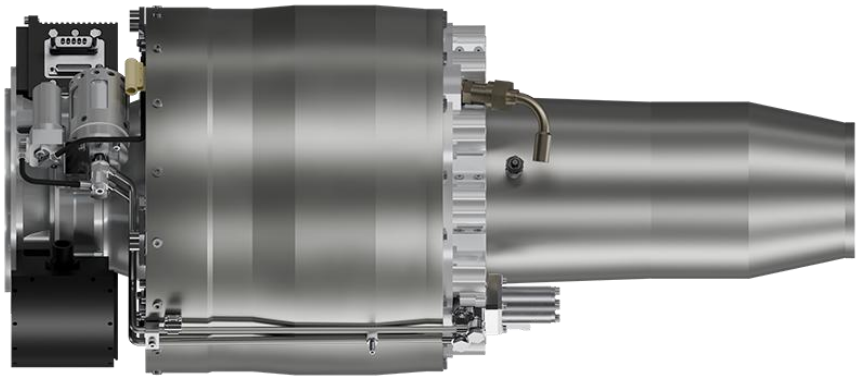
BPS-TJ100AERO TURBOJET ENGINE

TECHNICAL USE AND MAINTENANCE MANUAL



SHANDONG EARTH SHIELD DEFENSE TECHNOLOGY CO., LTD

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1. Scope

This document primarily describes the use and maintenance of the BPS-TJ100turbojet engine (hereinafter referred to as the "engine").

2. Reference Standards

GJB241A-2010 General Specification for Aero Turboprop and Turbofan Engines

GJB 5100-2002 General Specification for Turbojet and Turbofan Engines for Unmanned Aerial Vehicles

GJB 3186-1999 General Technical Requirements for Aircraft Engine Piping Systems

GJB 4053-2000 General Specification for Aircraft Engine Digital Electronic Control Systems

GJB 243A-2004 Flight Test Requirements for Aircraft Gas Turbine Powerplants

GJB 269A-2000 General Specification for Aircraft Rolling Bearings

GB/T 4240-1993 Stainless Steel Wires

GB 6537-2006 No. 3 Jet Fuel

GJB 1263-1991 Synthetic Lubricating Oils for Aircraft Turbine Engines

HB 0-2-2002 Anti-Loosening Methods for Threaded and Pin Connections

3. Engine System Composition

The composition of the engine system is shown in Table 1.

Table1 Engine System Composition

No.	Name	Quantity per Set	Remarks
	Engine Body	1 unit	
	ECU	1 set	24~28VDC Power Supply
	Igniter Assembly	1 piece	Installed on the engine body and tested OK
	Electric Fuel Pump	1 piece	
	Starter-Generator	1 set	
	Fuel Quick-Disconnect Coupling	1 piece	Optional

4. Engine System Basic Dimensions

The basic dimensions of the BPS-TJ100engine system are shown in Table 2, and the corresponding outline dimensions of the engine body are shown in Figure 1.

Table2 BPS-TJ100Engine System Basic Dimensions

Name	Dimension	Remarks
Engine Casing Diameter	φ272mm±0.5mm	
Engine Length	625mm±2mm	
Engine Mass	≤20kg	
Engine Mass (excluding battery and communication converter module) weighing record;		

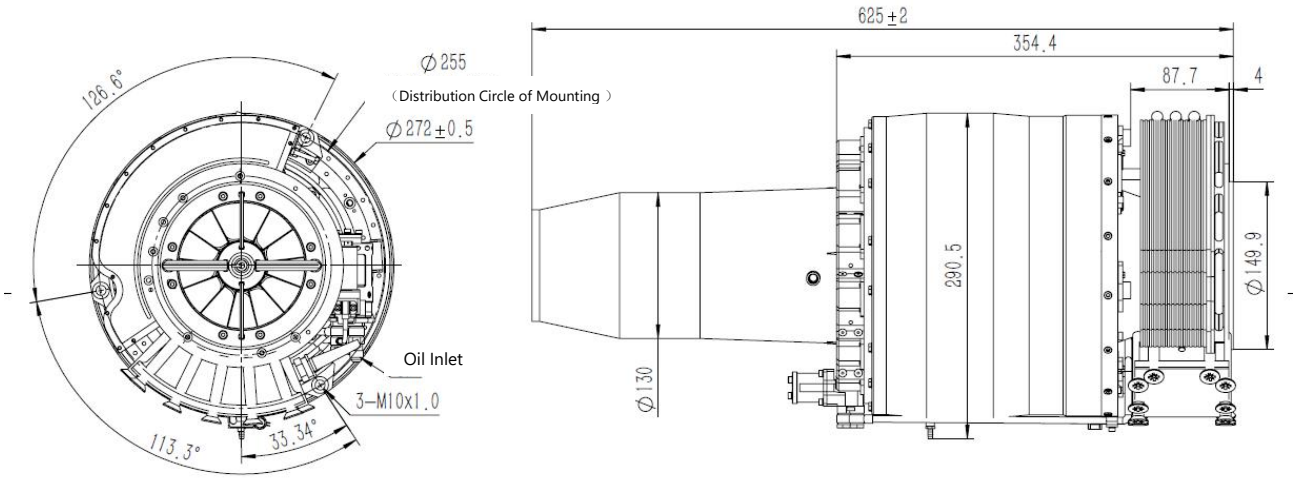


Figure1 Engine Outline Dimension Diagram

5. Engine Performance

Atmospheric Pressure 101.325kPa, Atmospheric Temperature 15℃, Altitude 0 meters:

