



GLADIATOR G30

Horizontal Directional Drill

GLADIATOR HDD, LLC.

Operation and Safety Manual

G30 Operation Manual

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Warning

Unsafe use of this equipment may result in serious personal injury or even death. This manual contains important information about safe operation and recommended maintenance of the G30. All operators and ground personnel must read and understand this manual carefully before starting the machine. Experienced operators should always pay attention to the precautions in this manual. In addition, this manual can provide training assistance for new employees. If you need to replace the manual, please call GLADIATOR HDD, LLC.

Introduction

This manual covers the operating instructions of G30. Please read it carefully before using this product. Only after special training, familiarity and mastery of the performance, structure, use and maintenance methods of this drilling rig and supporting equipment can it be operated. If you have any questions about any function of this drilling rig, please contact the factory.

The information, specifications and recommended maintenance guidelines of this manual are valid according to the printing. “GLADIATOR HDD” reserves the right to modify this manual without further notice. If you find that your drilling rig is different from the information in this manual, please contact the factory.

Limited Warranty

This warranty is provided by “Gladiator HDD” and covers the equipment and products sold. “Gladiator HDD” warrants to the initial purchaser that the equipment will be free from defects in material and workmanship for 1 year from the date of shipment, or 2,000 hours of operation (2 years/3,000 hours for the engine, 5 years/10,000 hours for the rack and pinion), whichever comes first. Once the equipment is placed into service as a retail, rental or lease, a completed Warranty Registration Certificate must be submitted to “Gladiator HDD” to begin and confirm warranty coverage.

The Limited Warranty does not cover (1) batteries, light bulbs, fuses, various types of gaskets and packings, filter elements, engine oil lubricants, fluids, track chains, track drive sprockets, drill rods, auger sections, die racks, wrench consumables, guide bushings, shaft seals, mud rotary assemblies, valves, piston bushings, centrifugal pumps, shaker screens and other parts subject to normal wear or aging; (2) engines; (3) transmissions not manufactured by “Gladiator HDD”; and (4) downhole tools and accessories. “Gladiator HDD” extends to the initial purchaser any warranty (if any) provided by the manufacturer or supplier of any original parts.

Claims for defects in material and workmanship shall be made in writing by the initial purchaser to “Gladiator HDD” within ten days of discovery of the defect. “Gladiator HDD” reserves the right to dispatch a service representative, a contractually authorized representative, or to require that the equipment be returned to the factory for product inspection. Failure by the purchaser to allow the foregoing may result in the voiding of warranty coverage.

During the warranty period, Gladiator HDD may, at its option, repair or replace with new, free of charge, any part of the equipment that “Gladiator HDD” finds to be defective in material or workmanship. Replaced or repaired parts provided under the terms of this Agreement will be warranted in a similar manner for the remainder of the warranty period. Any parts replaced under

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the terms of the warranty become the property of “Gladiator HDD” and must be returned to “Gladiator HDD” upon written request, transportation prepaid.

In no event shall “Gladiator HDD” liability exceed the purchase price of the equipment. “Gladiator HDD” reserves the right to satisfy its warranty obligations by refunding the full purchase price to the purchaser upon return of the equipment, with the purchaser prepaying transportation costs to “Gladiator HDD”.

This warranty applies only if the defective equipment has been properly maintained and operated in accordance with Gladiator HDD regulations. This warranty does not apply if the alleged defect is attributable to unauthorized modification or repair, installation of parts, improper storage of the equipment, neglect or abuse of the equipment on behalf of or on behalf of the purchaser, improper operation of the product or use beyond the limits of the product design, or other company-promoted product accessories.

If any experiments are conducted to determine or prove defects in material or workmanship, reasonable notice shall be given to “Gladiator HDD” and conducted under conditions agreed upon by the parties, and “Gladiator HDD” may send a representative to attend any tests conducted. “Gladiator HDD” may elect to charge the customer for the cost of any tests conducted on the products sold hereunder at the customer's request.

The remedies in this warranty shall be the exclusive and sole remedies of the purchaser. No warranty, express or implied, including, but not limited to, any warranty that the equipment is of merchantable quality or that the equipment is suitable for any particular purpose is provided. “Gladiator HDD” shall not be liable for any incidental or consequential damages, losses or expenses (whether general, special, incidental or consequential) suffered by Buyer arising out of or in connection with the equipment. “Gladiator HDD” shall not be liable for incidental or consequential

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damages in any event, including but not limited to freight, transportation and replacement costs, downtime or other incidental to parts removed or replaced during the warranty period.

“Gladiator HDD reserves the right to modify, change and improve any product or part without incurring any obligation to replace any product or part. No person shall have the right to change or extend this warranty unless Gladiator HDD official written consent is obtained.

No used product delivered or provided by “Gladiator HDD” shall be sold as is without condition or warranty, at its original price, unless expressly agreed in writing with the customer. The customer agrees to inspect all such equipment before the purchase is completed and agrees to accept such equipment without any warranty of merchantability or fitness for a particular purpose.

By accepting this Agreement, the customer promises and agrees that if any product purchased hereunder is resold in its original form or as a component of another system, the above limited warranty terms will be included in all sales documents of the customer’s resale of any such product. In all such cases, the purchaser’s sales, purchase and acceptance of the delivery of the products sold hereunder from the customer will include the terms in this “Limited Warranty” and any previous terms of such terms, and the authorized representative of the purchaser who sells or delivers and subsequently understands the limitations of the warranty of “Gladiator HDD” or other product manufacturers, and “Gladiator HDD” disclaimer applies to the resale of such products. Customer agrees to indemnify and hold harmless Gladiator HDD from any such losses, claims or damages, including attorneys' fees and expenses arising from any breach of the above covenants.

Safety Awareness Program

1. Understand Operational Safety

This manual is part of the equipment safety system and is required for use when training personnel to operate the machine or work on site. Please ensure that there is always a copy on the machine and that the operator has read, understood and can use it. Carefully follow the instructions, recommendations and procedures it contains. Safety is everyone's responsibility.

2. Signal Words

Signal words are used to identify safety information in this manual. They are retained to avoid personal injury.

Danger is used for high-risk prompts that, if not avoided, will result in death or serious injury.

Warning is used for medium-risk prompts that, if not avoided, may result in death or serious injury.

Caution is used for low-risk hazards that, if not avoided, may result in minor or serious hazards.

Caution: Hazard warning signs are posted on machines to inform operators and others that these machines are potentially dangerous when in operation. These signs should be kept clean and legible. Replacement stickers can be purchased from

“Gladiator HDD”

Revision History

[illegible]

To Customers

First of all, thank you very much for choosing the G30 horizontal directional drill produced by “Gladiator HDD” and becoming our loyal customer. This directional drill comes with standard equipment and authorized accessories and is intended for underground drilling and pullback operations.

This manual is essential for the safe operation of the G30 horizontal directional drill. Do not allow anyone to operate or repair this product without reading it. Only operators who have received special training can operate and service this equipment correctly and safely.

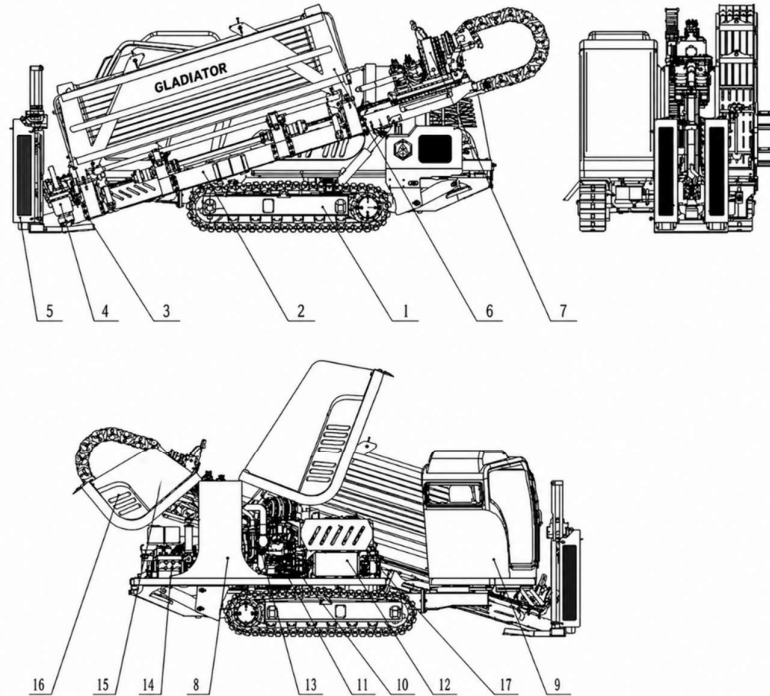
Do not use this product for purposes other than those described in this manual. Please consult “Gladiator HDD” for possible changes, additions or improvements to this product to meet various safety requirements. “Gladiator HDD” will not be responsible for any equipment failure, personal injury or other accidents caused by exceeding the scope of use or modification of this product without “Gladiator HDD” authorization or final confirmation.

Make sure this manual is complete and intact. Please contact Gladiator HDD for more manuals and further information or help about this equipment. In addition, “Gladiator HDD” agrees to conduct relevant service and technical personnel training to ensure that your equipment can obtain the best repair and maintenance methods.

Overview

Components of G30

GLADIATOR HDD G30 COMPONENT OVERVIEW



Component Index

1 Chassis Assembly

2 Beam Assembly

3 Clamp Assembly

4 Auto Grease Injector Assembly

5 Auto Anchor Assembly

6 Auto Rod Loading Box Assembly

7 Power Head

8 Cover Assembly

9 Cab Assembly

10 Euro V Power System

11 China III Power System

12 Electrical Schematic

13 Hydraulic Schematic

14 Mud Pump Assembly

15 Gladiator Decal Placement

16 Paint Scheme

17 Wear Parts List

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Operation and Maintenance Manual

Title G30 Operating and Safety Instructions Manual

Version A01

Ownership of Information

Gladiator HDD reserves the ownership of the information in this manual.

The use of the manual is limited to the customer's purpose of installing, using and maintaining the relevant equipment. Gladiator HDD declares that the information in this manual meets the technical and safety specifications of the machine. Gladiator HDD does not assume any responsibility for direct or indirect damage to personnel or property when the manual or machine is used in violation of the information contained in this document.

The information in the manual refers only to the machine mentioned in the "Machine Information Data" below. Gladiator HDD reserves the right to modify or improve the manual and machine without further notice.

Manufacturer Information

GLADIATOR HDD

Machine information data

Type: Horizontal directional drilling machine

Model: G30

Serial No.: _____

Date Of Production: MONTH _____ YEAR _____

File Scope

This manual covers the operation, safety, and maintenance of the G30. Planning the trajectory of the borehole, selecting the drilling fluid, operating the drilling fluid recovery system, and selecting and operating the guidance system are not within the scope of this document.

Personnel Qualification

Improper operation may result in serious injury, death and equipment damage. Relevant personnel should read and understand the operator's manual and receive appropriate training according to their responsibilities. The user must ensure that all personnel receive safety instructions and must check all warning signs on the machine with all personnel.

- Only qualified and authorized personnel are allowed to transport, operate and maintain the machine.

Declaration of Conformity

If a declaration of conformity is required, we will issue the relevant document when the equipment is delivered. For a sample text, see Chapter 19. This declaration is not required in most countries.

Use of Personal Protective Equipment



Failure to use personal protective equipment will result in serious injury or death to the operator. Operators and all personnel on the work site should use appropriate protective equipment according to their duties.

Legal Disclaimer

Note: The company assumes no responsibility for any personal injury or property loss caused by operating the equipment in violation of the instructions in this operating manual.

Purpose of Machine

This machine is designed for drilling circular holes in the ground for laying pipelines or cables without the need for subsequent backfilling and compaction.

Ground Leveling and Soil Conditions

This machine is specially designed for underground circular section drilling operations for laying pipelines or cables without backfilling and compaction.

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Ambient Conditions

Temperature Limits: The machine is filled with lubricant at the factory and is designed to operate at temperatures between +5°F and +110°F (-15°C and +43°C). If the temperature exceeds this range, please refer to the following professional handling suggestions and contact GLADIATOR HDD, LLC.

Please refer to the subsequent "Working in Hot Weather" and "Working in Cold Weather" for more information.

Relative Humidity: 100%

Maximum Altitude: 6500 feet (2000 meters) above sea level

The atmospheric conditions in the working area should ensure sufficient visibility.

Do not operate the equipment when there is a possibility of lightning strike.

Transport

This equipment should be transported using a tractor in accordance with local and national transportation regulations. At the same time, the components can be disassembled and shipped separately to reduce the transportation weight.

Operation

It is recommended that only one person operate the control device. Other trained personnel may work around the G30 equipment provided that they wear appropriate personal protective equipment and follow the safety procedures in this manual. In addition, the operator must continuously grasp the real-time location information of all personnel present.

Warranty: General Conditions

This warranty service is based on the premise that all personnel have read and understood all safety warnings and operating instructions. The scope and duration of the warranty are subject to the conditions and restrictions contained in the warranty certificate (see page 3 for details). If you have any questions about the warranty terms or equipment operation, please contact the technical support department immediately and call us

Request for Service/Support

Whether or not you need service support during the warranty period, please contact the company.

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Please provide the equipment model, serial number and accumulated operating hours.

Warranty and Service for Diesel Engine

This engine warranty service is applicable worldwide and is provided by engine dealers in the region where the equipment is sold. Only diesel engine dealers are authorized to perform warranty repairs, provide technical services and supply original spare parts.

Instruction Manuals

This manual contains the supporting instructions for non-original components (such as diesel engines) as supplementary appendices. If you need to obtain the translated version of the appendix, please contact the corresponding equipment manufacturers directly.

Safety Information

Safety Regulations and Practices

This manual contains essential information on the safe operation specifications and safety practices for the G30 equipment. All operators must thoroughly read and understand this "Operation and Safety Instructions Manual" before starting the equipment. Strict adherence to the safety and operational guidelines in this manual will effectively ensure the safety and productivity of the work site.

Emergency Procedures

Emergency Shutdown: Press the red emergency stop button at one of the following locations:

- On the right side of the cab control panel
- On the external hydraulic connector attachment of each power unit
- Engine control panel in the power unit

All operators should be familiar with the location of the emergency stop button before starting the equipment at the work site.

Response to Electrical Strike

The G30 is equipped with an anti-electric shock system. If the drill bit comes into contact with the power line and becomes energized, the anti-electric shock system will sound a loud, audible

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signal. The alarm will continue until contact with the power line is broken and the anti-electric shock system is reset.

- When on the equipment, please remain in place.
- Stay calm and wait for orders.
- Immediately reverse the direction of the drill rod propulsion and try to cut off contact with the power line.
- Do not touch any part of the equipment when you are not in the equipment operating position (because the equipment may be energized).
- Immediately notify the public safety department to block the scene.
- Immediately notify the power company for emergency disposal.
- Wait until the relevant power department confirms that the power is cut off and the working area is safe before leaving the equipment.

People around the equipment must remain still. The potential difference between the equipment and the ground or between the human feet may reach a lethal level. Do not touch any parts connected to the drilling rig, such as the equipment body, hydraulic pipelines, drill rods, water circulation system, mud mixing system, etc., which may be energized.

If the anti-electric shock system alarm is triggered (possibly caused by the cutting of the communication line), it must be treated as an actual electric shock accident before official confirmation. The above emergency response process must be strictly followed, and final confirmation from the power authority must be awaited.

Response to a Gas Strike

Evacuate the site immediately, shut down the power system, and immediately eliminate all sources of open flames and sparks. Do not attempt to reverse the drilling direction to disengage (mechanical movement may produce sparks). Contact the emergency service department and the gas company as soon as possible and initiate the emergency response procedures stipulated in Article 43 of the "Town Gas Management Regulations".

Response to a Fiber Optic Strike

Stop drilling immediately. Do not look directly at the cut optical cable end face (may cause Class III laser radiation damage as defined in GBZ 35-2017 "Occupational Eye Injury Diagnosis Standard"). Inform the pipeline owner according to the requirements of YD/T 814-1996 "Technical Specifications for Construction and Acceptance of Communication Pipeline Projects".

Response to a Communications Line Strike

Stop drilling operations immediately, notify the telecommunications operator in writing within 30 minutes in accordance with Article 56 of the Telecommunications Regulations, and cooperate in

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the loss assessment as required by YD 5103-2014 "Telecommunication Line Engineering Construction Supervision Specifications".

Response to a Sanitary/Storm Sewer and Water Strike

Stop construction immediately and warn people around to keep a safe distance ($\geq 15\text{m}$). People who come into contact with sewage must receive medical treatment in accordance with GBZ 1-2010 "Industrial Enterprise Design Hygiene Standards". Immediately initiate the emergency procedures of CJJ 6-2009 "Urban Drainage Pipeline Maintenance Safety Technical Regulations" and inform the municipal management department.

Basic Safety Guidelines



Dangerous sources at the work site may cause serious personal injury or death. All workers must match the corresponding protective equipment system according to the risk level of their positions.

Operation Qualification Management

All operators must complete the G30 dedicated operating system certification training before the equipment is put into use. This manual is included in the GB/T 33000 "Basic Specifications for Enterprise Safety Production Standardization" training system as a core training material. The training records must be archived for reference and are valid for 36 months.

Technical Documentation Configuration

The equipment must be equipped with a physical manual (waterproof and oil-proof package), and the electronic version must be deployed on the cloud (the version number is bound to the equipment serial number). A dedicated document cabinet must be set up on site to ensure that it can be accessed at any time 24 hours a day, 7 days a week, in accordance with the requirements of the ISO 30401 knowledge management system.

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Hierarchical Training System

Operators: pass the GB/T 23703 knowledge management assessment and master the SY/T 7354 trenchless equipment operating specifications.

Maintenance personnel: obtain TSG Z6001 "Special Equipment Operator Assessment Rules" qualification certification;

Visitors/temporary personnel: implement 15-minute safety quick training (including AR scene simulation) and sign a risk notification letter.

Newcomer Admission Mechanism

1. Implement three-level safety education (factory level/workshop level/position level), with a total study time of ≥ 72 hours;
2. Establish a "master-apprentice" supervision system (1:1 configuration, supervision period ≥ 3 months);
3. Set up an electronic fence within the 5m radius of the equipment operation, and unqualified personnel will trigger the UWB positioning alarm.

Safety Signage System

Equipment warning signs strictly follow the GB 2894-2008 standard. Chapter 3 "Safety Warning" contains:

Pictogram analysis (reference ISO 7010);

Risk level matrix (based on ANSI Z535.4 risk assessment model);

Emergency operation flow chart (including QR code link video demonstration).

- (1) Full-dimensional compliance requirements

Comply with but not limited to the following regulatory systems for occupational safety, environmental protection requirements, special equipment, and emergency management:

Drilling rig operating procedures
Mobile equipment operation specs

Rotary drill pipe operation
Noise Control

Drilling fluid system operation
Confined space entry

Loose drill pipe handling
Handheld/power tool management.

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Tool joint disassembly and assembly	Anti-electric shock protection
Traffic control systems	Worksite security and hazard isolation
Guide hole trajectory tracking	Vehicle operating specifications
Communication Protocols Underground	Material handling and manual lifting
Pipeline Positioning and Clearance	
Fall Prevention Systems	Trench support and slope treatment

The owner, employer, and equipment operator are responsible for understanding and complying with all applicable occupational health, safety, environmental, transportation, and operating regulations in the jurisdiction where the equipment is used.

Applicable requirements may include national, regional, provincial, state, territorial, and local laws, regulations, codes, standards, permits, and site-specific safety rules.

Before operating this equipment, ensure that all personnel are properly trained and that all required safety procedures, inspections, permits, and protective measures are in place.

Protective equipment that meets the following standards must be equipped

- Safety helmets
- Eye Protection
- Protective boots
- Insulated gloves
- High-visibility reflective clothing
- Hearing protection
- Special protective equipment
- Technical enhancement: Deploy an intelligent wearable monitoring system to detect the wearing status of equipment in real time and automatically lock the equipment when it does not meet the standards.

Emergency response mechanism for hazardous conditions

- Implement the three-level response of GB/T 29639-2020 "Guidelines for the Preparation of Emergency Plans for Production Safety Accidents in Production and Operation Units":
- **Level 1 response** (early warning): AI visual recognition of dangerous signs → sound and light alarm
- **Level 2 response** (disposal): Automatically cut off the power source + start emergency ventilation
- **Level 3 response** (evacuation): Trigger UWB positioning evacuation navigation (path optimization ≤ 3 seconds)
- Configure a multi-parameter hazard warning terminal (integrated

VOCs/temperature rise/vibration monitoring, warning accuracy $\geq 99.7\%$)

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Standardized gesture command system

Implement the extended version of GB 5082-85 "Crane Hoisting Command Signal" (adding 12 drilling-specific gestures)

Deploy an AI gesture recognition system based on the YOLOv5 algorithm (recognition accuracy $\geq 98\%$, latency $\leq 200\text{ms}$)

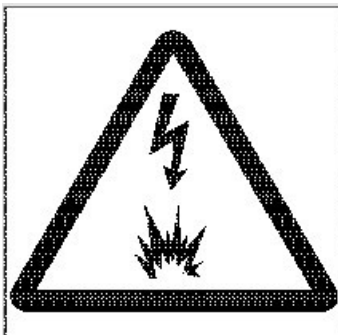
Establish a three-level command authority system (general command/regional command/emergency command), and display the command level through the digital badge LED

Configuration standards for on-site emergency rescue systems

- First aid facilities**
- Smart first aid kit
- Fire protection system
- Medical network
- VR First aid training cabin
- Personnel Qualifications

First aid personnel hold 100% certification rate (certified by the Red Cross Society)
Equipped with telemedicine consultation terminal

Utility Locations



Regulations for the prevention and control of electric shock and explosion risks

Underground pipeline calibration

According to Article 16 of the "Regulations on Urban Underground Pipeline Management", the following must be completed before construction:

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- Dial 114 to access the national unified underground pipeline service platform.
- Simultaneously contact the ownership units (gas/communication/electricity, etc.) that are not connected to the platform.
- Use the CJJ 61-2017 standard method to calibrate the pipeline (error $\leq \pm 0.3\text{m}$).

Drilling trajectory design

- Implement GB 50330-2013 "Technical Specifications for Building Slope Engineering" to set the safe clearance
- Consider the risk of guide hole deviation (according to ISO 22475-1 geological uncertainty coefficient ≥ 1.5)

Non-destructive verification

- Adopt GB/T 50269-2015 "Code for Acceptance of Construction Quality of Foundation

Engineering" method

Risk hole monitoring

- Technical requirements for setting up observation holes in high-risk areas
Electromagnetic interference prevention and control
- Implementation of GB/T 17626.3-2016 "Electromagnetic Compatibility Test and

Measurement Technology" requirements

Abnormal working condition handling

- Implementation of three-level response when positioning abnormality occurs:

Level 1: Stop advancing and start three-dimensional trajectory review (laser gyroscope accuracy $\pm 0.01^\circ$)

Level 2: Retreat to the nearest verification point (step distance $\leq 0.5\text{m}$)

Level 3: Start emergency hole expansion plan (maximum hole expansion diameter ≤ 1.5 times the design value)

Pull-back control

Special protection during the product pipeline installation phase:

- Real-time monitoring of pull-back force ($\leq 60\%$ of pipe yield strength)
- Configure ultrasonic thickness gauge (wall thickness measurement accuracy $\pm 0.1\text{mm}$)
- Set up anti-scratch roller bracket (Shore hardness $\leq 60\text{HA}$)

Surface Examination

Before construction, evaluate the surface for potential hazards along the planned drilling path and surrounding areas, including but not limited to:

- Transformer boxes, manholes, outbuildings, gas grills, outdoor lighting
- Trench linear depressions, recent road or pipeline repairs (may indicate the presence of additional buried pipelines)
- Verify the buried depth of water and gas shut-off valves
- Assume that all wires connected to utility poles are live
- Note that private pipelines and utilities not connected to the "One Call" system will not be marked

Key operating specifications

- Underground pipeline calibration
 - Dial 114 to access the national "One Call" system and obtain local pipeline contact information
 - Simultaneously contact pipeline ownership units that are not connected to the system
 - Operators must strictly abide by laws and regulations related to pipeline positioning and avoidance
- Drilling path design
 - When designing the drilling trajectory, ensure that the final hole after expansion maintains a safe clearance from the underground pipeline/structure
 - Special consideration is given to the risk of the reamer deviating toward the pipeline due to excessive steering or a small radius of curvature of the pilot hole
- Non-destructive verification
 - Use manual excavation and/or automatic vacuum equipment to open verification holes to accurately determine the location and depth of the pipeline
 - Observation holes (near the pipeline) need to be excavated in high-risk areas to visually monitor the construction process in real time
- Risk operation control
 - Use vacuum equipment to remove drilling fluid and strictly prevent and control high-pressure fluid risks
 - When drilling close to the pipeline, the distance must be continuously monitored after the drill bit/reamer passes through the observation hole

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- Be alert to the risk of pipeline damage caused by the increase in the size of the reaming hole or the straightening of the hole during the pullback stage

- Electromagnetic interference investigation

- The locator and operator need to carry tracking equipment for on-site investigation
- Evaluate the electromagnetic interference field (active interference source)
- Investigate passive interference objects such as reinforced concrete structures

- Abnormal working condition handling

When abnormal positioning data is found during drilling:

- Stop the operation immediately
- Withdraw and review the previous positioning data
- Only continue construction after confirmation
- The drilling trajectory deviates from the designed path, which may cause pipeline breakdown accidents, and must be focused on prevention and control

Overhead Hazards

Safety regulations for avoiding overhead lines

- Key periods for risk prevention and control

- Equipment entry/exit - Heavy equipment loading and unloading operations - Drill rod handling and operation process

- Safety distance standards

When the voltage is unknown:

- The minimum distance between the equipment and the power line is ≥ 6 meters

When the voltage is known: - Refer to the implementation rules of the "Electric Power Facilities Protection Regulations" to implement the minimum clearance

- Warning measures

Set up on both sides of the overhead danger zone:

- High-visibility warning signs (GB 2894-2008 standard reflective film, retroreflection coefficient $\geq 500\text{cd/lx/m}^2$)

- LED strobe warning lights (visible distance ≥ 200 meters) Designate full-time safety officers:

- Equipped with remote warning devices (UWB positioning accuracy $\pm 10\text{cm}$)

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- When the equipment approaches the danger zone, real-time warnings are given through the digital cluster system

References

Equipment Manufacturers Association, "Directional Drilling Tracking Equipment Safety Manual," 2000;

Directional Drilling Contractors Association (DCAA), "Guide to Safe Operations in Horizontal

Directional Drilling," 2000;

"Horizontal Directional Drilling Technical Guide," 1995.



Exit Pit Construction

During drilling operations, it may be necessary to build a receiving pit on the exit side of the crossing section to accommodate the cutter or mud motor. The construction team is responsible for building the receiving pit that meets safety standards in accordance with the Work Safety Law or applicable regulations of the country where the operation is located.

Before Starting the Machine

- Complete all maintenance items specified in this operation manual and Appendix A "Diesel Engine Manual".
 - Ensure that all fluid pipes are firmly connected before starting the equipment.
 - Check that all hydraulic joints, bolts and nuts are tight.
 - Clear all loose items stored inside and outside the equipment.
 - Remove non-belonging items from the equipment and its accessories.
 - Confirm that all protective covers, doors and other components are installed in place.
 - Ensure that all safety devices are correctly installed and functioning properly.
 - Master the real-time location information of all personnel on the work site.
 - Detect the anti-electric shock system and pass the compliant grounding, and

strictly follow the relevant procedures in Appendix 3 "Operation Instructions for Anti-Electric Shock System".

Operating Precautions

- Before starting the engine, ensure all controls are in the neutral or off position.
- Keep all personnel clear of rotating/moving parts before starting the machine.

- Test the functionality of all controls before using the machine.

Operator's Responsibilities

- The operator must read, understand and follow the requirements of this manual and perform the correct operating procedures.
- Only qualified and trained auxiliary personnel are allowed to operate the equipment.
- Before drilling, confirm that the underground pipeline is located and use standardized drilling processes to avoid it.
- Combine professional common sense and experience to evaluate the safety of the operation and only carry out construction when safety is ensured.
- Strictly abide by relevant national, provincial and local laws and regulations.
- Explain the meaning of equipment safety signs to operators one by one.
- Supervise all operators to comply with and implement safe operating regulations.
- It is strictly forbidden for personnel to approach rotating or moving parts.
- Conduct on-site surveys along the drilling path before construction and check dangerous areas such as trenches/slopes.
- Evaluate whether traffic conditions and terrain conditions meet safe operation requirements.
- Operators are strictly prohibited from leaving the operating station without permission when the engine is running.
- It is prohibited to operate the equipment under the influence of alcohol or drugs.
- Stop the machine immediately if any abnormal signs are found.

Crane Safety

- Keep a safe distance from the suspended load and wait until it is within reach before approaching.
- Use standardized hand gestures and clearly identify the responsible person.
- Do not use the equipment to lift people. .
- Perform regular inspections and standard maintenance.
- Ensure that all safety devices are properly installed and functioning properly.

Drilling Precautions

- Identify and avoid the risk of extrusion on the drilling rig and auxiliary equipment.
- Maintain a safe clearance between the borehole and all underground facilities ($\geq 900\text{mm}$, or implement higher requirements of the "Electric Power Facility Protection Regulations"). The minimum clearance needs to take into account the final expansion diameter and the bending radius of the guide hole.
- It is strictly forbidden to touch the rotating drill pipe.
- Surround the drilling rig equipment with a protective cover and post relevant warning signs to prohibit non-staff from entering.

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- Unauthorized personnel are prohibited from entering the 3m operating radius of the drilling rig.
 - It is strictly forbidden to start the equipment when there are people working around the drill pipe.
 - It is forbidden to operate before establishing effective communication with the locator/exit side personnel (using a digital cluster system with a signal coverage radius of $\geq 500\text{m}$).
 - Enable the remote locking system to prevent accidental movement of the drill pipe.
 - The operating torque/push-pull force of the drill pipe shall not exceed the manufacturer's rated value.
 - It is strictly forbidden to use the equipment torque to disassemble and assemble the tool joint outside the working range of the hydraulic wrench.
 - It is forbidden to use a pipe clamp to disassemble the tool joint.
 - Remote disassembly and installation of wrenches requires the three-point support stabilization method.

Drilling and Safety Precautions

- Two-way radio communication must be maintained between the entrance and exit sides.
- Before starting the rotation or movement of the drill pipe, all operators must be notified and a confirmation reply must be obtained.
- When crossing existing underground pipelines:
 - Excavate and expose the pipeline at the crossing point;
 - Implement endoscopy monitoring throughout the crossing process;
 - Pay special attention: power lines that pass safely during the drilling stage may cause secondary breakdown due to trajectory deviation during the expansion or pullback stage.
- It is strictly forbidden to cross the rotating drill pipe.
- Keep a safe distance when working near the rotating drill pipe.

Maintenance Precautions

- Disconnect all power (turn off the equipment and remove the key) and release system pressure.
- Allow the equipment to cool before maintenance (hydraulic components, engine, radiator and exhaust system may be overheated and cause injury).
- Perform lockout and tagout procedures.
- Strictly follow the maintenance procedures recommended by the manufacturer.
- Only professionally trained personnel are allowed to perform maintenance.
- Do not modify the equipment without authorization.
- Repair or replace damaged/missing protective covers, hatches, etc. in a timely manner.
- Replace blurred or damaged safety signs and keep them clean.

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- Use cardboard/wood chips to detect pressure leaks (do not operate with bare hands).
- If high-pressure hydraulic oil penetrates the skin:
 - See a doctor immediately (even if the injury is minor);
 - Must be treated by a doctor familiar with this type of injury (may cause serious injury or death).

Transporting Precautions

- Objects weighing more than 25 kg should be equipped with lifting lugs.
- Do not sit or stand on the equipment during operation.
- Thoroughly inspect the tractor trailer used for transportation, including but not limited to:
 - Braking system;
 - Tire condition and tire pressure; - Lighting system.
- Remove or secure all loose items to prevent them from falling off during transportation.

Welding Safety



Welding operations may involve exposure to hazardous sources such as high temperature surfaces, open flames, and toxic fumes.

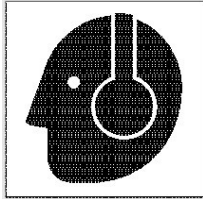
The following safety measures should be taken:

- Follow the established welding safety operating procedures and relevant regulations.
- Designate a dedicated person as a fire prevention supervisor.
- Ensure that there is always someone supervising during welding operations.
- Wear protective equipment such as welding masks and flame-retardant work clothes.
- Ensure that the work area is well ventilated.
- Provide a first aid kit near the work site.

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- When performing confined space welding, the "Safety Code for Confined Space Operations" and related procedures must be strictly followed.

Noise and Vibration

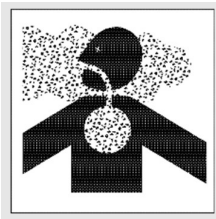


Long-term exposure to high noise environment may cause permanent hearing damage. Workers must wear hearing protection equipment.

When the equipment is in operation, the cab seat has a certain vibration. According to ISO 2732 and ISO 3945 standards, the vibration level measured is Class B - permitted, acceptable, and allowable vibration level.

