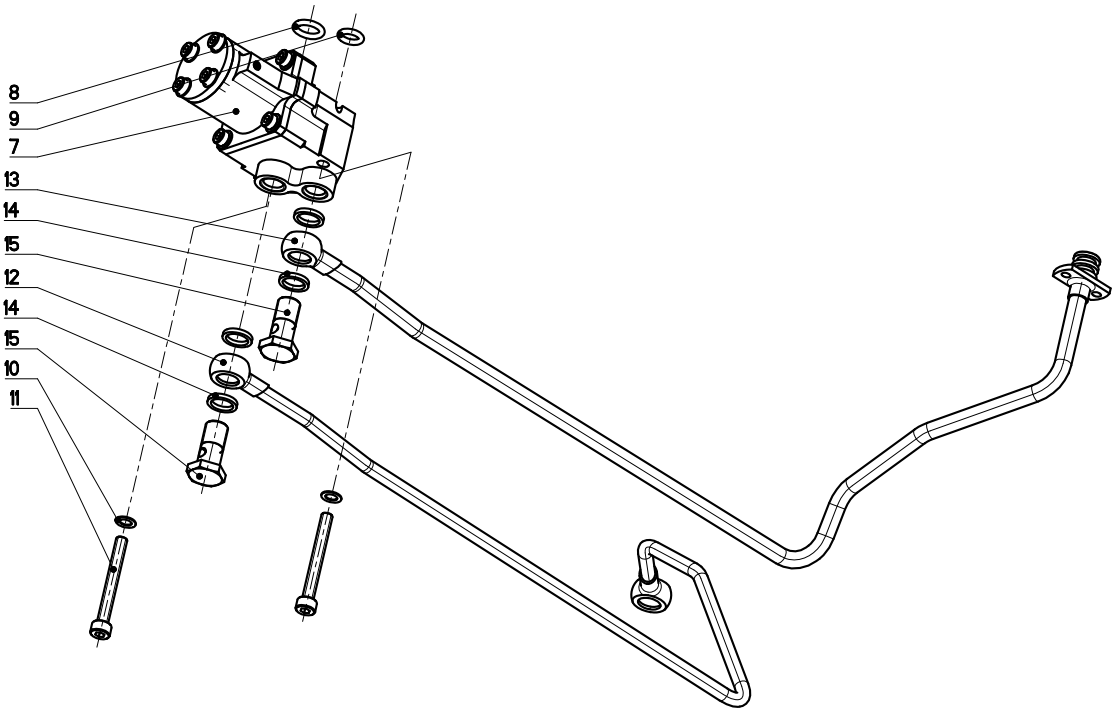


Figure 7-1/2 Turbojet engine (page 1 of 5)