Supertransient Thrust (Emergency)	1200N
Rated Thrust	1100N

Ground Idle Thrust	<160N
Thrust-to-Weight Ratio	6.1
Maximum Inlet Mass Flow Rate	Approximately 1.8 kg/s
Idle Rotational Speed	32000 r/min
Maximum Exhaust Gas Temperature (EGT)	<830℃
Specific Fuel Consumption (SFC)	1.2 kg/(daN·h)

6. General Safety Requirements for Use

Read this document carefully before using the engine to understand the safety precautions and usage requirements.

6.1 Test Environment

Perform a sufficient number of starting tests in a clean space and under good external engine conditions until the engine can start and run normally. If the test environment is poor, with airborne objects, etc., a filter screen or other dust/sand/stone prevention measures must be installed in front of the aircraft intake to prevent foreign objects from entering the engine and damaging rotating components such as the centrifugal impeller.

6.2 Hazard Area

Under no circumstances should the engine be started if any personnel are within the hazard area shown in Figure 2.

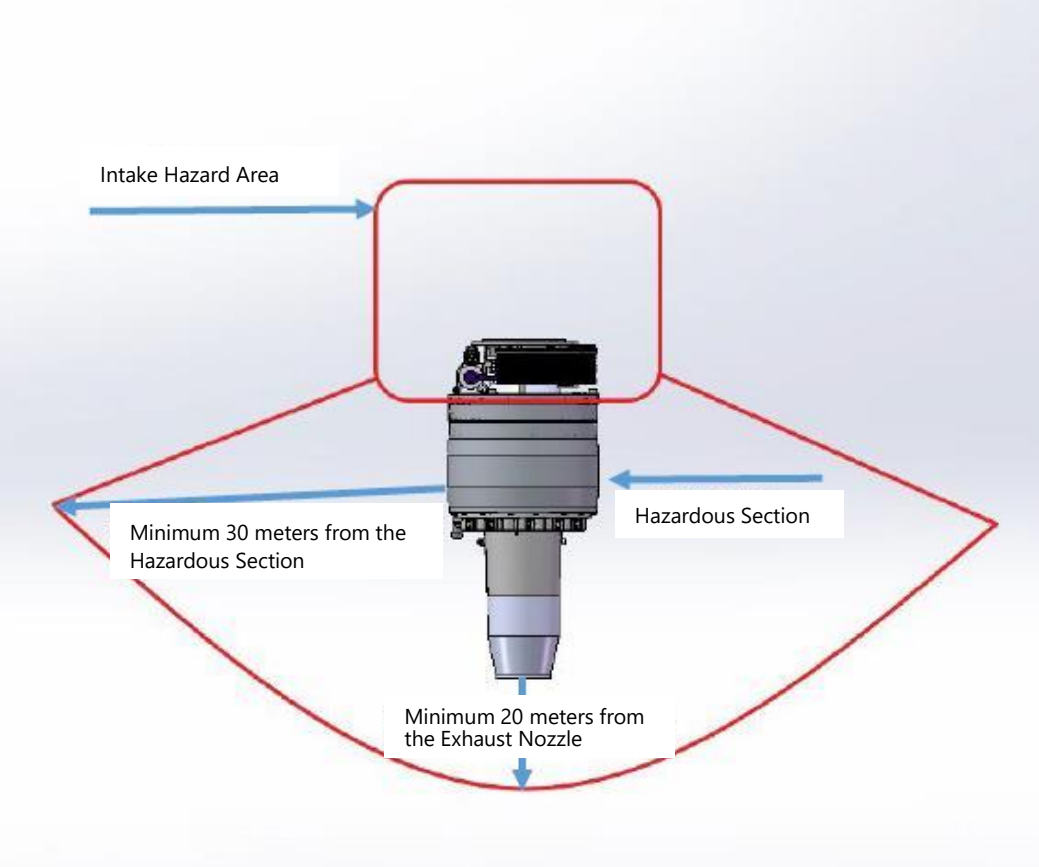


Figure2 Engine Minimum Hazard Area

6.3 Fire Extinguisher and Usage Requirements

Use a carbon dioxide (CO2) fire extinguisher. Ensure the fire extinguisher is operational and placed within easy reach. Extinguish fires after the engine has stopped. Do not extinguish fires from the intake.

6.4 Noise

Turbojet engines primarily produce high-frequency noise. Prolonged exposure to this noise may damage the operator's hearing. Therefore, always wear hearing protection when operating the engine.