The sound pressure level measured according to ISO 11202:1993, ISO 3746:1995, IEC 651:1979 and IEC 804:1985 is 102 dB.

Hazardous Chemicals



Respiratory hazards and dust protection regulations. Dust generated by drilling fluid additives (such as bentonite) may irritate the  respiratory tract or lungs, and long-term exposure may cause respiratory damage. Operators must wear respiratory protection equipment and use dust goggles.



Explosion risk prevention and control measures. Flammable solvents may explode when exposed to open flames, sparks or ignition sources. They must be stored in strictly sealed containers. It is strictly forbidden to place flammable solvents near open flames, sparks or other ignition sources.

Important Warning:

- Do not use containers that have the risk of leakage.
- Do not discharge waste liquid into the ground, sewage system, rivers, lakes or oceans.

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- Strictly follow the Waste Pollution Prevention and Control Law and Hazardous Waste Storage Pollution Control Standards for waste disposal.

Danger Zones -- Safe Distances



Electric shock hazard prevention and control. If you touch the power line during drilling operations, it may cause serious injuries or deaths. All personnel must wear insulating boots and insulating gloves.

Definition of hazardous area:

(1) Hazardous area: All areas where mechanical parts can be touched during equipment operation or maintenance

- Define warning range
- Personnel entering must wear a full set of protective equipment (including protective gear to prevent mechanical injuries)

(2) Safe clearance of live electricity:

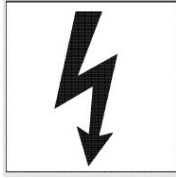
- 8-meter radius around the drilling point
 - Personnel on site for power operations must wear insulating protective equipment -
- During drilling/expansion, non-operating personnel are strictly prohibited from entering the area
- On-site control measures:

- Set up double-layer warning signs (outer warning belt + inner circle electronic fence)
- Deploy electromagnetic field monitoring system (field strength in the 30-1000Hz frequency band

≤5kV/m)

- Implement a "two-person operation" supervision system (one person operates, one person monitors)

Grounding



Warning of risk of electric shock. Improperly grounded components may be live, resulting in serious injury or death. Before starting the engine, all metal components must be connected to the same potential and connected to a unified grounding stake.

- Strictly follow national and local grounding regulations.

Causes of electrified metal components:

Electrified metal components on the drilling site may be caused by the following factors:

- Line fault or damage
- Inductive capacitance of equipment such as generators/motors/inverters/transformers
- Contact with local distribution lines or underground cables (Note: Strict protective measures must be taken to avoid the risk of electric shock) Requirements for equipotential connection:

1. Connection scope

- All metal components on the drilling site must be equipotentially connected as shown in the diagram
- Adjacent equipment (pipe racks, mud pumps, etc.) must be equipotentially connected to the drilling rig

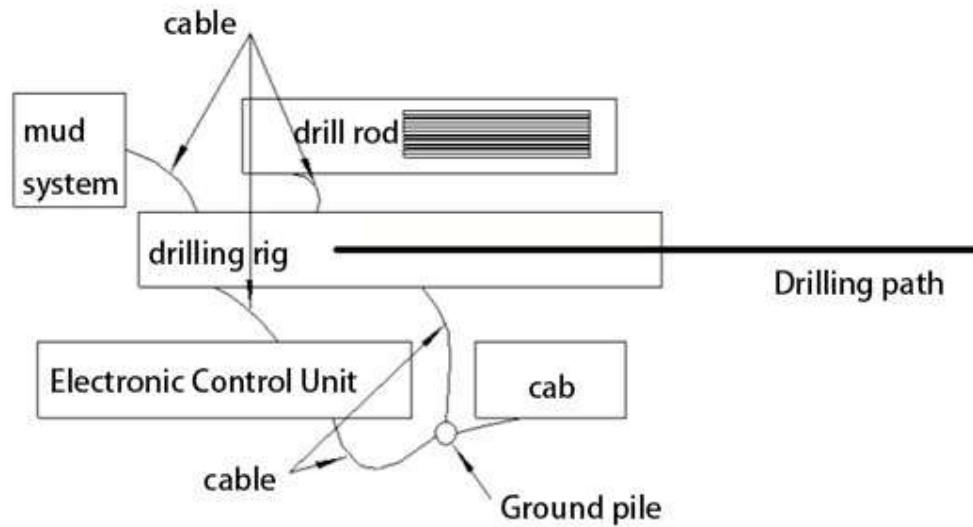
2. Technical principles

- Equipotential connection can eliminate the potential difference between components
- No current flows between components with equal potential

3. Safety benefits

- Reduce the risk of electric shock when personnel touch the drilling rig and adjacent equipment at the same time - Ensure that an effective discharge path is formed in the event of lightning strikes/leakage (grounding resistance $\leq 4\Omega$).

Typical Connection Scheme Diagram



Safety Features - Anti-electric shock system

The anti-electric shock system is a special electric induction device for equipment with a high probability of crossing underground live lines. For complete operating instructions, please refer to Chapter 5 Electric Shock Alarm-Anti-Electric Shock System Operating Instructions.

Safety Features - Remote locking system

The remote locking system can realize remote emergency braking of the drilling rig thrust and rotation (such as operation on the exit side of directional drilling). For complete procedures, please refer to Chapter 4 Radio Remote Control Operating Instructions.

Safety Features - Fire Extinguisher

Fire extinguishing devices that meet the following standards should be installed at appropriate locations outside the drilling rig and in the cab:

- Fire extinguisher type: dry powder type (certified by GB 4351.1-2005)
- Applicable fire categories:
 - Class B (liquid fire)
 - Class C (gas fire)
- Maintenance of fire extinguishers

Check whether the fire extinguisher is intact, including the cylinder, valve, nozzle and other components. If rust, deformation or damage is found, it should be dealt with in a timely manner. Check if the lead seal is complete and reseal it if it has not been opened. Check if the pressure gauge pointer is

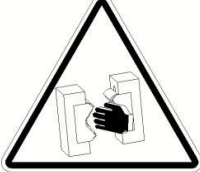
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in the green area (normal working pressure) every month. If the pointer is red or yellow, it needs to be refilled or repaired. Conduct a hydrostatic test (pressure $\geq 2.1\text{MPa}$) once a year or every two years to ensure structural safety. Measure the weight of the fire extinguisher and gas pipe every 12 months, and replace parts if the powder loss exceeds 100% or the gas loss exceeds 100%. Check the weight of the gas cylinder every six months (or after use), and repair or replace it if the leakage exceeds the standard. Maintain surface cleanliness, regularly remove dust and dirt, keep nozzles and pipelines unobstructed, and avoid chemical corrosion. After use, the top cover should be opened to clean the residual dry powder to prevent clumping from affecting the spraying. Check if the safety pin and operating mechanism are flexible, replace if damaged, shake the powder in the cylinder to prevent condensation, and ensure that the powder is in good condition. Storage should avoid environments with high temperature, humidity, or strong chemical corrosion, and ensure good ventilation. All maintenance work should be operated by professionals, and non professionals are not allowed to disassemble or repair it.

Safety Alerts



Track markings , prohibit personnel from sitting on the drilling rig tracks to prevent personal injury and other hazards.



Squeeze indicator: Fingers may be squeezed; do not insert.



Anchor markings: Easily entangled, keep away from danger.



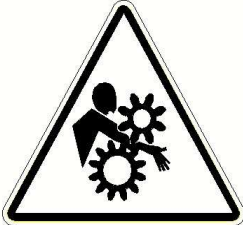
Anti-slip sign: Slippery, be careful.



Rear support foot marking: Drill rig rear support foot, be careful of pressing the foot when operating the multi-way valve.



Battery box label: Caution: Electric shock and corrosion



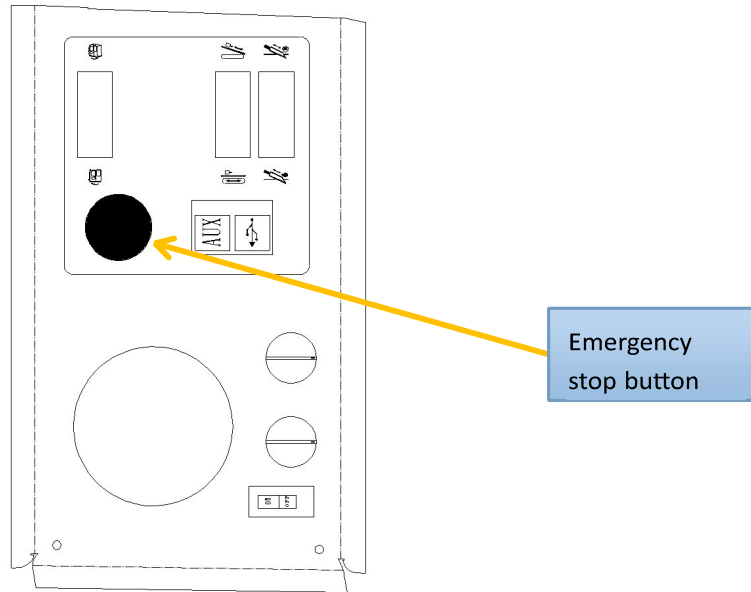
Gear symbol: Caution: Do not insert fingers.



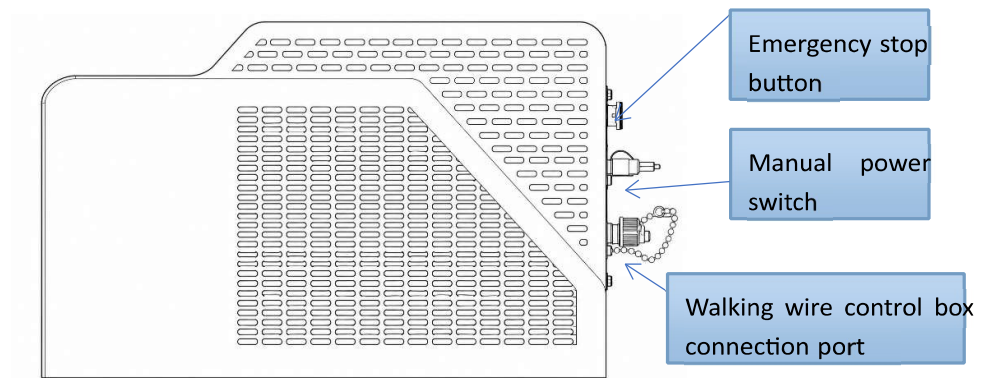
Silencer sign: Do not touch, beware of burns

Machine Controls

Safety Switches-Cab Configuration



Manual Battery Switch

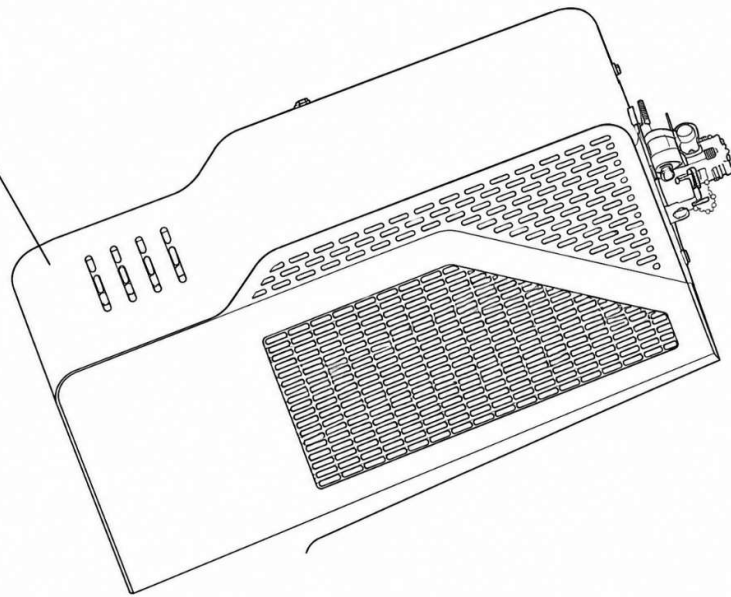


Important Notes:

- Do not disconnect the power switch while the engine is running.
- Do not attempt to stop the engine directly using this switch, as this will damage the electrical system.
- During maintenance, turn off the switch and use appropriate locks and markings.

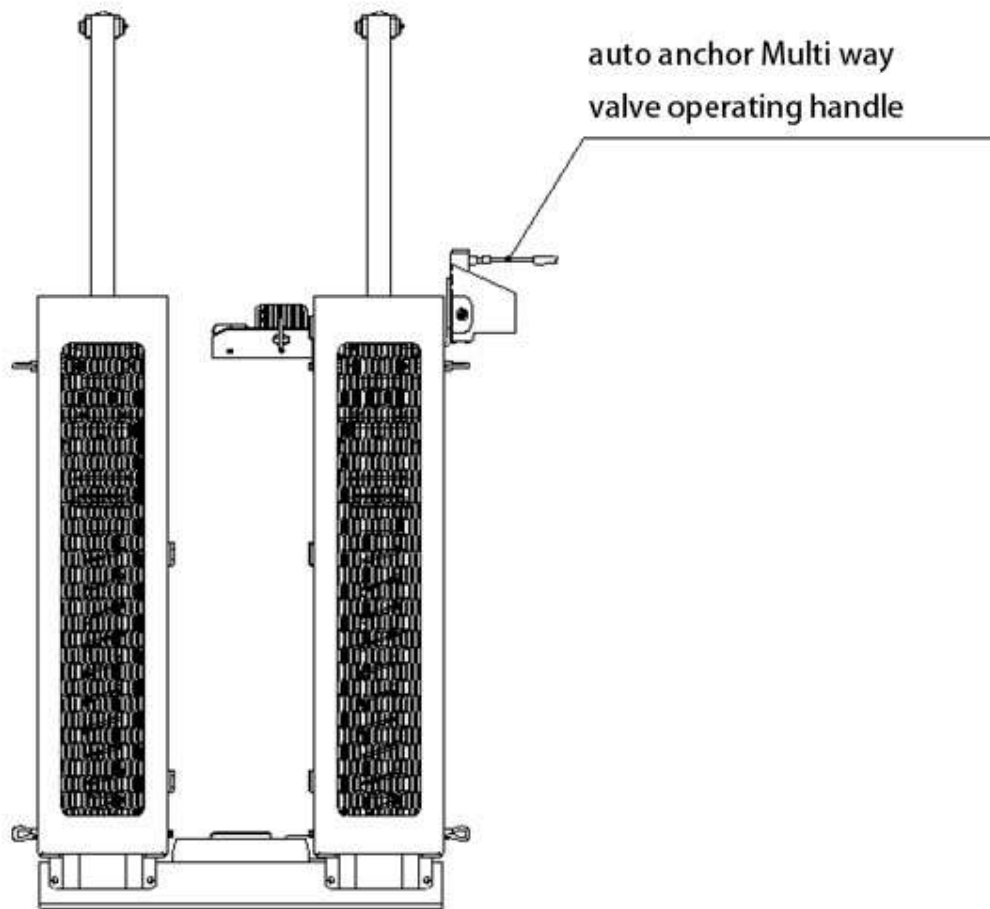
Rear support feet and luffing beam multi-way valve operating handle

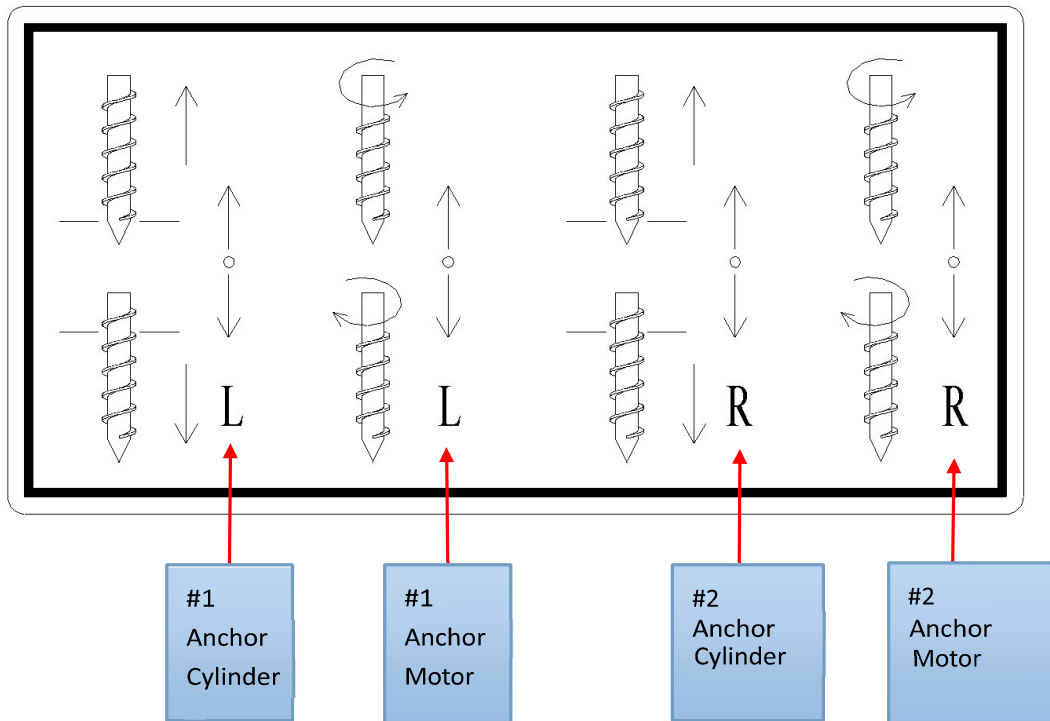
Multi way valve operating handle



- Luffing lever (left 1) – Controls the front luffing cylinder to change the pitch angle of the main beam.
- Luffing lever (left 2) – Controls the rear luffing cylinder to change the tilt angle of the main beam.
- Right outrigger cylinder lever (right 1) – Controls the right outrigger cylinder to adjust the stability of the chassis.
- Left outrigger cylinder lever (right 2) – Controls the left outrigger cylinder to adjust the stability of the chassis.

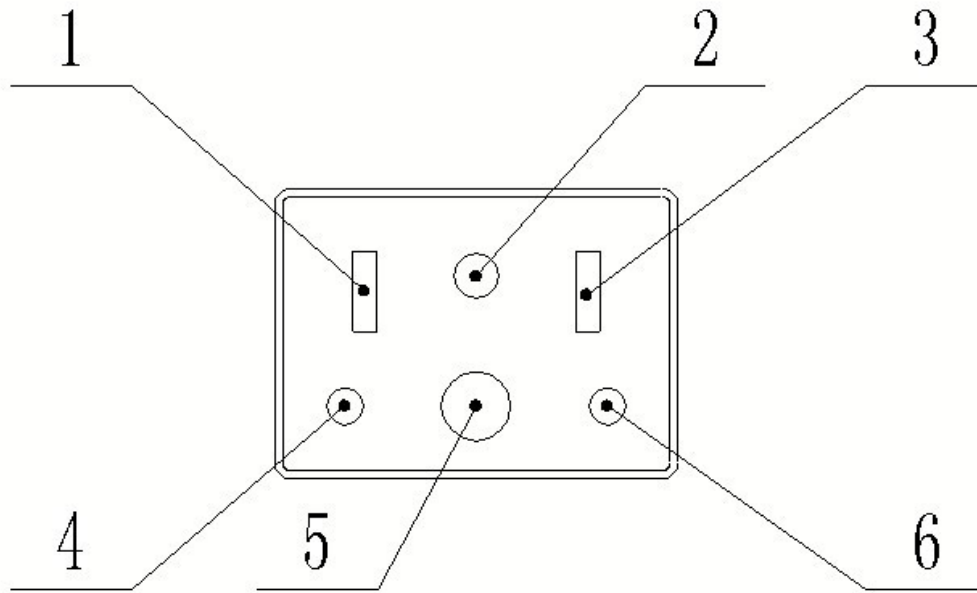
Automatic hydraulic anchor multi-way valve operating handle





- ▲ Anchor cylinders #1 and #2 – control the extension and retraction of the automatic hydraulic anchor lifting cylinder.
 - ▲ #1 and #2 anchor motors – control the rotation of the automatic hydraulic anchor bolt motors.
- Note: When fixing the front anchor plate with ground anchor bolts, the corresponding anchor cylinder and anchor motor handle must be activated simultaneously.**

Walking Wire Control Box



1. Left Track Travel – Controls the travel of the left track.

2. Emergency Stop Switch – Diesel engine emergency stop switch.

3. Right Track Travel – Controls the travel of the right track.

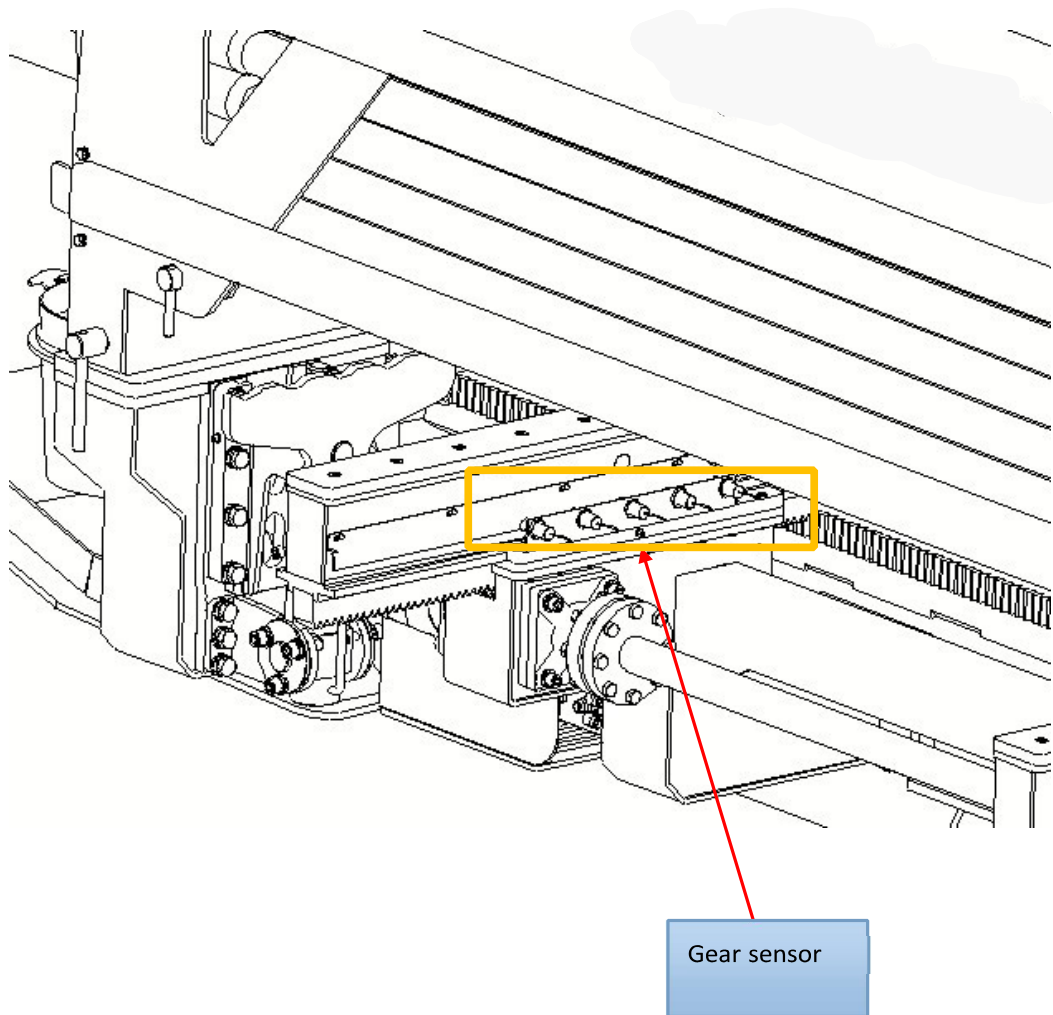
4. Throttle – Diesel engine throttle.

5. Start Switch – Starts the diesel engine.

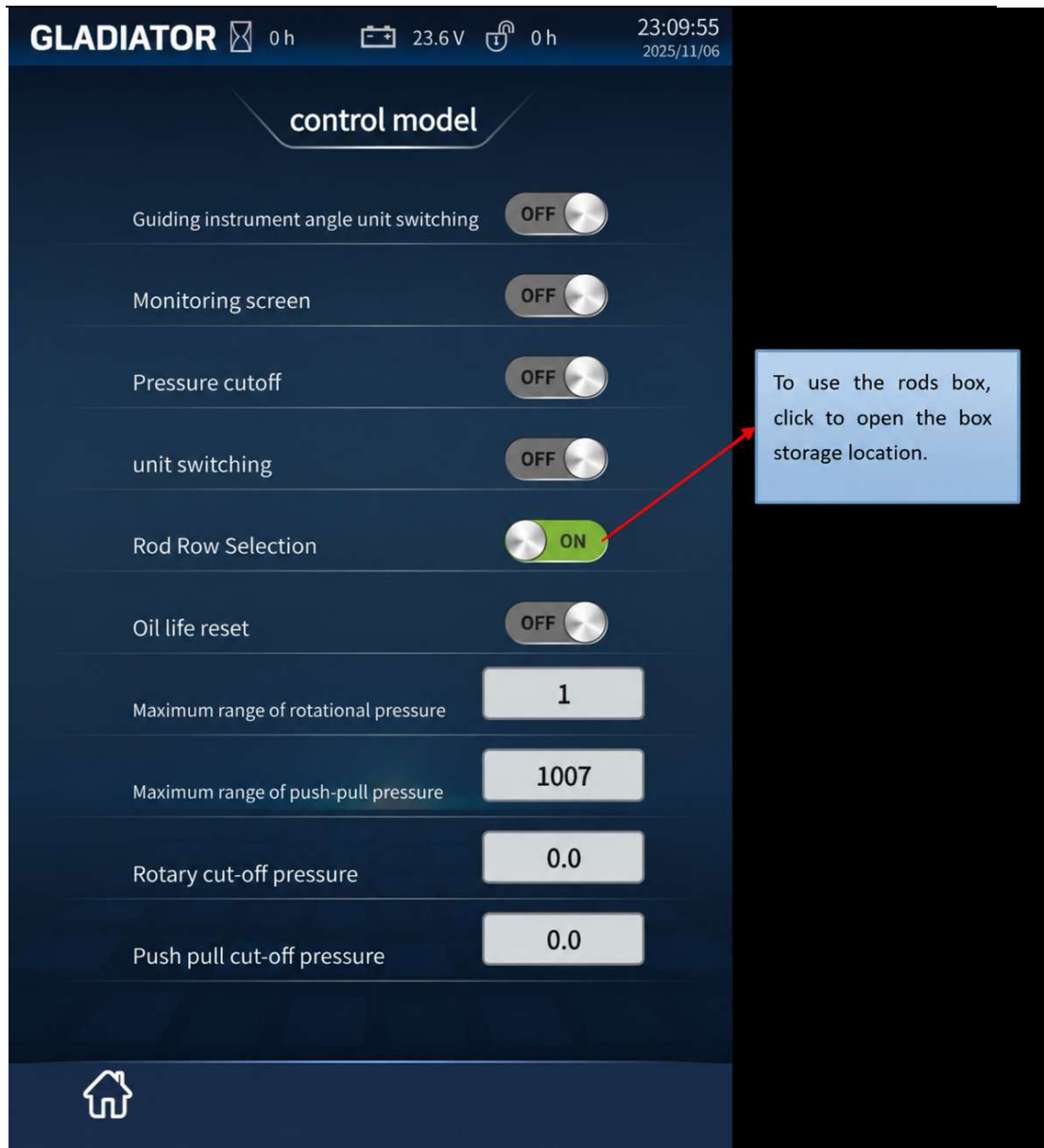
6. High-Speed Travel – Controls high-speed travel of the tracks.

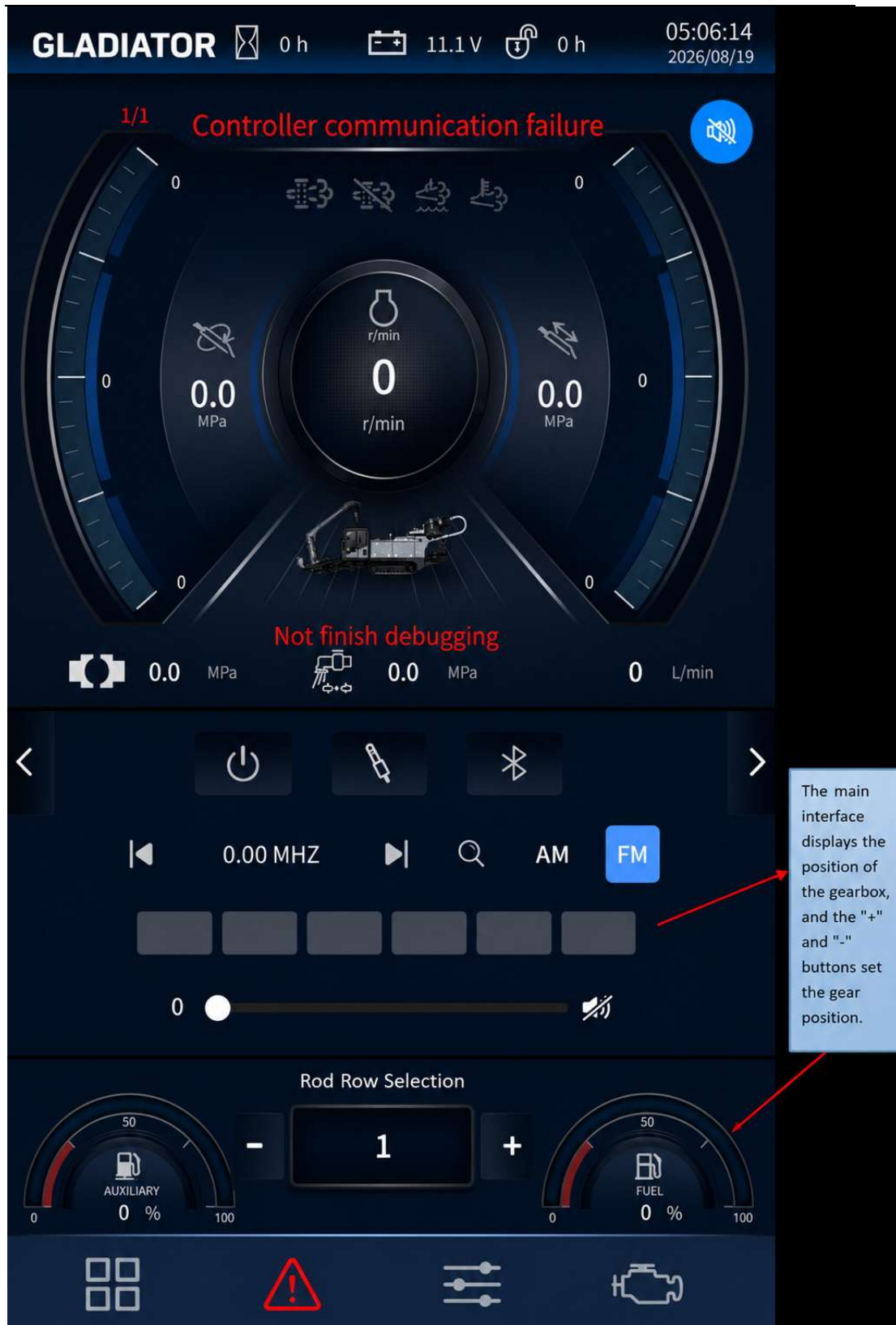
6. Auto rods box gear setting - display

Automatic hydraulic anchor multi-way valve operating handle

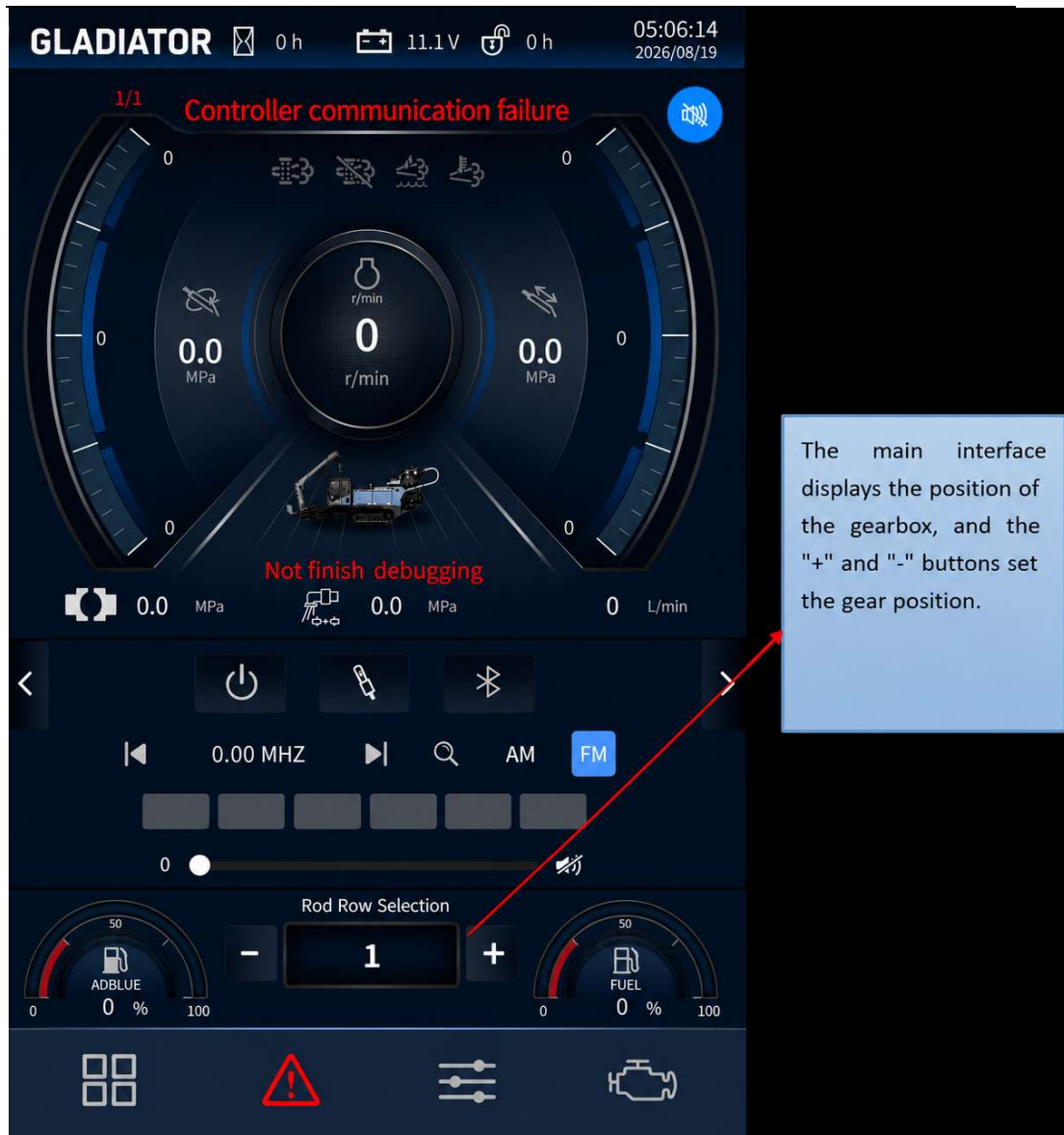


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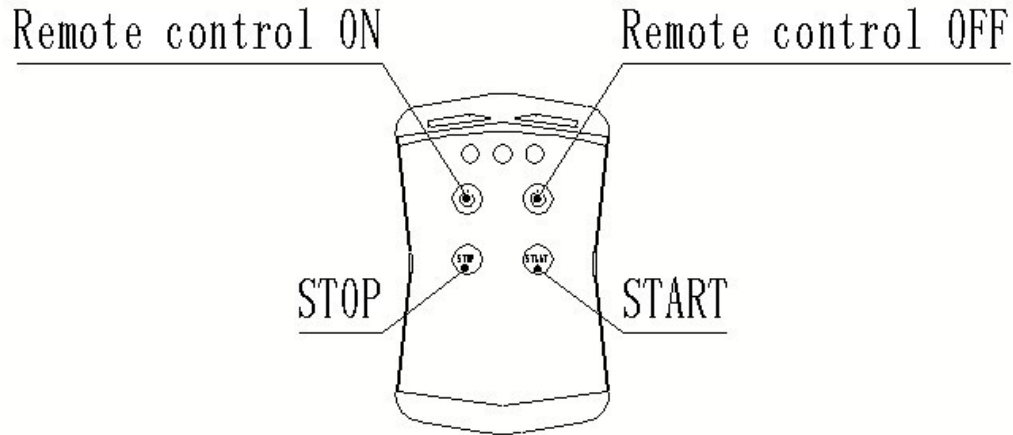