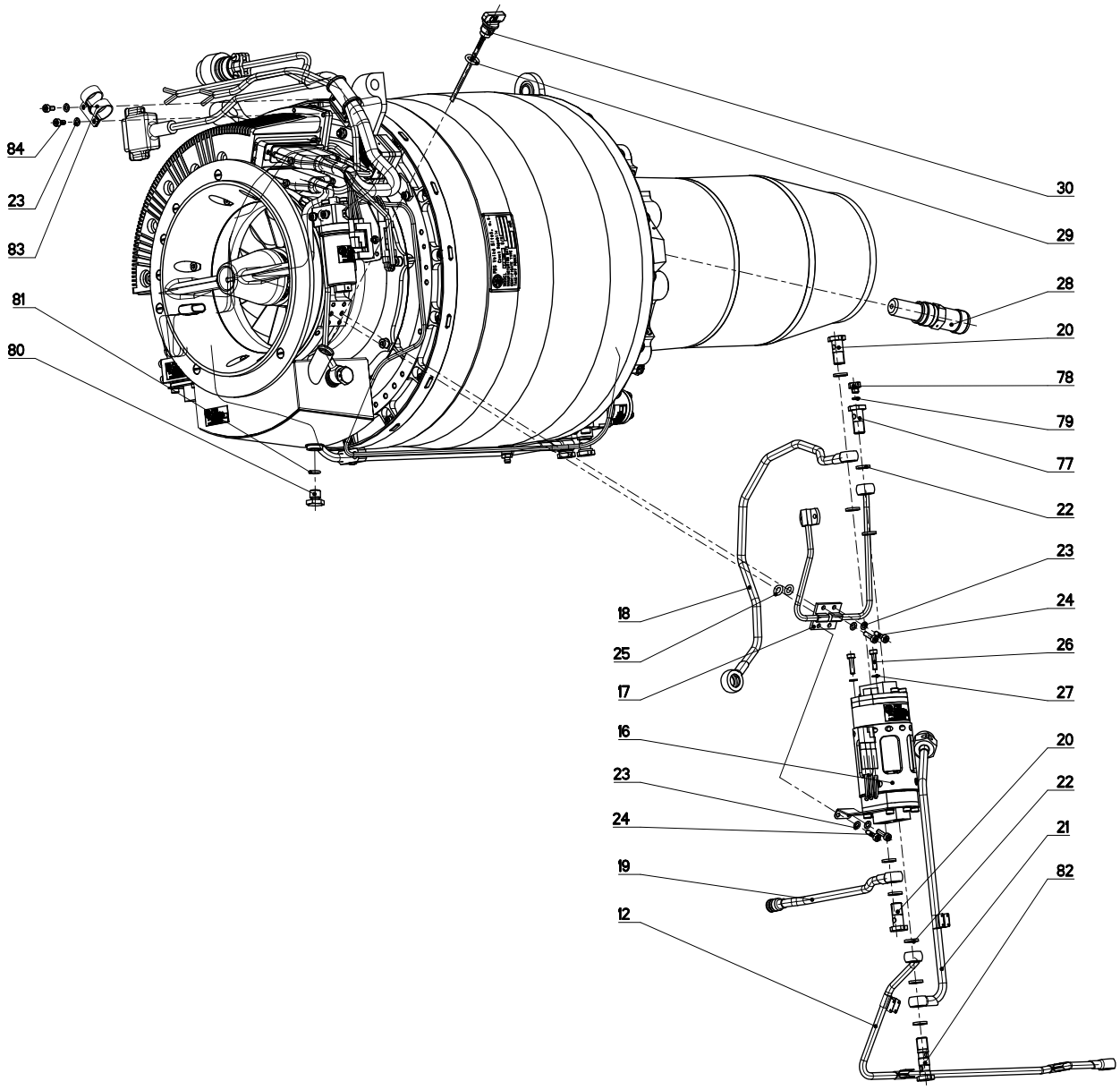


Figure 7-1/3 Turbojet engine (page 2 of 5)