7. Installation Requirements

7.1 Pre-Installation Check

The engine system should be inspected before installation. Installation may proceed only after confirming the engine system meets the following requirements.

a) The model, quantity, and serial numbers of the engine and accessories match the packing list.

b) The engine appearance is in good condition, with no dents or impact marks. The centrifugal impeller and turbine show no visible damage, cracks, or other surface defects. The tail nozzle shows no significant deformation. The engine rotor rotates smoothly, without abnormal noise, sticking, or obstruction.

c) Accessories are complete and in good appearance, with no surface rust, impact marks, or mechanical damage; cables have no breaks, insulation damage, or connector damage.

d) Fuel lines are clear and clean, with no compression, kinks, or scratches on the inner or outer walls.

e) Plastic plugs on the engine's oil and air interfaces should not be missing; remove only when connecting pipes. White caps on electrical connectors should not be missing; remove only when connecting.

7.2 Installation Dimensions and Interfaces

7.2.1 Engine Body Installation Interface

The engine body installation interface is shown in Figure 3. The engine intake end uses 3 threaded ports to connect with the flight platform.

Body Mounting Interface

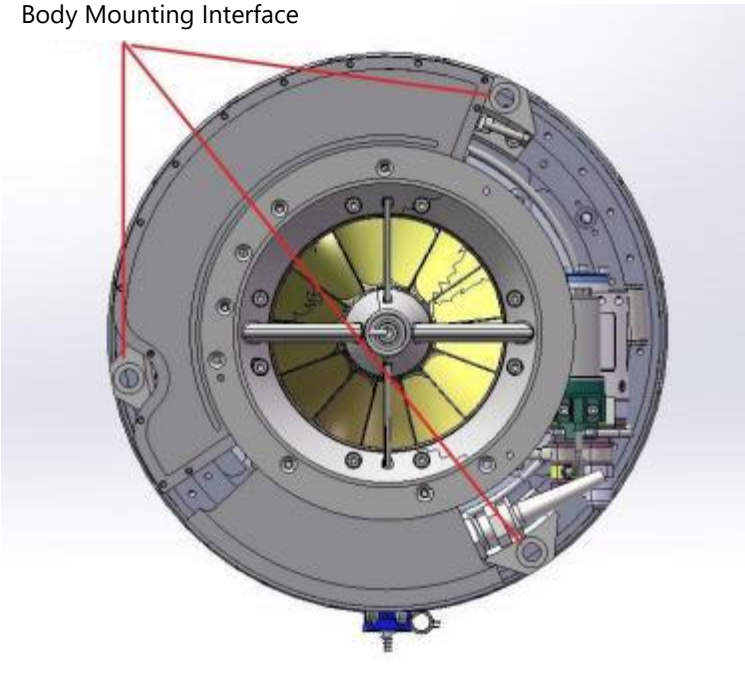


Figure3 Engine Body Interface Diagra

7.2.2 ECU Outline Dimensions and Interface

The ECU outline dimensions and interface are shown in Figure 4. Connect according to the physical interface labels during use. The 5-pin interface is the power interface, and the other interface is the communication interface.

Figure4 ECU Interface Diagram

7.3 Electrical Interfaces

7.3.1 ECU Operating Requirements

Operating Voltage: 24VDC ~ 28VDC; Note: Starting voltage not less than 24VDC

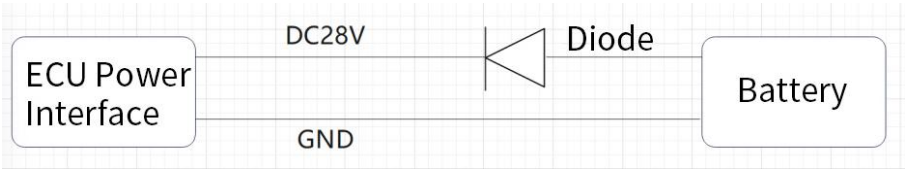
Operating Temperature: -40℃ ~ +60℃;

Steady-State Operating Current: Not greater than 10A;

Inrush Current: Not greater than 40A.

! Important Note:

The engine ECU power supply port 24-28VDC and the regulated output 28V share the same hardware interface. The regulated output interface does not have current limiting protection. When using a battery as the starting power source, the ECU power interface MUST NOT be directly connected to the battery (otherwise, it poses a system safety hazard). A unidirectional output diode (rated current ≮40A) must be added at the battery end, with adequate heat dissipation. This is not required when using an AC/DC power supply for the ECU.



7.3.2 Engine Interface Specifications

1) Fuel Pump Interface: Can be connected via fuel quick-disconnect coupling, as shown in the red box in the figure below.

2) Power Interface: ECU Power Interface JP2:

Figure 5 ECU Power Interface JP2

JP2 Definition		
Connector Pin Number	Symbol	Signal Definition
A	DC+	Ground Power Supply Voltage 24-28V and Regulated Output 28V
B	DC-	Ground Power Supply GND and Regulated Output GND

3) ECU Communication Interface: Input via 9-pin aviation connector, as shown below:

Figure 6 ECU Communication Interface

Aviation Connector Interface Definition		
Aviation Connector Pin Number	Signal	Remarks
1	CAN_H	
2	CAN_L	
3	CAN Shield	
4	Fuel Pump Emergency Stop Control Signal	Pins 4 and 5 shorted for emergency stop; open for normal start.
5	Emergency Stop Signal GND	
6-9	/	Reserved Backup

7.4 Communication and Control Commands

1) The Flight Control Computer (FCC) communicates with the turbojet engine controller via the CAN2.0 bus: the FCC sends control commands to the engine; the engine replies and periodically sends messages to the FCC.
2) CAN Bus Baud Rate: 78850 bps; Communication cable length not more than 10 meters.