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Wireless remote cut-off remote control



Remote control ON——Start remote control ;

Remote control OFF——Turn off the remote control ; STOP——Power head rotation/push-pull action lock ;

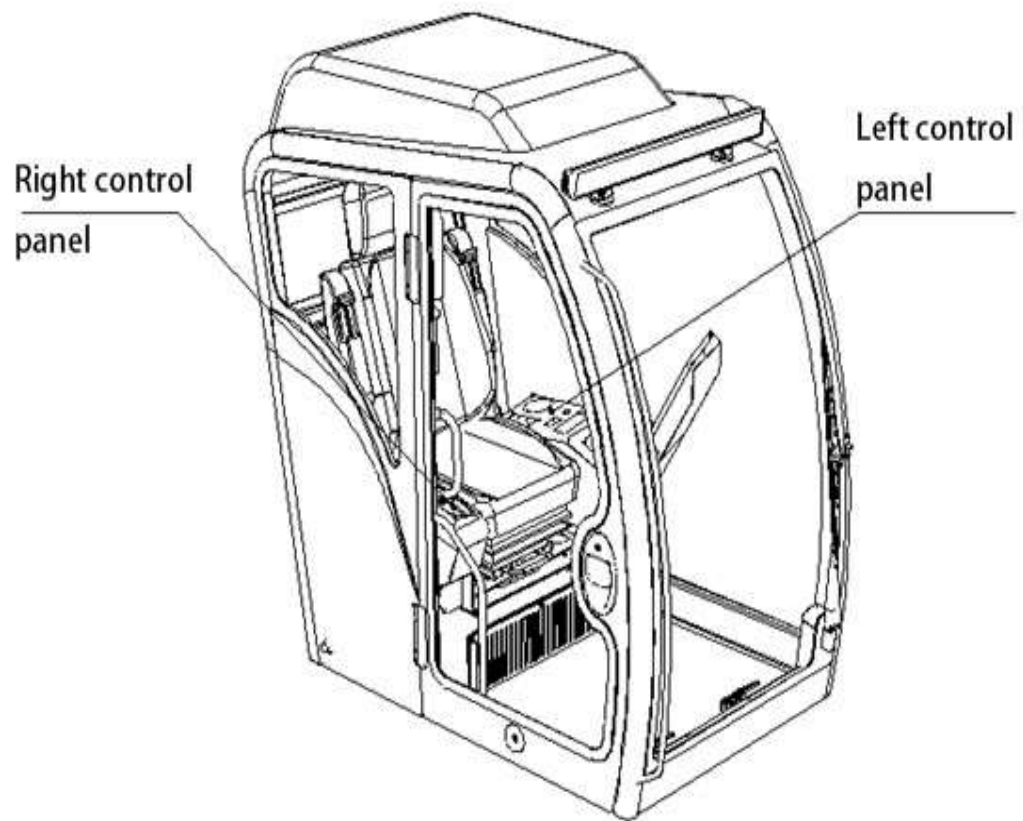
START——Power head rotation/push-pull action to unlock.

Precautions: When the remote control battery is low, pressing the start button on the remote control will cause the engine to shut off accidentally. Please be sure to ensure that the remote control battery is fully charged.

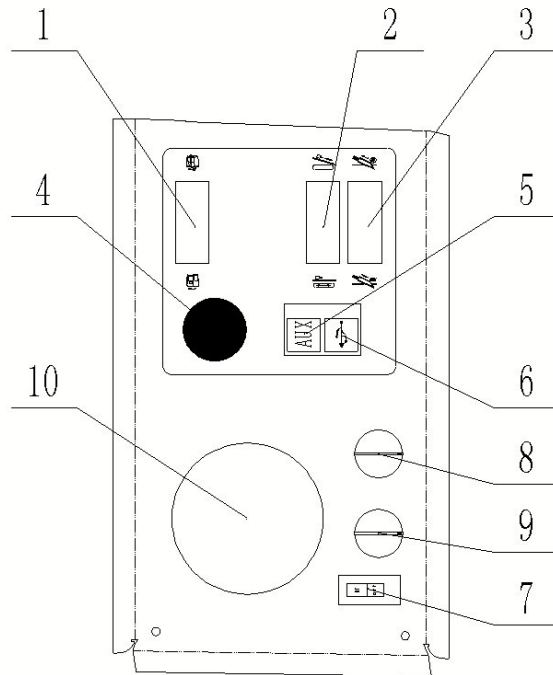
7. Operator control station - cab configuration

Each operating area of this control station has a detailed description, and all control devices are clearly labeled.

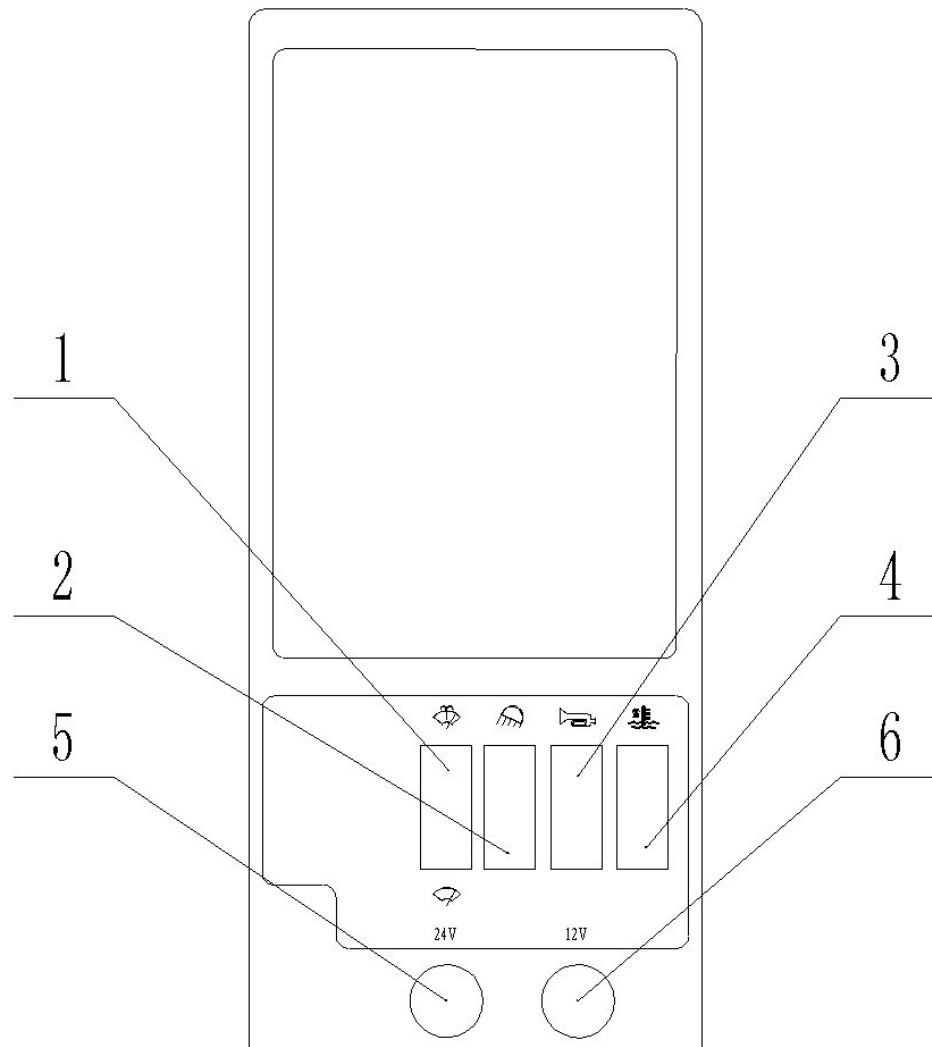
Operator control station-Cab configuration



Left Control Panel-Cab Configuration

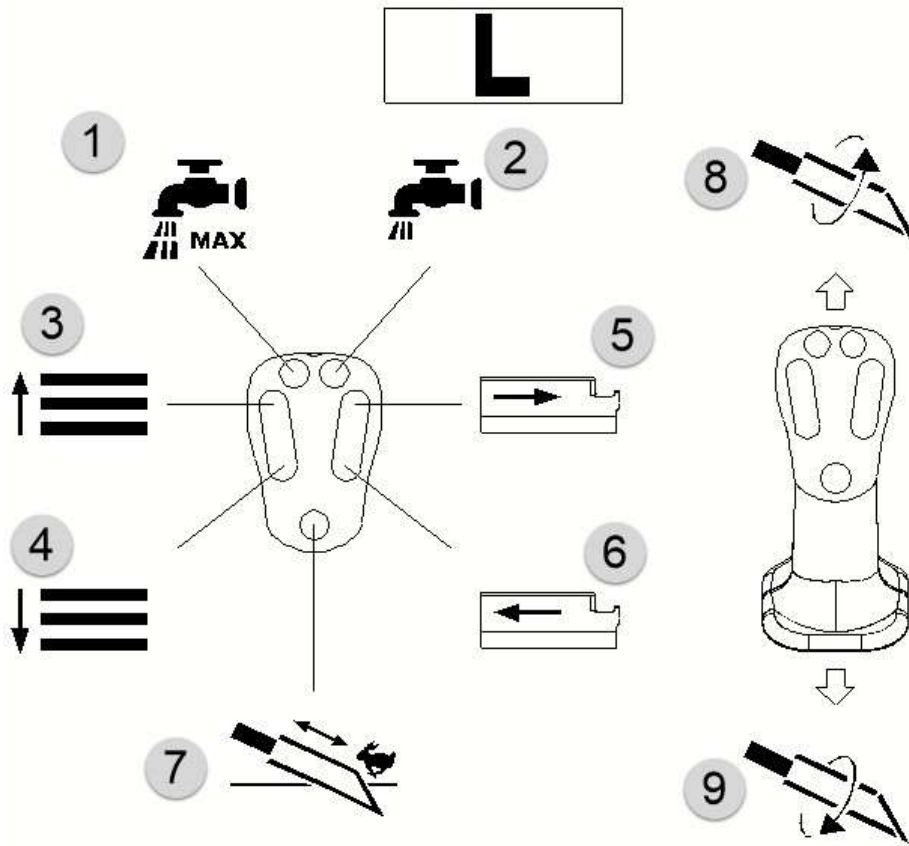


1. Cab rotation and cab reset;
2. Working and traveling;
3. Power head push/pull high, medium, and low speeds;
4. Emergency stop button;
5. Auxiliary interface;
6. USB interface;
7. Air conditioning switch;
8. Cooling switch;
9. Fan switch;
10. Cup holder.



1. Wastewater spray and wipers;
2. Lights;
3. Horn;
4. Engine coolant heater (optional);
5. USB charging port: 24V;
6. USB charging port: 12V.

Left Joystick -Cab Configuration



1. Mud pump maximum flow rate (one-button);
2. Mud pump switch;
3. Automatic box rods raising;
4. Automatic box rods lowering;
5. Automatic box rods sending;
6. Automatic box rods retracting;
7. One-button push/pull high-speed;
8. When the "Travel/Work" button is in the working position, pushing the handle forward reverses the power head;
9. When the "Travel/Work" button is in the working position, pulling the handle backward rotates the power head forward.

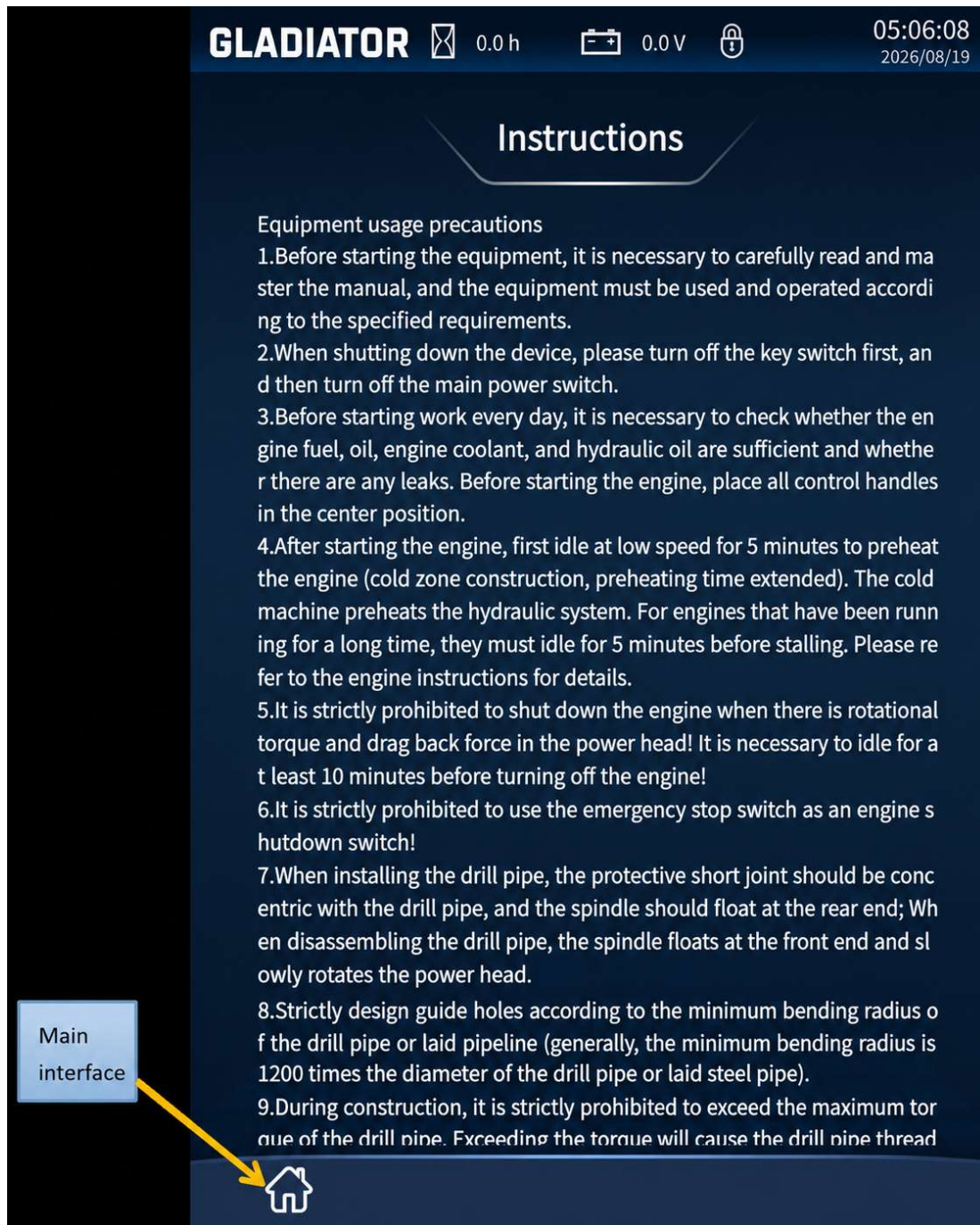
⚠ warning

When pushing or pulling, the transition from a standstill to high-speed movement must be gradual; sudden high-speed starts are prohibited. Similarly, the transition from high-speed movement to a stop must be gradual; abrupt stops are not allowed. Otherwise, damage to the push/pull gears, rack, clamp, and reducer will occur!

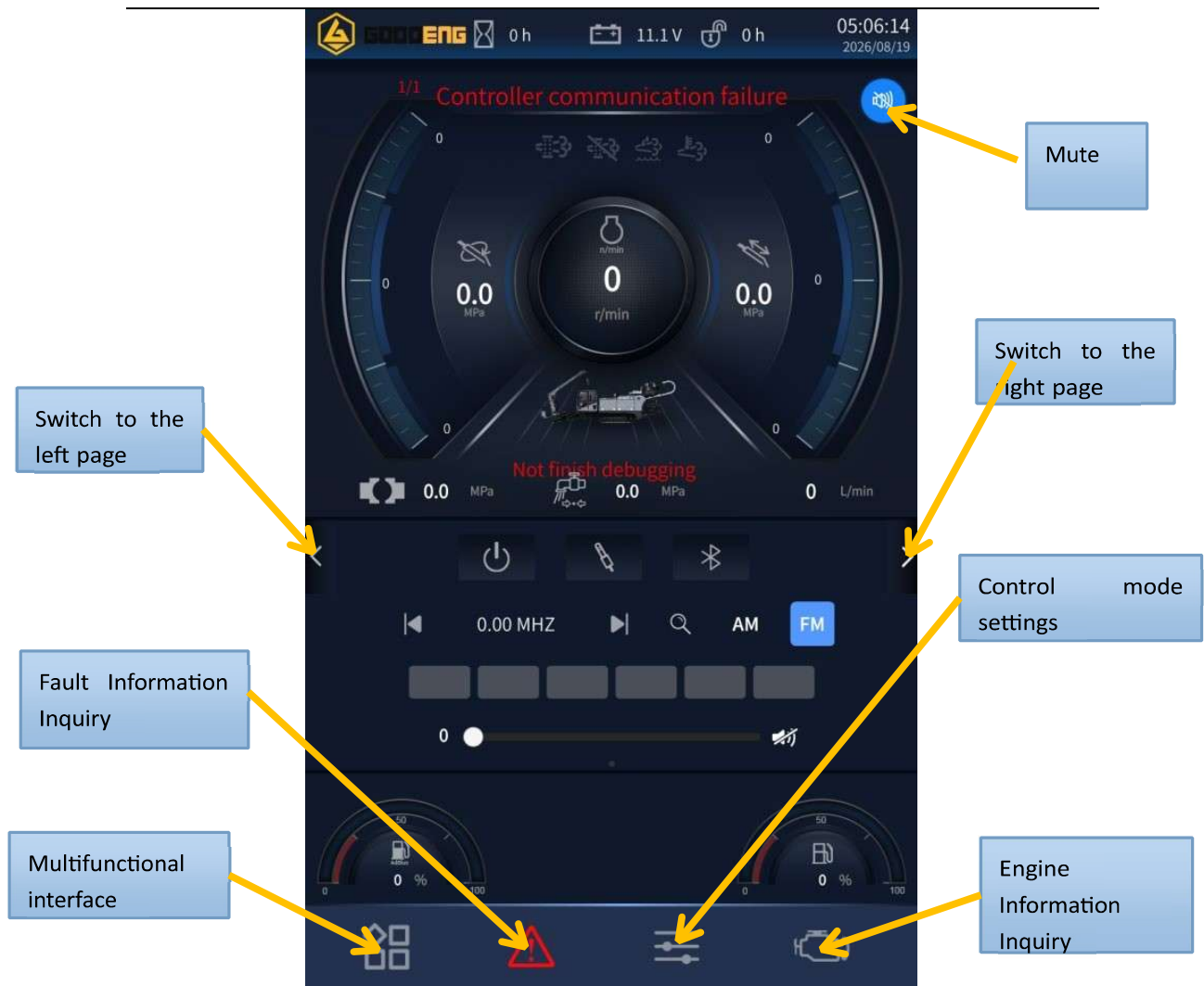
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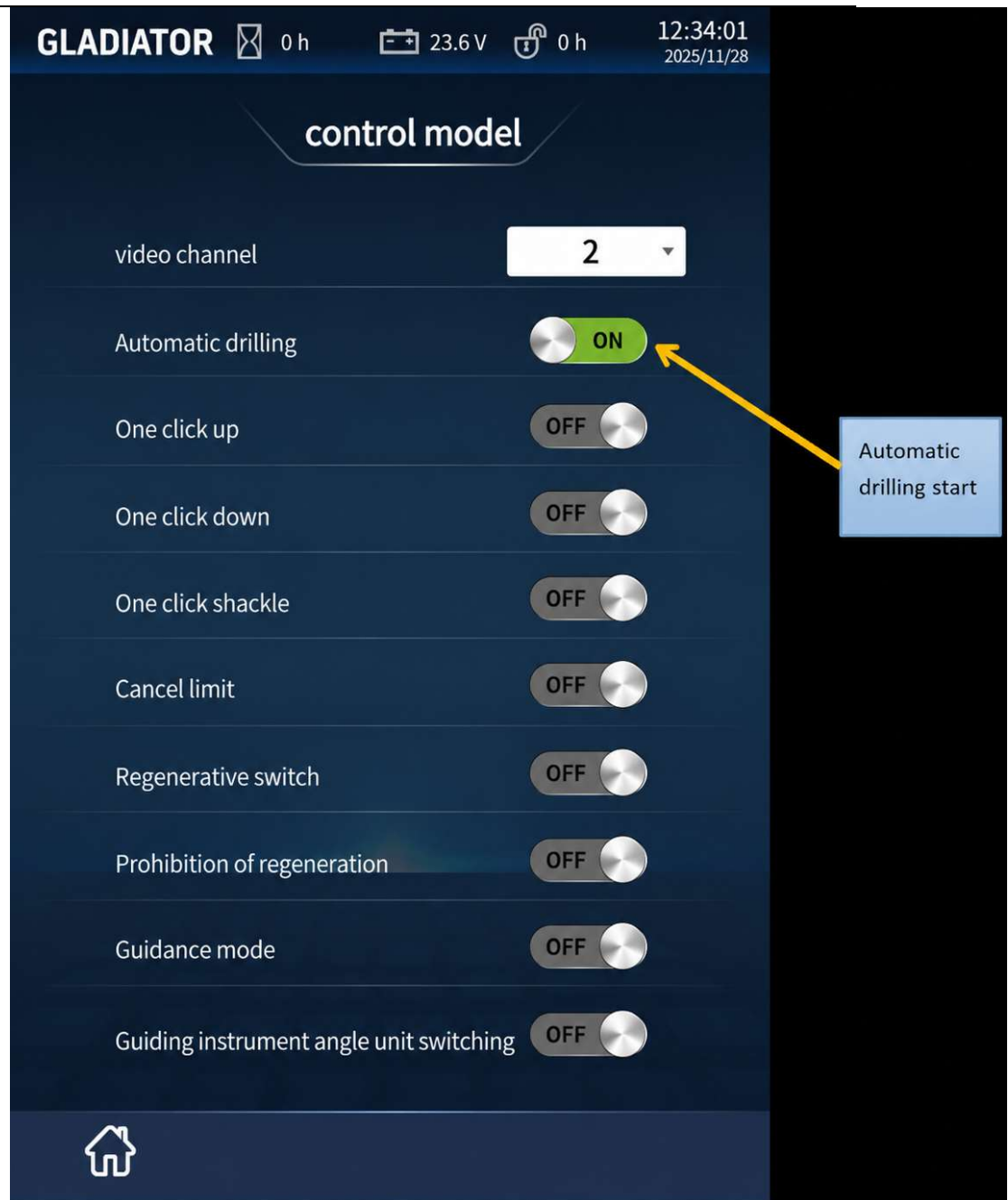
When switching between pushing and pulling, the operating handle should be paused in the neutral position.

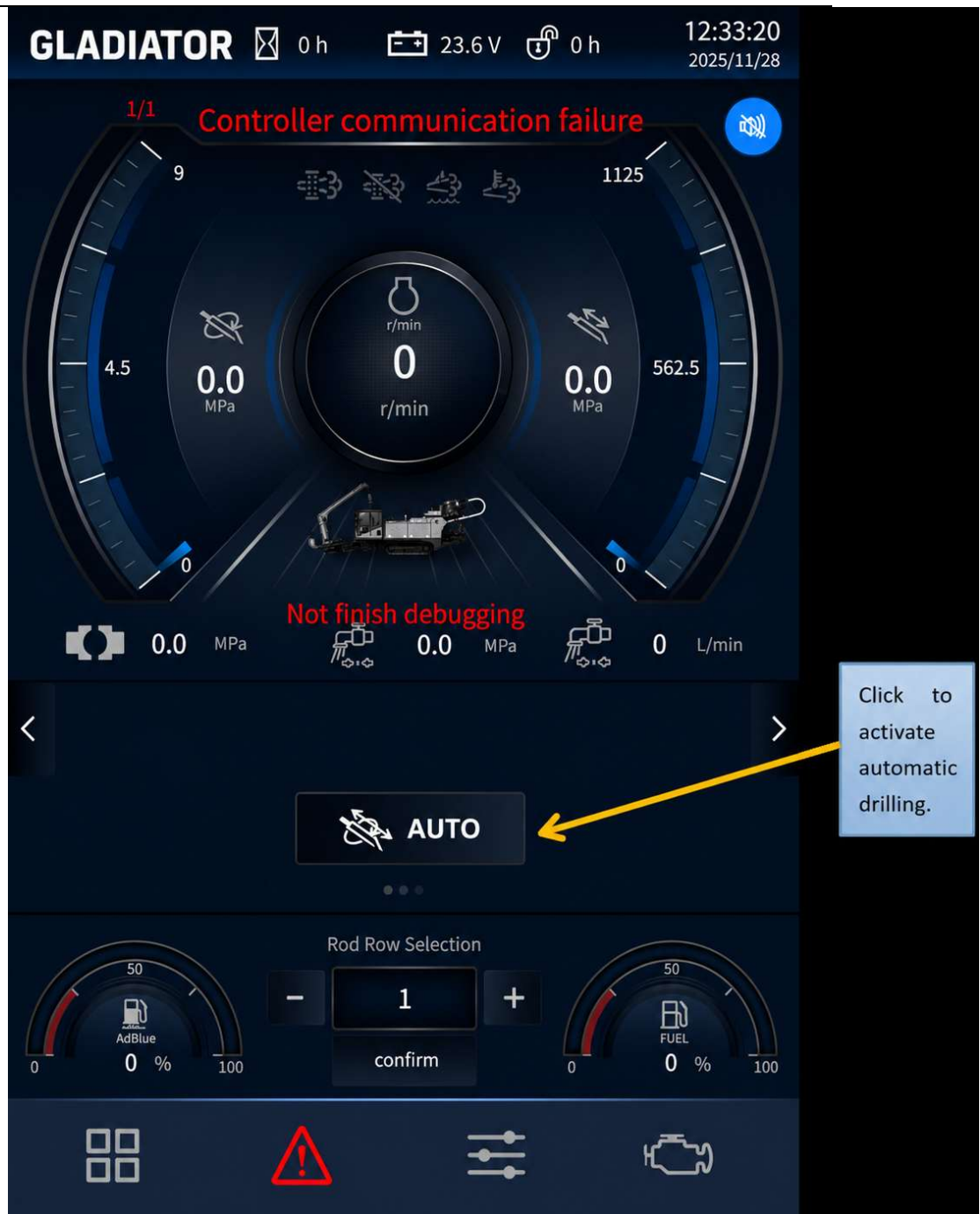
Direct switching is prohibited; otherwise, damage to the push/pull gears, rack, and reducer will also occur!