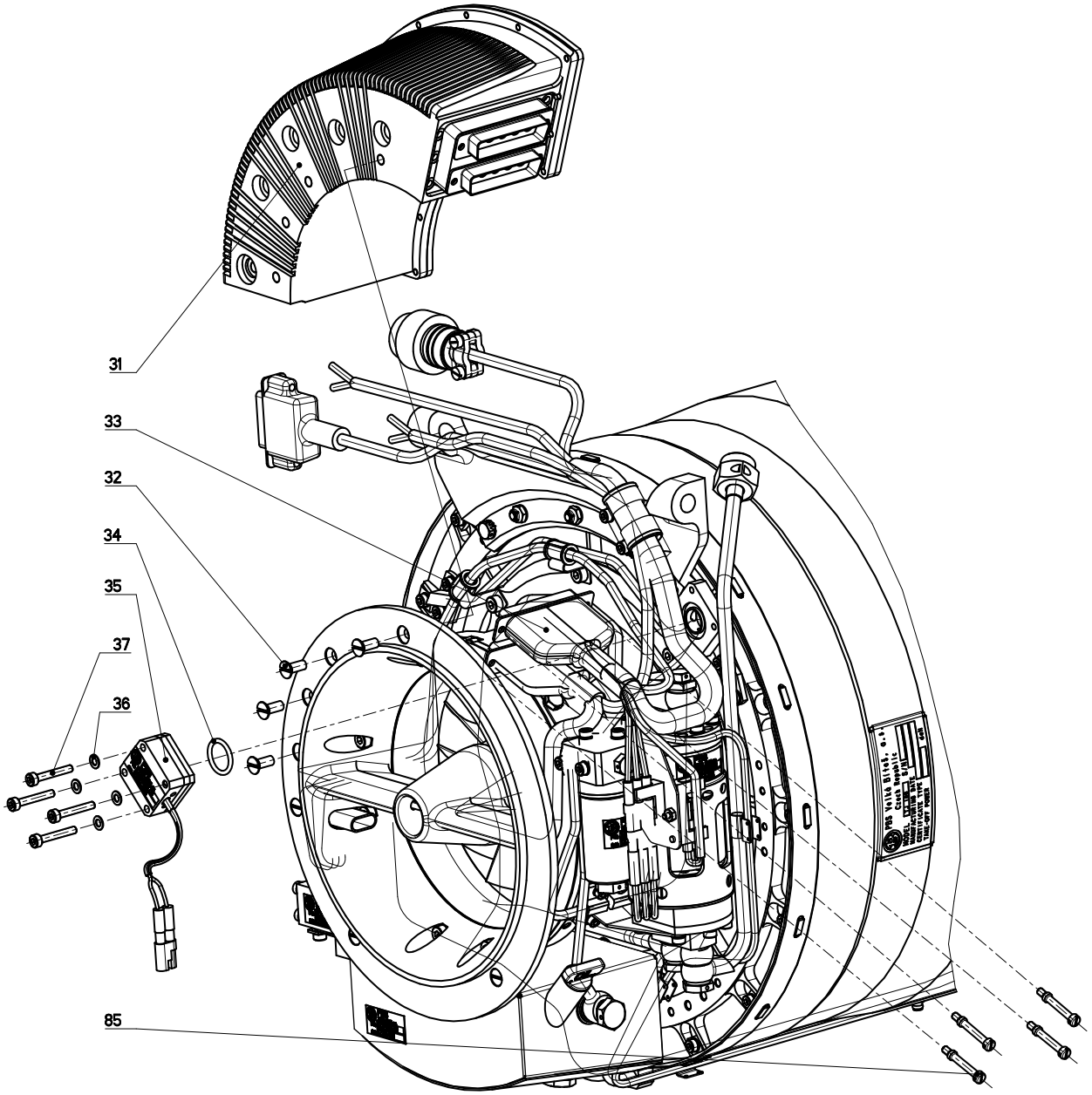


Figure 7-1/4 Turbojet engine (page 3 of 5)