7.4.1 Commands Sent from FCC to ECU

During ground testing, the FCC needs to read the corresponding registers of the Engine Control Unit (ECU). Reading data from the ECU is implemented via a "Request-Reply" method. The FCC can identify the type of reply information based on the CAN ID and "Message Code" of the reply data frame.

7.4.1.1 Data Format

1) Cold Cranking Data Format as shown in the table:

Engine Cold Cranking Write Request Data Frame (Numbers in table are Hexadecimal) Note: Cold cranking stop uses the same protocol.

Table1 Engine Cold Cranking Data Format

CAN Header			CAN Message							
Byte0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10
CAN ID		Length	Node ID	Data Type	Service Code	Message Code	Data			
07	D0	08	10	0A	67	3F	01			

Table2 Cold Cranking Reply Data Format

CAN Header			CAN Message							
Byte0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10
CAN ID		Length	Node ID	Data Type	Service Code	Message Code	Data			
07	D1	08	10	00	67	3F	00			

2) 0.3 Mach Ignition Start

Data format as shown in the table below:

Engine 0.3 Mach Ignition Start Write Request Data Frame (Numbers in table are Hexadecimal)

Table3 0.3 Mach Ignition Data Format

CAN Header			CAN Message							
Byte0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10
CAN ID		Length	Node ID	Data Type	Service Code	Message Code	Data			
07	D0	05	10	0A	67	40	01			

Table4 0.3 Mach Ignition Reply Data Format

CAN Header			CAN Message							
Byte0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10
CAN ID		Length	Node ID	Data Type	Service Code	Message Code	Data			
07	D1	08	10	00	67	40	00			

3) **Start**

The FCC sends the data frame shown in the table below to the ECU via the CAN bus.

Engine Start Write Request Data Frame (Numbers in table are Hexadecimal)

Table5 Start Data Format

CAN Header			CAN Message							
Byte0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10
CAN ID		Length	Node ID	Data Type	Service Code	Message Code	Data			
07	D0	08	10	0A	67	3C	01			

Table6 Start Reply Data Format

CAN Header			CAN Message							
Byte0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10
CAN ID		Length	Node ID	Data Type	Service Code	Message Code	Data			
07	D1	08	10	00	67	3C	00			

4) **Stop**

When stopping the engine, the FCC must write the data in the table below to the ECU's register. Engine Stop / Ground Operation Stop Write Request Data Frame (Numbers in table are Hexadecimal)

Note: Before engine stop, it is best to set thrust to 17%, approximately idle speed, then stop.

Table7 Stop Data Format

CAN Header			CAN Message							
Byte0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10
CAN ID		Length	Node ID	Data Type	Service Code	Message Code	Data			
07	D0	08	10	0A	67	3D	01			

Table8 Stop Reply Data Format

CAN Header			CAN Message							
Byte0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10
CAN ID		Length	Node ID	Data Type	Service Code	Message Code	Data			
07	D1	08	10	00	67	3D	00			

5) **Engine Thrust Setting Command**

The engine thrust setting command is shown in the table below.

Engine Thrust Setting Command (Numbers in table are Hexadecimal)

Table9 Thrust Setting Command

CAN Header			CAN Message							
Byte0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10
CAN ID		Length	Node ID	Data Type	Service Code	Message Code	Data			
07	D0	08	10	02	67	64	Ab	cd	ef	gh

The data contains 4 bytes (ab cd ef gh), representing a 32-bit floating-point number *x* (following IEEE-745-1985, 1 sign bit, 23 mantissa bits, 8 exponent bits). This number ranges from 0 to 100, representing the percentage of full thrust setting.

$x = espc \times 100(\%)$

Example: Set engine thrust to 50% (42480000 HEX)

Table10 Reply Command

CAN Header			CAN Message							
Byte0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10
CAN ID		Length	Node ID	Data Type	Service Code	Message Code	Data			
07	D1	08	10	00	67	64	00	00	00	00

6) Engine Fuel Pump Check Setting Command

Table11 Fuel Pump Check Data Format

CAN Header			CAN Message							
Byte0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10
CAN ID		Length	Node ID	Data Type	Service Code	Message Code	Data			
07	C0	08	64	04	00	22	00			

Table12 Fuel Pump Check Reply Data Format

CAN Header			CAN Message							
Byte0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10
CAN ID		Length	Node ID	Data Type	Service Code	Message Code	Data			
07	C1	08	64	04	00	22	00			

Table13 Fuel Pump Stop Data Format

CAN Header			CAN Message							
Byte0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10
CAN ID		Length	Node ID	Data Type	Service Code	Message Code	Data			
07	C0	08	64	04	00	21	00			