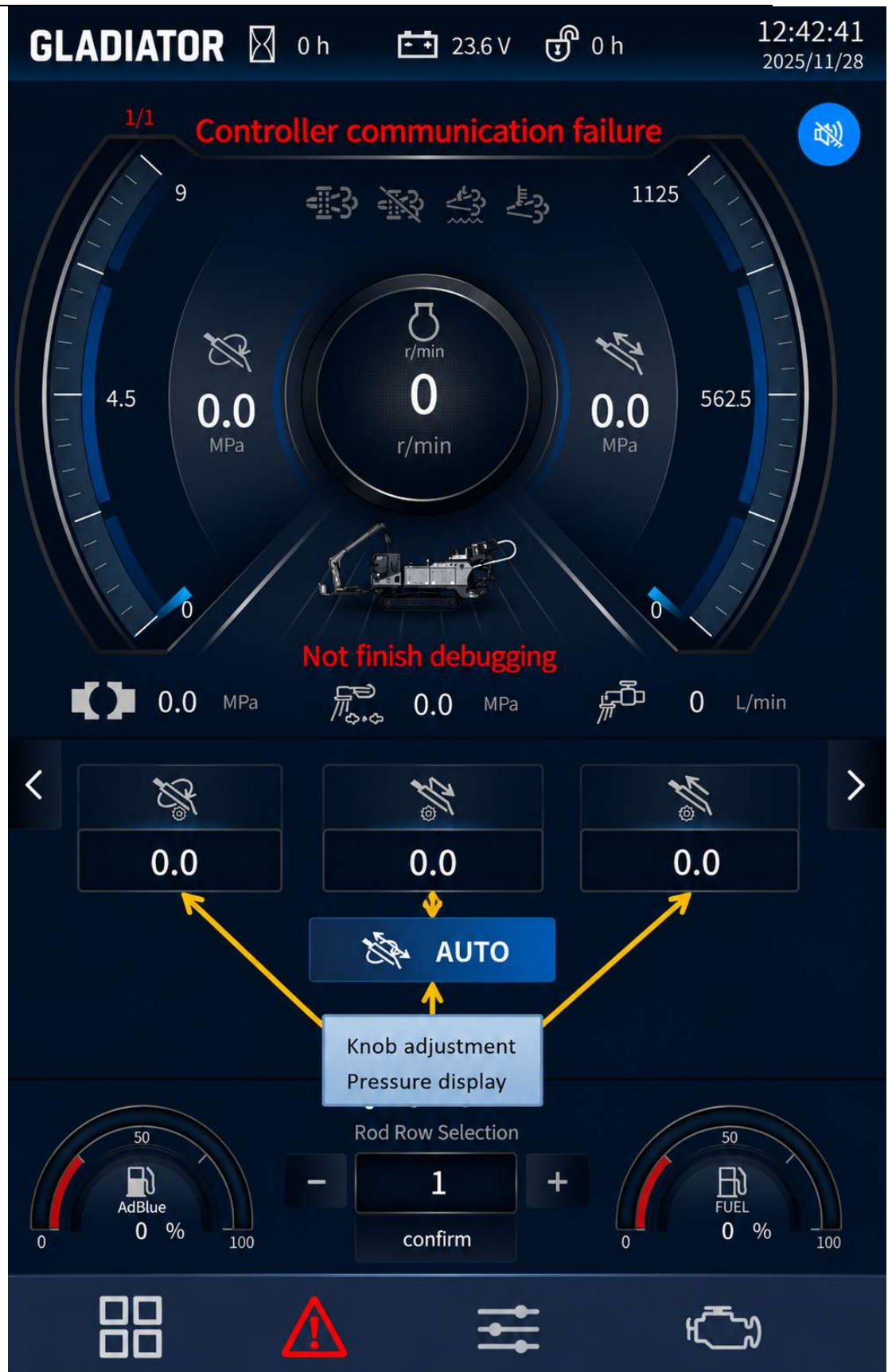
Monitor-Cab Configuration

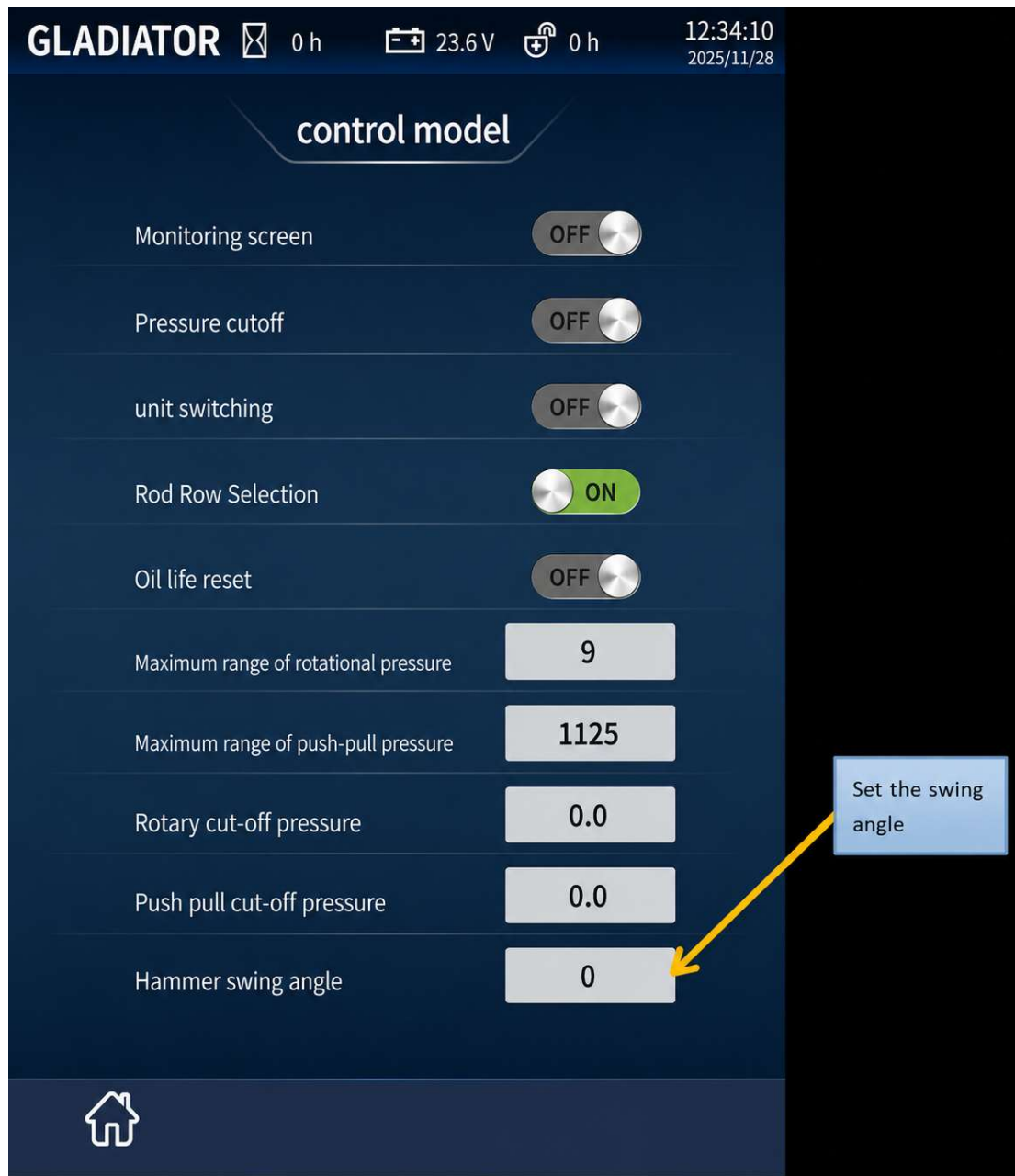
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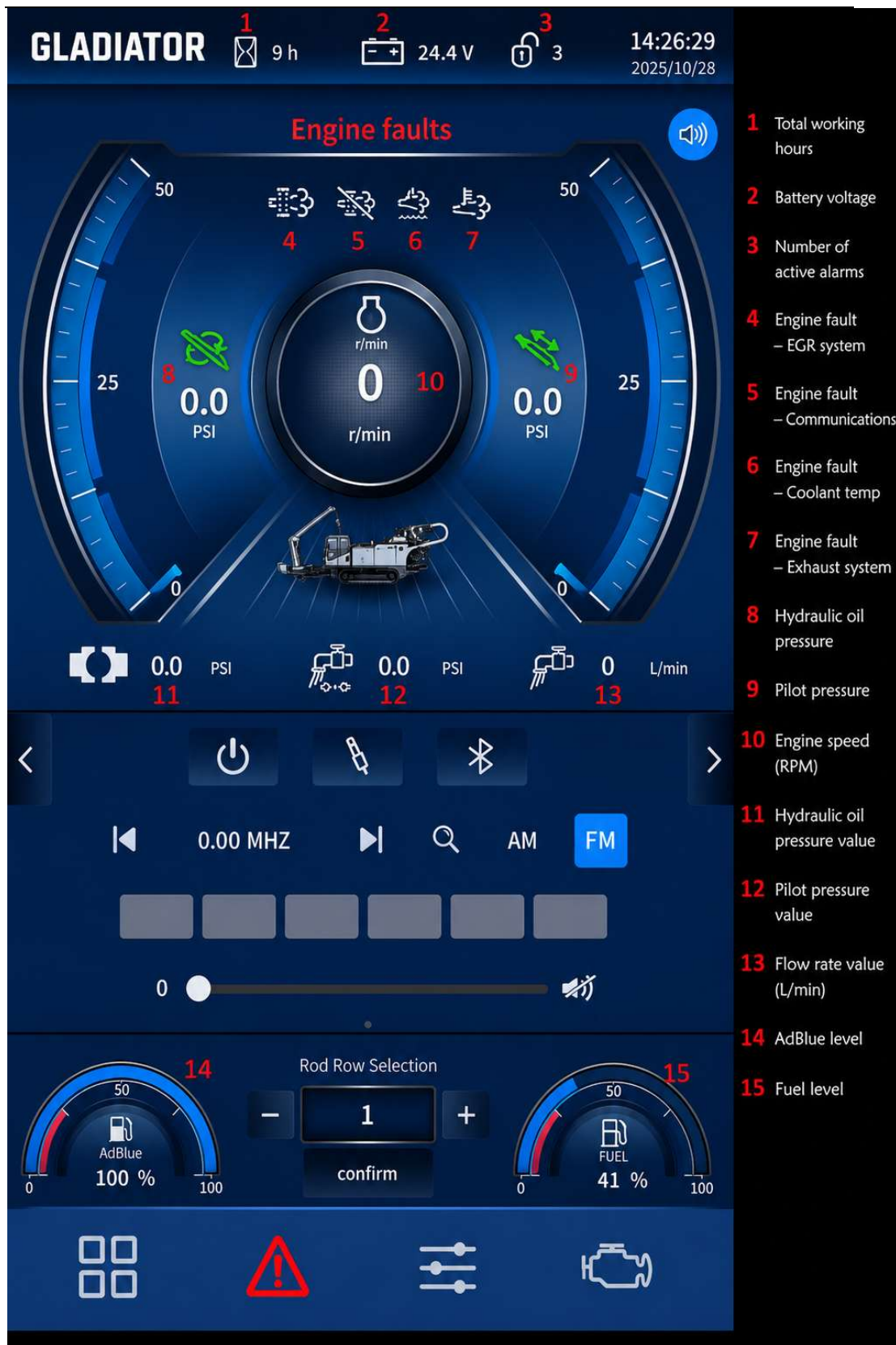




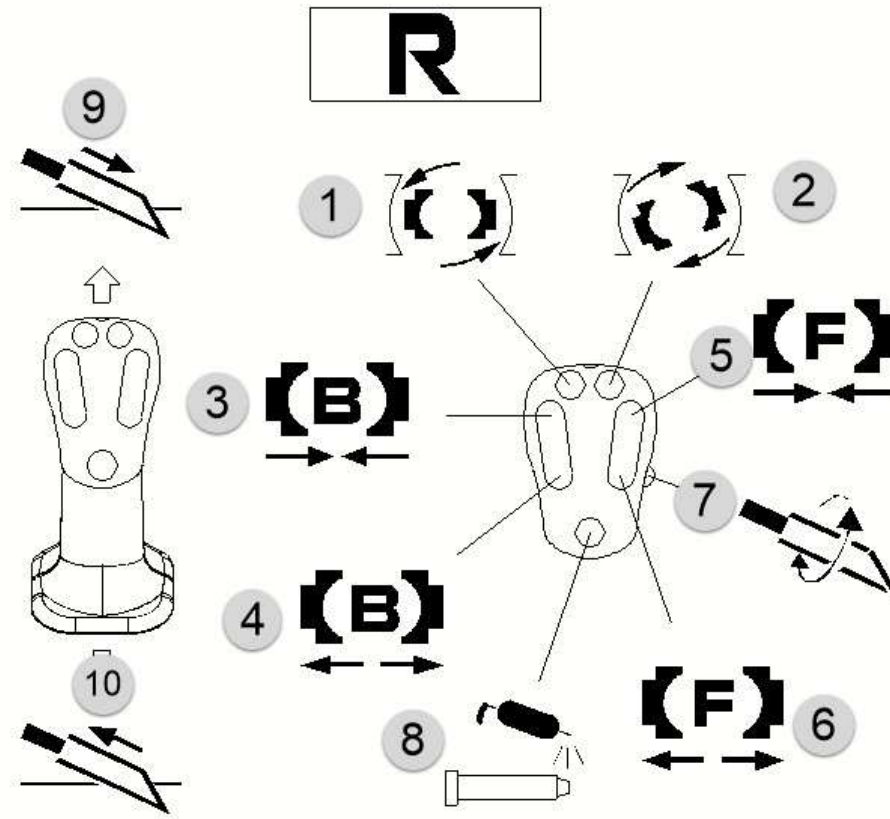




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Right Joystick



1. Clamp release;
2. Clamp reset;
3. Rear clamp tighten;
4. Rear clamp loosen;
5. Front clamp tighten;
6. Front clamp loosen;
7. Hammer pendulum drill (press and hold for 3 seconds to activate, then press and hold for another 3 seconds to deactivate);
8. Spray thread oil;
9. When the "Travel/Work" button is in the working position, push the handle forward to advance the power head;
10. When the "Travel/Work" button is in the working position, pull the handle backward to retract the power head.

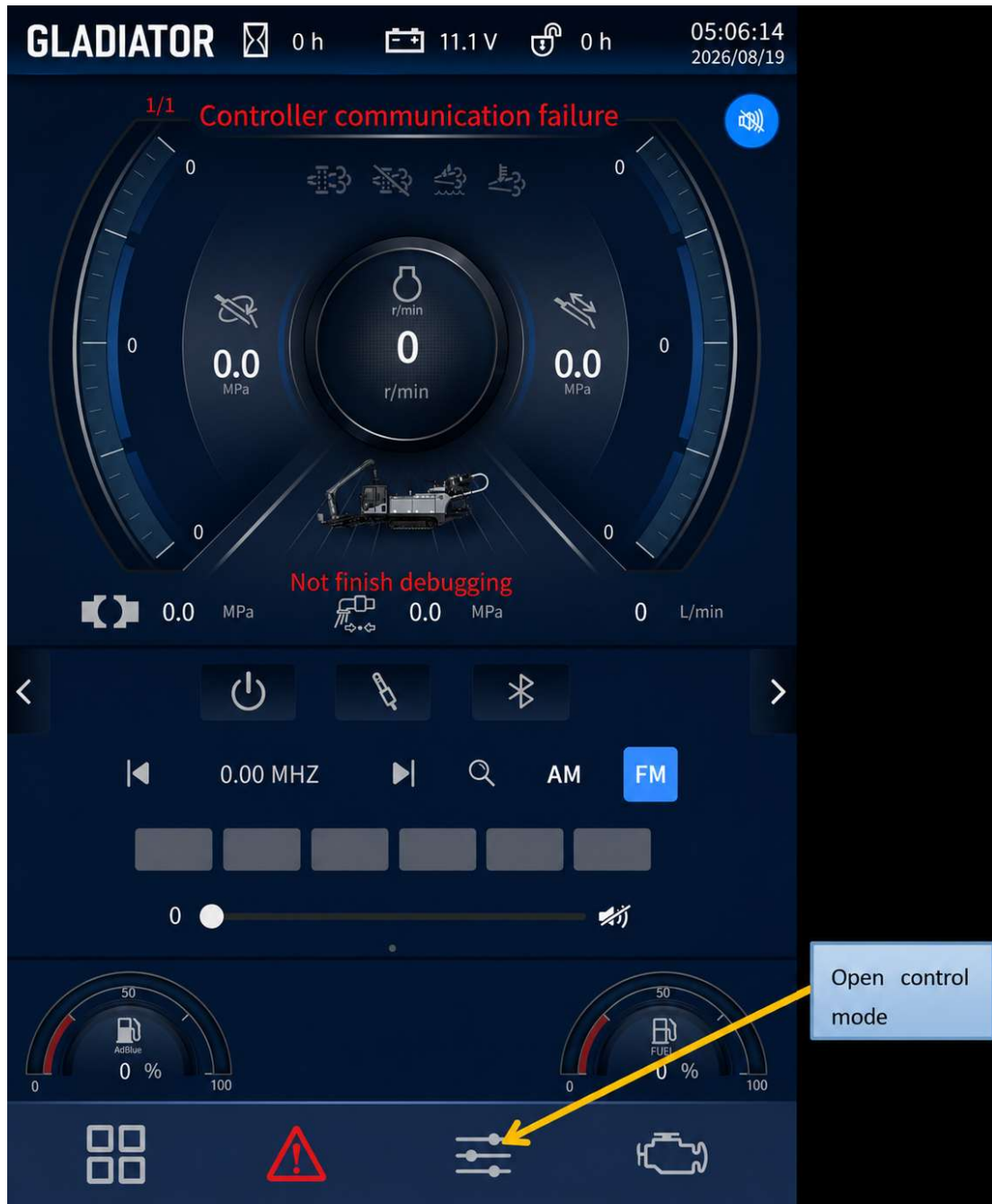
G30 Operation Manual

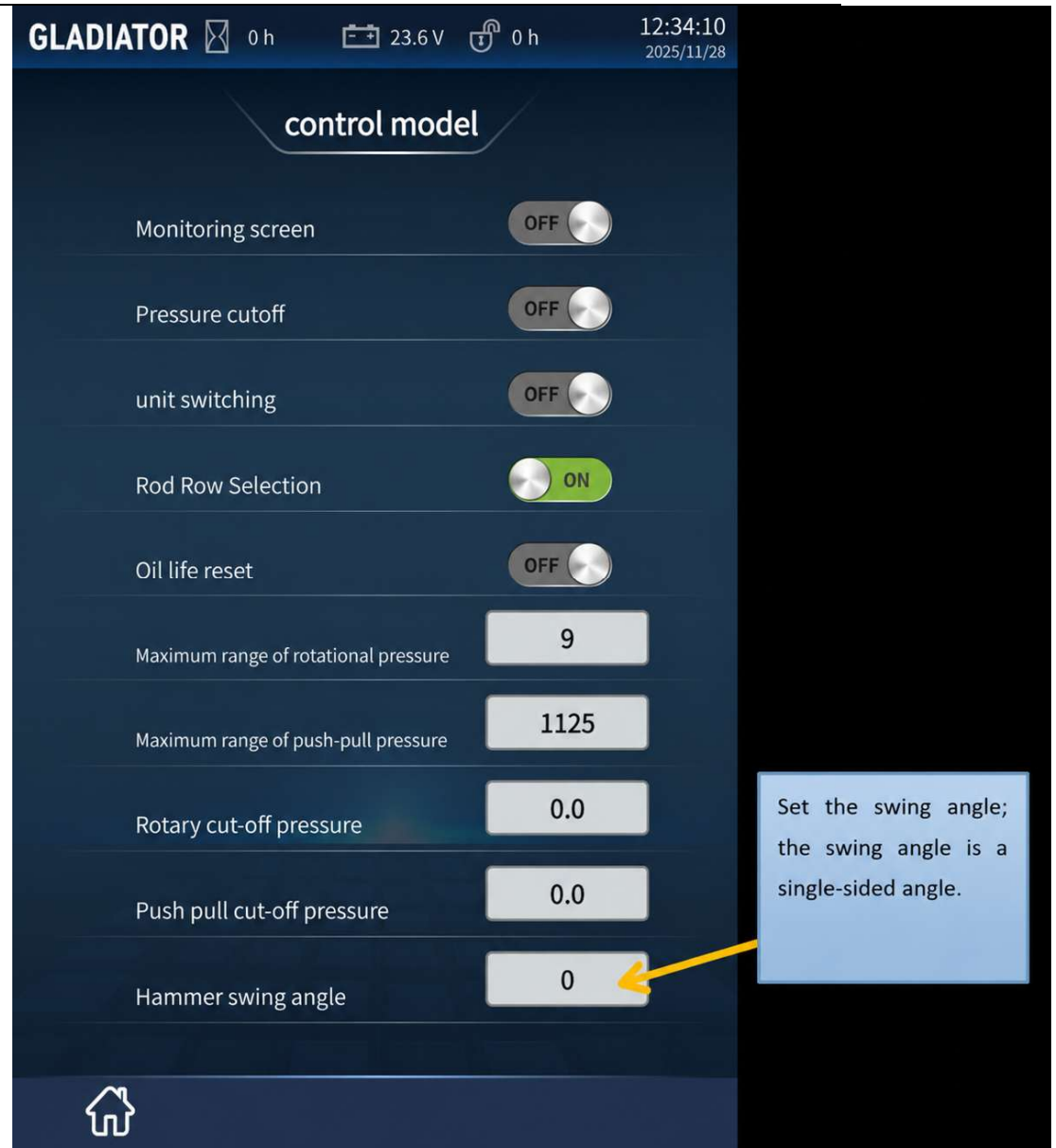
When pushing or pulling, the transition from a standstill to high-speed movement must be gradual; sudden high-speed starts are prohibited. Similarly, the transition from high-speed movement to a stop must be gradual; abrupt stops are not allowed. Otherwise, damage to the push/pull gears, rack, clamp, and reducer will occur!

When switching between pushing and pulling, the operating handle should be paused in the neutral position.

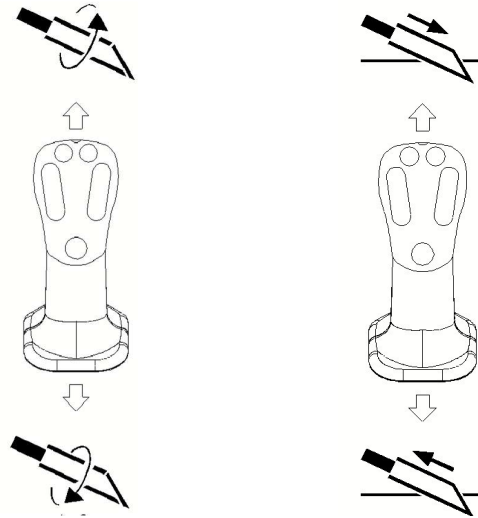
Direct switching is prohibited; otherwise, damage to the push/pull gears, rack, and reducer will also occur!

Automatic swing function operation steps Open the control mode on the monitor's main interface, and set the automatic swing angle within the control mode.





- ① Push the rotary control lever forward to determine the starting point of the swing. Release the rotary control lever and press and hold the swing drill button (button 7 in the figure below) on the right control lever for 3 seconds to activate the automatic swing drill. Control the push and pull control levers to carry out construction according to the needs of on-site construction.



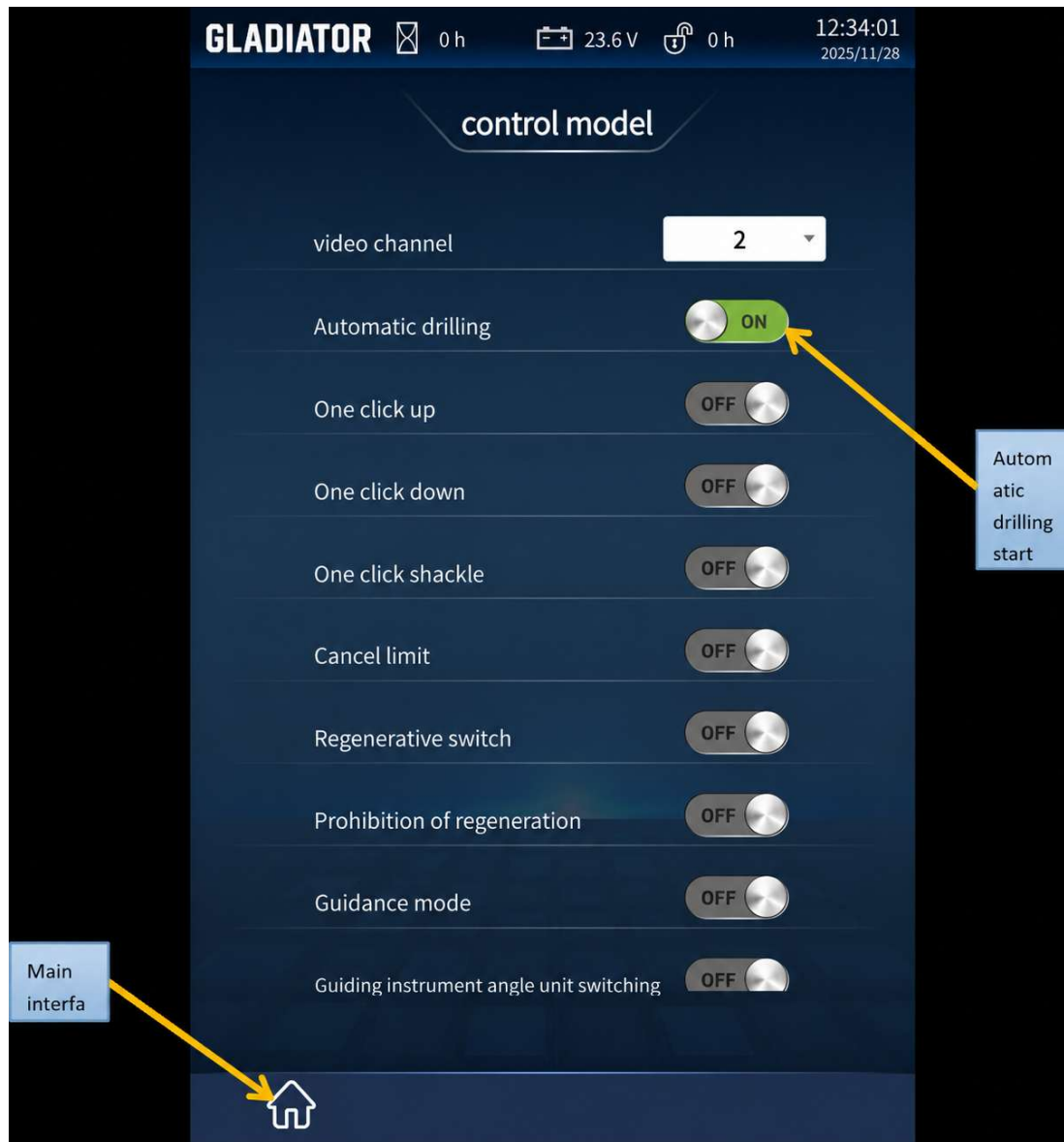
② With the left and right joysticks in the center position, press and hold the right joystick's swing drill button for 1 second to pause or end the automatic swing action.

To restart the automatic swing action (with the swing angle unchanged), repeat step ② (the swing system automatically remembers the last angle). To reset the swing angle, repeat steps

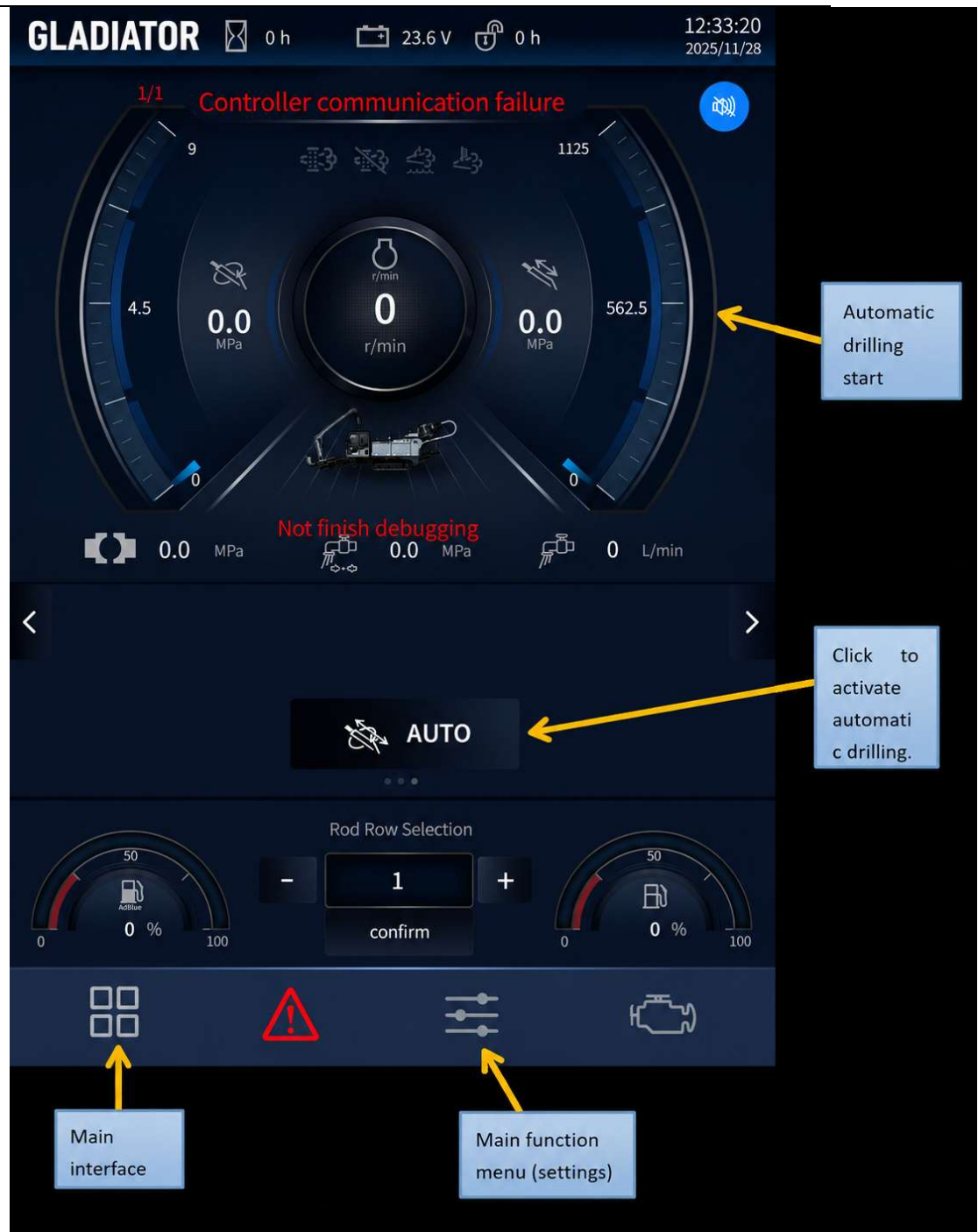
① and ②.

Automatic drilling operation steps

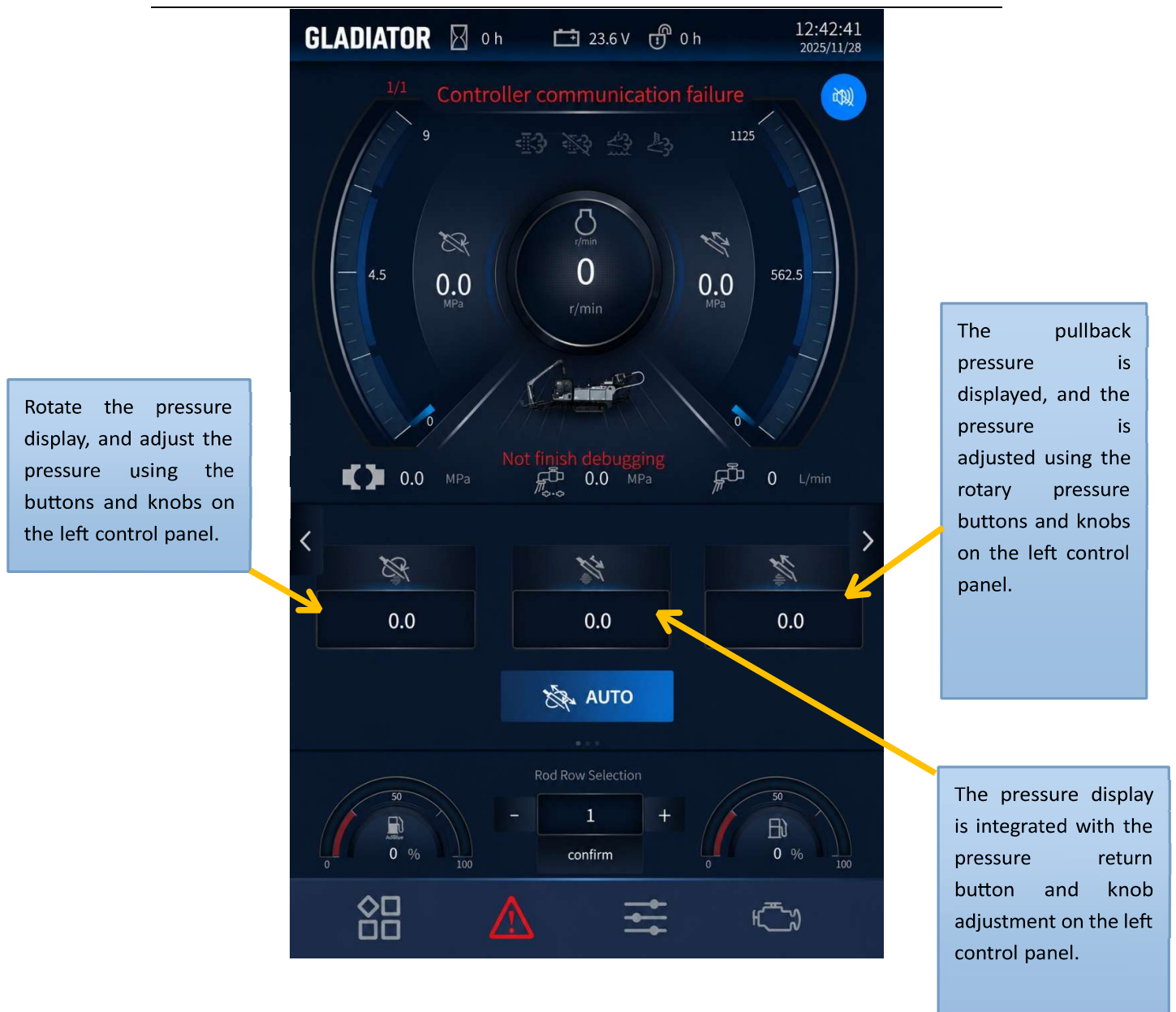
- ① Open the control mode on the main screen of the monitor and turn on automatic drilling.



- ② Tap the main interface button to return to the main interface, then tap the "AUTO" button to activate automatic drilling.



- ③ On the control panel, press the drag/rotate/push pressure setting button, and adjust the corresponding pressure using the pressure value adjustment knob.