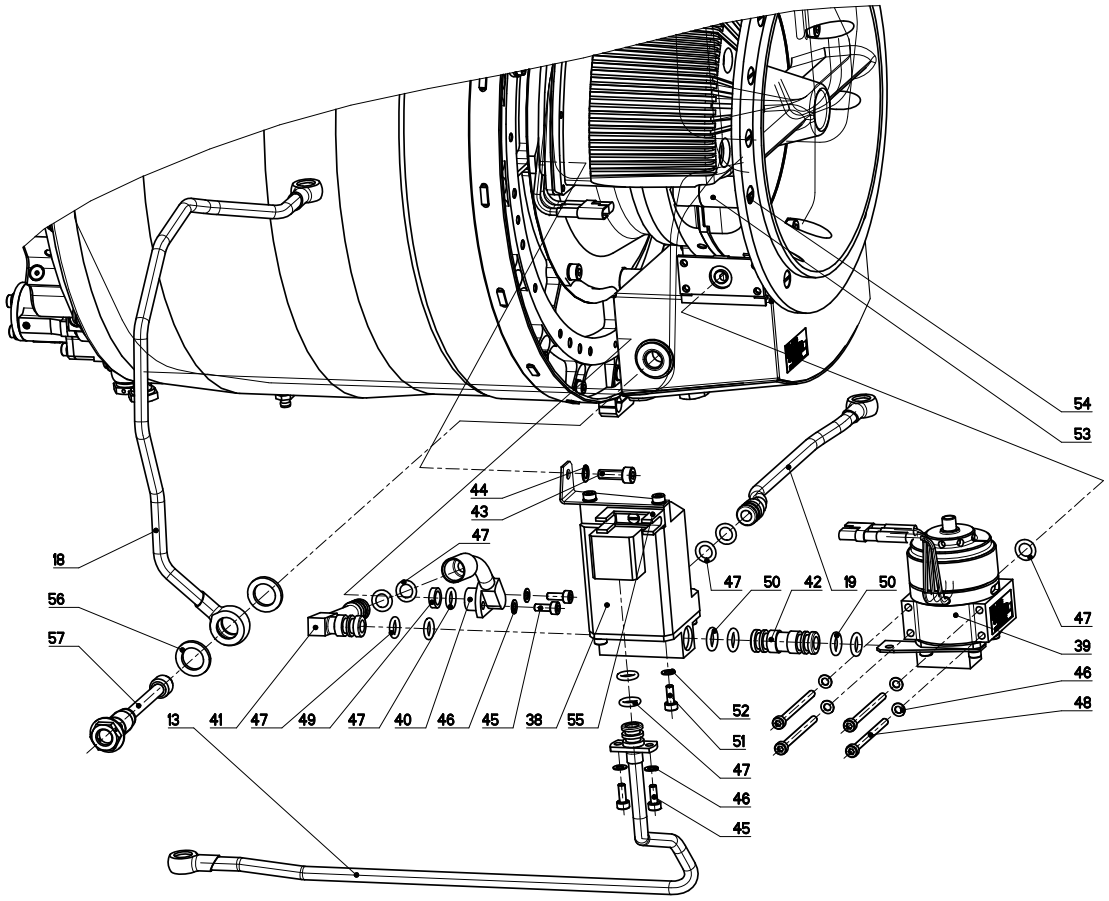


Figure 7-1/5 Turbojet engine (page 4 of 5)