Table14 Fuel Pump Stop Reply Data Format

CAN Header			CAN Message							
Byte0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10
CAN ID		Length	Node ID	Data Type	Service Code	Message Code	Data			
07	C1	08	64	04	00	21	00			

7.4.2 Commands Sent from ECU to FCC

7.4.2.1 Frame Format

Data format table is as follows:

The engine sends the message types in the table below to the CAN bus at a fixed frequency of 1.7Hz. Information cyclically sent by the engine (Numbers in table are Decimal)

Table15 ECU Return Data Format

No.	Message	CAN_ID	Transmission Frequency	Unit	Data Type (and Its Code)	Length
1	Inlet Air Temperature	200	1.4Hz	℃	AS_SHORT (06)	06
2	Exhaust Gas Temperature	201	1.4Hz	℃	AS_SHORT (06)	06
3	Engine Speed	203	1.4Hz	rpm	AS_ULONG (04)	08

Data type explanations:

1) AS_SHORT ------ 2's complement short integer, 16 bits;
2) AS_ULONG ------ Unsigned long integer, 32 bits;
3) AS_USHORT ------ Unsigned short integer, 16 bits;

7.5 Installation

Live working is prohibited during the installation of the engine system. Disconnect the power supply when connecting cables. This engine is ready for use after connecting the two electrical interfaces (communication and power) and one fuel interface.

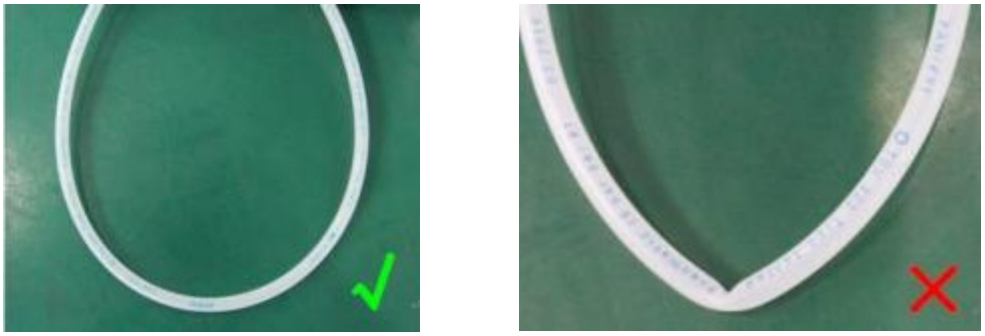
7.5.1 Fuel Line Installation

a) Connect the fuel tank directly to the fuel inlet for fuel line installation.

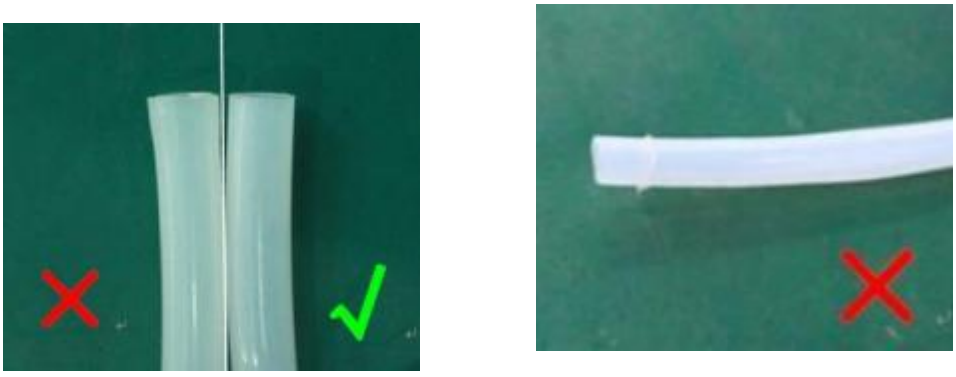
b) Fuel lines should be routed below cables whenever possible to prevent fuel droplets from falling onto cables during fuel line installation/removal.

c) Determine the length and cut the fuel lines according to the actual installation position of the accessories to prevent stretching or squeezing of the fuel lines. Use dedicated tube cutting tools or a utility knife to cut the fuel lines. The cut should be clean (perpendicular to the tube wall). Do not kink the fuel line during installation. Fuel line connector positions are strictly prohibited from secondary use. If disassembled and reinstalled, replace with a new tube or cut off the fuel line connector. See the figure below for details.

(a) Fuel Line Cut Schematic



(b) Fuel Line Bending Schematic



(c) Fuel Line Secondary Use Schematic

Figure5 Fuel Line Correct Cutting and Usage Diagram

d) Fuel lines with a single length exceeding 100mm should be secured. When securing, do not excessively squeeze the fuel line, do not cause significant scratches on the fuel line surface; and do not cause leaks at the fuel line and connector junction.

e) Before connecting the fuel line to the engine fuel inlet, purge the air from the fuel line. Only after visually confirming no air bubbles in the fuel line and ensuring no leaks at the fuel line connections, connect the fuel line to the engine fuel inlet.