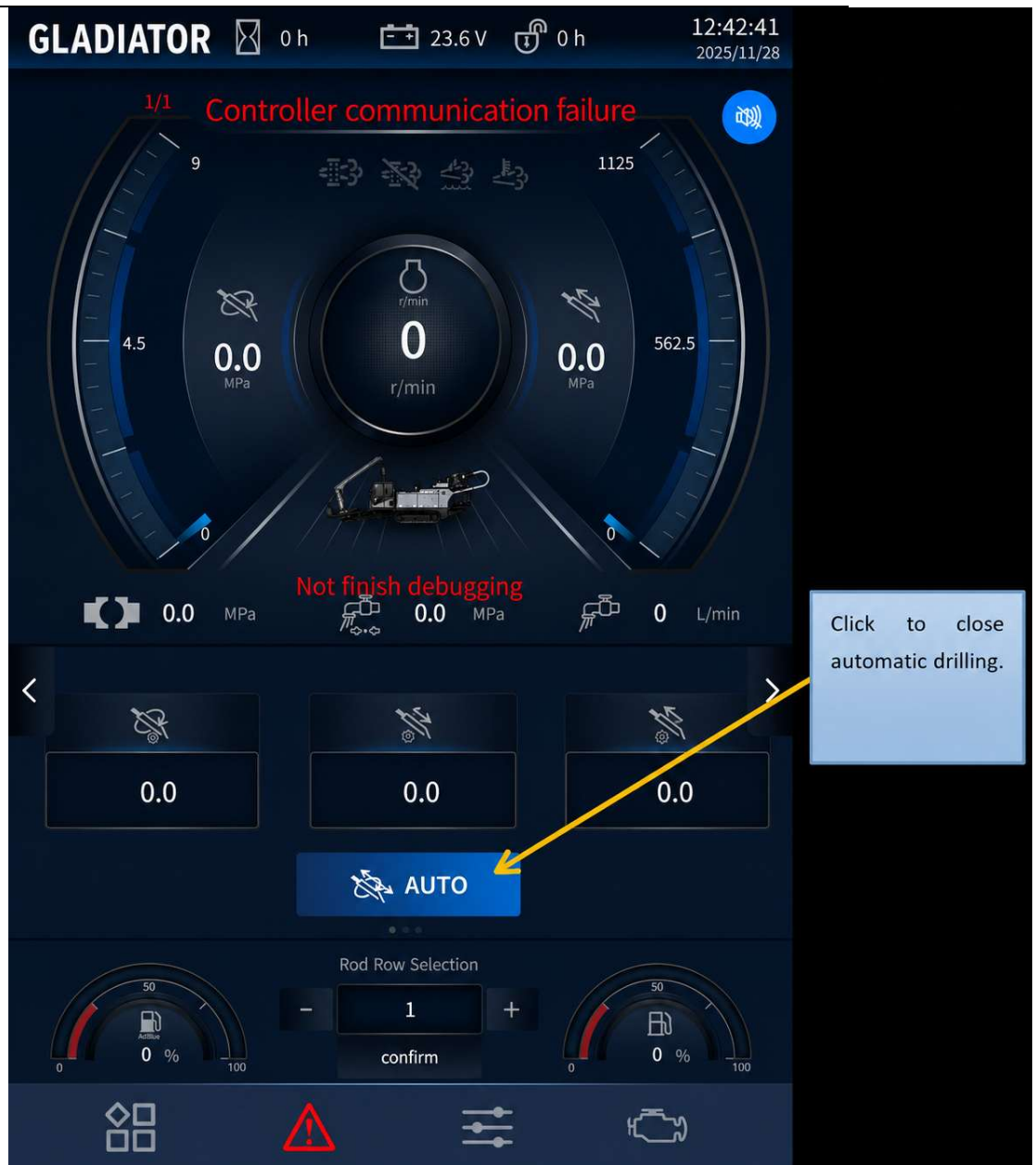


- ④ Control the push/pull/rotate handle, select the push/pull/rotate direction, and begin construction.



- ⑤ Return the push/pull/rotate handle to the neutral position, click the "AUTO" button on the main display interface to turn off automatic drilling, and then click the parameter settings interface on the screen to turn off the automatic drilling function.

To restart automatic drilling (with the rotation/push/pull pressure unchanged), repeat steps ①, ②, and ④ (automatic drilling data is automatically memorized); to reset the automatic drilling pressure, repeat steps ①-④.



BW-180 Mud Pump

Warning: When this pump is used to transport easily solidifying mud, if the pump is to be stopped for an extended period, it must be thoroughly cleaned with water to prevent the mud from solidifying and damaging the pump. Otherwise, the customer will be solely responsible for any consequences.

The drilling fluid used in this pump should not contain any chemical impurities that corrode metals or rubber components, and the temperature should not exceed 50°C. The recommended mud specifications are: specific gravity 1.03–1.12, viscosity 18–25S, sand content not exceeding 2%, maximum sand particle diameter not exceeding 1mm, pH value 7–8, and the mud must be free of mud clumps, weeds, leaves, etc.

BW-180 Mud pump technical specifications

Item	Parameters	
Type	horizontal, triplex, single acting reciprocation piston pump	
Cylinder dia. (mm)	70	
Stroke (mm)	60	
Pump speed (r/min)	260	103
Flow rate (L/min)	180	71
Pressure (MPa)	3.2	8
Max. Suction lift (m)	2.5(fresh water)	
Inlet port	2"	
Discharge port	1"	

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Size (L × W× H)	761×622×860mm
Weight(Kg)	252
Motor	2K604-0041
Hydraulic motor pressure(MPa)	17

Use and maintenance of BW-180 mud pump

The service life of a pump depends not only on its design and manufacturing but also on its operating conditions, operation, and maintenance. To ensure continuous and normal operation, this instruction manual must be strictly followed.

- ◆ 1) Precautions for Use
- ◆ The pump should be installed stably and reliably, secured with anchor bolts, and placed on a stable and firm surface.
- ◆ The pump's installation location should ensure the operator's safety and convenience. A water tank, return water trough, and sand and sludge removal device should be provided according to the site requirements, and the suction length and suction height should be minimized as much as possible.
- ◆ Operators must not leave the pump unattended while it is running.
- ◆ The pump's normal operating pressure must not exceed 80% of the rated pressure. When operating under the highest pressure condition, continuous operation time shall not exceed 1 hour;
- ◆ The safety valve device must not be removed. The opening pressure has been calibrated at the factory and should not be adjusted arbitrarily;
- ◆ The unloading valve must not be used for flow regulation, otherwise the tee will be quickly damaged and the pump's performance will be compromised;
- ◆ The pump must not operate without flushing fluid, otherwise the piston will be easily damaged;
- ◆ Ensure the hydraulic motor rotates clockwise (directly opposite the motor shaft);
- ◆ When assembling or disassembling parts, it is forbidden to strike parts with a hammer or iron bar. If striking is necessary, a wooden block or copper rod must be used as a pad.
- ◆ 2) Preparations before starting the pump

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-
- ◆ After the pump is installed or has been out of service for a long time, the following preparations must be made:
 - ◆ Check the flushing fluid suction pipe and filter. The suction pipe must be sealed and airtight; the filter suction hole must not be blocked by dirt, and the valve should open and close freely. During operation, the filter must be submerged 0.3-0.5m below the flushing fluid surface, and the distance from the bottom and wall of the flushing fluid pool should be greater than 0.5m.
 - 1) Check that the suction height does not exceed 2.5m (for clean water). For high-concentration flushing fluids, the suction height should be reduced accordingly, and the suction pipe length should not exceed 5m.
 - ◆ Add the specified grade of lubricating oil or grease to the pump body and all oil cups and nozzles in a timely manner, ensuring the oil level is appropriate.
 - ◆ Check the tightness of all components and parts, especially the connection between the piston, crosshead, and piston rod.
 - ◆ Check that the pressure gauge is intact and that the pointer has returned to the 0 position.
 - ◆ Fully open the unloading valve to ensure the pump is unloaded when starting.
 - ◆ 3) Starting and Stopping the Mud Pump.
 - ◆ According to the label on the cover plate, move the speed control lever to the desired pump speed and flow rate setting.
 - ◆ Start the hydraulic motor and bring it to normal operating speed.
 - ◆ Before stopping the pump, gradually open the unloading valve to unload the pump, and then stop the pump.** 4) Maintenance and Upkeep of the Mud Pump.
 - ◆ Before starting the mud pump each shift, a thorough inspection should be performed according to the "Preparatory Work Before Pump Start-up" procedure.
 - ◆ The pump's operating pressure should be strictly controlled according to the nameplate indication. Continuous operation at the rated maximum pressure should not exceed one hour, and the continuous operating pressure should be controlled within 80% of the rated pressure.
 - ◆ The fit between the piston and cylinder liner should be properly tightened to prevent leakage of flushing fluid; otherwise, adjustments or replacements should be made promptly.
 - ◆ Rubber parts should be stored in a cool, dry place with minimal temperature fluctuations (room temperature should be within a certain range). Store indoors at temperatures between 10 and 25°C, in low light, preferably without ultraviolet radiation (window glass should be painted red or orange-yellow, not blue), and for no more than six months
 - ◆ Metal parts such as piston rods, cylinder liners, crosshead sleeves, crossheads, and inlet/outlet valve seats should be stored in a dry room free of corrosive gases and coated with anti-rust oil or wax. Before use, remove the wax and clean thoroughly, checking for scratches and burrs, especially on working surfaces in contact with rubber parts. Apply lubricant during assembly.**
 - ◆ For long-term pump shutdowns, all water and oil in the pump must be completely drained.** Clean the mud, sand, and dirt from all components, and apply grease to the following parts: crankshaft journals, gearbox shaft, gears, crosshead, crosshead sleeve, pins, piston rods, valve covers, cylinder heads, valve seat bores, and the valve stems of safety valves and the valves and seats inside unloading valves, etc.

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- ◆ In cold winters or in cold regions, when the pump is shut down for an extended period, the flushing fluid inside the slurry pump and in all pipelines must be drained to prevent the equipment from freezing and cracking.
- ◆ To ensure the normal operation of the slurry pump, the pump's operating condition must be checked regularly, and any problems found must be eliminated promptly to avoid accidents. The maintenance cycle is shown in the table:

Checking points	Inspection time
1. Check the general condition of all the connections between different components, the mounting of pump to foundation, and the oil level of the lubrication oil inside the pump body.	1. Every working shift.
2. If or not the suction and discharge hoses are well fastened and sealed, or being blocked.	2. Every working shift.
3. The connection condition between piston, piston rod and crosshead.	3. At least once a week.
4. The anti-dusty seals of the inlet/outlet valves and connection rod.	4. Check as appropriate
5. Connecting rod bearings, gears and safety valves.	5. Once every 2 months.
6. Periodically disassembly, cleaning and inspection of different parts.	6. Once every 6 months.

Disassembly and Assembly of Wear Parts in Mud Pumps

- ◆ The pump can be disassembled as a whole or in parts; that is, it can be disassembled as a whole during major overhauls, and partially disassembled during maintenance or troubleshooting. ◆ 1) Disassembly of Wear Parts
- ◆ Piston: First, remove the cylinder head pressure plate nut, loosen the piston lock nut and piston pressure plate on the cylinder liner inner tie rod, then use a piston removal tool to screw into the piston seat, and use a hammer to repeatedly impact and remove the piston;
- ◆ Cylinder Liner: First, remove the pump head, remove the piston, and then the cylinder liner can be pushed out;
- ◆ Piston Rod Seal: After removing the cylinder liner, loosen the piston rod connection with the crosshead, disassemble the piston rod, and then open the pressure cap on the piston rod seal to replace the tie rod seal;
- ◆ Safety Valve: Open the upper cover, loosen the adjusting screw, remove the valve cover, and then replace the spring, valve, and valve seat;
- ◆ Unloading Valve: First, remove the handle rod, then loosen the flat nut, round nut, and sealing ring nut, etc., and then replace the V-ring seal, sealing ring seat, screw rod, and valve, etc.

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Loosen the connecting bolts between the upper and lower housings to replace the valve seat.

2) Assembly of Wear Parts.

- ◆ The tightening torque of the connecting rod screws should be 45~59 Nm, and a locking washer should be used to secure them.
- ◆ All connecting bolts and nuts should be tightened securely; there should be no looseness.
- ◆ When assembling the inlet and outlet valve seats, pay special attention to ensure that there are no foreign objects on the mating surfaces of the valve seat holes and the valve seat. After the valve seat is installed and tightened, there should be no looseness.
- ◆ When installing the piston, first place the clamping washer on the piston seat, then screw the piston seat onto the piston removal tool. When installing, be careful to rotate the piston seat to lock it into the pull rod to prevent rotation. Then loosen the piston removal tool and remove it. Install the piston according to the structural diagram. (When installing the piston, pay attention to the tightness of the thin nut; after hand-tightening, use a lever to tighten it another 1/4 to 1/2 turn). After running the machine for a few minutes, touch the cylinder liner to check for heat. If heat is found, the cylinder head needs to be disassembled again, and the hexagonal thin nut securing the piston needs to be loosened half a turn. Adjust until it is normal and does not overheat.

Lubrication of mud pumps

Pump lubrication is very important. To ensure the pump can work continuously and normally and reduce the wear of moving parts, lubrication should be performed regularly as listed in the table below. After a new pump has been working for 80 hours, the pump body must be cleaned and the oil changed. Thereafter, the oil must be changed every 200 hours.

Name of lubricated parts O	Brand of lubricating oil (grease)	Remarks
Gears and bearings in the pump body	15W-40 Diesel engine oil	All the time

Mud pump fault analysis and troubleshooting

Faults	Possible cause	Solutions
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The pump fails to reach the required displacement or cannot deliver the flushing fluid at all	1. Water filter is out of liquid. 2. Water filter is blocked. 3. Suction pipe is blocked. 4. Suction pipe is poorly sealed and air inside. 5. Intake valve or discharge valve does not work. 6. Piston or cylinder liner worn. 7. Suction pipe is not full of water or has air. 8. Suction height is over allowable value. 9. Suction pipe is too long or its diameter is too small. 10. Drainage gate is closed.	1. Make water filter into the liquid and no less than 0.3~0.5m. 2. Take it out and clean. 3. Take it apart and clean. 4. Check the connection and hose, and try to eliminate faults. 5. Replace the worn or failed valve parts, or clean the valves if blocked by muds and sands 6. Fasten the nut or replace the parts with new ones 7. Fill with water and eliminate air. 8. Lower suction height to under 2.5 m (for slurry, under 1 m). 9. Reduce the length within 5 m or increase pipe diameter to proper size. 10. Open the gate.
The pump runs difficultly	1. Piston and liner are assembled with too big interference fit value, or sealed tightly. 2. Connecting rod bearings are installed tightly. 3. Piston, connecting rod and cross head are skewed.	1. Loosen nut to reduce the interference. 2. Check fit clearance and eliminate fault. 3. Check and eliminate fault. 4. Check and tighten.
	4. Some connecting parts loosen.	

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The pump runs with abnormal noise	1. T Connection rod bush too loose or the gap is too big ; 2. The connection between cross head and piston rod is loosen. 3. Bearing and other parts are broken. 4. The valve lift is too big and cavitation appears.	1. Tighten the bush or change for new bush. 2. Check and tighten. 3. Check and change parts. 4. Lower the lift to 6~7 mm.
Pressure fluctuation rapidly	1. Some piston or cylinder liner is wearing. 2. Some valve seat or valve is wearing. 3. There is clearance between valve seat and valve seat hole. 4. Delivered medium contains much of air. 5. Water filter is blocked or out of fluid level. 6. Suction system is not sealed well. 7. The valve of some cylinder liner works abnormally.	1. Check and change for new part. 2. Check and change for new part. 3. Eliminate clearance. 4. Find reason and eliminate it. 5. Take it out to clean and make it down into the fluid. 6. Check and eliminate fault. 7. Check valve and valve seat.

Cylinder Bore (mm)	70	
Handle Position	快	慢
Pump Speed (r/min)	260	103
Flow (L/min)	180	71
Pressure (MPa)	3.2	8

The speed control lever must be set to the corresponding marking to achieve the corresponding pump speed.

The machine must be stopped when changing speeds.

For example, to achieve the "fast" speed, simply set the lever to "fast".

Preparation

Site Preparation



Drilling operations may require the construction of an exit side receiving pit. Pit bodies with a risk of collapse can lead to serious casualties. Construction must strictly comply with relevant national and local laws and regulations.

Allowable operating slope for G30

- Maximum lateral slope: 5°;
- Slope in the direction of travel: $\leq 16^\circ$.

- Excavate the exit side receiving pit according to the site conditions (specific requirements refer to Section 7 of Chapter 2 "Construction Specification for Exit Side Receiving Pit").
- Excavate a mud return pit at the equipment entry site.

Electric safety distance management:

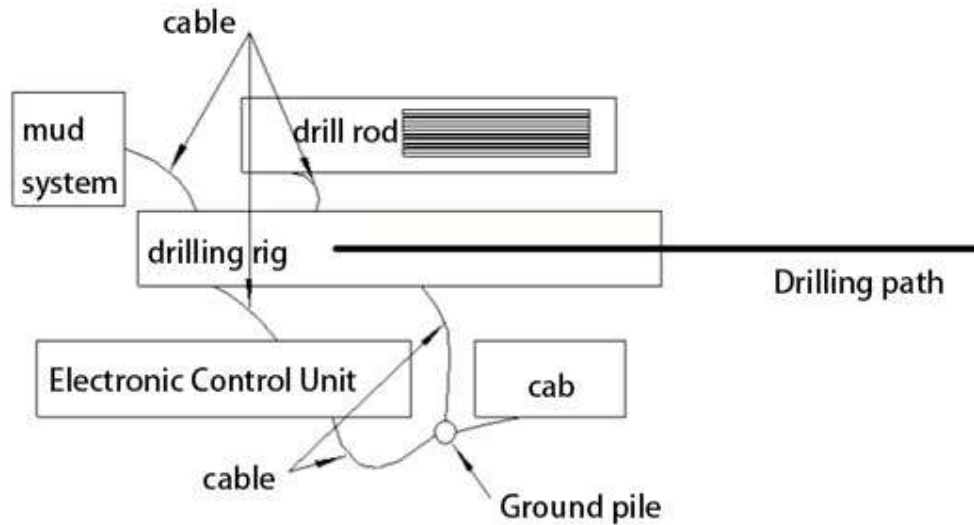
- Accurately measure and clearly mark the live safety net distance (see Chapter 2, Section 20 "Hazardous Areas - Safety Distance").
- Set up safety isolation belts around the dangerous area and prohibit unrelated personnel from approaching.

Personnel who are not wearing compliant protective equipment are strictly prohibited from entering the area.

Vegetation cleaning at the power operation site:

- Remove all vegetation (shrubs/weeds, etc.) around the operation station.
- When an electric shock accident occurs, vegetation may form conductive channels, posing a risk of secondary electric shock.

Site Layout



Hydraulic Cranes

When carrying out the final positioning installation of the drilling machine and power unit (PSU) in a restricted work environment, a bridge crane is required. The handling of drill rods and downhole tools can be done using cranes or excavators.

Prevention and control of subsidence

In the following working conditions, it is necessary to use shims or brackets to support the drilling machine and prevent equipment subsidence:

- Soft soil foundation operation ($N \text{ value} \leq 10$ standard penetration)
- Long term stationed construction (≥ 30 days)
- Freeze thaw cycle period (refer to GB/T 50123-2019 "Standard for Soil Test Methods" for freeze-thaw test requirements)
- Material: Hardwood (compressive strength $\geq 50\text{MPa}$) or composite material (ASTM D6108 certification)
- Size: Length x Width x Thickness $\geq 2\text{m} \times 0.5\text{m} \times 0.2\text{m}$
- Layout spacing: ≤ 1.2 times the distance between equipment tracks/legs
- Adopting hydraulic leveling steel bracket (bearing capacity $\geq \text{equipment weight} \times 1.5$ times safety factor)

-The bottom is equipped with anti-slip plates (friction coefficient ≥ 0.4), and the weight and grounding pressure of the equipment are detailed in Chapter 16 "Technical Indicators" (including rated grounding pressure parameters under no-load/full load conditions).

Protection of Wires, Cables and Hoses

The control device of the drilling machine is connected to the directional drilling machine through hydraulic hoses and cables, and the following protective measures must be taken: - Laying cables and hydraulic hoses in an overhead manner to avoid the risk of tripping by operators.

-Ensure that cables and hoses are kept away from water accumulation areas and drip locations.

-Avoid sharp edges and areas that may cause damage.

-Support and fix the cable to prevent the connector from being subjected to force due to the weight of the cable.

-The self weight tension of the cable may cause interface damage or poor contact.

-When disconnecting the cable, the connector should be pulled and the wire body should not be dragged directly.

Making Power Connections

Important Warning:

- Using hydraulic hoses or cables over 30.5 meters may cause control signal delay or distortion.
- Before making electrical connections, cut off all power sources in the system.

When connecting hydraulic hoses and cables, please follow the following best practices:

- Remove the interface protection cover.
- Ensure that the joint is clean and free of debris (metal shavings, mud, etc.).
- Hydraulic joint cleaning: Refer to Chapter 13 "Hydraulic Joint Cleaning Standards".
- Electrical connector cleaning: Refer to Chapter 13 "Electrical Connection Cleaning Standards".

(Note: It is recommended to use anhydrous ethanol and ultra-fine fiber cloth for cleaning)

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Crew

Basic operation team:

- Driller operator

- Operation position: Operator console (configured in the cab)

- Duties: Execute the prescribed drilling machine operation procedures

- Drilling locator

- Equipment configuration: Electronic Measurement Drilling System (MWD)

- Responsibilities: Real time calibration of drill bit trajectory (horizontal positioning accuracy $\pm$)

0.3m@10m Depth)

Expand work team:

1. Personnel on the entry side

- Crane operator: holding Q8 special equipment operation certificate

- Pipeline operator: implement trenchless pipeline construction specifications

- Guidance specialist: responsible for complex geological trajectory correction (minimum curvature radius $\geq$ 40 times the pipe diameter)

- Excavator operator: meets the safety requirements of hydraulic excavators

- Mud station operator: Monitor mud parameters (density 1.05-1.25g/cm³, viscosity 35-45s)

2. Personnel on the export side

- Certified welder: certified by the Special Equipment Welding Operator Assessment Rules

- Pipeline docking group: using laser alignment instrument (accuracy $\pm$ 0.1mm/m) -
Crane commander

The Bore Path

Core considerations

- Equipment positioning:

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Determine the optimal layout position of the drilling machine based on comprehensive terrain conditions and operating radius

- Incident angle setting: optimize the initial drilling angle based on geological characteristics and target depth
- Drill pipe bending limit: follow the curvature radius parameters provided by the manufacturer (usually ≥ 40 times the pipe-diameter)
- Pull back pipe restriction: simultaneously verify the tensile strength ($\leq 60\%$ yield strength) and bending stress ($\leq$ elastic limit) of the pipe
- Drill rod specification matching: optimize trajectory segmentation design based on single length (commonly 6m/9m/12m)

Underground pipeline avoidance: precise positioning of urban underground pipeline detection technology regulations On site execution standards

1. Trajectory identification

-Before construction, mark the drilling trajectory and pipeline position with ground paint (error

$\leq \pm 0.3\text{m}$)

-Set up 3D control stakes (plane accuracy $\pm 10\text{mm}$, elevation accuracy $\pm 5\text{mm}$)

2. Drilling control

-Initial two drill rods maintain straight drilling (deviation rate $\leq 0.5\%$)

-Avoid sharp turning maneuvers (recommended turning speed $\leq 1^\circ/\text{m}$)

3. Technical consultation

-Application for complex trajectory design requires registered geotechnical engineer to participate

-The bending parameters of the drill rod need to be obtained from the original factory in written technical documents (including ASTM E290 bending test report)

Guidance System

The guidance system is an electronic device enabling directional control of the borehole along a planned curved path.

Installed within the downhole directional drill bit, this device provides the operator with bit position information for adjusting the drilling direction.

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Guidance system is categorized into three types: wireless rotary-perforating, wired, and wired geomagnetic guidance. Wired geomagnetic guidance system is most commonly employed for long-distance deep-hole projects due to their superior capability and higher precision. This directional drilling machine does not include a guidance system as standard equipment. Technical specifications for operation and maintenance are provided by the guidance system manufacturer.

-Before starting drilling, ensure that the guidance system has been replaced with a new battery and calibrated through testing.

-Repeatedly check the position of the drill bit to ensure the correct trajectory.

-Be careful not to exceed the bending radius of the pipe, otherwise it may cause damage or breakage.

- Precautions

-The operation of this system must strictly follow the manufacturer's technical manual.

-During trajectory correction, gradual adjustments should be made to avoid sharp turns.

-Regularly conduct system accuracy verification (it is recommended to calibrate every 50 meters).

- Technical parameters

-Wireless drilling system detection depth: ≤ 15 meters.

-Positioning accuracy of wired magnetic guidance system: ± 0.1 meters/30 meters depth.

-Battery life: ≥ 24 hours (under normal temperature conditions).

(Note: Please consult the drill rod manufacturer for the bending radius parameter, with a typical value of 40 times the rod diameter.)

Mud Recycling System

Drilling operations may require a fluid volume of 200 liters per minute. The circulation system can remove solid particles from drilling fluid and usually includes a high-pressure pump (mud pump) used to pump fluid into the hole through the drill rod. This system enables the driller to recycle most of the drilling fluid for reuse, thereby reducing the amount of fresh water required for mixing.

- Consult drilling fluid suppliers to obtain:

-Guidance on drilling fluid selection.

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-Optimization of mixing ratio scheme.

-The flow rate setting of the mud pump during the drilling and reaming stages.

Technical document guidelines:

- Read the mud system manual.
- Consult the equipment dealer for the following operating instructions:
 - Operating procedures for mud system.
 - Drilling fluid circulation and supply process.

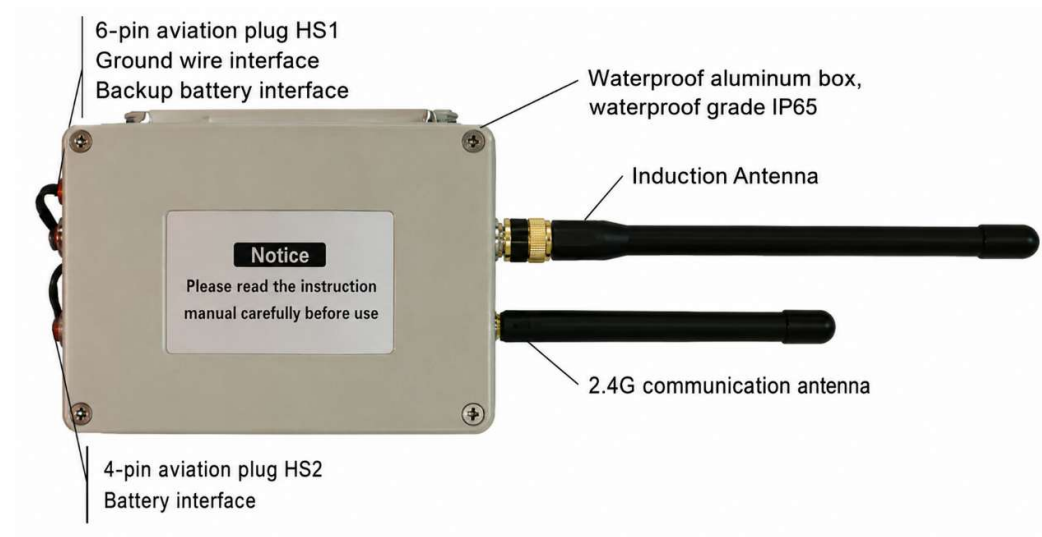
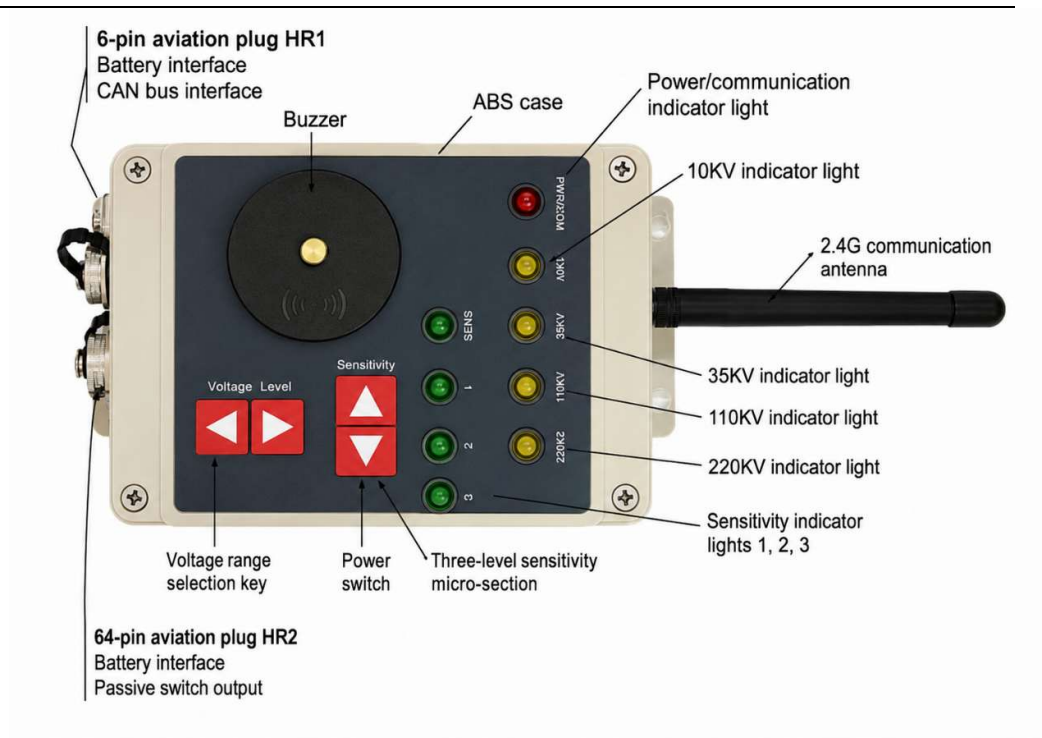
Note: The pressure of the mud pump needs to be dynamically adjusted according to geological conditions (recommended range 0.5-3MPa), and the mud specific gravity ($1.05-1.25\text{g/cm}^3$) and viscosity (35-45 seconds/Marsh funnel) should be regularly tested.

Electric shock alarm - anti electric shock system



Electric shock hazard warning. Drill pipe contact with power lines may cause equipment to become electrified, leading to serious injury accidents. All operators must be familiar with the sound and light alarm signals of the anti electric shock system and the emergency procedures when the equipment become electrified.

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Operation prohibition:

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- Do not operate the equipment until the anti electric shock system has completed testing and the fault has been completely eliminated.
- An anti electric shock system grounding post must be installed to ensure the normal operation of the system.

System Configuration Specification:

The G30 is equipped as standard with an electric shock detection device. This system is specifically designed for operations where there is a high probability of crossing live power lines. Should the drill rod come into direct contact with a live power line:

- The drill rod will have the same voltage as the power line-trigger an audible and visual alarm

Emergency response process:

When the alarm is triggered, the operator should immediately follow the operating steps specified in Chapter 2 "Emergency Procedures" for "Response to Electric Shock Accidents".

Re-construction inspection:

After the power department confirms that the equipment and associated devices have been completely powered off:

Retest the anti electric shock system.

Reconfigure the system according to the specifications.

Work can only re-construction after being signed and confirmed by the safety engineer.

Preparation before use:

- Carefully read and understand the operating instructions for the anti electric shock system.
- Before starting the operation, a system functional test (including grounding resistance testing, with a requirement of $\leq 4 \Omega$) must be completed.

Technical Specifications:

-In the absence of obstacles, the communication distance can reach over 200 meters. However, in

enclosed spaces with obstacles or shielding, the transmission distance may be shortened, depending on the specific situation on site.

-Due to the regulations in the power industry that the safe voltage should not exceed AC 36V (all voltages below are AC voltages), when the ground voltage of construction machinery is

G30 Operation Manual

higher than this voltage value, it is considered a dangerous voltage. The warning system uses non-contact methods to detect the electric field signal generated by the charged body. When the electric field strength value generated by the charged body of the machinery reaches the warning threshold, it will give a warning. It does not need to detect whether the machinery itself generates current. The warning system provides three sensitivities for on-site selection according to needs.

-Sending end $-40-85\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ (working outdoors), receiving end $-20\text{ }^{\circ}\text{C} \sim 60\text{ }^{\circ}\text{C}$ (working indoors).

-The sending end is an aluminum waterproof box that has been treated for dust and water resistance, with a protection level of IP65. It should be ensured that the sending end equipment is sealed and regularly inspected.

-The alarm volume of the receiving buzzer is greater than 95dB.

(Note: This system requires monthly simulated electric shock testing, and the retention period of test records shall not be less than 3 years.)

Remote Lockout System



Entangled danger warning. Unexpected movement or rotation of drill rods may result in serious injury accidents. When replacing tools, the remote locking system must be used to disable the drilling machine function.

Operation prohibition:

It is strictly prohibited to bypass the remote locking system, as operating in a disabled state may result in injury or death.

Before starting the remote locking system, ensure that the device battery is fully charged.

After long-term storage, it is necessary to reconnect the 12/24V DC power supply to charge to full power.

System Function Description:

The remote locking system can disable the thrust and rotation functions of the drilling machine remotely (such as on the directional drilling machine outlet side), allowing exit pit operators to safely handle pipe columns or exit side tools.

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System composition:

-Receiving-end: Installed on G30.

-Launch-end: The operation process is carried by personnel who need to come into contact with the drill rod.

Locking program:

-Press the "Lock Drilling Machine" button before starting work → send a signal to the receiving end → disable the rotation/thrust function.

2. Unlock the program:

-After personnel evacuate the danger zone→press the "Unlock Drilling Machine" button→the operator performs a system reset→ restoring drilling machine function

System restriction statement:

- This system cannot replace standard security procedures.
- It cannot be used as a communication alternative plan between personnel and operators on the export side.
- Non emergency stop device (emergency stop button should be used in case of emergency).

Usage guidelines:

- For comprehensive setup, testing, and operational guidance, refer to Appendix 2: Remote Locking System Manual.
- Operational instructions must be thoroughly read and understood prior to use.

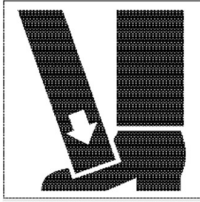
Technical Parameters:

- Effective control range: ≥ 150 meters (line-of-sight environment).
- Signal encryption level: AES-128.
- Battery life: continuous operation ≥ 8 hours (fully charged).
- Response latency: ≤ 200 milliseconds.