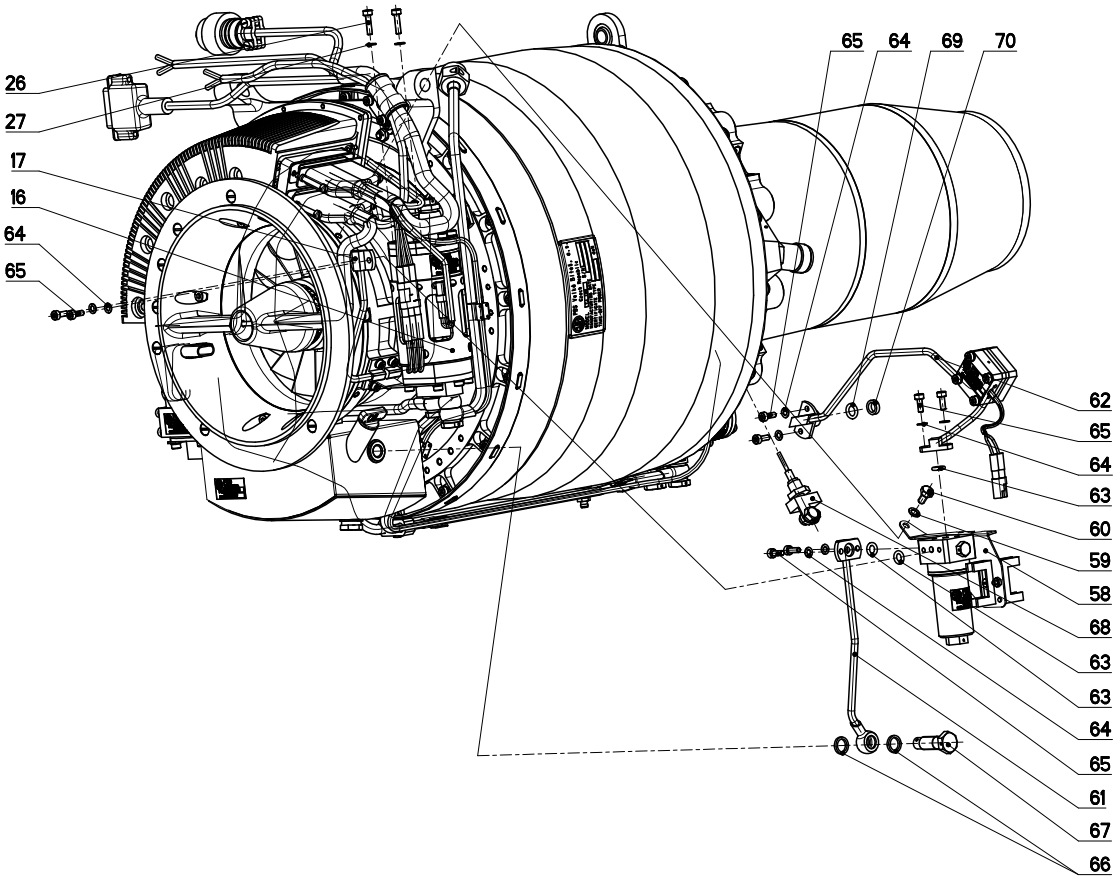


Figure 7-1/6 Turbojet engine

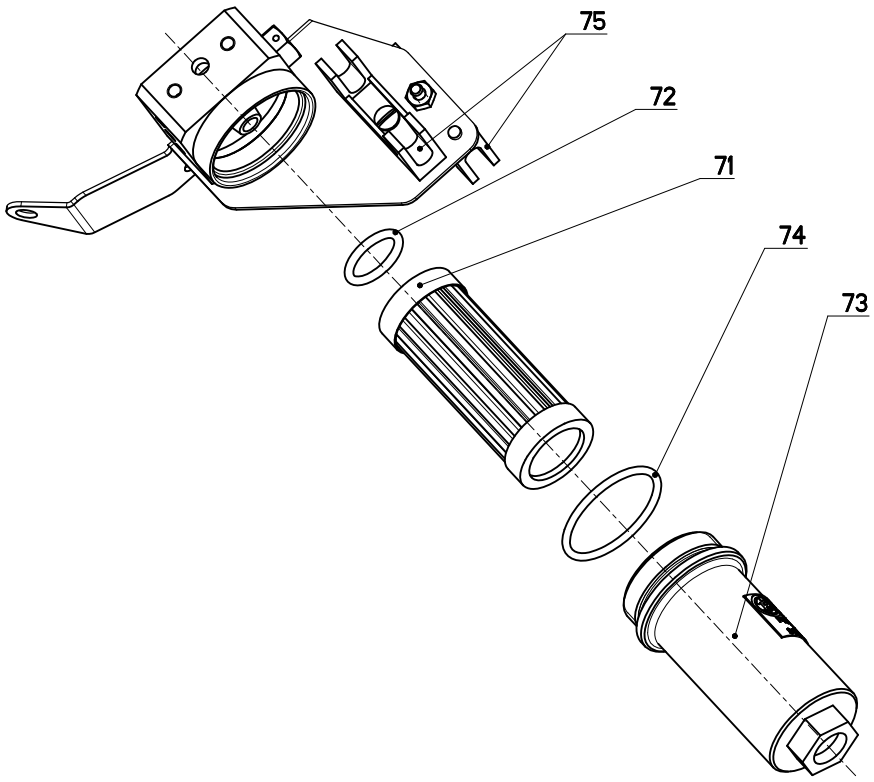


Figure 7-1/7 Turbojet engine (page 5 of 5)

Figure no., Ord. no., Sheet no.	Numeric identification	CAGE	1 2 3 4 5 6 7 description	UPA	UOC
1 -	470 102 09	2128G	Turbojet engine ……..…….	1	
2	450 088 12	2128G	. Flange cover 1…….	1	
3	100 083 40	2128G	. Plastic cap 102x2-4 ……	1	
5	81 068 56	2128G	. Plug M12x1 ….. …..…….….	1	
6	100 083 47	2128G	. Plug M18x1.. ……..……...	1	
86	470 181 01	2128G	. Inlet fairing ……..……..….	1	
87	470 181 02	2128G	. Outlet exhaust..…….....	1	
89	470 180 02	2128G	. Exhaust fairing foot …….....	1	
90	470 100 50	2128G	. Pin. …….…….....	9	
7	470 240 01	2128G	. . Bypass governor III ……..	1	
8	83 065 07	2128G	. . Ring 7.7x1.9 …….……	1	
9	81 065 20	2128G	. . Ring 5.7x1.9 ……...……....	1	
10	100 064 24	2128G	. . Washer 4 ……..…. ..	2	
11	100 054 08	2128G	. . Screw M4x35 ……	2	
12	470 320 01	2128G	. . Fuel piping Js4 …….	1	
13	470 330 01	2128G	. . Fuel piping Js4 …….	1	
14	100 065 88	2128G	. . . Sealing I 812 SF ……..….	4	
15	470 240 24	2128G	. . . Branch M8x 0.75 …..…….	2	
16	470 210 02	2128G	. Fuel oil pump …….…….	1	
17	470 290 01	2128G	. Pump cooler piping …….	1	
18	470 280 01	2128G	. Pump tank piping ……...…	1	
19	470 390 01	2128G	. Pump exchanger piping ……..	1	
20	470 210 24	2128G	. . Branch M8x 0.75……...	3	
21	470 420 01	2128G	. . Inlet piping …….	1	
22	100 065 88	2128G	. . Sealing I 812 SF …….…….	9	
23	100 064 06	2128G	. Washer 3 …..……	6	
24	100 054 03	2128G	. Screw M3x10 ……	4	
25	81 065 97	2128G	. Ring 4.47x1.78 ……...	2	
26	100 054 14	2128G	. . Screw M3x12 …….…….….	2	
27	100 064 20	2128G	. . Washer 3 ……..…….	2	
28	85 500 11	2128G	. Spark plug ……..…	1	
29	83 065 07	2128G	. Ring 7.7x1.9 ..……	1	
30	470 253 01	2128G	. TJ plug ……..……..…...	1	
31	470 160 01	2128G	. Control unit ..…….	1	
32	100 051 15	2128G	. Screw M4x10 …….	4	
33	470 400 01	2128G	. Cable harness …..……	1	
34	450 065 16	2128G	. Ring 12.42x1.78 ……	1	
35	470 340 01	2128G	. Pressure switch……...	1	
36	100 064 06	2128G	. Washer 3 ……...….	4	
37	100 054 16	2128G	. Screw M3x20 …….…….	4	
38	470 380 02	2128G	. Exchanger T ..…….……	1	
39	470 230 01	2128G	. Oil separator ..…….……	1	
40	470 360 01	2128G	. Outlet branch ……...	1	
41	470 360 03	2128G	. Spacer coupling T …….….	1	
42	470 100 49	2128G	. Coupling 10 T ..…….…….….	1	
43	100 054 09	2128G	. Screw M4x12 ..……	1	
44	100 064 24	2128G	. Washer 4 …..……	1	
45	100 054 10	2128G	. Screw M3x8 ……...	4	
46	100 064 06	2128G	. Washer 3 ……..…….	8	