7.5.2 Cable Installation

a) The ECU is already connected and securely fixed at the factory.

b) Electrical connection is completed by connecting the communication interface and the power interface.

7.5.3 Engine Body Installation

a) Before engine installation, remove the protective plugs (or red cloth bags) from the intake casing and tail nozzle. Shake the engine body to confirm there are no foreign objects inside before proceeding with installation. Take anti-FOD measures during installation; if any foreign objects enter the engine, clean them promptly;

b) Do not cause damage to the engine during the installation process;

c) Anti-loosening measures should be applied to bolts, nuts, and other fasteners according to the forms shown in HB 0-2-2002.

7.6 Post-Installation Confirmation

The installation sequence of the engine, accessories, and pipelines should be determined based on the actual situation. After the engine system installation is completed, an inspection and confirmation should be performed, and the following requirements should be met.

a) The engine system appearance is in good condition, with no obvious impact marks or surface defects and appearance damage that affect engine performance;

b) All parts, components, assemblies, and accessories are correctly installed, with no missing, incorrectly installed, or extra installations;

c) Cable connectors have good contact; pipelines are clear, and connector seals are good; no missed connections or wrong connections;

d) Fastener anti-loosening measures are in place; lock wire is tightly wound and not twisted;

e) No foreign objects such as wire ends, lock wire, etc., are present on or around the engine;

f) The quantity of spares, accessories, consumables, and tools is correct, with no missing items;

g) Perform a fuel flow test, observe if the flow direction in the fuel inlet line is correct and if the connection position is normal.

8 Engine Usage Requirements

8.1 Operating Conditions and Range

The engine operating conditions and range are detailed in Table 10.

Table3 Engine Operating Conditions and Range

Operating Envelope	Operating Altitude	0-8000m
	Mach Number	0Ma～0.8Ma
Start Envelope	Altitude	0-4000m
	Mach Number	0-0.3Ma
Operating Range	Operating Temperature Range	-40℃～+60℃
	Relative Humidity	≤95%±3%
	Roll Angle Range	-35°～35°
	Pitch Angle Range	-30°～30°
	Compressor Operating Speed Range	30000r/min～60000r/min
	Ambient Temperature Range for Ground Ignition Start	-20℃～+50℃

8.2 Permitted Fuels and Oils

8.2.1 Fuel

The engine uses a mixture of No. 3 jet fuel (GB6537-2006) and No. 4106 synthetic lubricating oil for aircraft turbine engines (GJB 1263-1991) (or Mobil 1 oil). The volume ratio of jet fuel to lubricating oil is 20:1.

Note: Supports non-standard grades of kerosene fuel and lubricating oil. Different grades of lubricating oil cannot be mixed.

8.2.2 Lubricating Oil

The gas generator bearings of the engine are lubricated using the mixture described in section 8.2.1.

8.3.1 Fuel System

The internal fuel lines of this engine have been installed and tested OK. During use, only need to connect the fuel inlet to the mixed fuel tank.

8.3.2 Fuel Tank Requirements

The fuel and oil are in one tank. The engine is supplied with fuel from this tank. A rigid tank (temperature resistant to 100℃) is recommended. The fuel outlet pressure must be between -20KPa and 50KPa to ensure normal engine operation.

8.3.3 Fuel/Oil Usage Instructions

a) The fuel/lubricating oil filled must comply with the provisions of section 8.2.1;

b) The oil must be clean (it is recommended to prepare the fuel fresh for each use) and must be filled through a fuel filter;

c) Cut off the power supply when refueling; refueling is strictly prohibited while the engine is running;

Note: Before refueling, ensure the fuel tank is clean, free of particles, plastic, and other solid foreign objects. The pump has strong suction capability and can clog fuel valves, engine nozzles, etc., affecting the normal operation of the engine system.

8.4 Engine Ground Starting

8.4.1 Individual Checks

8.4.1.1 Igniter Check

Perform an igniter check as needed. The check method is: Turn on the igniter via the ground control station (or host computer), without supplying fuel, for 3s~5s. Touch the casing around the igniter (be careful of burns). If the temperature increases, the igniter is normal.

8.4.1.3 Fuel Pump

Connect the fuel line (not connected to the engine), turn on the fuel pump via the ground control station (or host computer) (fuel pump runs at low speed), and bleed air from the fuel line until no bubbles are present in the line. After the check, connect the fuel line to the engine fuel inlet.

8.4.1.4 Speed Sensor, Temperature Sensor Check

If the speed and temperature displays on the ground control station (or host computer) are normal and reasonable, it indicates the speed sensor and temperature sensor are working normally.

8.4.1.5 Safety Check

After individual checks of the engine accessories, confirm there are no cables or other foreign objects at the engine intake, and no flammable or explosive materials near the engine. Have safety fire-fighting equipment ready.

During field testing, no personnel or other equipment are allowed within the engine minimum hazard area (see Figure 2); participants should wear ear muffs or other protective devices as the engine testing process generates high-frequency noise.

8.4.2 Starting

After the ground control station (or host computer) issues a "Start" command to the engine ECU, the ECU automatically controls the engine start sequence; no manual operation is required. The starting process is completed when the engine speed stabilizes at idle (speed 32000r/min).