(Note: This system requires monthly functional testing. Test records must include key parameters such as signal strength and response time.)

Set Up

Set Up the Machine

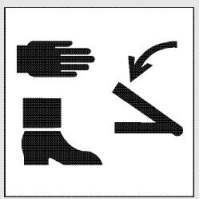


There is a risk of compression when lowering the front and rear legs.
During the stable operation of the equipment, all personnel must maintain a safe distance.



There is a risk of compression when lifting the drilling frame. All personnel must maintain a safe distance from the lifting frame.

- After lifting the drilling frame, the equipment must be fixed with support rods and locking devices before operation or maintenance can be carried out.

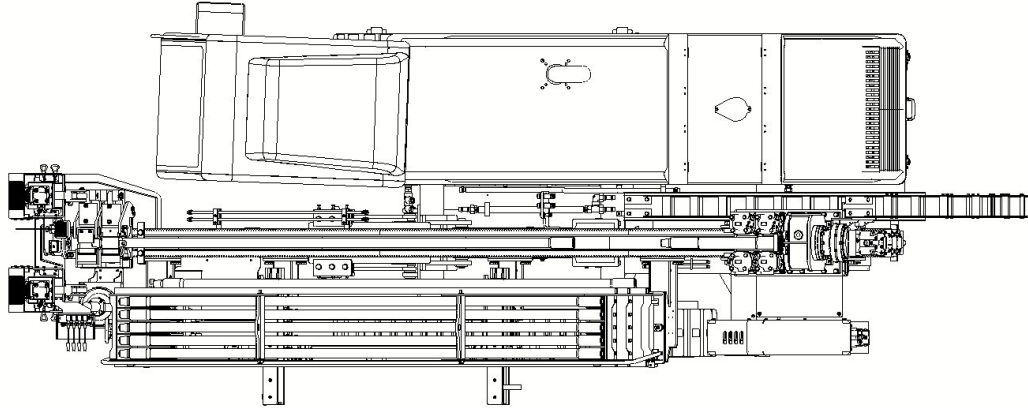


There is a risk of pinch injuries to the moving parts of the equipment.

During work, keep your body and clothing away from dangerous areas.

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1. Transport the equipment to the workplace and adjust it to the corresponding position, as shown in the following figure:



2. The equipment shall be enclosed with a protective cover and warning signs shall be posted to prohibit non staff entering;
3. Connect the cable connections in the device;
4. Adjust the position of the main beam that requires a proper burial angle, with the center of the power head spindle aligned with the center of the borehole, and a maximum drilling angle of 16° ;
5. Take out the electric remote cut-off remote control transmitter from the storage box;
6. Use the key ignition switch inside the cab to start the equipment;
7. Secure the anchor plate at the front end of the beam to the ground and fix the anchor bolts;

Use a multi way valve controller to lower the rear support foot;

8. Use a multi way valve controller to fully contact the rear support foot with the ground;
9. Add the drill rod to the drill rod box.

- Using appropriate lifting equipment, install the drill rods into the drill rod box, which can hold up to 65 rods;

- After installation, fix the outer guardrail of the drill rod box in place.

10. Insert the pin and fixing clip to secure.
11. Insert the pin to secure the hook.
12. Move the cab into place.
13. Place the mud system and connect it to the drilling machine.
14. Connect two mud hoses between the rear rotary joint and the mud inlet pipe of the frame.
15. Connect all components at the drilling site with connecting cables and install grounding stakes.

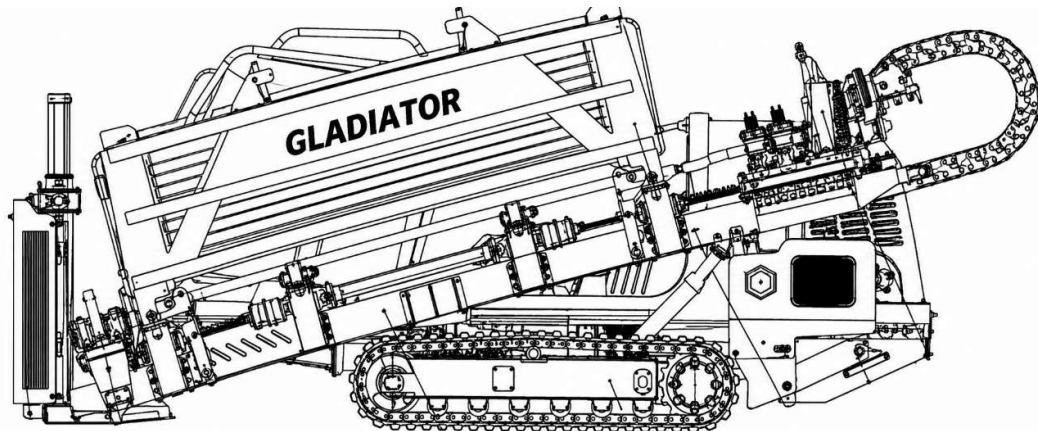
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16. Test the anti electric shock system (for complete information, please refer to Attachment three, Anti Electric Shock System Description).
 17. After successful testing, install the anti electric shock system ground stakes.
 18. Confirm that all protective devices are in place.
 19. Check all liquid levels and replenish as necessary.
 20. Check all connections.
 21. Start the power device (please refer to "Starting G30").
 22. Check the functionality of all buttons.
 23. Check all emergency stop and disable buttons.
 24. Cycle all devices several times.

Anchor the Machine

The machine anchoring should use the following anchoring system to stabilize the drill bit according to the soil conditions on site, in order to prevent the drill bit from moving when pushing the pipeline into the soil or pulling back the reamer.

1. Front anchor plate: After adjusting the equipment, lower the ground anchor plate at the front end of the beam and make full contact with the ground;
2. Ground anchor: anchoring by driving ground anchor into the ground;
3. Rear foot support: Lower the rear support and make full contact with the ground.



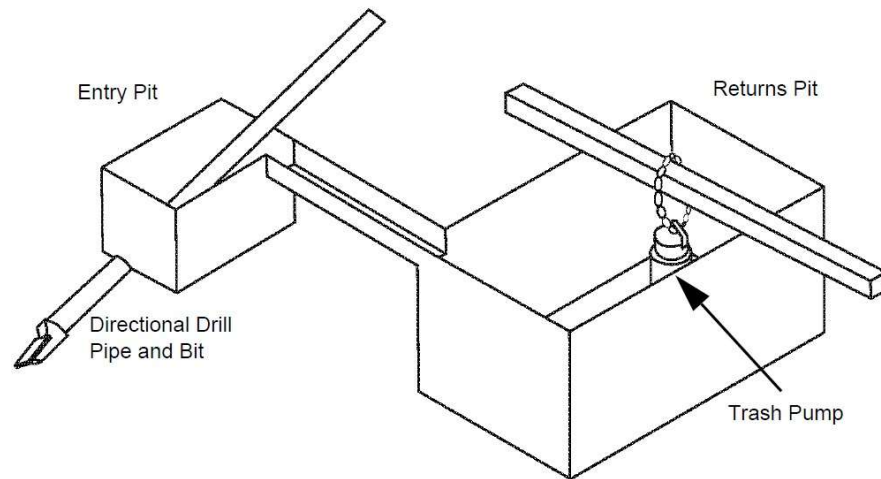
Excavate the Entry Pit and Returns Pit

Before excavating the entrance and returning to the pit, the directional drill machine should be firmly secured. The entrance pit is the place where the drill rod of a directional drilling machine enters the ground. This is also where drilling fluid returns from underground.

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As shown in the figure below, connect two pits with a shallow channel. The fluid returning from the hole enters smaller pits and overflows into larger pits. Many solids settle into the bottom pits of larger particles and do not need to be processed by fluid recovery equipment.

The suction pump provided by the contractor is installed in a larger pit. Hang the suction pump to prevent sediment from entering the recovery system from the bottom of the pit.



Starting the G30

Standard Starting Procedures



The signal light and operator display screen will warn of potential operational issues. If ignored, it may damage the machine. If there is abnormal noise, abnormal pressure values, or signal light, please stop the engine immediately and perform necessary repairs.



Do not use starting solution (ether). Will cause engine damage and personal injury.

G30 comes with the diesel engine manufacturer's manual. The following instruction covers the routine engine start-up procedures. For detailed start and stop procedures, engine maintenance and repair instruction, please refer to the manufacturer's manual.

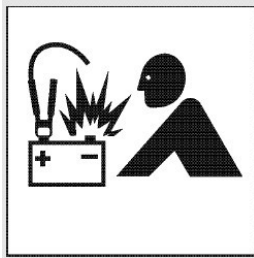
1. If you have not yet done so, please test the anti shock system and verify if the grounding post is correctly installed (please refer to Attachment three: Anti shock System Instruction Page).
2. Disconnect all battery chargers.
3. Pull out the emergency stop button on the console and in the power supply device. If any emergency stop button is pressed, the engine will not start.
4. Before each start-up of the drilling machine, a preliminary inspection must be conducted to confirm the leakage of the diesel tank, hydraulic oil tank, diesel engine oil level, all operating handle positions (required to be in position 0), power head oil level, pressure gauge, oil pipe joint box, motor oil cylinder.
5. Insert the key into the engine control panel, turn the key and keep it in the power on position.
6. After issuing a warning alarm, press the horn to sound the alarm for about 5 seconds, which will remind everyone at the work site that the engine is about to start. After the alarm stops, the engine will start. Every time you try to start the engine, press the horn to sound an alarm for about 5 seconds before restarting the engine.

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7. When starting the engine, it should idle for 5 minutes before starting the step-by-step acceleration. When the engine needs to stop working, it cannot be stopped directly while running at high speed. It must be turned to idle for 5 minutes before the engine can be stopped.

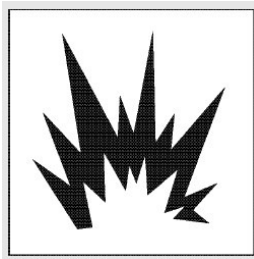
8. Before the drilling machine starts working, slowly operate each hydraulic control device without load for about 10 minutes. Failure to preheat the hydraulic oil may cause damage or malfunction of the hydraulic system.

Jump Starting the Machine



Warning of battery explosion risk. Jumping start may cause battery explosion. It is strictly prohibited to use batteries with cracked or leaking casings (replace them immediately upon discovery).

•Frozen batteries must be placed in a warm environment and completely thawed before use.



Explosive gas prevention and control. Batteries can produce explosive gases, keep away from sparks/open flames/cigarettes.

•Maintain ventilation (air exchange rate ≥ 12 times/hour) when charging in a confined space. •Operators must wear goggles.

1. Battery status check:

- If the battery ruptures/leaks→do not jump start→replace it immediately;
- If the battery freezes→remove the battery→operate after completely thawing.

2. Vehicle parking: the rescue vehicle and the rescued equipment should be parked in a noncontact manner (with a distance of $\geq 0.5\text{m}$).

3. System shutdown: shut down the engines and electrical systems of both vehicles.

4. Cable connection sequence (ensure that the clamps do not touch each other):

- ① Red positive electrode (+) clamp → positive pole of depleted battery;
- ② Another red positive electrode (+) clamp → rescue battery positive pole;
- ③ Black negative (-) clamp → rescue battery negative pole;

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- ④ Another black negative electrode (-) clamp → un-coated metal parts of the engine of the low voltage device (at least 0.3m away from the low voltage battery).
- 5. Power on preparation: turn on the battery switch and confirm that all emergency stop buttons are in the pop-up state.
- 6. Charging operation: start the rescue vehicle engine → run for ≥ 5 minutes to charge the depleted battery.
- 7. First start attempt: turn off the rescue vehicle engine → disconnect the cables in reverse order - attempt to start the engine of the low power equipment.
- 8. Secondary charging.
- 9. If the first attempt fails, reconnect the cable.
- 10. Start the engine of the rescue vehicle and increase the speed to run for a few minutes.
- 11. Final start-up.
- 12. After successful start-up, allow the engine to run for at least five minutes.
- 13. Disconnect cables in the following standard sequence:
 - ① Disconnect the black negative (-) terminal from the flat battery's engine;
 - ② Disconnect the black negative (-) terminal from the rescue battery;
 - ③ Disconnect the red positive (+) terminal from the rescue battery; ④ Disconnect the red positive (+) terminal from the flat battery.

Operating the G30

Test the Indicators, Emergency Stop Buttons and all Controls

If this operation has not already been done, verify that all gauges on the dashboard are functioning correctly. Test all emergency stop buttons, disable switches, and all controls.

Attach the Drilling Fluid Supply Connections

Connect the separately purchased mud mixing equipment hose to the directional drilling machine interface. Drilling fluid mixing must be completed before starting drilling.

Power Wrench Operation



The operation of pipe wrench may result in serious injury accidents. The fastening and dismantling of drill rod joints must use hydraulic clamps configured with the drilling machine.

The clamp consists of two separate clamps, a fixed clamp and a flip clamp. Fixed clamp is used to clamp and secure drill rods;

Flip clamp is used to clamp and rotate drill rods. A wrench is used to fill and loosen drill rods.

Adjust the pressure of the gripper to limit the force applied during the connection of the drill rod, in order to prevent damage to the pipeline drill rod threads. The maximum torque is provided by the drill rod supplier.

Checks During Operation



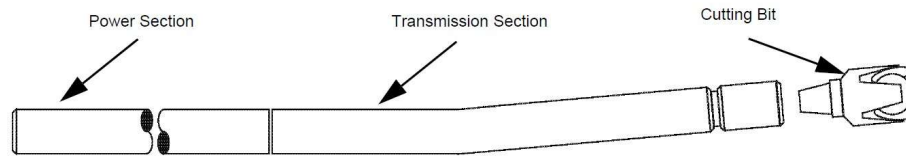
When monitoring instruments indicate values exceeding the normal operating range, the operator must immediately execute shutdown procedures. This constitutes the operator's duty.

Thrust and Pullback Force Controls

The maximum thrust and pullback force can be set through the bracket pressure control on the operator display screen. This can prevent applying too much force and damaging the downhole drilling tools and products being installed. It can also help the driller adjust the expansion speed of the drill bit.

Using a Mud Motor

Please follow the manufacturer's instructions for the installation and operation of the mud motor. Mud motors typically require the use of a non-magnetic pipe section, which is installed between the mud motor and the first section of the drill rod. The positioning signal stick or other instrument is located inside the non-magnetic part.



Using a mud motor usually requires digging a hole in front of the drill bit. The pit should allow the tricone drill bit to enter the vertical wall of the pit. The design of mud motors varies.

Automatic rod loading mechanism



Before loading the first drill rod onto the drilling rig, the joints of the two drill rods must be aligned with the main shaft of the bracket and the center of the clamp. Otherwise, it will damage the drilling machine and may result in personal injury or death.

Important reminder:

- When using the automatic drilling rod loading mechanism, do not place more than three drilling rods in the temporary storage area at once.

1. Position the sliding frame push-pull seat completely backwards, and then move the transfer arm to the first storage position.
2. Place a single drill rod on the temporary storage area of the drill rod transfer arm.
3. While the clamp is open and the head is rotating backwards, retract the transfer rod arm.
4. Grab the drill rod.
5. Rotate the main shaft all the way to the center of the thrust frame.
6. Use a tightly gripped rod to extend the loading arm to the loading position.
7. Slowly place the slide spindle into the rod box. Do not enter the container.
8. Slowly bring the wrench back onto the rod pin. Do not enter the wrench.
9. Use the screw buckle on the top pipeline loader to align the rod box upwards or downwards with the slide spindle pin.
10. Use the screw buckle on the lower pipeline loader to align the pipeline pin upwards or downwards with the wrench clamp.
11. Carefully check both ends of the pipeline again to ensure correct upward or downward alignment.
12. Use the joystick control button on the console to align the rod box left or right with the spindle pin.
13. Use the joystick control button on the console to align the rod pin left or right with the wrench clamp.
14. Carefully inspect both ends of the pipeline to ensure correct left and right alignment as well as up and down alignment.

15. On the console, set the stop position of the pipeline loader on the touch screen.
16. On the pipeline loader, set up a loading arm stopper.
17. Move the carriage backwards and then move the wrench forwards.
18. Return the pipeline to the temporary area.

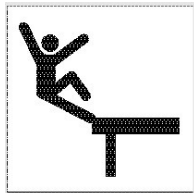
Fundamentals: Install drill rod



Rotating drill rods or moving slide frame may cause personnel to be caught up or crushed, resulting in serious injuries or fatalities.



During the operation of the rotating device and slide frame, it is strictly prohibited to stand on the cable walkway.



Unexpected movement of equipment may lead to falling accidents. All guardrail systems must be installed before using the walkway.

Steps:

- Preparation of guide drill bit: First, install the front plug and palm surface of the guide drill bit, then install the signal wand. After plugging, install the water plug, install the spring, screw on the small connecting rod, and use the eight way connection method. It is necessary to install the torque sleeve, screw on the positioning screw or left-hand nut, and then verify the clock point and distance measurement of the signal wand and signal receiver.

- Connect the suction port of the mud pump to the outlet of the mud mixing station to mix the mud.

- Apply thread oil to the male buckle of the rotary drive sub of power head (press the "thread oil" button), move the power head to the rear end, and release the front (fixed) and rear (flip) clamp.

- Place the drill rod into the transfer arm of automatic rod loading box and grab it tightly (operate the "top rod" and "manipulator" buttons), then send the drill rod to the center of the beam (operate the "send rod" button), and spray thread oil on the drill rod male buckle with an automatic refueling machine.

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- Push the power head (while rotating the main shaft of the power head), and when the rotary drive sub comes into contact with the drill rod, slow down the pushing speed; Ensure that the rotary drive sub is smoothly screwed into the drill rod, and after the drill rod is tightened, retract the transfer arm.

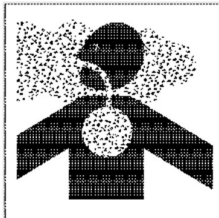
- Place the drill rod into the front clamp, tighten the front clamp, and slowly rotate the main shaft; Slowly tighten the drill rod, release the front clamp, push the power head to push the drill rod to the front end of the clamp, manually screw in the guide drill bit to connect with the drill rod, tighten the guide drill bit with wrench, and then rotate the main shaft to drill.

- After the drill rod is in place, clamp the front clamp and release the connection between the rotary drive sub and the drill rod by operating the "flip/reset" button. After loosening, the main shaft can be rotated in the opposite direction to perform a complete uncoupling action. Then move the power head to the rear limit position of the beam and repeat the above steps for drilling. During the drilling process, be sure to follow the command of the guide hand.

- When expanding the hole or dragging the pipeline, be sure to pay attention to the power head reaching the designated position, loosen the two ends of the drill rod before extending the drag plate head and retracting the drill rod into the drill rod box. (Warning: When extending the trailer body, fully open the robotic arm, otherwise it may damage the drill rod and cause an accident.)

Notes: When the power head is working, it is not advisable to suddenly stop at high speed when pushing and pulling the handle back to the neutral position, as this may damage the equipment.

Turn on the drilling fluid



Inhalation hazard. The dust generated in drilling fluid additives (such as bentonite) may irritate the respiratory system or lungs. Long term exposure may damage the respiratory system. Please use respiratory protection and dust goggles.

Prepare sufficient drilling fluid (mud). Check if the supply hose of the mud mixing equipment is securely connected to the directional drill machine. Please operate the delivery pump on the mud mixing equipment according to the manufacturer's instructions to ensure sufficient supply of drilling fluid to the mud pump. Even if the mud pump is not working, drilling fluid usually leaks out from the reamer. Do not let the mud pump run dry, as it may damage the pump.

When the G30 engine heats up, start the mud system and then heat up the engine of that system. The following steps are a general guide. For specific operating procedures and required

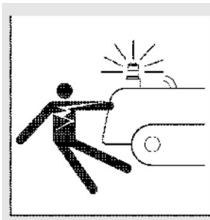
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mud flow rates, please refer to the Mud System Operator Manual and information provided by the drilling mud supplier.

When preparing to start drilling:

1. Use the mud flow control knob to increase the pressure of the mud pump to 30 psi (2.1 bar).
2. Before drilling, the pipeline needs to be filled with mud.
3. Increase pressure. When drilling guide holes, approximately 200 to 300 psi (14-21 bar) is required.
4. Monitor the mud flow rate by viewing the mud flow rate on the mud system console.
5. Set the required drilling fluid flow rate.

Make the pilot bore



Electric shock hazard. If the drill rod comes into contact with the power cord, the machine may become electrified. If the anti electric shock system beacon flashes, please turn back at least 25 feet (8m).

•Do not operate the machine until the anti electric shock system has been tested and all issues have been satisfactorily resolved.

•An anti electric shock system grounding post must be installed in order for the equipment to function properly.

Entanglement danger. Rotating the axis may cause limb compression or fatal injury. During operation, keep body parts and clothing away from rotating parts.



Before starting drilling, make sure that the steering surface position indicated by the signal wand is correct. Before pushing the drill bit into the formation, place the receiver above the guide drill bit and calibrate the depth value. Start drilling and position the first measuring point of the guiding drill bit after 1.5 meters. Verify the receiver by determining the true peak signal in the surrounding false signals. The

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specific method is to move the receiver in a straight line back and forth at the same horizontal height. On both sides of the drilling path, there are false signals that are weaker than the "real" peak signal.

Some tracking devices require the drill bit to be turned to the upright position for inspection, and the receiver must be parallel to and directly above the drilling line. Every drilling rod must undergo a directional control test, and if a sudden change of direction is required, it should be tested at every half of the length of the drill rod. If the diameter of the laid pipeline is large, the drilling angle can only be slowly changed to maintain the minimum load of the drilling machine during the pullback process. Insufficient directional testing can cause "snaking" or channel bending, which will increase frictional resistance and reduce construction efficiency. It is recommended to use a flag or paint to mark each directional point, which will help observe whether the drill hole is straight. When drilling under roads (especially those with steel bars), false signals will increase, which requires careful tracking and exploration of the "real" signal trajectory from false signals.

The formation of a basic borehole should include five construction steps: entering the soil, horizontal section, excavating, expanding back, cleaning the borehole, and pulling back.

Steps:

- (1) Manipulate the handle to adjust the position of the main beam that requires the insertion angle, ensuring that the center of the main shaft of power head is in line with the required drilling center, and then support the rear to the ground. The front anchor plate and rear support of the front end of the main beam must firmly support the ground. Manipulate the automatic hydraulic anchor operating handle to fix the ground anchor.
- (2) Check if the mud pump nozzle is unobstructed. (Note that a new dry battery should be installed in the wireless guidance hole signal wand, and it should be plugged after installation).
- (3) Install the guide drill bit and the first drill rod, screw the drill bit onto the starting rod, and insert the torque sleeve to position it. Then install the fixing bolts, adjust the throttle control button, and set the engine speed to full idle. When drilling, the minimum engine speed must be at 3/4 of the fully open throttle position.
- (4) Mix the mud used for drilling construction, and prepare the drilling machine for drilling operations.

Important reminder: Every time you connect the rotary drive sub of power head to the drill rod, spray thread oil on the threads of the rotary drive sub of power head and drill rod. This makes it easier to remove the buckle and can extend the service life of the rotary drive sub thread of power head. Do not use wrench to install and disassemble drilling tools (except for the installation of guide drill bits and reamers)

- (5) Start drilling

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Warning: a) It is not allowed to grab or manipulate the drill rod with hands and feet. Always keep your feet on the operating platform pedal and your hands on the operating stick.

b) High speed collision when connecting drill rods is not advisable as it can cause damage to the power head.

c) Only when all personnel maintain a safe distance from moving parts and the drilling machine, then the drilling machine can be operated.

Important reminder: •Keep the first drill rod moving straight forward to reduce lateral pressure on the drill rod. Push the drill rod with thrust until the second drill rod is connected, and no directional correction shall be made.

•Due to the importance of drilling the first drill rod for the correct start of the borehole, it is necessary to detect the position of the guide drill bit on the drilling path of the drill rod during construction. After the first drill rod is fully drilled into the ground, directional correction can be carried out.

•Transitional changes in direction may cause damage and breakage of the drill rod, and even soil layers may lock the drill rod, increasing torque and push-pull force.

(6) Guide hole drilling

Turn on the mud pump switch to operate and generate pressure. When drilling guide holes, in general, the mud pressure required for wireless guidance is $>2\text{MPa}$; The mud pressure required for wired guidance is $3\text{--}4\text{MPa}$ (needs to be changed to PSI). Rotate the drill bit so that the palm is facing upwards, push the drill bit into the ground, and try to keep the drill rod moving in a straight line as much as possible. After the drill bit is fully drilled into the ground, start rotating the drill rod clockwise. This is the operation process for advancing the first drill rod.

The steps for adding drill rods: Push the drill rod into the ground until the power head reaches the front end and stops. Then move the power head backwards and pull the drill rod back about 1/4 inch.

Attention: Clean the drill bit head to reduce nozzle blockage. When using a clamp to replace the drill rod before drilling, the mud can be smoothly sprayed out. After drilling a drill rod, the mud pump will naturally shut down to minimize mud loss before adding or removing the drill rod.

(7) Excavation of guide hole

Control the drill bit to rotate upwards and drill out of the ground, plan the excavation point, and ensure that the deformation of the drill rod is within the minimum bending radius range of the drill rod.

Attention: If the excavation point of the guide hole is located in the working pit ditch, embankment, etc., no directional change operation is required.

End of Pilot Bore Drilling



Entangled danger prevention and control. Unexpected movement or rotation of drill rods may result in serious injury or death. When replacing tools or installing rods, the remote locking system must be disabled the drilling machine function.

- During the pre-expanding hole and pullback stages, a rotary swivel is required.
- The driller maintains real-time communication with the personnel at the export pit.
- It is strictly prohibited to start the drill rod rotation without the safety confirmation of all personnel.
- It is strictly prohibited to bypass the remote locking system. Disabling the remote locking system to operate equipment will result in injury accidents.



Pipe wrench may cause injury or death. Do not use Pipe wrench.

Tighten and loosen the drill pipe joint with a pipe stripper.

Adopting an upward tilt guidance mode to ensure the drill bit safely exits the ground. Real time voice communication with exit personnel. Perform 3D laser scanning to confirm personnel

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clearing before leaving the site. The curvature radius of the export trajectory is $\geq$ the minimum bending radius of the pipe.

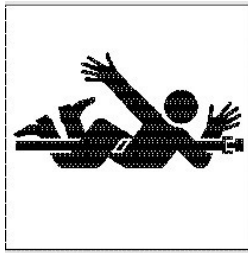
1. When the drill bit is exposed from the ground, please notify the driller and activate the remote locking system to disable the drilling machine.
2. Turn off the diesel engine and remove the ignition key.
3. Communicate with all personnel to inform them that the drill rod is being dismantled and secured on the exit side, and that the engine must be kept off to ensure the safety of the crew.
4. Use appropriate tools, such as pipe stripper at exit side, to remove the drill bit assembly.

Please use the tool correctly according to the manufacturer's instructions.

5. Remove the guidance system.
6. Thoroughly clean the guidance system and store it in a safe place.

Pullback Operations

Backreaming and Pullback



Risk of unexpected drill pipe movement. Sudden movement or rotation of the drill pipe can result in serious injury or death. When replacing or adding drill pipe, the remote locking system must be activated to disable the drilling rig's functions.

- Standard-compliant rotary actuators must be used for pre-reaming and pullback operations.
- The driller and exit pit personnel must maintain real-time communication via a digital trunking system.
- Drill pipe rotation must not be started without full safety confirmation.
- Bypassing the remote locking system is strictly prohibited; operating equipment without the remote locking system will result in injury or death.



Pipe wrenches can cause injury or death. Do not use pipe wrenches. Use shackle pliers to tighten and loosen drill pipe joints.

After the pilot hole is completed, use a reamer to enlarge the diameter of the hole so that the product tubing (cable, pipe, etc.) can be pulled back from the hole. A rotary reamer connector must be used so that the pulled-back tubing does not rotate with the reamer.

- (1) Turn off the engine, remove the key, and then activate the remote locking system.
- (2) Using appropriate tools, remove the drill assembly, loosen the torque sleeve, separate the drill bit and starter rod, and install the selected reamer in place of the pilot drill bit.
- (3) Using appropriate tools, install a rotary reamer after the reamer. The rotary reamer eliminates the twisting of the pulled-back tubing.
- (4) If reaming is to be performed, install a pull ring after the rotary reamer so that more drill rod can be pulled in without rotating the tubing. This technique prevents the tubing from coming off the drill rod during the pre-reaming process. If the tubing diameter is 2 inches (50 mm) or smaller, a pull ring can also be used to pull small-diameter tubing (cable, pipe, etc.) into the pilot hole.
- (5) Ensure all personnel at the exit point maintain a safe distance from the reamer and pipeline.
- (6) Start the engine.
- (7) Start the mud system to ensure the reamer nozzles are open.
- (8) Reset the remote locking system to restore normal function.
- (9) Slowly pull the reamer back into the pilot hole. The drill rod must be rotated clockwise.
- (10) Slowly pull the reamer into the hole. Pull back at a low speed, ensuring the mud flow rate is adjusted to meet the reaming requirements. Mud must flow out of the outlet during reaming.
- (11) As you pull the drill rod back, remove each section of the drill rod. Follow these steps:

After retracting the drill rod, clean it with a mud scraper or a high-pressure water gun.

Warning: a) During drilling and reaming, the drill pipe must only be rotated clockwise, never counterclockwise, as it cannot be re-engaged once it comes loose in the borehole.

b) Abruptly changing the drill bit's direction may cause damage and breakage of the drill pipe.

Continue Backreaming

. Continue backreaming, removing the drill rod as it exits the pit. Repeat the above steps until all drill rods are removed.

Steps for disassembling drill pipe during backreaming or pullback :

- a) First, secure the drill pipe with the clamping device, then tighten the flip clamp. After flipping, completely loosen the drill pipe joint. Reset the flip clamp and tighten the drill pipe again, then rotate the power head reducer counterclockwise to unscrew it.
- b) Simultaneously, slowly move the push-pull seat backward until both threads are completely

disengaged and a gap appears between the ends of the two drill pipes. Then, activate the highspeed retraction button to retract the power head to the rear limit position of the main beam.

Note: When separating the two drill pipes, ensure the drill pipes continue to rotate.

- c) Operate the rod delivery button to extend the rod delivery arm. Grasp the drill pipe with the

manipulator and rotate the power head reducer counterclockwise to unscrew the drill pipe from the reducer. Then, retract the rod delivery arm and release the manipulator. Next, operate the push rod upward button to automatically push the drill pipe back into the drill pipe box.

Warning: When extending the feed arm, ensure the manipulator is fully extended and can be inserted under the drill pipe.

- d) Move the power head towards the front end of the main beam, and simultaneously rotate the power head reducer counterclockwise. As the reducer engages with the internal thread end of the next drill pipe, tighten the reducer onto the drill pipe. Clamp the drill pipe with the fixing clamp, and release the power head after ensuring it is fully tightened (reference preload pressure: 15MPa).

- e) Turn on the mud pump to inject mud into the drill pipe, and once mud flow appears in the

borehole, continue the reaming, cleaning, and pullback operations.

Note: Before each connection of the power head reducer and drill pipe, apply thread lubricant to the threads of the power head reducer. Never use pipe wrenches to install or remove drilling tools (except for installing the guide drill bit, installing the drill pipe and reamer on the exit point side; however, during these installations, the driller must not operate the machine to prevent dangerous accidents).

End of Pullback Operations

After the pipes or cables are installed and pulled back to the borehole inlet, the pullback operation is complete.

Equipment Shutdown



Water may damage delicate electronic components. Spraying water onto electronic components and control panels is strictly prohibited.

Daily operating procedures after operation:

- Run the engine at idle for at least 5 minutes to allow it to cool down completely.
- Turn off the engine and remove the key, storing it in a safe location.
- Clean the equipment, removing all mud and other debris.

Drill Pipe Breakage and Handling Methods

Analysis of the causes of drill pipe fracture

- The exit side of a horizontal directional drilling rig (usually near the borehole exit point) is a critical area where drill rods experience complex stress and are prone to breakage. The main causes include:
- Drill rod quality or maintenance issues: using excessively worn, bent, or surface-scratched drill rods, or failing to conduct regular inspections (e.g., thread wear, fatigue cracks in the rod body).
- Improper operation: exceeding the drill rod's allowable tensile force, torque, or radius of curvature; forcibly applying pressure when the drill is stuck, leading to excessive torque.
- Formation and mud factors: in complex formations such as gravel and sand layers, failure to use high-quality mud for wall protection can cause borehole wall collapse and spalling, increasing the load on the drill rod.

- Enlargement and thread issues: unreasonable enlargement grading (excessive grade difference), dynamic bending effect at the connection between the drill rod and the reamer, or excessively tight/loose thread connections, or failure to use high-quality thread lubricant.。

Equipment for handling broken members on the outlet side

Broken Drill Rod Retrieval Equipment: Male/Female Cone Drill Rod

- Applicable Scenarios: Used to retrieve the remaining drill rod when it breaks at the exit side and the broken portion falls into the hole.
- Working Principle: The male cone (with tapered internal thread) or female cone (with tapered external thread) engages with the internal/external threads of the broken drill rod. The broken drill rod is then lifted out using the drilling rig's power to reverse or apply pressure.