47	450 065 12	2128G	. Ring 6.07x1.78 ..…….	10	
48	100 054 11	2128G	. Screw M3x40 ….……	4	
49	470 100 11	2128G	. Spacer ring …….	1	
50	100 065 32	2128G	. Ring 6.5x2..…….….....	4	
51	100 054 10	2128G	. . Screw M3x8 ..……..…….	1	
52	100 064 06	2128G	. . Washer 3 ……..…….	1	
53	470 370 01	2128G	. Suction ……...……	1	
54	100 051 15	2128G	. Screw M4x10 ….……	1	
55	100 082 04	2128G	. . Mounting clip 637-520. …....	1	
56	100 065 89	2128G	. . Sealing I DNG SF …..…….	2	
57	470 252 01	2128G	. . Swinging suction…….……	1	
58	470 220 01	2128G	. Oil filter …..…..……..……	1	
59	100 064 24	2128G	. Washer 4 ……..……..……	1	
60	81 052 41	2128G	. Screw M4x8 ……...	1	
61	470 310 01	2128G	. Filter - tank piping …….	1	
62	470 350 01	2128G	. Filter - switch -bearing piping .	1	
63	100 065 97	2128G	. Ring 4.76x1.78 ……	3	
64	100 064 06	2128G	. Washer 3 …..……	8	
65	100 054 10	2128G	. Screw M3x8 ……...	8	
66	100 065 88	2128G	. . Sealing I 812 SF ….…….	2	
67	470 260 01	2128G	. . Safety valve…..…….	1	
68	84 185 01	2128G	. Exhaust gas temp. transmitter..	1	
69	450 065 12	2128G	. Ring 6.07x1.78 ..…….….	1	
70	470 100 11	2128G	. Spacer ring …..…….….....	1	
71	470 221 01	2128G	. . Filter 40 ...……..……..…….	1	
72	450 065 42	2128G	. . Sealing ring …..……..….	1	
73	470 220 12	2128G	. . Filter cover…...……	1	
74	100 065 67	2128G	. . Ring 21x1.5 ……..….	1	
75	100 082 04	2128G	. . Mounting clip 637-520. …....	1	
76	470 220 16	2128G	. . Split lock washer……..	1	
77	470 210 43	2128G	. . Filling branch……	1	
78	470 220 17	2128G	. . Plug M5…….……	1	
79	100 025 06	2128G	. . Ring 4x1……	1	
80	470 250 14	2128G	. Plug M8x0,75 …….……	1	
81	85 065 04	2128G	. Ring 5,7x1,4 …….……..	1	
82	470 100 46	2128G	. . Screw M8x0,75 ..…..…..……	1	
83	470 100 39	2128G	. . Cable clip …….……	1	
84	100 054 05	2128G	. . Screw M3x6 …….……	1	
85	470 100 41	2128G	. . Connectors Screw …….	4	

- Item not shown
= Alternative part
NP Nonprocurable as a spare part