Note: If the engine fails to ignite on the first attempt, the engine body must be cold cranked before starting again. If the exhaust gas temperature during the previous start was above 60℃, cold crank until it is below 60℃ before starting again; if the exhaust gas temperature during the previous start was below 60℃, cold crank for 30s before starting again to remove excess fuel and prevent overtemperature during the next start.

8.4.3 Test Run

After the engine starts successfully, issue speed commands to the engine ECU via the ground control station (or host computer) for the test run. After the test run, send a "Stop" command to the ECU to complete the test run, and the engine stops operating.

8.4.3.1 Test Run Limitations

a) The maximum engine operating speed shall not exceed 60000r/min.

b) The exhaust gas temperature during stable operation at various power settings shall not exceed 800℃, and the instantaneous surge temperature during start shall be less than 830℃.

8.4.3.2 Test Run Precautions

Execute an emergency stop if any of the following situations occur during the test run:

a) Hot Start / Hung Start: Increasing fuel flow, the displayed speed cannot increase, temperature rises, accompanied by a long flame at the tailpipe outlet (similar to the flame during start);

b) The engine consistently produces abnormal sounds at different speeds, such as "whistling" or "screeching" sounds;

c) Continuous sparks appear at the engine tail nozzle;

d) Unexpected situations such as fire occur;

e) Other situations deemed by the on-site technical responsible person that may endanger engine safety.

Note: In case of urgent situations requiring immediate engine shutdown, initiate emergency stop.

8.4.4 Cooling

The engine needs cooling after shutdown:

a) During normal engine shutdown, the ECU will automatically control the starter motor to cool the engine until the exhaust gas temperature drops below 60℃;

b) During abnormal engine shutdown, after the engine stops, blow air into the engine through the intake for cooling until the engine exhaust gas temperature is below 60℃;

c) Avoid burns during the engine cooling process.

Note: After engine shutdown, under cold cranking conditions, a 15min interval is required before the next test run.

8.4.5 Test Run Fault Handling

a) If the test run is interrupted due to faults not related to the engine body, resume the test run only after the fault is eliminated. If the test run is interrupted due to engine body faults or emergency stops caused by test run limitations, stop the test run and resume only after the fault is eliminated;

b) Test run faults should be resolved by professional technical personnel;

c) Common potential engine faults and troubleshooting methods are listed in Appendix B.

8.5 In-Flight Operation

After the flight control system starts the engine on the ground to 32000r/min and stabilizes the speed for 2-4 minutes, the flight control system can then control the engine's corresponding operating state (i.e., set the engine thrust output percentage) to complete the flight mission.

8.6 Turnaround

a) Handle the engine and accessories with care during turnaround to avoid damaging external pipelines or accessories;

b) It is strictly forbidden to throw the engine or lift it by its head or tail structural parts. It is strictly forbidden to use sensors, cables, etc., to move the engine or for any other purpose.

8.7 Transportation

a)The engine system should be transported using a dedicated packaging case. The engine should be reliably positioned and secured within the case, and the case should be lined with shock-absorbing material to prevent damage during transportation. The packaging case must not be subjected to heavy pressure, inverted, or rolled. It must be securely fixed within the transport vehicle;

b)When the engine is packed with the aircraft, covers should be placed on the aircraft intake and plugs on the engine exhaust to prevent foreign object ingress;

c)The engine system can be transported by railway, air, road, or ship. During railway transport, shunting is not allowed. During ship transport, attention should be paid to mold prevention, salt spray prevention, and water immersion;

d)The transport vehicle must be waterproof. The engine system is prohibited from being transported together with chemicals such as kerosene, gasoline, acids, and alkalis.

8.8 Storage

a) The engine system should be stored in its packaging case;

b)For long-term storage, the warehouse should have facilities for rain prevention, moisture prevention, mold prevention, sand/dust prevention, static electricity prevention, explosion prevention, lightning protection, and protection against snakes and rodents. The environment should meet: temperature -40℃ ~ +55℃, relative humidity not more than 80%;

c) For temporary storage, the storage period generally should not exceed three months. The storage location must be protected from rain and moisture.

9 Service Life and Maintenance

9.1 Engine Service Life

The engine service life is approximately 30 hours or 200 starts or 3 years, whichever comes first.

9.2 Use and Maintenance Records

The user and maintenance unit should keep records of the engine system's use and maintenance. The use and maintenance records should include the following:

a)Engine test run records, including test speed, test duration, cumulative operating time, and whether it was normal;

b) Engine faults and repair status;

c) Replacement status of accessories and ground equipment.

9.3 Replacement of Accessories

During engine operation, if an engine accessory fails and cannot be repaired, it must be replaced. If the engine is installed on the aircraft and the accessory cannot be replaced on the aircraft, the engine must be removed from the aircraft for the replacement operation.

Before replacing accessories, disconnect the engine system power supply. After replacement, re-perform installation and inspection according to the corresponding requirements in Section 6. When accessories or ground equipment are replaced, a replacement record should be made.

If the igniter, speed sensor, or temperature sensor need replacement, it must be performed by the engine manufacturer's professional technical personnel. The replacement operation should be carried out as follows:

a) After connecting the new igniter to the engine, connect it to the ECU. Turn on the igniter via the ground control station (or host computer). If popping pulse sounds are emitted from the igniter tip, it indicates normal operation. After installation, confirm the igniter and the corresponding start fuel line interface are properly installed.

b) The temperature sensor is correctly installed if inserted 2cm~4cm into the tailpipe and does not wobble.

9.4 Foreign Object Debris (FOD) Control

To ensure there are no foreign objects inside the engine and accessories, all engines and accessories must not be left open during turnaround, transportation, and storage. If protective caps on hoses, screw plugs, or front/rear covers (or cloth bags) are removed for work, they must be reinstated immediately after work completion. If engine blade damage occurs due to foreign objects, the engine must be returned to the factory for repair.

10 Use and Maintenance Tools

The tools required for the use and maintenance of the engine system are shown in Table 15.

Table4 Engine Use and Maintenance Tools

No.	Name	Specification	Quantity	Purpose
1	Open-End Wrench	6mm～16mm	1 Set	Tightening/loosening nuts and hex studs
2	Utility Knife	100mm	1 Piece	Cutting hoses
3	Hexagon Allen Wrench	1.5mm～10mm	1 Set	Tightening/loosening hexagon socket screws
4	Flat-Head Screwdriver	-	1 Piece	Tightening/loosening cable connectors

Note: The tools listed in Table 15 are provided by the user.

11 Safety requirements

a) Except for engine assembly, maintenance and other work needs, the engine air circuit, oil circuit and electrical interface shall not be left open;

b) During the transportation after installation, foam and other shock absorbing materials should be filled around the engine;

c) The engine shall be handled, transported, installed and checked carefully to prevent damage to the engine or bumps and injuries to personnel;

d) After engine start to slow down, it is forbidden to stand within the radius of 1m in front of the intake, within 30m on the side of the engine and within 20m behind the tailpipe;

e) During operation and test run, it is strictly prohibited for excess material to enter the engine;

f) Engine exhaust port is prohibited to test under wind conditions to prevent wake from burning the body;

g) The test site shall formulate corresponding safety guarantee plans and emergency plans, and be equipped with fire fighting equipment such as CO2 fire extinguishers.

Appendix A Possible engine faults and troubleshooting methods

order number	fault phenomenon	Possible causes	Method of exclusion
1	Engine ground start ignition failure, exhaust There was no significant rise in gas temperature.	1. The starting fuel supply is not normal. 1.1 There is air in the pipeline and it is not purged. 1.3 The oil pump does not work properly. 1.4 The throttle tube in the starting oil pipe assembly is blocked. 2. The igniter works abnormally. 2. 3. The temperature sensor works abnormally.	1.1 Remove air from the fuel system: Open the oil line joint in the starting oil circuit and Drain the oil outward until there are no bubbles in the oil. 1.3 Control the oil pump to supply oil through the host computer. After confirming that the oil pump supplies oil normally, continue to test the car. If it still cannot start normally, replace the oil pump; 1.4 If the throttle tube in the starting oil pipe assembly is confirmed to be blocked, replace the starting oil pipe assembly. 2. Check the voltage input of the igniter and troubleshoot according to the fault. If the igniter is faulty, replace the igniter.
2	When the engine is driven on the ground, the exhaust temperature rises to a certain extent and then drops after ignition. The engine fails	1. Abnormal main fuel supply: 1.1 There is air in the pipeline and it is not purged. 2. Engine fuel pipe assembly blockage.	1.1 Remove air from the fuel system: Open the oil pipe joint in the starting oil circuit and drain the oil out until there is no bubble in the discharged oil. 2. Return to the factory for

order number	fault phenomenon	Possible causes	Method of exclusion
	to ignite		maintenance.
3	The oil pump speed does not increase until the engine speed reaches 60,000 r/min	1. The oil filter is blocked for a long time without cleaning. 2. Oil leakage at a certain oil pipe interface in the pipeline. 3. The oil pump load increases due to the low position of the oil tank.	1. Clean the oil filter. 2. Check the oil circuit system, replace the oil leakage in time if there is any; if it cannot be repaired, return to the factory for repair. 3. Appropriately reduce the vertical height of the oil tank and minimize the height difference between the oil level of the tank and the engine.
4	During the test, the engine speed suddenly decreased and the oil pump speed increased	1. Too much impurity in the fuel blocks the oil filter.	1. Replace clean fuel oil. 2. Return to the factory for maintenance.
5	The flight control system can receive the ECU data, but the ECU does not respond to the flight control system instructions	1.ECU voltage is too low. 2. The ECU cable fault causes the flight control system command not to be received.	1. Use a digital multimeter to measure the ECU communication cable. If there is a fault, replace the cable.
6	Engine accessories are not implemented according to ECU instructions	Engine harness cable connection loose and detached.	Check whether the engine accessory cable is connected to the ECU cable correctly and securely.
7	Overtemperature overspeed		Self-levelling parking protection