Drill Rod Unloading Auxiliary Equipment: Automatic/Semi-Automatic Drill Rod Unloading Device

- Lifting-type Drill Rod Unloading Device: Consists of lifting equipment (such as a small crane), a flexible connecting section (steel chain/nylon rope), a rigid connecting section (solid rod body), and a casing (lined with rubber). The casing matches the outer diameter of the drill rod (5~15% clearance). The broken drill rod is slowly unloaded from the drilling rig's exit side using the lifting equipment, avoiding the high risks associated with manual handling.
- Automatic Drill Rod Changing Device: Such as a top-mounted automatic drill rod loading and unloading mechanism or a fully automatic drill rod changing system with dual floating sensor grippers (applied to large-tonnage drilling rigs). Through the gripper base, angle adjustment device, and dual floating sensor grippers (sensing drill rod pressure and automatically gripping), the automatic unloading and replacement of broken drill rods is achieved, reducing manual intervention and improving the safety of operations on the exit side.

Drill Rod Inspection and Prevention Equipment

- Regular Inspection Tools: Using non-destructive testing equipment such as ultrasonic flaw detectors and magnetic particle flaw detectors, the drill rods are regularly inspected for fatigue cracks and thread wear.
- Torque and Tension Monitoring Equipment: Drill rod torque sensors and tension sensors are used to monitor the stress state of the drill rods in real time during construction, preventing overload breakage.。

Handling Procedures for Fractured Outlet-Side Members

- **Stop Construction and Assess:** Upon discovering a broken drill pipe on the exit side, immediately stop the drilling rig and assess the location of the break (inside/outside the borehole), the extent of the break, and the surrounding environment (e.g., borehole wall stability, ground load)
- **Retrieve the Broken Part Inside the Borehole:**** If the broken part has fallen into the borehole, use a male/female drill bit to retrieve it, ensuring no residue remains.
- **Remove the Broken Drill Pipe:***Use an automatic/semi-automatic drill pipe removal device to remove the broken drill pipe from the drill rig's exit side, avoiding manual forced disassembly.
- **Replace with a New Drill Pipe:**Select a high-quality drill pipe that meets construction requirements. Before replacement, inspect its appearance (no bending, scratches) and performance (torque, tensile strength meet standards).
- **Adjust Construction Parameters:**Optimize drilling torque, rotation speed, and mud properties according to formation conditions to prevent recurrence of breakage.。

Equipment Shutdown

Normal planned stop

This is a planned and systematic shutdown procedure for situations such as completing a drilling cycle, changing drill pipe, performing maintenance, or ending the day's work.

- **Stop drilling/pull-back force:** The driller will first place the push/pull handle in the neutral position (neutral) to stop the push or pull force on the drill pipe. Then, the rotary handle will be placed in the neutral position to stop the rotation of the drill pipe.
- **Stop the mud pump:** Turn off the mud pump. This is a crucial step to stop the delivery of drilling fluid (mud) into the hole.
- **Note:** Before stopping the mud pump, sometimes clean water is pumped for a period of time to flush the pump and pipelines and prevent mud settling and solidification.
- **Remove the drill pipe load:** If the shutdown is for changing drill pipe or performing other operations, the current drill pipe needs to be disconnected from the drill spindle or the next drill pipe using the uncoupling device. Operate the uncoupling device to loosen the threads, and then move the drill pipe back into the drill pipe box.
- **Move the equipment to a safe location:** Move the drill head to a stable location suitable for long-term storage. The equipment must then be moved from the work site and parked on a flat, firm surface.
- **Completely shut down the engine/power supply.** Run the engine at idle for at least 5 minutes to allow it to cool down completely, then shut it down according to the prescribed procedure.

- Perform post-shutdown checks and maintenance, including routine upkeep such as checking hydraulic fluid and fuel levels, cleaning the mud filter, and checking for loose bolts in critical areas.
- Clean the equipment, removing all mud and other debris, especially from hydraulic components and electrical interfaces.



- Water may damage delicate electronic components. Spraying water onto electronic components and control panels is strictly prohibited.

Emergency Stop

- Use the emergency stop button. Press or strike this button firmly to immediately cut off the main power supply to the drilling rig, or cut off the hydraulic or electrical supply to all major actuators, bringing all actions to an instantaneous stop. The location of the emergency stop button is shown in Sections 1 and 2 of Chapter 4, Mechanical Control.

Emergency shutdown procedures

- First priority: After an emergency shutdown, ensure the safety of on-site personnel.
- Troubleshooting: After confirming safety, identify the cause of the emergency shutdown.
- Do not restart immediately: Never reset the emergency stop button or restart the equipment

before the problem has been identified and resolved. Blindly restarting may cause more serious damage.

- Seek support: Notify the on-site supervisor and equipment maintenance personnel.

Operating in Different Climates

Operating in Hot Weather

To prevent equipment damage during high-temperature operation, please implement the following protective measures:

- Operate the engine according to the high-temperature operating guidelines in the diesel engine manual.
- Use the correct coolant-water mixture ratio according to the operating temperature range.
- Regularly check coolant performance and ensure the radiator and reservoir levels are normal.
- Select the appropriate engine oil viscosity grade for the operating conditions as specified in the diesel engine manual.
- Clean dirt and debris from the radiator and engine daily, and check the air filter dust collection valve.
- Electronic components in the equipment may have special requirements under high-temperature conditions; please consult the relevant component user manuals to confirm the operating condition requirements.

Operating in Cold Weather

When the ambient temperature is between -40°F and +5°F (-40°C to -15°C), only machines specifically configured at the factory can operate. Some machines are equipped with engine preheaters to maintain the minimum temperature required to start the diesel engine.

All machines are equipped with preheaters and temperature gauges on the hydraulic oil tank.

Use the preheater to raise the hydraulic oil temperature.

- The diesel engine cannot be started until the oil temperature reaches 15°F (-9.5°C).
- Controls cannot be operated until the oil temperature reaches 40°F (4.4°C).
- The hydraulic controller should be run at 800 rpm (or idle) until the oil reaches 70°F (21.1°C).

Other precautions and special procedures for operation in cold weather are:

- Ensure the battery is fully charged.
- Use the recommended oil viscosity under the operating conditions specified in the diesel engine manual.

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- Use appropriate cold-weather fuel. Low temperatures can cause water to accumulate in the fuel tank.
 - Inspect the collection bowl at the bottom of the fuel-water separator near the engine fuel system. Use the drain valve at the bottom of the collection bowl to drain water from the bowl.
 - Use an appropriate coolant and water mixture within the operating temperature range. Test the coolant regularly. Maintain the coolant at the correct level in the radiator and water tank.
 - Before starting operation, thoroughly heat the engine. Slowly operate each hydraulic control for approximately ten minutes. Move the machine slowly.
 - After each drilling operation and when the machine is not in use, open all mud joints and drain any remaining mud from the system.

Engine Preheating Devices

The G30 engine is equipped with an engine block heater. Before starting the engine, plug the engine block heater's power cord into an external power source to heat the engine coolant. In extremely cold temperatures, the engine block heater may also be kept plugged in for extended periods to maintain the engine coolant temperature while the engine is not running.

If the air temperature drops to but does not fall below -30°F (-34°C), use the engine block heater for at least two hours before starting the engine. This period may vary depending on surrounding weather conditions, such as strong winds. When nighttime temperatures approach -40°F (-40°C), heating may be required even when the engine is not running. After starting the engine, do not operate the preheater for more than three (3) minutes.

For more information on the engine block heater and operating requirements in extreme weather conditions, please refer to Annex 1: "Diesel Engine Manual".

Engine Preheating Devices



The preheating equipment operates at high voltage (110V or 220VAC). Connect to a circuit equipped with a ground fault interrupter (GFI). Prevent cables from contacting water or other liquids.

When operating at low temperatures, it is necessary to use a preheating device to maintain the temperature of the engine oil in the diesel engine when the machine is shut down. Connect the preheating device to a 110/220V 50/60Hz single-phase power supply with a rated power of 1 kW.

Machine Storage and Transport

Minimum Storage Space Required

For information on the G30's dimensions and weight, please refer to the "Specifications" section to determine storage requirements. The surface must be sufficiently rigid to support the machine's weight and prevent sagging.

Storage Site Conditions

If the machine has been lubricated, it can be exposed to the elements for up to 30 days. Protect the machine from salt or acid environments, solvents, gases, flammable liquids, and explosives.

For periods exceeding 30 days, the machine should be stored in a covered, dry area.

The recommended storage temperature range is 32°F to 120°F (0°C to 50°C). For temperatures outside this range, please refer to Appendix 1: "Diesel Engine Manual".

Preparations for Storage

For short-term storage (i.e., less than 30 days):

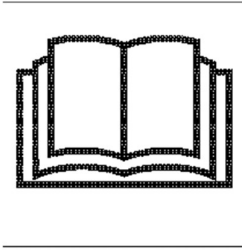
1. Clean the machine as described in the "Cleaning" section following this.
2. If freezing temperatures are anticipated, pre-add antifreeze to the drilling fluid system when the machine is not in use.
3. Remove deposits and water (diesel fuel and engine oil) from the fuel tanks.
4. Disconnect the remote lockout system battery charger. This charger is not affected by the battery switch. Leaving it connected may cause the power unit battery to discharge.
5. Lubricate the entire machine according to the 10-hour inspection and maintenance schedule. Apply oil to all exposed hydraulic cylinder rods to prevent corrosion.

For storage longer than 30 days

Follow the short-term storage procedure plus the following additional steps:

- Store the machine in a covered, dry location.
- Store the diesel engine for extended periods according to the manufacturer's instructions.
- Remove and store the battery, keeping its temperature between 32°F and 105°F (0°C to 45°C).

Transportation



Incorrect operation of control devices and unsafe use of techniques can lead to serious injuries or equipment damage. Personnel must read the manual and learn the standardized equipment transport and hoisting procedures.

The machinery must be transported in accordance with local laws and regulations. All components must be properly secured to the drilling rig. If the drilling rig exceeds the permitted overall dimensions, these must be marked according to the highway laws of the country or state involved in the transport. The transporter is responsible for using the correct mode of transport and complying with all other applicable regulations.

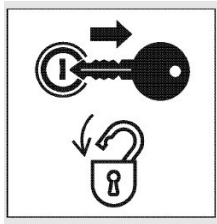
Precautions:

When the drilling rig is being moved onto the trailer or truck, the engine should be running at low speed.

The drilling rig must be securely fastened during transport. It should be placed firmly on the floor of the trailer or truck bed, with the rear support lowered and resting on the floor. During transport, the power head should be positioned in the middle of the main beam to prevent instability.

To prevent the drilling rig from sliding or tipping over on the trailer or "scaffolding" during loading and transport, all oil, grease, and ice must be removed from the area between the drilling rig and the trailer or "scaffolding" to ensure the surface is non-slip. When loading and unloading, the drilling rig should be moved along the centerline of the trailer or "scaffolding." Drilling rig operators and other personnel are not allowed to ride on the drilling rig.

General Maintenance



Failure to shut down the machine and lock the system before performing maintenance work can result in personal injury or even death. Turn off the power, release system pressure, and then turn the battery switch to the OFF position. Remove the key from the engine start switch. If the machine is equipped with a lock, install one on the battery switch. Before operating on the machine, use the appropriate locking and marking procedures.

Handle hydraulic fluid, transmission fluid, diesel engine oil, pin and bearing grease, diesel engine coolant, battery fluid, and fuel with care. Consult the Material Safety Data Sheet. Dispose of waste fluids in accordance with laws and regulations. Take appropriate precautions to ensure these fluids do not leak or spill onto the ground, into sewage systems, streams, rivers, lakes, or oceans.

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Engines, mufflers, gearboxes, and hydraulic systems can reach very high temperatures. Do not attempt maintenance immediately after stopping work. Wait until the parts have cooled down.

For additional drawings, diagrams, and instructions required for maintenance and repair, please contact GLADIATOR HDD.

Qualification of the Technician

Ensure all on-site personnel performing visual inspections of the drilling rig are appropriately trained to identify problems and have read this manual.

Maintenance technicians must be trained in directional drilling rig operation. Maintenance technicians are responsible for using appropriate testing and repair equipment, personal protective equipment, and being aware of safety hazards during maintenance.

Cleaning



Water can damage sensitive electronic components. Do not spray water on electronic components and control panels.

General Cleaning

Clean all marker panels and all lighting equipment. Do not direct water spray directly into the muffler or air filter, electronic components and control panels, or onto covers and open water tanks. Do not use acidic or abrasive solutions. Keep hydraulic connection covers and caps clean.

Contamination of hydraulic fluid can negatively impact the performance of the G30.

Cleaning Plastic and Resin Parts

When cleaning instrument clusters, gauges, dashboards, plastic windows, etc., avoid using gasoline, kerosene, paint thinner, and similar materials. These materials can cause discoloration, cracking, or deformation of the parts being cleaned. Only use water, mild soap, and a soft cloth to clean these parts.

Cleaning Hydraulic Connections

Hydraulic couplings and protective covers must be kept clean and free of debris. Use a petroleum-based vapor aerosol cleaner. Failure to keep hydraulic couplings clean will affect equipment performance, cause serious damage, and void the product warranty.

Cleaning Electrical Connections

Electrical connectors and dust caps must be kept clean and dry. Use a high-quality electrical contact cleaner. When disconnecting cables, cover the connectors and cable ends with dust caps. Failure to keep electrical connectors clean may affect equipment performance, cause serious damage, and void the product warranty.

Welding

Important:

- Turn off the engine.
- Disconnect all electrical connections before welding. Disconnecting the battery negative cable from the battery is especially important. Clamp the welder's grounding wire onto the part to be welded, as close to the weld seam as possible.
- Do not ground the welder using electrical components.
- Do not weld near water tanks or flammable liquids.
- Failure to follow welding procedures may damage electrical and mechanical components.

Damage to components due to incorrect procedures is not covered under warranty.

If welding at lower temperatures is required, consult the factory for more information on preheating or post-weld heat treatment requirements. Welding should not be performed when the ambient temperature is below 0°F.

Diesel Engine Maintenance

Engine maintenance items are not covered in this manual. For recommended engine oils (gasoline, engine oil, antifreeze) and inspection and maintenance schedules, please refer to Appendix 1: Diesel Engine Manual. Your engine may have specific requirements related to its emission system.

Approved Replacement Fluids

When adding or changing fluids, use the same fluid as that in your system. Avoid mixing different fluids, as they may be incompatible. Please use the fluids listed in the table below, or contact the manufacturer for advice on the compatibility of new fluids with the fluids currently in use.

Approved alternative fluid

(Ambient temperature 5°F to 110°F [-15°C to 43°C])

For temperatures outside this range, please consult the factory.

Table 1. List of Lubricating Oils for Drilling Rigs

Name	Brand:	Applications:	Frequency of use
Industrial Closed Gear Oil		Power head gearbox	1. The lubricating oil must be changed after the initial 150 hours of operation, and the power head gearbox oil must be changed every 500 hours of operation.
	L—CKD220	Reducer; Power head reducing thread; Protective shorting thread; Floating spindle	The lubricating oil must be changed after the first 150 hours of operation. Then, depending on the gearbox's operating conditions, the oil should be changed after 2000 or 4000 hours of operation, and at least once a year.
	GB5903		Apply thread oil once each time the drilling rig is installed or removed.
Threaded Oil	L—CKC220	Mulch pump gearbox; Transfer case	Apply lubricant after each of the two work cycles, and repeat this process.

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Total Loss System Oil (Machine Oil)	GB5903	Applications: Power head gearbox	1. The lubricating oil must be changed after the initial 80 hours of operation, and the power head gearbox oil must be changed every 200 hours of operation. 2. The crankcase oil level should be checked every 10
			hours of mud pump operation.

Table 2 List of Lubricating Greases for Drilling Rigs

Name	Grade	Applications:	Frequency of Use
Lithium-based grease	No. 1 General Purpose Lithium-Based Grease GB/T 7324	1. Centralizer, push-pull seat hook plate, main beam guide rail surface, clamp tilting cylinder, front clamp cylinder, rear clamp cylinder, mud rotary joint	Replace every 50 working hours
	(Winter Use)	2. Leg assembly, main beam luffing mechanism	Replace every 50 working hours
	No. 3 General Purpose Lithium-	3. Shaft pins, bearings, towing gears	1. Shaft pin: Lubricate daily 2. Shaft pin: Adjust lubrication cycle

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	Based Grease GB/T 7324 (Summer Use) (Butter)		according to bearing operating condition
Graphite grease		Applications:	Lubricate daily

Scheduled Maintenance

Hazardous area maintenance

When operators or assistants need to work on the drilling rig in the work area or hazardous area, and this involves activating one or more machine functions (such as starting, moving, rotating, lifting, etc.), strict safety measures must be taken to ensure personnel safety and prevent accidental injury or equipment failure.

- Minimize Personnel Entry into Hazardous Areas Minimize the need for personnel to enter the drilling rig's work area or hazardous area by utilizing remote control, automated systems, or mechanical assistance.
- Risk Assessment A detailed risk assessment must be conducted before any personnel enter or operate the equipment to identify potential hazards (such as mechanical movement, high-pressure fluids, falling objects from heights, electrical risks, etc.) and develop appropriate control measures.
- Lockout/Tagout If it is necessary to shut down the machine's engine, remove the key and turn off the power to ensure that the equipment cannot be accidentally started during maintenance or personnel entry.
- Communication and Coordination All relevant personnel (operators, assistants, supervisors) must have a clear understanding of the work plan, operating procedures, and potential risks. Maintain communication using clear signals, gestures, or radio communications, especially in noisy environments.
- Authorization and Supervision: Only trained and authorized personnel are permitted to enter hazardous areas or work near the drilling rig. A designated person must supervise to ensure that safety procedures are followed.
- If it is absolutely necessary for an operator or assistant to activate one or more machine functions in the hazardous area (e.g., adjusting drill strings, testing actions, etc.), the following conditions must be met.

Clear Instructions and Confirmation Mechanism

Activation must be preceded by clear instructions issued by a supervisor or responsible person and confirmed by the operator.

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- Jogging Control

If possible, use jogging mode, where the machine runs only at extremely slow speeds for short periods to allow for immediate stopping.

- Emergency Stop Device

Ensure the emergency stop button is in a quickly accessible position and is functioning correctly.

- Observation and Clearance

Before activating the machine, ensure all personnel are in safe locations and that no other personnel have entered the danger zone.

Maintenance and upkeep of hydraulic systems

Maintenance and upkeep of hydraulic hoses and fittings (see Table 3)

Table 3 Maintenance and Care of Hydraulic Hoses and Fittings

Maintenance and upkeep items	Inspection content	Maintenance and care methods
Hydraulic hoses and fittings	1. Check hydraulic hoses and fittings for leaks every 10 working hours or daily. 2. Before starting the machine, check for leaking or damaged hydraulic hoses and fittings.	Replace immediately if there is leakage or damage.

1.1 Fastener maintenance and care

Table 4 Maintenance and Care of Fasteners

Maintenance and upkeep items	Inspection content	Maintenance and upkeep
Fastener	1. Inspect fasteners in critical areas, such as hose clamps, knots, and fasteners at	1. Tighten all loose fasteners. 2. Replace any damaged or
	the reducer diameter.	missing fasteners.

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Fastener	2. Check the push-pull mechanism for wear and damage every 10 working hours.	1. Replace the severely worn push-pull rack. 2. Replace the damaged pushpull rack.
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Important Note: Using a drilling rig with damaged hydraulic hoses and fittings, or with loose or damaged fasteners, may result in personal injury.

Hydraulic oil maintenance and upkeep

Table 5 Maintenance and Care of Hydraulic Oil

Maintenance and upkeep items	Inspection content	Maintenance and care methods
Hydraulic oil level	1. Check the hydraulic oil level every 10 hours of operation or daily; when checking, ensure the drilling rig is parked on a flat, level surface;	If the oil level is below the mark on the oil level indicator, add hydraulic oil to the hydraulic tank until the oil level reaches the (full) mark on the indicator. Do not overfill.
	2. Every three months, the hydraulic oil should be checked to ensure it meets the standard requirements;	If the hydraulic oil does not meet the standards, it should be replaced; the hydraulic oil filter must be replaced every time the oil is changed.
	3. Replace the hydraulic oil or filter element after the first 500 hours of operation. Thereafter, replace the hydraulic oil filter element every 1000 hours.	1) When replacing the filter element, place an oil pan under the filter to allow the oil to drain to the ground. 2) Use a filter wrench to remove the filter, discard the old filter, and wipe the mounting surface clean with a cloth. 3) Apply a layer of clean hydraulic oil to the O-ring of the new filter; install the new hydraulic oil filter. 4) Tighten the filter element by hand until it touches the filter housing, then tighten it another 3/4 turn.

Important Notes: Keep the hydraulic oil clean. Filter the hydraulic oil thoroughly. Do not overheat the oil under overload conditions. Fill the hydraulic oil tank with L-HM46 antiwear hydraulic oil. If the ambient temperature is above 40°C, it is recommended to use LHM68 high-temperature anti-wear hydraulic oil. If the ambient temperature is below 5°C, it is recommended to use L-HM32 or L-HM46 low-temperature anti-wear hydraulic oil.

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Precautions: When draining hydraulic oil and from the filter, always collect the waste oil in a container and dispose of it properly. Never discharge hydraulic oil onto the ground.

Maintenance and upkeep items	Inspection Content	Maintenance and care methods
Oil level of mud pump	1. Check the oil level using the oil level indicator next to the crankcase.	If the fuel level is low, you need to add fuel, but do not overfill.
	2. At the work site, the oil level in the crankcase should be checked every 10 hours of operation of the mud pump. When checking, make sure that the drilling rig is parked on a flat and level ground. After adding oil, install and tighten the plug.	Fill the mud pump gearbox with total loss system oil (machine oil) or engine oil L- -AN46GB443 (winter use) AN100GB443 (summer use) 15W-40 (engine oil)

Maintenance and upkeep of mud pumps

Table 6 Maintenance and Care of Mud Pumps

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Diesel engine maintenance and upkeep

Table 7 Maintenance and Care of Diesel Engines

Maintenance and upkeep items	Inspection content	Maintenance and care methods
Diesel engine	1. The diesel engine should use No. 0 diesel fuel. 2. For detailed usage and maintenance instructions for the diesel engine, please refer to the accompanying manual and operation and maintenance booklet.	Using other types of diesel fuel will cause a decrease in engine power and an increase in fuel consumption.

Precautions: When the temperature is below -5°C, it is recommended to use -10 diesel fuel; when the temperature is below -15°C, it is recommended to use -20 diesel fuel; when the temperature is below -30°C, it is recommended to use -30 diesel fuel.

Battery maintenance and care

Table 8. Maintenance and Care of Storage Batteries

Maintenance and upkeep items	Inspection content	Maintenance and care methods
Storage battery	The battery should be checked every 250 hours of operation or every 6 months (starting from the first use).	Maintenance and Care Procedures: 1. Turn off the generator and remove the key from the ignition switch; 2. Ensure the battery surface is clean and free of debris; 3. Check the electrolyte level. If low, add clean or distilled water until the level reaches the opening ring groove of each cell's filler neck; 4. Check the terminals for corrosion; use a wire brush if necessary;

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		5. Check the battery cables for damage; replace any damaged cables. Note: When disconnecting the battery terminals, disconnect the negative terminal first, then the positive terminal; when connecting the cables, connect the positive terminal first. Connect the negative terminal; 6. Check the battery charging status; if the battery needs charging, a 24V battery charger should be provided; when replacing the battery, ensure the tower wire is connected to the negative terminal and the positive cable to the positive terminal; Precautions: To prevent battery damage, do not tighten the battery excessively during installation; 7. Battery cables and terminals: The battery terminals must be kept clean and secure; to prevent starting difficulties, keep the battery cables clean and secure; to prevent future corrosion, apply petroleum jelly or a small amount of grease to the terminals.
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Cooling system maintenance and upkeep

Table 9 Maintenance and Care of the Cooling System

Maintenance and upkeep items	Inspection content	Maintenance and care methods
Cooling system	1. Check the radiator for any debris.	Use a light to check the radiator for blockages; clean the radiator fins with compressed air or a suitable pressure cleaning device to ensure proper ventilation; if the fins are damaged, carefully straighten them; Important Notes: • Always wear a mask when cleaning the radiator fins with compressed air or other equipment; • Damaged or unclean radiator fins will reduce cooling efficiency and may cause engine damage;

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	2. The engine cooling system needs to be cleaned every 1000 hours of operation.	Steps for cleaning the engine cooling system: 1) Drain the coolant from the cooling system by opening the radiator drain valve and the engine block drain valve; 2) Circulate clean water through the system to flush it, then drain the water; Precautions: When draining coolant from the cooling system, always use a container (with a capacity larger than the cooling system) to catch the coolant; never
		allow coolant to spill onto the ground; Warnings: • Hot coolant may spray out if the radiator cap is unscrewed; hastily unscrewing the radiator may cause burns; • The correct way to unscrew the radiator cap is to allow the system to cool down, turn the radiator cap to the first notch, and wait until all pressure is released.

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	3. The engine coolant must be changed every 1000 working hours; Otherwise, it may cause the engine to overheat;	Important Notes: • When changing engine coolant, never pour cold coolant into a hot engine. The temperature difference between the metal and the coolant may cause cracks in the cylinder block and cylinder head. • Ensure the drain valves on the engine block and radiator are in the closed position. Steps for changing engine coolant: 1. Slowly pour a 50:50 mixture of water and ethylene glycol into the radiator until the level reaches the neck of the filler neck. 2. With the radiator and coolant reservoir full, start the engine and let it idle at low speed for about 5 minutes. The coolant level will drop. 3. Turn off the engine and remove the key. Then add coolant to the neck of the radiator filler neck. 4. Replace the radiator. 5. Fill the coolant reservoir to the specified level.
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Maintenance and upkeep items	Inspection content	Maintenance and care methods
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Intake system	1. Regularly inspect the hoses and clamps connecting the air filter and turbocharger; check the hoses for wear and damage; confirm that the clamps are tight.	Steps to remove the outer filter element: Loosen the latch on the air filter cover and remove the filter cover from the air filter housing; remove the outer filter element from the air filter housing;
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Maintenance and upkeep of the intake system

Table 10 Maintenance and Care of the Intake System

2. Clean or replace the air filter element according to the following steps:
1) Check the

element should be cleaned more frequently.
4) Check the removed filter element for damage and ensure the rubber seals at the ends are intact.

	system every 50 working hours; 2) Check the dust removal valve for blockage and for wear and damage every 10 working hours; 3) Clean the air filter element every 50 hours; an indicator will react after the filter plunger. Note: When the drilling rig is operating in dusty areas, the air filter	Air filter element: 1. Press the rubber sealing ring with your finger. If the rubber sealing ring is not responsive and cannot return to its original shape, the filter element should be discarded; 2. If most of the dirt and dust on the filter element is dry, you can blow it away with compressed air. Remember to wear a mask when using compressed air; Precautions: Keep the compressed air nozzle 127 mm (5 inches) away from the filter element. Move the nozzle up and down while rotating the filter element; the nozzle outlet pressure must not exceed 241 kPa (35 PSI); use a water hose without a nozzle and with a pressure less than 27 kPa (40 PSI) to flush away soapy water from the filter element and allow it to air dry;
6. Winter and summer maintenance and upkeep		

Table 11 Maintenance and Care in Winter and Summer

Maintenance and upkeep items	Inspection content	Maintenance and care methods
Winter protection	1. When the outside temperature reaches 0°C, antifreeze measures must be taken for the water tank.	1. After each day's work, a certain amount of antifreeze needs to be added to the mud system to prevent it from freezing. 2. Steps for adding antifreeze: 1) Add 19 liters of a 50:50 water-ethylene glycol mixture to the antifreeze tank and open the antifreeze valve; 2) Start the engine and turn on the mud pump. Once the water-ethylene glycol mixture flows out from the power head reducer, turn off the mud pump; 3) Collect, store, or properly dispose of the used antifreeze.
	2. Check the mud	Make sure to drain all the mud from the mud

7. Maintenance and upkeep of the power head gearbox

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	pump when the drilling rig is not in use.	pump.
	3. Check diesel engines that are not using antifreeze.	All water in the diesel engine and tank must be drained; otherwise, the equipment may freeze and crack.
	4. Check the location where the drilling rig is parked.	The drilling rig should be parked on wooden planks to prevent the tracks from freezing to the ground. If the drilling rig tracks are frozen to the ground, do not attempt to move the rig, as this will damage the track drive system.
Summer protection	1. Check the coolant level in the coolant tank and radiator.	Maintain the coolant level in the coolant tank and radiator at the appropriate level.
	2. Inspect the radiator cover.	Confirm that the radiator cover is working properly; replace the radiator cover if necessary.
	3. Inspect the radiator and engine surface.	Clean debris from the radiator and engine daily.
	4. Check the fan belt	Confirm the fan belt is in good working order; replace it if necessary.

Table 12 Maintenance and Care of the Power Head Gearbox

Maintenance and upkeep items	Inspection content	Maintenance and care methods
Power head gearbox oil	Change the power head gearbox oil every 500 working hours.	1. Add industrial closed gear oil (L-CKD220GB5903) to the gearbox. 2. Filling method is as follows: 1) Unscrew the filler cap plug, install and tighten the drain plug. 2) Add lubricating oil to the power head gearbox until the vernier caliper reaches the required level. 3) Install and tighten the filler cap plug.

8. Maintenance and upkeep of the protective short circuit of the power head

Table 13 Maintenance and Care of Power Head Protection Short Circuit

Maintenance and upkeep items	Inspection content	Maintenance and care methods
Power head sub saver	The threads of the power head protection short circuit should be checked daily for wear or damage.	1. During operation, the reducer thread of the power head must be lubricated with thread lubricant. Precautions: Due to drilling operations, the drill pipe must be connected to the power head protective short connector. Using a worn or damaged power head protective short connector will cause wear and damage to the drill pipe threads. If the power head protective short connector threads are worn or damaged, it should be replaced. 2. To replace the power head protective short connector, please follow these steps: 1) Clamp the power head protective short connector with the rear (reverse) chuck. After rotating the power head counterclockwise, remove the power head protective short connector. Move the power head back approximately 500 mm (20 inches), loosen the power head protective short connector from the chuck, and remove it. 2) Thoroughly clean the threads at the reducer front end with a wire brush and cleaning fluid, and apply thread lubricant. 3) Place the power head protective short connector back into the rear (reverse) chuck, clamp the chuck, and slowly rotate the power head clockwise until the threads are fully screwed in.

Maintenance and upkeep of pins and racks

Table 14 Maintenance and Care of Shaft Pins and Racks

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Maintenance and upkeep items	Inspection content	Maintenance and care methods
Pins and racks	All shaft pins and push-pull racks on the drilling rig must be lubricated daily.	Apply lithium-based grease to the shaft pins and graphitecalcium-based grease to the push-pull gears.

Daily Inspection and Maintenance Checklist for Gear Reducer

Table 15 Daily Inspection and Maintenance of the Gearbox

Maintenance and upkeep items	Inspection content	Maintenance and care methods
Routine inspection	During normal use, the speed reducer should be checked regularly to ensure it is operating normally and to check for abnormal noise, oil leaks, or loose fasteners.	If any abnormalities are found, timely and effective treatment should be given to eliminate the fault.
Oil change maintenance	Newly purchased speed reducers should have their lubricating oil changed after 150 hours of operation. After the oil change, change the oil again after 500 hours of operation. If the total annual operating hours are less than 100 hours, the oil must be changed once a year.	When testing oil quality, the lubricating oil must be replaced immediately if any of the following conditions are encountered: 1) Foreign matter content in the lubricating oil >2%; 2) Metal abrasive particles in the lubricating oil >0.5%; 3) Water content in the lubricating oil >2%.

Specific operating procedures for changing lubricating oil	Changing lubricating oil requires following certain specifications to ensure the safety of the overall operation. This places high demands and standards on operators, who must strictly adhere to the specifications and ensure attention to every detail and precaution.	The specific procedure for adding oil to the speed reducer is as follows: 1) Disconnect the hydraulic motor or disconnect the main power supply, and then wait until it cools down to a residual temperature (the speed reducer should still be warm when changing the oil). 2) Place a suitable oil collection tray at the bottom of the speed reducer's drain hole. 3) Loosen and remove the oil filler plug, breather, and drain plug. 4) Drain all remaining lubricating oil from the speed reducer and remove any metal particles or other impurities from the casing. 5) After draining, reinstall the drain plug (tighten it). 6) Add the same brand of lubricating oil through the oil filler hole, paying attention to the amount added, until it reaches 1/3 of the oil level mark on the speed reducer. 7) After adding oil, tighten the oil filler plug and breather, etc.
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Electrical Component Maintenance Instructions

Table 16 Maintenance and Care of Other Components

Component name	Model	Regular inspection cycle	Recommended time change
Emergency stop button	XB2BS542C	Visual Inspection: Weekly, inspect the emergency stop button for any visible physical damage, cracks, or oil stains. Ensure the red markings are clearly visible and the yellow background is undamaged. Confirm the button can be pressed and reset smoothly. Functional Test: Monthly, start the engine and run it at idle, then press the emergency stop button (ESTOP). Expected Result: The engine should immediately shut off and stop running.	15 years
Wired control box	Wired control box assembly	Daily Inspection: Visual Inspection: Inspect the control box housing, cables, and cable entry points for signs of compression, cuts, wear, or oil contamination. Confirm all buttons have a clear tactile feedback, strong rebound, and no sticking. Weekly Inspection: Check the connection between the control box plug and the equipment interface for secureness and absence of corrosion. Inspect the cable for signs of fatigue in areas prone to bending. Monthly Inspection: Perform a comprehensive functional test. Test all buttons for proper functioning, with no response delays or signal fluctuations.	12 years

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Electric control handle	SMC82A89-CAN-24-YQ38	Daily Inspection: Confirm that the controller operates smoothly and without sticking in all directions. Inspect the controller cable and sheath for obvious wear, dents, or oil buildup. Press the buttons to confirm that the actuation force is normal, the feel is clear, the rebound is strong, and there is no sticking. Weekly Inspection: In	12 years
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		addition to the daily inspection, check the button area housing for cracks or looseness, considering the overall controller. Monthly Inspection: Perform a functional test to confirm that the system only responds to controller commands when the controller is pushed or the buttons are toggled, and all actions should stop immediately after the controller returns to the neutral position or the button is released.	
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Rocker switch	CVJB2S00B- AZZ00-000- XJSGD	Daily Inspection: Visually inspect the switches for physical damage. Weekly Inspection: Tactile Inspection. Switch the rocker switch back and forth, feeling for smooth and firm movement, clear positioning, and no looseness or jamming. Monthly Inspection: Functional Verification. Perform a complete mode switch in a safe open area: Switch to "Walking" mode and verify that the equipment's movement functions (such as travel speed and steering) are normal. Switch to "Working" mode and verify that the working functions (such as drill pipe rotation, push/pullback) are normal. Confirm that there is no impact or malfunction during mode switching.	12 years
Controller	RC28-14/30	Weekly Inspection: Confirm that the controller is securely fixed to the mounting bracket without any looseness; check that all wiring harness interfaces (power, CAN bus, I/O interfaces) are tightened properly without any signs of looseness. Monthly Inspection: Combine monthly tests of other components (such as emergency stop, mode switching) to indirectly verify whether the controller's input/output response	20 years
		is normal and rapid.	

Maintenance and upkeep of other components

Table 16 Maintenance and Care of Other Components

Maintenance and upkeep items	Inspection content	Maintenance and care methods
Hoses	Check for damage to hoses every six months.	If there is any damage, repair or replace it.
Various components, pipes, bearings, pump shafts, and cylinder piston rods	1. Inspect the oil seals of all components, pipes, bearings, pumps, and shafts every six months. 2. Check for oil leaks from the hydraulic cylinder piston rod every six months. 3. Check for loose mounting bolts and pipe supports for all components every six months.	1. Replace any damaged oil seals immediately. 2. Identify and repair or replace any leaking oil from the cylinder piston rod. 3. Tighten any loose bolts or pipe supports immediately.
Cabinet door	Check the cabinet doors	The cabinet doors must not be left open during use to prevent dirt accumulation and rainwater from entering.
Hydraulic system	Hydraulic system inspection	The inspection items are as follows: 1. Check for leaks in all hydraulic valves, hydraulic cylinders, and pipe fittings. 2. Check for abnormal noises when hydraulic valves or hydraulic motors are running. 3. Check if the hydraulic cylinders move normally and smoothly during operation. 4. Check if the pressure displayed on each pressure gauge in the hydraulic system is within
		the specified range and if the pressure is stable.

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Fastener	Check for loose, damaged, or missing fasteners;	Regularly tighten all fasteners and replace any damaged or missing fasteners.
Nylon sheet maintenance	Regularly check the wear condition of the nylon sheet and adjust the fastening screws of the nylon sheet as needed.	If the wear and tear is excessive, please replace it promptly.
Fuel tank and pipeline	Regularly clean the fuel tank and pipes.	1. Fuel tank: Generally cleaned every six months. 2. Pipelines: Cleaning cycle depends on the working environment and level of contamination.

Troubleshooting

Hydraulic system section

Table 17 Common Fault Handling for Hydraulic Systems

fault phenomenon	failure cause	Exclusion method
Low Pressure	1. Pressure gauge is damaged	Replace pressure gauge
	2. Pump speed is too low	Check the diesel engine
	3. Leakage in actuator	Replace the sealing of the actuator or replace the actuator (hydraulic cylinder or motor)
	4. Oil pump damage	Repair or replace the oil pump
	5. Oil pipe leakage	Check and replace the oil pipe
	6. Improper pressure adjustment	Adjust pressure
	7. Insufficient hydraulic oil	Add hydraulic oil
The actuator is moving too slowly (hydraulic cylinder or motor)	1. Leakage in the actuator	Replace the sealing of the actuator or replace the actuator (hydraulic cylinder or motor)
	2. Oil pump leakage	Repair or replace the oil pump
	3. The check valve in the oil circuit fails and causes oil leakage	Repair or replace the check valve
	4. The solenoid valve fails and the valve is not fully open	Clean or replace the solenoid valve
	5. Overload	Reduce load
	6. Improper adjustment of relief valve	Adjust overflow
	7. The variable mechanism of the oil pump fails and cannot increase the flow rate	Check the oil pump and repair or replace it

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	8. Insufficient hydraulic oil	Add hydraulic oil
	9. The system oil temperature is too high and the leakage is too large	Cool hydraulic oil
	10. Filter element clogged	Check and clean all filter elements
The system oil temperature is too high	1. The relief valve pressure is too high	Adjust the relief valve pressure appropriately
	2. Too little hydraulic oil	Add hydraulic oil
	3. Internal leakage of system actuator	Repair or replace the internal leak component
	4. System cooling device is damaged	Heat dissipation device

Note: Change hydraulic oil regularly and keep it clean.

Electrical parts

Table 18 Common fault handling table for electrical appliances

fault phenomenon	failure cause	Exclusion Method
The battery cannot be charged	1. Generator burned out	Replace or repair the generator
	2. The electronic regulator is burned out	Switch regulator
	3. Battery damage	Battery replacement or repair
	4. Poor wiring	Reconnect the wire
	1. The operation button or handle is damaged	Replace the button or knob
The device has no related operation actions	2. Poor wiring	Check and reconnect the wires
	3. Relays burn out	Replace the relay
	4. The solenoid coil or relay coil is burned out	Check and replace the relevant coil

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	5. The solenoid valve is stuck	Clean solenoid valve
	6. The battery is dead	Charge the battery
	7. Press the emergency button or fail to close the power switch	After handling the incident, remove the emergency button or turn off the power switch
	8. The voltage regulator or switching power supply is damaged	Exchange related accessories
	9. Fuse blown	Replace fuse

Track section

Table 19 Troubleshooting Guide for Walking Parts (Treadplates)

fault phenomenon	failure cause	Exclusion method
Walking weakness	1. Motor leakage	Repair or replace the drive motor
	2. Insufficient pressure adjustment of the walking system	Adjust pressure
	3. Oil pump leakage	Repair or replace the oil pump
	4. The relief valve is blocked or damaged	Clean or replace the relief valve
	5. Tires loose	Re-adjust the track tension mechanism
Track Drag Chain	1. Insufficient tension	Adjust the tension mechanism
	2. Tread plate fracture	Replace track plates
	3. Chain rail cracking	Change track

Power Head Section

Table 20 Troubleshooting Guide for Rotating Components of Power Head

fault phenomenon	failure cause	Exclusion Method
No rotation force	1. Electromagnetic valve leakage	Repair or replace solenoid valve
	2. Oil pump damage	Repair or replace the oil pump

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	3. Hydraulic motor leakage	Repair or replace the motor
	4. System oil temperature is too high	Lower the oil temperature
	5. System oil shortage	Add hydraulic oil
Rotation speed is too slow	1. Overload	Reduce load
	2. Low system pressure	Increase system pressure
	3. The electro-hydraulic valve is jammed	Clean solenoid valve
	4. Insufficient oil pump supply	Repair or replace the oil pump
	5. Motor leakage	Repair or replace the motor
No rotation	1. The closed pump is damaged or the closed pump coil is burned out	Repair or replace the closed pump or coil
	2. Handle damage	Repair or replace the handle
	3. Motor damage	Repair or replace the motor

Table 21 Troubleshooting Guide for Push-Pull Section of Power Head

fault phenomenon	failure cause	Exclusion Method
No drag	1. Motor leakage	Repair or replace the motor
	2. The relief valve of the proportional multi-way valve is jammed	Repair or replace the relief valve
	3. Push and pull speed is too slow	Rotate slowly
No push-pull action	1. Motor damage	Repair or replace the motor
	2. Handle damage	Repair or replace the controller
	3. Oil pump damage	Oil Change Pump
Gearbox noise	1. Gearbox oil shortage	After replacing the damaged part, add oil
	2. Bearing damage	Replace the damaged bearing

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Gearbox oil leak	1. The paper pad at the motor installation is damaged or not properly installed	Replace the paper pad
	2. The oil seal or gasket at both ends of the spindle output is worn or not properly installed	Replace the oil seal

Clamps

Table 22: Troubleshooting Guide for Common Clamps

Clamping weak	1. The multi-way valve is blocked.	Clean clamping multi-way valve
	2. The clamp strip is severely worn	Replace clip
	3. Internal leakage of clamping hydraulic lock	Replace or repair hydraulic lock
	4. Leakage in the clamping cylinder	Repair the clamping cylinder and replace the relevant seals

Mud pump section

Table 23 Mud section common fault handling table

fault phenomenon	failure cause	Exclusion method
The slurry pump is not pumping water	1. Air enters the mud pump	exhaust-gas disposal
	2. No water enters the mud pump	Fill the water tank, open the water valve, and ensure smooth water flow.
	3. The mud pump does not rotate	Check whether the mud pump drive motor is working properly, whether the hydraulic pipeline has pressure, and whether the solenoid valve is working
	4. Mud pump pressure is too small (water pressure)	The pump cylinder liner and bushing require replacement due to wear. The water source contains excessive impurities, necessitating the disassembly and cleaning of the pump head inlet and outlet valve seats.
	5. The seat of the slurry pump check valve is worn or the steel ball is not round	Replace accessories
The mud pump cannot achieve the discharge volume or cannot discharge the medium at all	1. Filter exposed above water	Immerse the filter in the liquid surface to a depth of at least 0.3-0.5m
	2. Filter blockage	Remove the filter and clean it
	3. Water intake pipe blockage	Disassemble the water intake pipe and clean it
	4. The water suction pipe is not tightly sealed and air is sucked in	Check the connection and hose and try to eliminate
	5. The inlet and drain valve is jammed and does not work	If the valve or valve seat is stuck due to wear, replace the parts. If the pump head is blocked by mud, open the bottom of the pump head and clean the cylinder liner.

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	6. Piston or cylinder liner wear	Open the cylinder liner, adjust and
		tighten the copper screw sleeve that holds the piston, and replace the piston and cylinder liner;
	7. The water absorption channel is not filled with water or air pockets are formed	Fill with water and vent air (optional water funnel for filling and venting)
	8. The water absorption height exceeds the allowable height	Adjust the water absorption height to within 2.5m (or 1m for thick slurry)
	9. The water suction pipe is too long or too small in diameter	Shorten the length by no more than 5m and increase the pipe diameter to the specified size
	10. Insufficient oil pump oil supply or insufficient pressure, motor speed and torque reduced	Check and fix
The mud pump is difficult to operate	1. The piston and sealing ring are too tight, and the sealing is too tight	Relax the adjusting nut to reduce the interference of the sealing ring
	2. The connecting rod bearing tightly clamps and locks the crankshaft journal	Check the gap and adjust
	3. The piston, piston rod, crosshead, and connecting rod mechanism are misaligned	Check and fix
	4. Some connecting parts are loose	Check and tighten
Abnormal noise during operation	1. The connecting rod bearing is loose or the clearance is too large	Adjust the bearing bushing clearance or replace the bearing bushing
	2. The piston rod and crosshead connection is loose	Check and tighten
	3. Bearing, gear or other parts are damaged	Check and replace damaged parts

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	4. The bearing clearance at the end of the crankshaft, first and second shafts is too large	Check and adjust the adjustment bolts on the shaft end cover
Excessive pressure pulsation	1. The pressure gauge head hole is blocked	Clean the pressure gauge head hole
	2. The piston of a cylinder is badly worn	Check and replace new parts
	3. The piston of a cylinder is badly worn	Check and update new parts or repair valve seat holes
	4. The valve seat of a cylinder	Check and clear
	is blocked by impurities and cannot work	
	5. The clearance between the valve seat and the valve seat hole is too large	Remove gaps
	6. The discharge medium contains a large amount of gas	Check the cause and fix it
	7. Pressure gauge damage	Replace pressure gauge
Local fever or temperature rise	1. Excessive lubricating oil in the crankcase exceeds the specified liquid level height	Check and drain oil to the specified height
	2. The connecting rod bearing is too tight and the clearance of the three conical bearings is too small	Check and adjust to a reasonable gap
	3. The piston seal is too tight	Loosen the seal tightness
Shift Gear	1. The top adjustment bolt is not properly tightened after shifting into neutral, failing to secure the positioning steel ball on the gear lever.	Check and tighten the top adjustment bolt until it can't be turned any further
	2. The clamping screw on the fork and gear shift lever is not tightened	Check and tighten the fastening screw, and add wire to prevent loosening

fault phenomenon	failure cause	Exclusion Method
The reducer is overheating	1) Overload 2) Insufficient or excessive lubrication	1) Check the actual load, adjust to the specified value or replace the reducer with a larger power
The safety valve and unloading valve are leaking, and the safety valve is not working properly	1. Insufficient pre-pressure of compressed spring in safety valve	Adjust spring pressure
	2. The valve seat section is uneven and the inner hole is not round	Check and repair
	3. Oil and debris at the contact between the valve and the valve seat	Check and clean
	4. Compression spring jammed	Relax again to ensure spring clearance

Reducer section

		2) Use oil according to the prescribed amount
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Abnormal and stable operating noise	1) Noise from rotation or grinding, bearing damage 2) Knocking noise, irregular engagement	1) Check oil 2) Contact the user service organization
Unstable abnormal operating noise	Oil contamination or insufficient oil	Change or add oil to the specified level
Ventile oil leak	1) Too much oil 2) The ventilator is not installed correctly	1) Adjust oil level 2) Install the ventilator correctly
oil leak	Seal damage	Contact the user service provider
The output shaft does not rotate when the motor rotates	The reducer key connection is broken	Send for repair

Table 24 Common fault handling of reducer

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Specifications

Main theoretical and technical parameters

Main theoretical parameter G30

project	unit	parameter	remarks
outline dimension	mm	5685*2105*2630	
Host Quality	KG	8500	
Rated working pressure of hydraulic system	Mpa	30	
Maximum torque of the power head	N•m	5700	
Maximum speed of the power head output	r/min	193	
Maximum push/pull force of the power head	KN	146	
Maximum push-pull speed of the power head	m/min	4	carrying idler
Drill pipe diameter × drill pipe length	Mm	Φ60×3000	
Power Head Diameter Change		60 female - 60 female	
Incidence Angle	linear	17	
Maximum slurry flow	L/min	180	
Maximum mud pressure	Mpa	8	
Maximum bore diameter	Mm	Φ700	Address-based
Maximum borehole length	m	200	Address-based

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climbing capacity	linear measure	18	
Automatic rod box	root	65+1	
speed of travel	km/h	2.98-5.06	
Hydraulic tank capacity	L	200	
Diesel tank capacity	L	180	

Major Dispositions

name	model	qualification
Diesel Engine	F3.8 C148 Cummins (Euro 5)	110KW/2200rpm
	QSB3.9-C130-30 Cummins (National III)	97KW/2200rpm
gear pump	Closed-loop pump S90-R-075 and loadsensitive pump HP5V76/HP5V45	
Spindle motor	CMV-A3-085	
Power head pushpull motor	Worm gear motor 6K series (390cc displacement)	
Feed Motor	6K-390-612-1024 Wire laying hydraulic motor	
Hydraulic Anchor Motor	2K-395-604-0078 Wire laying hydraulic motor	
drive-by-wire	RC28-14/30(R917A07683)	
crawler unit	8TM	
mud pump	Elephant 180L/min	

List of wear parts

No.	name	Materials and Specifications	quantity	Component
1	Primary diesel filter	FS90193 (5396530)	1	Powertrain (Euro 5)
2	Secondary diesel filter	FF90533 (5303404)	1	Powertrain (Euro 5)
3	Oil filter	LF 9230 (4989314)	1	Powertrain (Euro 5)
4	air cleaner element	A034R678	1	Powertrain (Euro 5)
5	air cleaner element	AA90145	1	Powertrain (Euro 3)
6	oil filter	C3908616(LF3345)	1	Powertrain (Euro 3)
7	fuel filter	C5301448 FF5767	1	Powertrain (Euro 3)
8	fuel filter	C5289992(FS36210)	1	Powertrain (Euro 3)
9	Fuel/water separator	C5290009 (C5300516) (FS36230)	1	Powertrain (Euro 3)
10	batten	DZ10A.5.2-2100*27 (black)	8	retainer

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11	Slurry Pump Accessories	BW180.00.00GD	1	Borrow, Elephant Select
12	Return Oil Filter	V2.1217-08	1	Hydraulic pressure system

13	Pipeline filter cartridge	HSTX-120×10	1	hydraulic pressure system
14	O molding ring	φ47.5×3.55	5	hydraulic pressure system
15	O molding ring	φ35×3.1	5	hydraulic pressure system
16	O molding ring	φ8×1.5	5	hydraulic pressure system
17	O molding ring	φ10×1.5	5	hydraulic pressure system
18	O molding ring	φ12×2	8	hydraulic pressure system
19	O molding ring	φ15×2	5	hydraulic pressure system

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20	O molding ring	$\phi 16.3 \times 2.4$	5	hydraulic pressure system
21	O molding ring	$\phi 20.3 \times 2.4$	5	hydraulic pressure system
22	O molding ring	$\phi 33.3 \times 2.4$	5	hydraulic pressure system
23	O molding ring	$\phi 9.25 \times 1.78$	8	hydraulic pressure system
24	O molding ring	$\phi 22 \times 2.5$	5	hydraulic pressure system
25	O molding ring	$\phi 10 \times 2$	5	hydraulic pressure system
26	O molding ring	$\phi 158.42 \times 2.62$	5	hydraulic pressure system
27	O molding ring	$\phi 278.77 \times 5.33$	5	hydraulic pressure system
28	Two-position reset switch (Jialing)	CVBB2S00B-AZZ00-000-XJSGD	1	electrical system
29	Two-position reset switch (Jialing)	CVAB2S00B-AZZ00-000-XJSGD	1	electrical system

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30	Three reset switches (Jialing)	CVLB2S00B-AZZ00-000-XJSGD	1	electrical system
31	Three non-reversible switches (Jialing)	CVJB2S00B-AZZ00-000-XJSGD	1	electrical system
32	Copper Plugin	JK967-199 rocker switch accessories	12	electrical system
33	Connector (Jialing)	190-17509-001/VC2-01	4	electrical system

Safety Management Specifications for Scrapped Equipment: Technical Requirements and Implementation Guidelines

ISO 12100:2010

Safety principles and scrapping requirements

As a large-scale underground construction equipment, the decommissioning process of G30 involves high-risk operations and must adhere to systematic safety management methods. According to the core principles of EN ISO 12100:2010, mechanical safety must be ensured throughout the equipment's entire lifecycle, from design and manufacturing to usage and final disposal. Clause 6.4.5 of this standard specifically emphasizes that risk control measures should extend continuously to the "disposal and decommissioning" phase, requiring the consideration of final safety disposal plans during the initial design stage.

During equipment decommissioning, ISO 12100 mandates that manufacturers and operators must identify and control major hazards associated with the process, including but not limited to residual energy release (hydraulic, electrical, gravitational), hazardous material leaks (lubricants, hydraulic fluids, fuels), structural instability, and operational errors. For equipment like G30 systems containing large rotating components, high-pressure hydraulic systems, and potential contaminants, a systematic control procedure must be established throughout the decommissioning process to ensure safety from decision-making, equipment decommissioning, on-site dismantling to final disposal.

It is worth noting that GB/T 43746.1-2024 "Safety requirements for drilling and foundation construction equipment Part 1: General requirements" has clearly included "scrap and waste disposal" as a key link in the whole life cycle safety management of construction equipment, requiring manufacturers to provide relevant safety disposal information and users to establish special management system.

Table: Analysis of Major Hazard Sources and Consequences in the G30 Scrapping Phase

class of risk	Specific manifestations	Possible consequences	ISO 12100 Corresponding Clause
mechanical hazard	Unexpected startup, component detachment	Compression, impact, and cut injuries	4.2.1

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class of risk	Specific manifestations	Possible consequences	ISO 12100 Corresponding Clause
electrical hazard	Residual capacitance discharge, cable damage	Electric shock, short circuit fire	4.2.2
Chemical hazard	Oil leakage, battery acid leakage	Soil pollution, chemical burns	4.2.7
Ergonomic hazard	Improper disassembly posture and manual handling	Muscle and bone injuries	4.2.10

Abandonment conditions determination

Technical scrapping conditions

The G30 shall initiate scrapping evaluation procedures when reaching the following technical conditions:

- Structural integrity failure: Critical load-bearing components such as main beams and rotating platforms exhibit irreversible deformation or cracks. After thorough inspection and evaluation, these structures are confirmed to have lost load-bearing capacity, posing imminent disintegration risks. Particularly for equipment with over 10 years of service, key structural elements have suffered material degradation due to cumulative fatigue, with safety factors now below the design specifications.
- Irreversible functional failure: Power station output power drops by over 30%, main pump pressure remains below 70% of rated value continuously, or control system multi-way valve assembly suffers severe internal leakage. Even after major overhaul, basic performance cannot be restored. Particularly for imported legacy models, discontinued spare parts make component replacement difficult, resulting in technical performance failing to meet basic construction requirements.
- Safety device failure: Critical safety functions such as the automatic shutdown system, overload protection device, and emergency braking system are non-functional and irreparable, or the original design no longer complies with current safety standards (e.g., EN 16228 series drilling rig safety standards).

Economic scrapping conditions

When the economic rationality of maintaining the operation of the equipment is lost, the scrapping assessment should be started:

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- Excessive maintenance costs: If the maintenance expenses exceed 60% of the equipment's net value for three consecutive years, or a single overhaul costs over 50% of the equipment's residual value, scrapping becomes more economical. For instance, replacing a drilling rig's gearbox typically costs 30-40% of the equipment's residual value.
- Serious deterioration of energy efficiency: the fuel consumption rate of the equipment exceeds the standard of the new machine by more than 45%, and the engine overhaul still cannot be improved, resulting in high operating costs.
- Low comprehensive benefit: due to backward technology, the work efficiency of shift is 50% lower than that of similar new equipment, which cannot meet the basic project progress requirements.

Safety and Environmental Compliance Disposal Conditions

- Safety standards are not met: the equipment design does not meet the requirements of the current mechanical safety directive (such as the lack of emergency stop system, protective devices are not up to standard), and the safety operation requirements cannot be met even after modification.
- Excessive pollutant discharge: the engine discharge exceeds the current stage of national nonroad machinery emission standards (such as national 4 or above), and the feasibility of upgrading is not available.
- Environmental risks are uncontrollable: the hydraulic system leakage rate is more than 5%/month, there is a risk of continuous pollution of soil and groundwater, and the remediation cost is not economical.

Policy-based scrapping conditions

- Compulsory elimination of equipment: the models listed in the elimination category of the "Industrial Structure Adjustment Guidance Catalog" of the National Development and Reform Commission, such as the early mechanical directional drilling machine.
- Exceeding the service life of special equipment: The drilling crane with a lifting capacity of $\geq 1t$ has not passed the regular inspection or has exceeded the designed service life.

Table: G30 Scrap Technical Conditions Comparison Table

Measurements	Specific indicators	Scrap threshold	test method
configuration state	Main beam deflection	$>L/500$	Total station measurement
power performance	engine power	$<\text{Rated } 65\%$	Platform Test

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hydraulic pressure system	system pressure	70% of rated value	Pressure gauge test
economical efficiency	Maintenance/Residual value	>50%	cost analysis
Eco-friendliness	Particulate emissions	>0.4g/kWh	Exhaust testing

Abandonment procedure management

Abandonment application and preliminary assessment

The equipment using department shall conduct a preliminary evaluation based on the above scrapping conditions and fill in the G30 Scrapping Application Form, which includes the following core contents:

- Basic equipment information: manufacturer, model, factory number, commissioning date, accumulated working hours, and historical maintenance records.
- Technical condition analysis: comparison of data from the last three test reports, current fault list, and assessment of repair feasibility.
- Economic analysis report: maintenance cost statistics in the past three years, salvage value estimation, replacement/maintenance cost-benefit comparison.
- Security risk description: a list of projects that do not meet current security standards and an analysis of previous security incidents.

Technical appraisal and joint review

A technical appraisal committee composed of the following experts shall be established:

- Equipment engineer: responsible for evaluating structural integrity, hydraulic system status, and power performance.
- Security Officer: Review the effectiveness of equipment safety devices and identify risks in the decommissioning process.
- Environmental experts: Test for oil leaks, asbestos content (in brake pads), PCB (transformers), and other pollutants.
- Financial representative: calculate the net value of equipment, disposal cost, and the impact of asset cancellation.

The appraisal process should employ quantitative assessment tools, including:

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- Non-destructive testing: magnetic powder flaw detection and ultrasonic thickness measurement are carried out on key load-bearing parts.
- Function test: Perform no-load and load tests under controlled conditions and record performance parameters.
- Service life assessment: Predicts the end of service life based on cumulative working hours and load spectrum analysis.

Approval Decisions and Hierarchical Authorization

Establish a hierarchical approval mechanism to determine permissions based on the original value of the equipment:

- Original value <500,000 yuan: approved by the person in charge of the using unit and reported to the equipment management department for record.
- 500,000-2 million yuan: approved by the company's equipment supervisor and co-signed by the safety and technical departments.
- > 2 million yuan: Submit to the asset management committee under the board of directors for approval, and report to the superior group for record.

Special equipment (such as truck crane) must obtain additional cancellation permission from the market supervision and administration department, and the "Special Equipment Scrap Record Form" can be processed before disassembly.

Asset processing and financial processes

3.4.1 Financial liquidation

Within 5 working days after the equipment is scrapped, the financial department shall complete the write-off of fixed assets. The equipment that has been fully depreciated shall be treated as residual value; the equipment that has not been fully depreciated shall be replenished in a lump sum.

1. Residual value processing

- Recyclable Component Management: Disassemble functional components from the machine (e.g., engine, hydraulic pump, drill pipe joint, wear-resistant sleeve). After cleaning, inspection, and repair, these parts are stored as second-hand components or sold externally (marked as "disassembled scrap equipment parts"). The entire machine must not be resold for other uses to prevent obsolete equipment from entering the secondary market.
- Waste materials disposal: For the main body of the machine (such as the frame and power head shell) that cannot be repaired, it shall be disposed of through public auction

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or entrusted to a qualified waste materials recycling company (which shall have the "Recycling Resources Business License") to ensure the maximum residual value.

Waste disposal risk control

Demolition Work Preparation

- Plan Preparation: The Registered Safety Engineer shall develop the "Special Plan for Demolition of Scrapped Drilling Rig", specifying the disassembly sequence (electrical components first, then mechanical parts), lifting points, personal protective equipment requirements, and identifying high-risk phases through HAZOP analysis. The plan shall include:
 - ✧ Frame lowering control program
 - ✧ Hydraulic pipe pressure relief method
 - ✧ Battery safety disconnect procedure
 - ✧ Hazardous substance (engine oil, hydraulic oil, coolant) treatment plan
- License management: Implement the work permit system. When performing dangerous operations such as high-altitude work and hot cutting, the High-risk Work Permit must be obtained.
- Personnel training: brief the demolition personnel on the plan, and focus on the training of residual risk identification (such as spring energy storage, hydraulic pressure storage) and emergency response skills.

Isolation of Hazardous Energy

- Electrical isolation: Disconnect the main power supply, lockout/tagout (LOTO), discharge the capacitors, and verify no residual voltage remains in the circuit. The control cabinet must be permanently marked as 'Do Not Use' to prevent accidental reconnection.
- Hydraulic pressure relief: Release all hydraulic energy through the manual relief valve and confirm the pressure gauge reads zero. For gravity components like lifting cylinders, mechanical support devices must be installed.
- Kinetic energy elimination: remove the fixed rotary platform in front of the rotary motor, and brake the rotating mass body such as the flywheel.

Environmental Protection Requirements

- Oil recovery: Use special suction equipment to collect residual oil in the oil tank and pipeline (300-800L waste oil can be recovered per drilling rig on average), and submit it to the hazardous waste disposal unit.
- Hazardous substance treatment:

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- ✧ Asbestos-containing components (brake pads, gaskets) should be removed using wet methods and packaged in sealed containers.
 - ✧ PCB capacitors are registered separately as hazardous waste
 - ✧ Special treatment of lead solder and mercury switches
- Part cleaning: The oil-contaminated parts are treated in the special cleaning area, and the waste water is discharged into the industrial sewage treatment system after pretreatment in the oil separator.

Process Safety Control

- Area isolation: Set up a warning zone with a 2-meter-high hard barrier, and hang a warning sign at the entrance ("Scrap Work Area, Unauthorized Personnel Prohibited").
- Lifting management: When the weight of disassembled parts exceeds 1t or the size is greater than 2m, the certified crane operator shall operate the redundant lifting with double strand steel wire rope.
- Cutting fire prevention: remove combustible materials before hot cutting, provide fire monitoring personnel and fire extinguishing equipment, and install anti-backfire device on acetylene bottle.
- Component disposal: For components that may be reused (such as undamaged walking motors and control valve groups), after professional testing and qualification, the available spare parts label is affixed to the warehouse, and the traceability file is established.

Table: G30 scrapping and dismantling risk control measures

Risk type	control measures	Responsible Position	Supervision requirements
Start unexpectedly	Lock main switch + warning sign	electrician	Daily check
Oil spill	Leak-proof tray + oil absorbent felt	Environmental Officer	real time protection
Structure collapse	Temporary support + pre-tensioned straps	Crew Command	Load Test
harmful dust	Wet cutting + local ventilation	safety officer	Dust detection

Documentation and Information Management

Scrapping Process Record

The whole process of scrapping should be documented for traceability:

- Technical appraisal report: includes test data, performance evaluation, and the committee's concluding opinion.
- Disposal record form: Detailed record of the whereabouts of dismantled parts (reuse, remanufacturing, recycling, waste disposal).
- Environmental treatment certificate: hazardous waste transfer form, harmless treatment certificate, final disposal certificate.
- Asset cancellation documents: asset write-off vouchers from the finance department and tax filing materials.

Manufacturer Information Responsibilities

In accordance with ISO 12100 clause 6.4, G30 manufacturers shall provide safety decommissioning guidelines in the user manual.

- Recommended disassembly sequence: Identify key connection points and specify components to be removed first.
- Residual risk warning: indicate the location of components containing hazardous substances (such as nitrogen accumulator in shock absorber, mercury-containing sensor).
- Special tools list: provide oil circuit cleaning device, accumulator pressure relief tool and other special disassembly equipment.
- Material composition description: List the content of hazardous substances above the threshold (such as lead-based bearing bushing, chromium-containing anticorrosive coating).

Organizing Knowledge Management

After equipment is scrapped, knowledge accumulation should be completed:

- Failure analysis report: organize typical failure modes of the equipment during its whole life cycle and provide feedback to the design department.
- Summary of disposal experience: The safety and environmental protection experience of scrapping process is incorporated into the revision of the company's "Equipment Scrapping Operation Manual".
- Data archiving requirements: Disposal materials shall be retained for at least the equipment's design life (G30:15 years), while special equipment shall be permanently retained in accordance with regulations.

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By rigorously implementing an ISO 12100-based scrapping management system, enterprises can not only effectively control operational risks during the G30 scrapping phase, but also drive continuous improvement in product safety design through a closed-loop lifecycle data system, thereby achieving sustained enhancement of intrinsic safety levels. Furthermore, standardized equipment disposal prevents obsolete machinery from entering informal markets, reducing environmental pollution and safety hazards while fulfilling corporate environmental and social responsibilities.

Appendix

Appendix A: List of Attachments

Annex 1: Diesel engine manual

**Appendix 2: Remote Lock System Operation and Safety Manual Appendix 3:
Anti-electric shock system instruction manual**

Appendix 4: G30 Parts Manual

Appendix 5: G30 Design Calculation Book

Appendix 6: Electrical schematic

Appendix 7: Hydraulic schematic

Sample Declaration of Conformity

Compliance Statement

Date: _____

Manufacturer: GLADIATOR HDD, LLC.

Product specification model: G30

Identification of product: 30,000lb class Horizontal Directional Drill

This statement complies with the requirements and related requirements of basic health and safety.

This machine complies with the following standards and related regulations:

- ☐ OSHA 29 CFR 1910 (general industry)
 - ☐ OSHA 29 CFR 1926 (construction)
 - ☐ ANSI B11 series (machine safety)
 - ☐ ANSI/RIA R15.06 (if robotics or automation are involved)
 - ☐ SAE J-series standards
 - ☐ EPA Tier 4 Final emissions requirements
 - ☐ FCC Part 15 (electronic equipment)
- The technical documents are stored at GLADIATOR HDD, LLC.

Person Authorized to Compile the Technical File: