HIGH-PERFORMANCE DRILL PIPE LINE

Technical Solution

2026-1-25

HOTSTONE GROUP CO., LTD

Content

Appendix 1: Project Description and Process Specification

1 General Information

The purpose of these technical requirements specification is to purchase a package of equipment for production of seamless hot-deformed pipes and design services (basic and detailed engineering), installation and commissioning supervision services and information and consulting services

1.1 Equipment application

The equipment is intended for production and finishing seamless hot-deformed pipes with a diameter of 36-190 mm from hot-rolled or turned round bars

1.2 Equipment operation conditions

Description of the existing situation and of the area where the equipment is to be operated. A new pipe-rolling shop with a corresponding infrastructure is expected to be located on the site of Alexey Ugarov OEMK in a stand-alone building. Delivery of feedstock to the new shop and shipment of finished products from it shall be carried out by rail and/or road transport

Equipment operation environment: high dust concentration; shop ambient temperature +5 to +40 ºC; relative humidity (5-80)% at temperature of 20 ºC

2 Equipment requirements

Equipment to be delivered shall provide for patent freedom-to-operate as regards Russian Federation and leading industrial states.

Equipment specified in a proposal shall be certified for application in industrial conditions of metallurgical production as per the law “On industrial safety of hazardous production facilities” No. 116- FZ and meet the requirements of technical regulations in force on the territory of the Eurasian Customs Union.

Design solutions, choice of electrical and energy equipment shall ensure the minimum possible specific consumption of all types of energy resources during operation, electric motor drives shall be equipped with frequency regulation, buildings and facilities shall have a high energy efficiency class and comply with the requirements of Federal Law No. 261-FZ “On Energy Saving and improvement of energy efficiency of the Russian Federation”.

2.1 . Functional requirements to equipment

Equipment should operate in automatic, semi-automatic and manual modes. Control system of equipment shall have a possibility to interchange data with the existing and developed Automatic Process Control Systems (APCS) and Manufacturing Execution Systems (MES) of Customer

The main operations that shall be provided by the configuration of the equipment to be supplied:

- ✧ accounting of primary parts received in warehouse.
- ✧ finishing processing of feedstock billets (scale removal, straightening, control of inner and surface defects, peeling of surface defects, cutting);
- ✧ heating of feedstock billets before rolling.
- ✧ incoming billets surface descaling at different processing steps(where necessary);
- ✧ centering of feedstock billets.
- ✧ production (rolling) of pipes in accordance with the production program and quality requirements.
- ✧ external, internal or combined upset of pipe ends.
- ✧ pipe heat treatment.
- ✧ processing of pipe ends for welding.
- ✧ coupling fabrication.
- ✧ couplings heat treatment.
- ✧ pipes finishing.
- ✧ cutting regular or premium threads on heads and tails of pipes.
- ✧ coupling screwing-on.
- ✧ marking of pipes.
- ✧ application of conservation coatings (if required);
- ✧ formation of bundles of finished products, weighing and strapping.
- ✧ labels manufacturing and tagging bundles.
- ✧ issuance of bundles to the finished product warehouse, accounting of finished

products.

- ✧ carrying out certification tests (including hydrostatic).

2.2 . Performance Requirements

2.2.1 Feedstock parameters

2.2.1.1 Feedstock is round rolled bars with a diameter of 45-190 mm in a hot rolled condition or round rolled bars with a diameter of 45-180 mm in a turned condition, transferred to the new shop in bundles with weight up to 10 tons. Rolled bars parameters

- ✧ Diameter accuracy corresponds to standard rolling accuracy asper GOST 2590;
- ✧ out-of-straightness not exceeding 5 mm/m
- ✧ length: 2500-11800 mm for diameters from 45 to 83 mm,4000-5900 and 8000-11800 mm for diameters from 85 to 190mm.

2.2.1.2 Chemical composition of the incoming billets to be possibly used is indicated in the standards pursuant to Table 1

Steel Groups	Standards
Spring steel	GOST 14959, DIN 17221
Bearing steel	GOST 801, DIN 17230
Cold-heading steel	GOST 10702, DIN 1654
Non-alloyed structural stee	DIN EN 10025
Carbon steel	GOST 380
Alloyed and carbon structural steel	GOST4543,GOST1050,DINEN10083,DIN EN 10084, ASTM A29/A29M, PD 970
Tool steel	GOST 1435, GOST 5950, ISO 4957
Free-cutting structural steel	GOST 1414
High-strength steel	GOST 19281

2.2.1.3 Equipment package shall ensure production and tests of seamless hot-finished round pipes with the following parameters

- ✧ Pipes outer diameter range from 36 to 190mm. Diameter tolerance for pipes with diameter up to50mm ±0,35mm, for pipes with diameter over 50mm ±0,8% of diameter.

- ✧ Range of pipe lengths to be produced is from 2 to 13m. Cutting accuracy +10 mm (± 5 mm)
- ✧ Pipe wall thickness tolerance (+0/-12,5) % of wall thickness nominal dimension.
- ✧ Pipe out-of-straightness not exceeding 1 mm/m;
- ✧ Pipe out-of-straightness not exceeding 1 mm/m;

2.2.2 Performance features

The equipment shall ensure performance in production of commercial pipes at the level of 300 thousand tons per year, considering the data of tables 2, 3 and 4 and with average pipe length of 8200 mm. Annual operating effective hours of equipment not more than 7100 hours. Mode of operation - continuous (on a twenty-four-hour basis, in two 12-hour shifts).

Table 2

No	Pipe Type	Dia mm	Element	Thread	Thermal	Qty/ton/year
1	Casing tube (632,31446, 53365, 53366, API5CT)	102-178	Coupling	Type1–79% Type2–21%	52 %	110 000
2	Tubing pipe (633,31446, 53365, 53366, API5CT	48-114	Coupling	Type1–71% Type2–29%	60%	100000
3	Drill pipe (631,32696)	60-127	Joint and upsetting	100%	68%	20 000
4	Oil and gas pipe (550?30564,API5L)	36-190			52%	40000
5	Normal and mechanical tubing (800, 8731, 8732, 9567, 53383, 56030)	60-179			70%	30000
Total						300000

Note: thread type 1 – covers threaded joints of the types: buttress thread, NU, EU pursuant to GOST 33758 and GOST R 53365,33758 和 GOST R 53365

Thread type 2 – covers threaded joints of the types: OTTG and connection of tubing pipes with trapezoidal thread and metal-to-metal seal assembly (HKM) pursuant to GOST 33758 and GOST R 53365.

Table 3

Casing tube								
Diameter, mm	102	114	127	140	146	168	178	Total
Wall thickness, mm	6-8	5.5-10	6-10	6-12	6-12	6-12	6-14	
Pipe grade*	P1, P2, P3							
Production, thous.tones per year	3.2	30.3	6.4	12.8	3.2	25.5	28.6	110
Tubing								
Diameter, mm	48	60	73	89	102	114		Total
Wall thickness, mm	4-5.5	5.5-6	5.5-8	5.5-8	6-8	6.8		
Pipe grade*	P1, P2, P3							
Production, thous.tones per year	5.0	16.0	62.0	14.0	1.0	2.0		100
Drill pipe								
Diameter, mm	60	73	89	102	114	127		Total
Wall thickness, mm	6-8	5.5-10	6-12	6-8	8-10	8-10		
Pipe grade*	P1, P2, P3							
Production, thous.tones per year	0.4	1.8	1.6	4.2	6.4	5.6		20
Oil and gas pipe								
Diameter, mm	36-60		61-140		141-190			Total
Wall thickness, mm	4-10		4-18		4-22			
Steel grade	09Г2С (09G2S), 12ГФ (12GF), 06ГФБМ (06GFBM), 13ХФА (13HFA), 20, 20А, 20КТ, 20С,12ГМФБ (12GMFB),17Г2ФА (17G2FA), 15ГФБА (15GFBA) and others							
Production, thous.tones per year	3.7		20.5		15.8			40
Conventional and mechanical tubing								

Diameter, mm	60-119	120-179	Total
Wall thickness, mm	4-40	4-55	
Steel grade	09Г2С (09G2S), 10,20,35,45, 32Г2ФА (32G2FA), 38Г2ФБА (38G2FBA), 32Г2У (32G2U), 40Х, 40ХН2МА (40HN2MA), 22ХГ2 А-2 (22HG2A-2), 18ХГТ (18HGT), 25ХМ1ФБ А (25HM1FBA), 13ХФА (13HFA), 26ХГМА (26HGMA), 30ХГСА (30HGSA), ШХ15 (SHH15) and others		
Production, thous.tones per year	16.9	13.1	30

pipegradesgroupsP1,P2,P3conformitywithpipegradesgroups as per GOST is defined in the Table 4.

Table 4

Pipe grade group	Pipe grades as per GOST
P1	K72, K, J55, Д, K55
P2	N80 type Q, E, L80 type 1, L80 type 13Cr, N80 type 1
P3	M, P110, Л, C90 type 1, R95, C90, T95 type 1, P110 type 13Cr, C110, T95S, Q135, Q125, T95, S, G, X

A proposal shall present productivity of the mill and productivity of the main units depending on the size of feedstock billets, diameter and wall thickness of pipes. All productive capacity figures shall be proved by calculations and equipment specifications. A proposal shall include a calculation of the required storage capacity for feedstock billets and finished products to ensure uninterrupted operation of the shop for at least 5 days.

In addition to the calculation of productivity, the proposal shall provide data on the time required for readjustment of equipment when changing a finished section and a steel grade.

2.3 Requirements to layout solutions and equipment configuration

2.3.1 Requirements to equipment and material configuration

2.3.1.1. Equipment package of the pipe rolling plant shall include:

- ✧ 1 set of main process equipment.
- ✧ tools, jigs and fixtures to provide possibility to process the complete range of sections of feedstock billets as well as to adjust equipment (separate units) if

applicable

- ✧ hydraulic, pneumatic and lubrication equipment set;
- ✧ 1 set of electrical equipment and automation devices (including visualization and material tracking system)
- ✧ 1 set of equipment to supply utilities (within battery limits)
- ✧ other equipment required to ensure production.

2.3.1.2.The main process equipment package shall include (but not limited to) the following:

- ✧ equipment for feedstock billets accounting in the warehouse
- ✧ equipment for receiving feedstock material and preparing it for feeding to processing (scale removal, straightening, control of inner and surface defects, peeling of surface defects, cutting)
- ✧ equipment for heating feedstock billets.
- ✧ equipment for scale removal from the surface of a feedstock billets at various processing steps
- ✧ equipment for centering feedstock billets.
- ✧ equipment for pipe manufactures (rolling);
- ✧ equipment for pipe end upset.
- ✧ equipment for heat treatment of pipes;
- ✧ equipment for finishing and packaging of pipes (including straightening, cutting to specific lengths, scale removal from inner and outer part of pipe, pipe outer surface peeling (pipes pursuant to GOST 56030, GOST 800), non-destructive testing of geometry and defects, processing of pipe ends, weighing, marking, preservation, etc.)
- ✧ equipment for thread cutting on head and/or tail part of the pipe
- ✧ equipment for couplings and joints fabrication.
- ✧ equipment for heat treatment of coupling.
- ✧ equipment for applying zinc or phosphate coating to the threaded surfaces of couplings and to the sealing conical bores of couplings.
- ✧ equipment for couplings screwing-on
- ✧ equipment for welding joints to the body of drill pipes, mechanical processing and non-destructive testing of welded joint areas.
- ✧ equipment for finished products transfers to warehouse;
- ✧ equipment for feedstock billets accounting in the warehouse
- ✧ transporting and transferring equipment;
- ✧ lifting equipment (except for overhead travelling cranes of the Buyer’s supply).

2.3.1.3. Auxiliary equipment shall include:

- ✧ equipment for preparation of rolling stands.

- ✧ equipment for repair of interchangeable equipment and tools.
- ✧ equipment for repair of supports of mill rolls.
- ✧ equipment for the mechanical repair workshop
- ✧ diagnostic equipment
- ✧ special-purpose equipment and tools for maintenance and repair
- ✧ equipment for testing finished products.
- ✧ equipment for preparation and grinding of mill rolls.

2.3.1.4. Scope of supply shall include minimum one set of rolls with mandrels for the entire products mix in the basic configuration, and optionally minimum two sets of rolls with mandrel to meet the annual needs of the shop.

When configuring hot and cold cutting saws, provide for one spare set of saw blades.

2.3.2 Requirements to layout solutions

2.3.2.1.The pipe production complex is expected to be located in a stand-alone building. The main process equipment shall be arranged in the form of production process lines (pipe rolling, finishing, heat treatment, coupling production and etc.). Equipment shall be arranged inside a rectangular building with a maximum bay width of 36 m (along construction axes) and a column spacing of 12m.Aproposalshallcontain a general layout with consideration of location of warehouses for feedstock billets and finished products, main and auxiliary equipment, control rooms and panels, built-in and attached premises, lifting mechanisms, transporting and transferring equipment, road and railway entrances.

2.3.2.2. Requirements to utilities (utility parameters):

Electric energy:：

- power voltage AC, 50Hz, 10 kV +/- 5%.

Nitrogen:：

- pressure (0.6-0.8) MPa;
- N volume fraction N 纯度 99.95 %; - O2 volume fraction O2 纯度 maximum 500 ppm; - dew point minus 漏点- 55 °C.

Compressed air:

- pressure 0.53 - 0.6 MPa;
- dew pointfrom minus 23.5 ºC to plus 5 ºC.

Process water:

- pressure, MPa0.5...0.6 (at pump station);
- pH factor 8,0…9.5;

- suspended substances, mg/dm3 ≤5.0;
- total hardness, ºH 3.0 - 4.7;
- total alkalinity, mg-eq/dm³ 0.7...1.2;
- salinity, mg/dm3 ≤750; - calcium, mg/dm3 ≤90; - total iron, mg/dm3 ≤ 0.3.

Natural gas::

- pressure, MPa1.2;
- calorific value, MJ/m3 33.5...35.

Oxygen::

- pressure, MPa1.2...1.35;
- purity, %99.2.

Steam:

- pressure, MPa0.8...1.0; - temperature, °C175...190.

Argon:

- pressure, MPa1.2;
- purity, %99,95;
- dew point, °Minus 75.

2.3.2.3. Mechanical equipment requirements

- ✧ a proposal shall contain the type of mill rolls and the type of support bearings of rolls.
- ✧ All gear boxes and bearing assemblies shall be equipped with cup sealings.
- ✧ mechanisms shall have a dirt-protected design.
- ✧ to provide for centralized supply of lubrication to actuating mechanisms. For those friction units that cannot be connected to the centralized lubrication system, an individual station for grease lubrication shall be provided

2.3.2.4. Requirements to power equipment:

- ✧ equipment of energy complex and electrical grids shall correspond to all the requirements of regulatory documents for this technical specification. Manufacturers of power equipment to be used for this project shall be agreed upon with the Buyer
- ✧ scale pit pump station equipment shall be equipped with oil collecting devices. Pumping equipment of vertical configuration shall be avoided.
- ✧ Aspiration system shall bear ranged in the form of local systems
- ✧ instrument air drying compressor unit shall be provided.
- ✧ all power supply systems shall have primary and backup equipment (pumps, compressors, fans, filters, etc.)

- ✧ equipment shall be manufactured in compliance with actual chemical analysis of process water specified in clause 2.3.2.2.

2.3.2.5. Requirements to electrical equipment:

- ✧ equipment of integrated power grid and electrical networks shall correspond to all the requirements of regulatory documents for this technical specification. Manufacturers of electrotechnical equipment to be used for this project shall be agreed upon with the Buyer
- ✧ in terms of reliability of power supply, the power-consuming units of the mill belong to the first category, and the power-consuming units of heating furnaces and water treatment belong to a special group of the first category (three power supply feeds). MV level should be 10 kV.
- ✧ for energizing the power-consuming units of the mill 0.4kV, complete two-transformer substations 10/0.4 kV with cast coil dry-type transformers (Geafol type)to be located in the electric rooms of the mill shall be provided
- ✧ electrical equipment located in electrical rooms shall haveIP-31 and on machinery IP-54 and be installed in cabinets with lockable doors. Cable connectors shall have cap to prevent Ress of dust and moisture
- ✧ Electrical equipment shall have fault detection system to monitor, register and isolate faults.
- ✧ Electrical equipment that will be placed in electrical rooms shall be equipped with cooling system and alarm system in case of overheating situations.
- ✧ as electric drives without speed control for mechanisms, squirrel cage induction motors, suitable for severe operation conditions, elevated temperatures and aggressive media of the rolling mill shop, with the temperature, feedback, vibration (if required) sensors, shall be used.
- ✧ Adjustable drives must provide the necessary range of regulation, protection,self-diagnosis,reserveavailability,interchangeabilityof components and modules, availability of maintenance, be equipped with a human-machine interface for visualization (in Russian language) of the drive operating parameters, its settings, the presence and possibility of expanding communication interfaces for integration and exchange of information with other technical devices (PLC, digital drives), made on an element base that matches or is close to the technical characteristics of SIEMENS or ABB.
- ✧ delivered cables for electrical connections shall be with flexible copper conductors; control cables shall have 10% of standby conductors. Data analog transmission cables must be shielded. All cable products shall be flame retardant, low smoke and gas emission (нг-LS, нг-FRLS)and be qualified for operation under severe conditions and high temperatures in the rolling mill.

- ✧ As terminal connections terminals for industrial use shall be used: spring, screw terminals, ensuring high reliability of connections, mounting, non-oxidation of contact parts, resistance to vibration and mechanical stress. 10% redundancy of terminals shall be provided in terminal connections.

- ✧ switching equipment for industrial purposes based on equipment that meets or is close to the technical characteristics of SIEMENS, Schneider Electric, ABB, and Phoenix Contact shall be used.

2.3.2.6. Requirements for weighing equipment:

- ✧ accuracy class - medium (III).
- ✧ scales type for end products weighing before shipment commercial.
- ✧ All components of scales shall have industrial design.
- ✧ Used load cells shall be of membranous or torsional type. A balancing box must be used to connect them to the weighing terminal
- ✧ weighing terminals must be desktop or built-in with the function of transmitting data to the newly developed automated control system of the shop, data exchange with existing and to be developed automated process control system and automated control system (MES) systems of Customer .Data transmission shall be performed in automatic mode (type of communication and telegram exchange structure will be agreed upon during engineering phase)
- ✧ Weighing systems must have visual and audio alarms in case of scales overloading with the generation of an error and its transmission to the automated process control system in real-time mode without disrupting the technological process.
- ✧ weighing scales to be supplied shall correspond to GOST OIML R 76-1-2011, shall be registered in GOSREESTR State Register of the Russian Federation and be purchased and placed in operation within valid period of the Pattern Approval Certificate. Documentation to be delivered shall be in Russian language (translated into Russian), comprising as follows: data sheet, set up guide, operating manual and certificates of conformity, verification certificate.

2.3.3 Ergonomic requirements

For the performance of works upon maintenance, adjustment and repairs of the equipment, access to all components and units of the equipment shall be provided

Equipment construction shall provide its erection, operation and maintenance in accordance with requirements of occupational health and safety rules, as well as environmental protection guidelines effective in the Russian Federation.

2.4 Requirements for equipment reliability

The equipment shall show high indicators of maintainability, durability and reliability. Equipment performance capability and its integrity shall be ensured by means of actions specified in equipment operating manuals. Proposal shall specify estimated operational life of theequipmentprovidedthatalltheSupplier'srecommendationsregarding operation and repair of equipment are observed. Equipment shall not have modules, assemblies or devices that need regular maintenance or adjustment (setting) made at manufacturer’s factory only.

2.5 Warranty Requirements

2.5.1 Performance figures requirements

Main requirements to be included in performance guaranteed figures list are specified in clauses 2.2.2 and 2.2.3 thereof.

Performance test procedure, list of final performance guarantee parameters and figures (including minimum permissible) shall be preliminary specified in the Supplier’s offer and then harmonized during technical review.

2.5.2 Warranty period requirements

Equipment operation warranty period shall be at least12months from the date of signing performance and quality guarantee certificates.

2.6 Requirements to Automated Process Control System

Supplied equipment of automated systems, network and server equipment shall be registered in unified registers of notifications about characteristics of cryptographic security tools and goods that contain them. (According to regulations on import and export of cryptographic security tools in the customs territory of Eurasian Economic Union (Appendix No.9 to Decision of Eurasian Economic Commissions of 21of April 2015, No.30)

Automated process control system shall comply with requirements of technical policy of automated process control systems of Customer

The equipment shall operate in automatic, semi-automatic and manual modes and shall be integrated with MES of the Shop under design.

Telegram structure and scope of data transmission shall be harmonized during engineering. Control and automation equipment is preferably from Siemens (upon agreement with the Buyer it is possible to use analogues produced in the Russian Federation or other countries presented in the Russian market)

All delivered software shall have proper licenses

Application software for control systems and visualization systems shall be supplied with opensource codes as given in international standard IEC61131-3, LAD/FBD programming language, without password or any other protection types. STL language might be used for implementation of complex functions. All comments shall be in Russian language

When using equipment that requires special programming or parameterization, service software packages and equipment shall be supplied thereto

Automation systems shall be open for extension and modification

Processes shall be controlled in automatic mode. Equipment status and operation shall be monitored from pulpits or workstations.

Interface screens of automated workstations shall present information about the status of process equipment (position, on / off, movement direction and rate), values of process parameters (pressure, flow rate, volume, etc.), status of major process equipment control units (control switches, emergency breakers, controller commands)

Information on interface displays shall be easy-to-understand, and where possible - descriptive notes and designation of parameters shall be introduced.

The system shall provide archiving of messages about emergency and hazardous(alert)

conditions of technological equipment, tripping, change of blocking conditions, exceedance of monitored parameters over the reference value ranges. Message history viewscreen shall filter messages by type, machinery group, time of registration, and export and print out a list of messages from an archive. Messages of different types shall be displayed in different colors on the screen.

It is essential that main parameters of technological and electrical equipment are archived numerically. Trends of archived values shall be shown in workstation displays machinery group wise with an option to filter by time period, enable or disable certain parameters. Make provision for export and print out of archived data.

Application software shall be additionally supplied on electronic media (distribution kit on CD/DVD or Flash)with installation and setting manuals. Make provision for installed software image formation and deployment.

Make provision for remote technical support via Internet during warranty and after-warranty periods.

2.6.1 Automatic process control system functions

Automated Process Control System shall ensure the following functions:

- ✧ manufacturing process control.
- ✧ flow lines process visualization.
- ✧ function of warning, emergency and routine signalization.
- ✧ centralized collection, processing and storage of data upon process flow status and equipment condition
- ✧ real-time reporting on equipment operation and providing reports to process staff.

2.6.2 Equipment configuration of the Automated Process Control System

As basic automation tools process controllers ensuring high productivityofcyclicprocessesinindustrialproductionsectorsSimatic S7 1500, Simatic S7 1200 are preferable for usage (upon agreement with the Buyer similar controllers produced in the Russian Federation or in other countries, presented in the Russian market might be used).

For process visualization WinCC SCADA, latest release as of the time of development, shall be used(license type RC, Runtime and Configuration). Number of authorized

licenses of tagged variables shall exceed number of used during engineering by25% minimum. Software with open code, without passwords or other protection (except for Siemens standard functions). Application software shall be developed via one system software package TIA PORTAL®. Control system shall include troubleshooting and event archiving system-Iba PDA(to record and analyze errors, forming error occurrence source).

For continuous operation of visualization systems and network components make provisions for supply of voltage stabilization devices, industrial uninterrupted power supplies (UPS) with power reserve, internal and external (mechanical) bypass, interface module of relay outputs to output data about UPS and battery operating modes and status to the warning and alarm systems, PLC and visualization systems.

To energize PLC, operational circuits, decentralized peripherals and field sensors, redundant power from two independent power supplies using redundant systems SITOP POWER® SIEMENS shall be provided. (Analogues produces in the Russian Federation or other countries, presented in the market, might be used upon agreement with the Buyer)

For selective tripping and distribution over Automated process control system operative circuits areas, modules «SITOP select» ® by SIEMENS shall be provided (Analogues produces in Russian Federation or other countries, presented in the market, might be used upon agreement with the Buyer).

Instrumentation equipment shall ensure preliminary and emergency (sound and light) signalization about current values of technological parameters. All instrumentation installed beyond the manufacturing equipment, shall be located in hermetically sealed sensor cabinets with lighting and heating, equipped with shutoff devices (taps, valves, protective sleeves, etc.) to allow their removal without process shutdown.

Devices filled with mercury, as well as radioisotope instruments shall not be applied in measurement and control systems.

Automation equipment located in electrical rooms should have IP-31 and machinery IP-54 and be installed in cabinets with lockable doors. Cable connectors shall have caps to preventing Ress dust and moisture

To monitor process variables modern electronic transducers with normalized output

signals(4-20mA) and24V DC power supply shall be used, measurement error +/- 0.25%

Types and manufacturers of electrical equipment, automated control systems, automation means shall be harmonized with Buyer at stage of reviewing.

Final package of Automated Process Control System equipment, software, licenses, and open access codes shall be harmonized at the stage of technical review.

2.6.3 Reliability of the Automated Process Control System

- ✧ Equipment shall have features required for reliable operation in rolling mill
- ✧ Equipment shall ensure reliable transmission of signals.
- ✧ Equipment shall have alarm system and troubleshooting system
- ✧ UPSs shall keep computers and data processing equipment operating for at least 30 minutes.
- ✧ Equipment shall not have modules, assemblies and devices that need regular maintenance or adjustment (setting) made at manufacturer's factory only.

2.7 Digitization requirements

2.7.1 Configuration of digital solutions used

2.7.1.1 Newly developed Automated process control system of the shop (Buyer's supply): The architecture of automated production control system (MES, level L3) should be built based on modern solutions using virtualization of applications, containers, microservices based on Linux. Provide an availability level of at least9 9.9%, RPOnomorethan1.5 hours, RTO close to 0. Database - Oracle Database Server (current version at time of delivery), Linux platform

Automated Process Control System shall ensure the following functions:

- ✧ Receiving the orders list, displaying production schedule, tasks generation
- ✧ operational planning of activities, based on priorities and calculations of optimum utilization of equipment (scheduling)
- ✧ production accounting, production information storing and reports generation.
- ✧ production history tracking with possibility of reports generation and storage.
- ✧ control of warehouses, inter-shop and intra-shop movements, product inventory.
- ✧ generation and printing of quality certificates and other shipping documents for product shipment, exchange of information with Russian Railways automated

controlling system (ETRAN)

- ✧ registration, displaying and generation of reports on quality indicators.
- ✧ products certification with possibility of analysis and reports generation.
- ✧ control of equipment operation with the ability to obtain data onequipmentoperatinghoursandfailuresfromtheprocesscontrolsystem, generation of reports on equipment operation
- ✧ collection, storage, analysis and generation of reports on equipment downtime.
- ✧ keeping production reference data guides.
- ✧ MES system shall be integrated into the common information space and shall be open for extension and modification. Integration with SAP ERP,MES systems, laboratory and information system, operational planning system (scheduling), calendar management system, automated process control system, external systems Russian Railways ETRAN, customs declaration system.

2.7.1.2. Energy resources accounting (the Buyer's supply)

- ✧ Measures to equip the facility with metering devices for all types of energy resources used must comply with the requirements of Federal Law N261-FZ "On energy saving and increasing energy efficiency of the Russian Federation"
- ✧ Utility counting systems shall be based on controllers and transmitters that have normalized output signal(4-20mA), ensured utility counting and transmitted figures to Automated Control System
- ✧ Power distribution dispatching system shall be based on controller with integration to Automated Dispatch Management System ELEKTRO and have the following functions
- ✧ collecting equipment status data and visualizing one-line diagrams.
- ✧ recording emergency events with time tag and visualizing them
- ✧ switching device remote control option;
- ✧ electrical power counting and transmitting to related systems of upper level.
- ✧ Controller brands and manufactures are specified at review stage with prior approval by the Buyer.
- ✧ All design solution shall be at state-of-art level using energy-saving technology and equipment and shall comply with ISO 50001 "Energy management systems. Requirements with guidance for use

2.7.2 Requirements to digital solution integration

Control system of equipment shall have a possibility to interchange data with the existing and developed Automatic Process Control Systems (APCS) and Manufacturing Execution Systems (MES) of Customer

2.8 Environmental requirements

Equipment shall comply with requirements of the Environmental protection legislation of the Russian Federation (Federal Law of January 10,2002 N7-FZ(asamendedonJuly2,2021) “On Environmental Protection

Equipment shall ensure avoidance/minimization of negative impact to the environment in accordance with environment protection regulations, which can be achieved on the basis of utilization of the best technologies available. (Information and technical reference book on the best available technologies ITS 27-2021 “Production of products for further processing of ferrous metals”)

2.9 Labor safety and health requirements

Equipment shall comply with requirements of the legislation of the Russian Federation and requirements of effective in the Russian Federation technical guidance documents on occupational health and safety.

Mechanisms, assemblies and parts that endanger personnel safety shall have necessary protective and fencing devices in accordance with legislative, regulatory and legal acts in the field of labor protection and occupational safety.

3 Requirements to scope supply and services

3.1 Scope of supply shall include

- ✧ Technical documentation package
- ✧ A set of main and auxiliary equipment
- ✧ Special tools, diagnostic equipment and accessories for the equipment installation, commissioning and testing

- ✧ Special tools, diagnostic equipment and accessories for repair and maintenance (optionally)
- ✧ Spare parts, tools (including for thread cutting), consumable materials, fast wearing parts for the equipment installation, commissioning and testing periods.
- ✧ Fast wearing parts for 1 year of operation (optionally)
- ✧ Consumable materials for 1 year of operation (optionally)
- ✧ Process lubricating and hydraulic fluids required for the equipment first filling (optionally);
- ✧ Spare parts, consumable materials, process lubricating and hydraulic fluids for warranty period of operation (optionally);
- ✧ .Power and control cables (cable routing lengths will be specified during technical study)
- ✧ A set of process fluid pipelines with shutoff valves within battery limits.
- ✧ Final scope of supply shall be finalized during technical study

3.2 Scope of services shall include

- ✧ Scope of services shall include
- ✧ Installation and commissioning supervision services (including cold tests, hot tests and performance tests)
- ✧ Installation information and consultation services including Buyer's personnel training prior to equipment placing in operation

3.3 Requirements for division of supplies and services

Supply matrix and battery limits shall be harmonized at the stage of technical review. Preliminary division of supplies and services between the buyer and the supplier is presented in the table5.

No	Description	Responsible Party
1	Package of technical documentation Required for project implementation	
1.1	Basic engineering	Supplier
1.2	Detail engineering	Supplier
1.3	Project design documentation	Buyer
1.4	Construction documentation	Buyer
2	Supply of equipment broken down by each unit and each option separately	
2.1	Equipment of L1, L2 automatic process Control system and link with MESL3	Supplier/Buyer
3	Construction and installation works	

3.1	Execution of construction and Installation works	Buyer
3.2	Construction and installation works supervision	Supplier / Buyers
4	Commissioning	
4.1	Commissioning execution	Supplier / buyer
4.2	Commissioning supervision	Supplier
4.3	Equipment cold tests	Supplier/buyer
4.4	Equipment Hot Test	Supplier/buyer
5	Employee Training	Supplier
6	Performance Test	Supplier/buyer

4 . Requirements to supply technical documentation

4.1 Requirements for basic and detailed engineering development

Technical documentation for the equipment (including equipment of the Supplier's sub suppliers) shall be in Russian language (translated into Russian) in 3 copies on paper and one soft copy complete with graphic and application software enabling relevant technical documentation editing.

4.2 Requirements for technical documentation development

- ✧ Supplier-developed technical documentation must include drawings, assignments, explanations, specifications and guidelines in a scope sufficient to enable the Buyer to develop design and construction documentation.
- ✧ Operation and maintenance manuals, SPTA (spare parts, tools and accessories) list shall be made in accordance with GOST 2.601.
- ✧ When designing electrical machines and locating equipment the following documents shall be complied with: Rules for electrical installations, 7th edition, Rules for the technical operation of consumer installations, Earthing arrangements, protective conductors and protective bonding conductors GOSTR 50571.5.54-2013 (IEC60364-5-54:2011), Electromagnetic compatibility of technical equipment, Immunity to power frequency magnetic field GOST R 51317.4.1- 2000 (IEC61000-4-1-2000), GOST R 50648 (IEC 1000-4-8-93), Safety requirements for electrical equipment of industrial machines and mechanisms as per GOSTR IEC 60204-1-2007.

4.3 Requirements to scope technical and operation documentation supplied together with equipment

4.3.1 Equipment to be supplied shall have the following:

- ✧ Requirements to scope technical and operation documentation supplied together with equipment
- ✧ Pattern Approval Certificate of Measuring Instruments.
- ✧ certificates of registration of measuring units in the National Register of Measuring Equipment of the Russian Federation
- ✧ certificates of primary verification of measuring instruments, measuring instruments data sheets.
- ✧ notification numbers from the unified register of notifications about characteristics of cryptographic devices and items containing such devices.
- ✧ software licenses

4.3.2 Technical documentation shall contain the following:

- ✧ Construction assignment for the shop building, comprising drawings, plans, sections of the shop, showing the following:
- ✧ locations, spans and lifting capacity of overhead cranes, crane rail head marks.
- ✧ location and lifting capacity of the fixed to the building structures devices servicing the equipment inaccessible by overhead cranes.
- ✧ Location and lifting capacity of cranes (jib and slewing cranes, crane beams, telphers) and transportation and transfer equipment.
- ✧ main equipment layout and dimensions with indication of foundation depths.
- ✧ locations and preliminary dimensions of shop-floor premises and basements with indication of marks and depths.
- ✧ Openings in walls and roofs with indication of their dimensions and position relative to the building axes.
- ✧ process loads (from Supplier-provided pipelines, equipment, etc.) on building structures, their rates and application locations.
- ✧ locations with noise levels exceeding the standards.
- ✧ construction assignments for equipment foundations.
- ✧ construction assignments for built-in premises.
- ✧ assignment for heating and ventilation.
- ✧ assignment for exhaustion of hazardous emissions.
- ✧ assignment for utility media, water supply and lubrication

- ✧ data on consumption of utility media, lubrication and process media.
- ✧ coordinates of pipeline hook-up at battery limits.
- ✧ assignment for thermal insulation of pipeline and equipment.
- ✧ Assignment for engineering of fire-fighting system and fire alarm system.
- ✧ operation manuals, SPTA (spare parts, tools and accessories) lists and datasheets complying with GOST2.601-2013 and GOST2.610-2006.
- ✧ Description of the technology with indication of processing modes depending on pipe dimensions and types and steel grade.
- ✧ general view drawings of equipment and major units
- ✧ general view drawings of hydraulic systems with specifications
- ✧ equipment specifications with weight indications.
- ✧ production drawings for fabrication of quick-wearing parts;
- ✧ single-line diagrams for drives and power feeders.
- ✧ wiring schematic diagrams.
- ✧ layouts of equipment in cabinets, in control rooms as well as relevant specifications.
- ✧ manuals for erection, commissioning and operation of electric motors, transformers, converters, control cards, proportional valves and measuring systems.
- ✧ repair manual.
- ✧ equipment installation, operation and setup instruction.
- ✧ maintenance instructions
- ✧ spare parts and special tools lists.
- ✧ motor lists, lists of gear motors and converters.
- ✧ electrical equipment specifications.
- ✧ terminal connections diagrams and cable logs.
- ✧ standard manuals for automation devices.
- ✧ dispatching system diagrams, tracking and accounting systems diagrams.
- ✧ application software of automatic process control systems shall on electronic media (distribution kit on CD/DVD or Flash) with possibility of installed software image formation and deployment. Installation and setup manuals.
- ✧ Final composition and scope of technical documentation shall be specified and discussed at the stage of proposal technical study.

5 Packaging Requirements

Packing and preservation shall ensure complete safety of the equipment against all types of damages, as well as storage of the Equipment under conditions of hot summer and cold winter (± 40 °C) at least for 1 year provided that the Buyer observes storage conditions of the equipment. Equipment shall be carefully packed by the Supplier in

such a way as to prevent damage in transit, during storage and handling operations. Packing shall be suitable for manual handling, crane handling and handling with other handling machinery.

6 Requirements to the scope of technical proposal

Work under these technical requirements specification shall result in technical-commercial offering to supply equipment, technical documentation and service as follows:

information (technical description, drawings, diagrams, functions, etc.) about delivered facility (mechanical, pneumatic, hydraulic, electric, electronic equipment, software and hardware of Automated Process Control System) as required herein.

- ✧ process description and calculation of equipment performance evaluation.
- ✧ Equipment layout, equipment dimensions, equipment estimated weight.
- ✧ all types of utility media parameters and consumption figures.
- ✧ consolidated table of installed power of power-consuming units, their types and electric energy consumption
- ✧ electric equipment and drives control hardware package structure with content thereof
- ✧ estimated annual operating costs of the equipment to be supplied
- ✧ shop-floor workforce size required to operate and maintain equipment (operators, mechanical engineers, hydraulic engineers, electricians, automation engineers, etc.);
- ✧ reference list of executed projects
- ✧ vendor list (manufacturers of equipment components);
- ✧ division list of supplies and services (responsibility matrix)
- ✧ project schedule includes manufacturing and shipment periods and time required for equipment installation and commissioning.
- ✧ list of services rendered by the Supplier which include design services (basic and detailed engineering), installation and commissioning supervision services, information and consulting services.
- ✧ List of replacement and quick wearing parts with indication of their replacement intervals, tools and accessories for equipment maintenance during warranty period.

- ✧ list of optional units, systems and mechanisms, which are not mandatory for achievement of the project's KPI, but their integration in the project scope might improve operational performance features of the facility or improve the products quality indicators more than the requirements stated therein.
- ✧ List of spare parts, tools and accessories recommended for the first year of operation, based on the experience of the core production equipment Supplier.

7 Production Process Configuration and Workflow

Bundle Feeding: Material is taken from the central storage yard by crane and loaded onto the feeding rack.

Drill Pipe End Face Machining (Lathe Station 1): Turning of the thickened pipe end face.

Pipe End Machining (Lathe Station 2): Turning of the drill pipe tool joint end face.

Friction Welding: Qualified pipe blanks from previous machining steps are friction welded with tool joints to form drill pipe blanks.

Coaxially Inspection:

- ✧ Check parallelism and angular misalignment after welding of joint and pipe body;
- ✧ Remove internal weld flash and punching tools from the pipe bore
- ✧ Mark the weld seam position

Weld Seam Annealing (Two Stations): Induction heating for annealing of the weld area.

Weld Seam Machining (Lathe Stations 3 & 4): Turning of external flash generated during welding.

Weld Seam Quenching (Two Stations): Induction quenching furnace for austenitizing and spray cooling quenching.

Weld Seam Tempering (Three Stations): Induction tempering furnace for tempering of quenched weld seams.

Weld Seam Grinding (Four Stations): Automatic internal grinding and manual external grinding of weld seam surfaces

Magnetic Particle Inspection: Magnetic particle testing of weld seams.

Ultrasonic Inspection: Ultrasonic testing of weld seams.

Final Inspection Station: Recheck coaxially and appearance of pipe body and tool joint.

Drill Pipe Lifting: After one end is processed, the drill pipe is lifted for the next operation.

Repeat the above steps until the other end completes final inspection.

Thread Greasing and Protector Installation: Apply grease to finished thread ends and install protectors.

Length Measurement, Weighing, Marking, and Stamping:

Measure length and weight of each pipe, apply spray marking, and stamp identification marks.

UV Coating and Curing: Apply UV paint coating and curing treatment.

Bundling: Finished pipes are collected from the collection rack by crane and stored in the warehouse.

7.1 High-Performance Drill Pipe Line Process Flow

Single-end processing line: After one end is completed, process the other end.

A-End:

Pipe End Machining → Friction Welding → Coaxially Inspection → Weld Seam Annealing → Weld Seam Machining → Weld Seam Quenching → Weld Seam Tempering → Weld Seam Precision Grinding → Magnetic Particle Inspection → Ultrasonic Inspection → Final Inspection → Drill Pipe Lifting

B-End:

Pipe End Machining → Friction Welding → Coaxially Inspection → Weld Seam Annealing → Weld Seam Machining → Weld Seam Quenching → Weld Seam Tempering → Weld Seam Precision Grinding → Magnetic Particle Inspection → Ultrasonic Inspection → Final Inspection

Final Steps:

Thread Greasing & Protector Installation → Length Measurement, Weighing, Spray Marking & Stamping → UV Coating & Curing → Bundling & Storage → Intermediate Warehouse

Appendix2: Technical Specification

1 Overview

1.1 Project Scope

This project is an EPC (Engineering, Procurement, and Construction) turnkey contract. The scope includes the drill pipe production line and associated auxiliary facilities, as detailed below:

- ✧ **Drill Pipe Production Line:** Utilizes transport chains, material shifting platforms, inclined racks, and conveyor roller tables for steel pipe handling, minimizing noise pollution caused by pipe-to-pipe contact during transfer.
- ✧ **Power Supply and Distribution System:** Ensures adequate power supply for the entire project.
- ✧ **Compressed Air System:** Meets the compressed air consumption requirements of the project.
- ✧ **Dust Removal System**: Complies with standard emission requirements
- ✧ In**dustrial and Domestic Wastewater**: Industrial wastewater, including waste emulsions, shall be collected centrally and treated by the Buyer (Owner). / Domestic sewage shall be discharged to a designated point outside the workshop.
- ✧ **Lifting and Transport Equipment**: Configured according to project requirements.
- ✧ **Fire Protection System:** Designed in compliance with the latest national fire safety regulations and approved by fire authorities. The Seller shall perform specific tasks as described in Appendix 3: Scope and Handover Table.

1.2 General Requirements

- ✧ All equipment shall be equipped with independent hydraulic stations, with hydraulic oil tanks made of stainless steel.
- ✧ **Lubrication**: All lubrication points must be filled with appropriate lubricating oil or grease after assembly.
- ✧ All conveyor roller tables shall adopt independent drive systems, grouped control, and variable frequency speed regulation.: Roller spacing: approx. 2000 mm./Roller type: “V” shape, with a standard V-angle of 140° unless otherwise specified.
- ✧ **Electrical Control System:** Shall control mechanical, fluid (including hydraulic, pneumatic, lubrication, cooling), monitoring, and supervisory functions to meet production and process requirements.

- ✧ Industrial and domestic wastewater will be treated in accordance with unified environmental protection requirements. Industrial wastewater, including waste emulsions generated during production, will be collected centrally and handled by the Buyer (Owner) to ensure compliance with relevant discharge standards. Domestic sewage will be discharged to a designated centralized point outside the workshop to maintain a clean and safe plant environment.
- ✧ Auxiliary equipment shall not use compressed air as a power source; if hydraulic power is used, independent hydraulic stations shall be provided.
- ✧ For all auxiliary equipment that includes alignment stations, the alignment roller tables shall be fitted with a 20 mm thick polyurethane layer with anti-slip ribs (hardness ≥90A) to minimize pipe wear. Each alignment roller table shall have fixed safety guards installed on both sides, and these guards shall be equipped with a circular polyurethane buffer layer of at least 30 mm thickness to provide additional protection.
- ✧ Both parties shall arrange for the dispatch of personnel and provide necessary training to ensure proper operation and maintenance of the equipment. The Seller is responsible for organizing technical training sessions covering equipment operation, safety procedures, and routine maintenance, while the Buyer shall ensure that the designated personnel attend and complete the training as require
- ✧ Design shall be rational, easy to operate, convenient for maintenance, technologically advanced, and economically efficient.
- ✧ All stepping devices shall adopt mechanical gear structures.
- ✧ All equipment shall be equipped with secure and reliable network data interfaces that comply with international standards, such as RJ45 and RS485. These interfaces must provide real-time access to equipment operating status (including start, stop, running, standby, and fault conditions), fault information, and process parameters. The preferred communication protocol is OPC-UA. Standard protocols such as MQTT and Modbus TCP shall also be supported, with ready-to-use data acquisition services provided. If other protocols are required, the Seller shall supply SDK packages and complete documentation for secondary development in electronic format. Any licensing, port activation, or authorization necessary for external data services must be included and activated with the equipment to ensure continuous and reliable operation.

- ✧ All material shifting platforms shall include blocking devices to ensure smooth pipe transfer and minimize pipe-to-pipe collision.
- ✧ The project shall be implemented in accordance with the Buyer's overall BIM requirements and integrated into the Buyer's BIM framework.
- ✧ All bearing housings shall be made of steel.

2 Introduction to Drill Pipeline Mechanical Equipment

2.1 Composition of Drill Pipe line Equipment

No	Item	Unit	Qty	Remarks
1	De-Bundle and Loading Device	Set	1	
2	Drill Pipe End-Face Machining Lathe	Set	1	
3	Pipe End Machining Lathe	Set	1	
4	Friction Welding Machine	Set	1	
5	Post-Weld Coaxially Inspection Device	Set	1	
6	Weld Seam Annealing Device	Set	2	
7	Weld Seam Flash Removal Lathe	Set	2	
8	Weld Seam Quenching Device	Set	2	
9	Weld Seam Tempering Device	Set	3	
10	Weld Seam Grinding Device	Set	4	
11	Magnetic Particle Inspection Device	Set	1	
12	Ultrasonic Testing Device	Set	1	
13	Single-End Finished Product Inspection	Set	1	
14	Greasing and Robotic Protective Cap Applicator	Set	1	
15	Length Measurement, Weighing, Spraying & Marking	Set	1	
16	UV Coating and Curing Device	Set	1	
17	Bundling and Collection Device	Set	1	

18	Auxiliary Equipment for Entire Line	Set	1	

2.2 Detailed Introduction of the equipment of the line

2.2.1 De-Bundle and Loading Device

The **loading device** is designed to receive steel pipes from the intermediate turnover storage and transfer them to the chamfering machine via a V-type transport chain. It consists of a receiving rack, a blocking device, a V-type transport chain, and a set of V-type supports.

The receiving rack adopts an inclined structure, with the blocking device positioned at its center to perform both blocking and releasing functions, driven by a hydraulic cylinder. After the steel pipes are temporarily held by the blocking device, they are conveyed through the V-type transport chain to the V-type supports located at the chamfering machine inlet.

This arrangement ensures smooth and efficient material handling, allowing the step-beam transfer mechanism of the chamfering machine to pick up the pipes reliably and accurately.

Specification of the de-bundle and loading device

No	Item	Specification
1	Steel Pip Od Dia	φ60.32～φ127mm
2	Pipe Wall Thickness	6.45～11.4mm
3	Processed Pipe Length	6～12m
4	Stopper Device Pattern	Hydraulic Stopper Arm
5	Max Loading Capacity	10 T

2.2.2 Drill Pipe End-Face Machining Lathe (No2/No3)

This lathe is specifically designed for machining pipe threads and is widely used in industries such as petroleum, chemical, geological exploration, water conservancy, and municipal water supply. It can cut both metric and British standard pipe threads. With

its large spindle through-hole diameter, the machine is particularly suitable for threading oilfield casings and drill pipes.

In addition to its specialized applications, the lathe can also serve as a general-purpose machine in the mechanical industry. It supports a wide range of operations, including turning external and internal surfaces, tapering, arc profiling, step cutting, threading, and chamfering, making it ideal for mass production of pipe components.

Equipment Technical Performance Description:

✧ The front and rear chuck flanges use a short taper connection, offering higher rigidity compared to traditional threaded connections, easier disassembly, and improved machining efficiency.

✧ The spindle is manufactured from high-strength forged material for durability and precision

✧ The guideway width is 580 mm, ensuring excellent operational stability.

✧ The large and medium carriage is driven by a rapid traverse motor, enhancing processing efficiency.

✧ The main drive system adopts an 11 kW Yaskawa inverter from Japan and a Taiwan spindle motor, enabling stepless speed regulation. Motor operation and braking are controlled via the inverter, resulting in faster machining cycles and eliminating mechanical failure risks.

✧ A large-stroke pneumatic chuck is used for clamping workpieces, providing convenient and reliable loading/unloading while reducing operator labor intensity.

✧ The spindle box is lubricated by an oil pump from Taiwan, ensuring smooth and stable operation.

End Face Machining Lathe Specification

Item	Unit	Specification
Max swing over bed	mm	φ680
Max swing over carriage	mm	φ400
Max pipe diameter range	mm	φ195
Max workpiece length	mm	1000

Spindle through-hole diameter	mm	φ200
Spindle speed range	r/min	20～380
Spindle speed Pattern	级	Stepless
No of longitudinal and transverse feed rates		各 32
Tool post feed per spindle revolution (Longitudinal / Transverse)	mm/r	0.1～1.52/0.05～0.76
No of metric thread pitches		22
Pneumatic chuck diameter	mm	φ510
Pneumatic chuck clamping stroke	mm	27
Metric thread pitch range	mm	1～15
Number of British thread pitches		28
British thread pitch range	t.p.i	1～14
Rapid carriage traverse speed	m/min	3.8
Distance from tool mounting base to spindle center	mm	32
Tool section size	mm	30×30
Tool post rotation angle		±90°
Tool post rotation angle	mm	1100
Maximum travel of cross slide	mm	445
Maximum travel of compound rest	mm	200
Tailstock sleeve Diameter	mm	100
Tailstock sleeve travel	mm	250
Tailstock sleeve taper		莫氏 5 号
Center taper		莫氏 5 号
Main motor power	kW	11
Machine dimensions (L × W × H)	mm	3200×1250×1420
Machine weight	kg	5800

2.2.3 Friction Welding Machine

The friction welding equipment is designed to join qualified pipe blanks, processed in previous steps, with drill pipe tool joints to form an integrated drill pipe blank. This process utilizes friction welding technology to achieve a strong bond and precise coaxial alignment, ensuring accuracy and reliability for subsequent machining operations. The main unit is a high-performance domestic friction welding machine, supported by auxiliary components such as conveyor rollers and loading/unloading racks. These auxiliary devices enable stable material transfer and efficient handling during the welding process, ensuring continuous and safe production.

2.2.4 Post-Weld Coaxially Inspection Device

This equipment is primarily designed to check the parallelism and angular misalignment of the joint after welding to ensure compliance with quality standards. In addition, it removes the internal weld flash and punching tools from the pipe cavity and marks the weld seam position for easy identification in subsequent processes. The system consists of conveyor rollers, powered rotating support rollers, and loading/unloading racks. Auxiliary tools include a saddle gauge and internal punching tools, which are provided by the user.

2.2.5 Weld Seam Annealing Device

The main unit of this equipment is an induction heating furnace, designed for annealing the weld area through induction heating to relieve welding stress and enhance weld quality. Auxiliary components include conveyor rollers, powered rotating support rollers, loading/unloading racks, and an automatic weld seam recognition system, ensuring stable positioning and automated operation during the heating process.

In terms of technical performance, the system is capable of performing post-weld heat treatment on friction-welded drill pipes that meet API SPEC 5D standards, covering sizes from Φ43 to Φ168, including internal upset, external upset, and combined internal/external upset configurations for E/G/X/S steel grades. The annealing temperature range is 700–950°C, with a control accuracy of ±10°C from the set value, and an annealing time of 60–90 seconds. The system utilizes two KGPS 200KW/500Hz medium-frequency power supplies, along with one annealing medium-frequency transformer and induction coil, ensuring efficient and stable heating performance.

Welding Seam Annealing Device

No	Item	Item	Qty
1	Medium-Frequency Power Supply	KGPS-200KW/500Hz	2 Unit
2	Heating Transformer (Integrated in Cabinet)	GR2-800KVA	2 Unit
3	Fine Adjustment Mechanism (Integrated in Cabinet)	Fron/ Rear/Left /Right	2 Set
4	Induction Coil (Single Turn) |	Φ60-73 Drill Pipe	2 Set
		Φ89-114 Drill Pipe	2 Set
		φ127-139.7 Drill Pipe	2 Set
5	Compensation Capacitor (Integrated in Cabinet)	0.75-2000-0.5S	2 Set
6	Medium-Frequency Cable (Integrated in Cabinet)	DL-3000	2 Set
7	Heating Integrated Cabinet	Includes water and circuit system	2 Unit
8	Accessories	Quenching copper busbar, cables	2 Unit
9	Main Control Console	HX-1	1 Set
10	Infrared Pyrometer for Annealing	250-1400℃（Raytek USA / Optris Germany	2 Unit

2.2.6 Weld Seam Flash Removal Lathe

This lathe is specifically designed for machining pipe threads and is widely used in industries such as petroleum, chemical, geological exploration, water conservancy, and municipal water supply. It can cut both metric and British standard pipe threads. With its large spindle through-hole diameter, the machine is particularly suitable for threading oilfield casings and drill pipes.

In addition to its specialized applications, the lathe can also serve as a general-purpose machine in the mechanical industry. It supports a wide range of operations, including turning external and internal surfaces, tapering, arc profiling, step cutting, threading, and chamfering, making it ideal for mass production of pipe components.

Equipment Technical Performance Description:

✧ The front and rear chuck flanges use a short taper connection, offering higher rigidity compared to traditional threaded connections, easier disassembly, and improved machining efficiency.

✧ The spindle is manufactured from high-strength forged material for durability and precision

✧ The guideway width is 580 mm, ensuring excellent operational stability.

✧ The large and medium carriage is driven by a rapid traverse motor, enhancing processing efficiency.

✧ The main drive system adopts an 11 kW Yaskawa inverter from Japan and a Taiwan spindle motor, enabling stepless speed regulation. Motor operation and braking are controlled via the inverter, resulting in faster machining cycles and eliminating mechanical failure risks.

✧ A large-stroke pneumatic chuck is used for clamping workpieces, providing convenient and reliable loading/unloading while reducing operator labor intensity.

✧ The spindle box is lubricated by an oil pump from Taiwan, ensuring smooth and stable operation.

End Face Machining Lathe Specification

Item	**Unit**	**Specification**
Max swing over bed	mm	φ680
Max swing over carriage	mm	φ400
Max pipe diameter range	mm	φ195
Max workpiece length	mm	1000
Spindle through-hole diameter	mm	φ200
Spindle speed range	r/min	20 ~ 380
Spindle speed Pattern	级	Stepless
No of longitudinal and transverse feed rates		各 32
Tool post feed per spindle revolution (Longitudinal / Transverse)	mm/r	0.1 ~ 1.52/0.05 ~ 0.76
No of metric thread pitches		22
Pneumatic chuck diameter	mm	φ510
Pneumatic chuck clamping stroke	mm	27

Metric thread pitch range	mm	1 ~ 15
Number of British thread pitches		28
British thread pitch range	t.p.i	1 ~ 14
Rapid carriage traverse speed	m/min	3.8
Distance from tool mounting base to spindle center	mm	32
Tool section size	mm	30×30
Tool post rotation angle		±90°
Tool post rotation angle	mm	1100
Maximum travel of cross slide	mm	445
Maximum travel of compound rest	mm	200
Tailstock sleeve Diameter	mm	100
Tailstock sleeve travel	mm	250
Tailstock sleeve taper		莫氏 5 号
Center taper		莫氏 5 号
Main motor power	kW	11
Machine dimensions (L × W × H)	mm	3200×1250×1420
Machine weight	kg	5800

2.2.7 Weld Seam Quenching Device

Equipment Purpose

The main unit of this system is an induction quenching furnace, designed for austenitizing and spray cooling quenching of the weld area. This process enhances hardness and wear resistance, ensuring the reliability of drill pipes under demanding operating conditions

Equipment Composition

The system consists of the induction heating furnace as the core unit, supported by auxiliary components such as conveyor rollers, powered rotating support rollers, loading/unloading racks, an automatic weld seam recognition system, and a spray

cooling device. These components work together to provide stable positioning and automated operation during heating and cooling.

Application Scope

This equipment is suitable for drill pipes that meet API SPEC 5D standards, covering sizes from Φ43 to Φ168, including internal upset, external upset, and combined internal/external upset configurations for E/G/X/S steel grades. It meets the stringent heat treatment requirements of the oil and gas industry.

Process Parameters

The quenching temperature range is 860–950°C, with a control accuracy of ±10°C from the set value, and a heating width of 60–70 mm. The quenching process consists of three stages: 60 seconds of heating, 60–120 seconds of soaking, and 70–120 seconds of cooling, ensuring uniform structure and stable performance of the weld.

Electrical Configuration

The system utilizes two KGPS 250KW/1000Hz medium-frequency power supplies, along with one independent quenching medium-frequency transformer and induction coil. This configuration guarantees high heating efficiency and process stability, meeting the demands of continuous production.

Equipment Configuration

No	Item	Size	Qty
1	Medium-Frequency Power Supply	KGPS-250KW/1000Hz	2 Unit
2	Quenching Transformer (Integrated in Cabinet)	GR2-1000KVA	2 Unit
3	Fine Adjustment Mechanism (Integrated in Cabinet)）	Up/Down, Front/Back	2 Set
4	Induction Coil (Single Turn)	Φ60-73 Drilling Pipe	2 Set
		Φ89-114 Drilling Pipe	2 Set
		Φ127-139.7 Drilling Pipe	2 Set

5	Compensation Capacitor (Integrated in Cabinet)	0.75-2000-1s	2 Set
6	Medium-Frequency Cable	DL-3000	2 Set
7	Heating Integrated in Cabinet	Includes water and circuit system	2 Unit
8	Accessories	Quenching copper busbar, cables	2 Set
9	Main Control Console	HX-2	2 Set
10	Spray Ring	Stainless	2 Set
11	Infrared Pyrometer for Quenching	400-1600℃（Raytek USA / Optris Germany	3Unit

2.2.8 Weld Seam Tempering Device

Equipment Purpose

The main unit of this system is an induction tempering furnace, designed for tempering the weld area after quenching. This process relieves quenching stress, improves toughness, and ensures the reliability of drill pipes under demanding operating conditions.

Equipment Composition

The system consists of the induction heating furnace as the core unit, supported by auxiliary components such as conveyor rollers, powered rotating support rollers, loading/unloading racks, and an automatic weld seam recognition system. These components work together to provide stable positioning and automated operation during the heating process.

Application Scope

This equipment is suitable for drill pipes that meet API SPEC 5D standards, covering sizes from Φ43 to Φ168, including internal upset, external upset, and combined internal/external upset configurations for E/G/X/S steel grades. It meets the stringent heat treatment requirements of the oil and gas industry.

Process Parameters

The tempering temperature range is 615–720°C, with a control accuracy of ±10°C from the set value, and a heating width of 60–70 mm. The tempering process consists of two stages: 60 seconds of heating and 200–400 seconds of soaking, ensuring uniform structure and stable performance of the weld.

Electrical Configuration

The system utilizes three 200KW/500Hz medium-frequency power supplies, each equipped with an independent tempering transformer and induction coil. This configuration guarantees high heating efficiency and process stability, meeting the demands of continuous production.

Equipment Configuration

No	Item	Size	Qty
1	Medium-Frequency Power Supply	KGPS-250KW/1000Hz	3 Unit
2	Quenching Transformer (Integrated in Cabinet)	GR2-1000KVA	3 Unit
3	Fine Adjustment Mechanism (Integrated in Cabinet)）	Up/Down, Front/Back	3 Set
4	Induction Coil (Single Turn)	Φ60-73 Drilling Pipe	3 Set
		Φ89-114 Drilling Pipe	3 Set
		Φ127-139.7 Drilling Pipe	3 Set
5	Compensation Capacitor (Integrated in Cabinet)	0.75-2000-1s	3 Set
6	Medium-Frequency Cable	DL-3000	3 Set
7	Heating Integrated in Cabinet	Includes water and circuit system	3 Unit
8	Accessories	Quenching copper busbar, cables	3 Set
9	Main Control Console	HX-2	2 Set
10	Spray Ring	Stainless	3 Set
11	Infrared Pyrometer for Quenching	400-1600℃（Raytek USA / Optris Germany	3Unit

General description of heat treatment equipment for weld seam annealing, quenching, and tempering

Equipment Configuration Description

- ✧ After the drill pipe enters the induction coil, it rotates while being heated. The mechanical components for the drill pipe's entry and exit from the coil, as well as positioning, stopping, and rotational movement, are to be provided by the user.
- ✧ The induction coil (including the heating transformer) is equipped with fine adjustment functions in the vertical, horizontal, and front-back directions to ensure accurate heating position.
- ✧ Since D1 is much larger than D2, when the drill pipe enters the coil, sufficient clearance must be maintained between D1 and the inner side of the coil. This results in a large gap between the coil's inner diameter and D2, requiring multiple heating coils. The solution includes four different coil specifications.
- ✧ According to heating requirements, each power supply is equipped with an infrared thermometer for temperature detection and control.
- ✧ Thermometer selection: Raytek brand infrared thermometer from the USA.
- ✧ Quenching coil height positioning is adjustable between 1150–1250 mm.
- ✧ Each process uses an independent medium-frequency power supply and operates on a single station, enabling continuous production. Heating temperature is adjustable and controllable, ensuring a 100% product quality compliance rate. The single-power control method ensures adaptability to various heating process requirements, allowing users to redefine or modify heating temperatures and process parameters. It also guarantees precise control of the quenching and tempering heating zones and temperature-affected areas for each drill pipe, avoiding uneven temperatures caused by multi-station heating with a single power source.

Description of Main Components of Complete Equipment

1) Utilities:

✧ Low-voltage power supply: 380 V, 50 Hz, 3-phase, 4-wire

✧ Water quality: Industrial-grade clean circulating water

✧ pH value: 7–8.5

✧ Cooling water pressure (inlet pressure): 0.2–0.4 MPa

✧ Cooling water temperature (inlet temperature): < 35°C

2) Equipment Technical Parameters

1	Power Supply Capacity	200kw /250kw
2	Power Supply Frequency	500HZ/1000HZ
3	Input Current	350A/400A
4	Input Voltage	3x380V
5	Out Voltage	750 V
6	No of workstation	1
7	Total Cooling Water Flow Rate	120 M^2 /h (7 Unit)

3) Technical Features of Medium-Frequency Power Supply

✧ Equipped with a digital constant-power control system (highly integrated control circuitry).

✧ Automatically adjusts matching according to load changes, improving heating speed and saving energy (by 5–10%).

✧ Multiple protection functions (overcurrent, overvoltage, water pressure, phase loss, undervoltage, overload).

✧ Low failure rate and easy maintenance.

✧ Long-term operation without temperature drift; stable operating point.

✧ Cabinet adopts an integrated frame structure for high rigidity, rational layout, and standardized medium-frequency power supply design.

✧ Smooth adjustment curve with high linearity and no impact.

✧ 100% start-up reliability (whether under no-load or full-load), using zero-voltage sweep-frequency start mode for greatly improved start-up performance.

✧ Simple operation with stepless adjustable output power (5–100%).

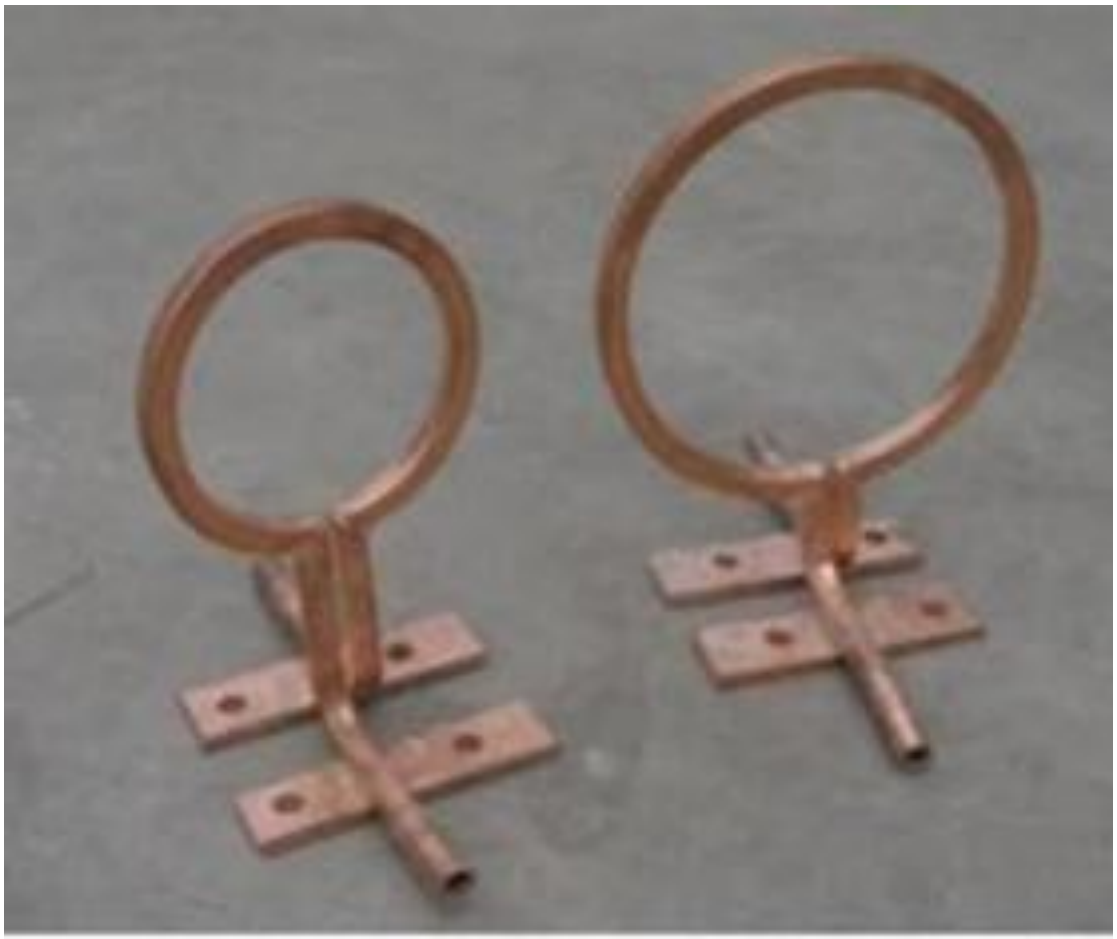
✧ Pure digital circuit with strong anti-interference capability.

4) Induction Coil

Single-turn and multi-turn induction coils are used. The tempering induction coil adopts double-turn or multi-turn winding and is installed in an enclosed configuration, which helps to correct the material properties in the heat-affected zone around the weld and

reduce stress concentration caused by welding. The quenching induction coil uses a single turn winding.

In the spray quenching process, the heating coil and the spray ring are generally arranged as two separate axial components, maintaining a fixed distance between them (typically 350–500 mm for standard drill pipes). With proper coil design and by adjusting the transformer turn ratio for quenching, the process can meet the required quenching specifications.



5) Heating Assembly

The heating assembly mainly consists of a heating transformer, a two-dimensional adjustment mechanism, and compensation capacitors. The heating transformer is primarily used to adjust load matching, facilitating power output and achieving impedance matching. The medium-frequency transformer is water-cooled and installed in a fully enclosed structure, providing an attractive and dust-proof design.

The transformer adjustment frame: The inductor and transformer are mounted on the adjustment frame. Through the fine-tuning device on the frame, the inductor can be

adjusted in two spatial directions and quickly replaced.

6) Spray Quenching Method

In the drill pipe heat treatment process, spray quenching is generally used, which involves rapidly spraying water onto the workpiece. This method is mainly applied to parts requiring localized quenching. Since this quenching technique does not form a vapor film on the surface of the workpiece, it ensures a deeper hardened layer compared to conventional water quenching.

Quenching Spray System (Provided by User)

- ✧ Return water from the quenching liquid should be equipped with a filter.
- ✧ The quenching liquid must be monitored, mainly for water level (maximum and minimum) and concentration.
- ✧ The spray structure should ensure uniform distribution.

7) Description of the Main Control System

- ✧ **Main Control Console:** The control console is sturdy and durable, with an overall height not exceeding 900 mm. The operating panel height is between 700–750 mm. It features an attractive appearance and is equipped with necessary sealing and cooling systems to ensure proper functioning of the industrial computer, PLC, and electrical components inside the cabinet. All electrical components within the console are protected against overvoltage.

  Manual and automatic buttons for the production line can be integrated into the console. The console is ergonomically designed, and the circuit layout strictly complies with relevant national technical standards. All electrical components are arranged logically for ease of operation and maintenance.

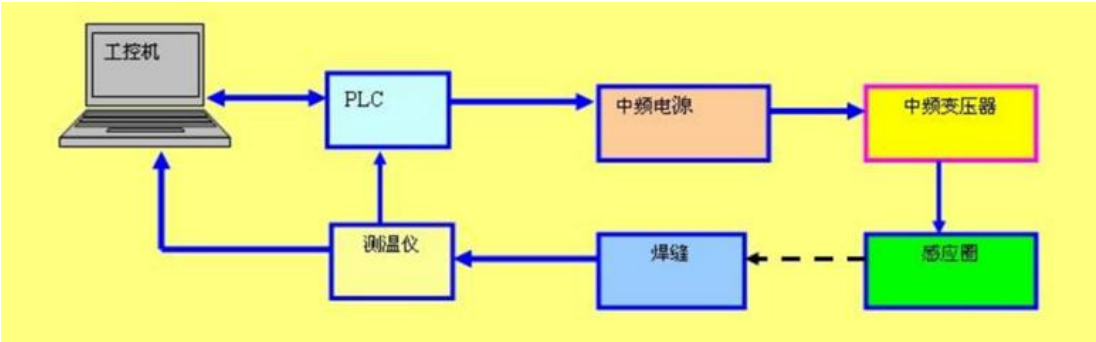
- ✧ **Main Control System:** The control system mainly consists of an industrial computer, PLC, industrial configuration software, and infrared thermometers. Its features and functions include:

  A. Real-time temperature curve display, with an update cycle of less than 0.5 seconds.

B. Historical data query function, allowing data to be exported via USB and printed.

C. Real-time display of equipment operating status; in case of abnormal conditions, the system provides alerts on the industrial computer and triggers visual and audible alarms on the console, enabling accurate identification of basic fault points.

D. Temperature closed-loop control software system.



8) Temperature Measurement System

Infrared **thermometers** are used to measure the workpiece temperature during heat treatment. The infrared thermometers are Raytek brand from the USA.

- ✧ Annealing thermometer range: TH40 (250–1400°C) infrared thermometer
- ✧ Quenching thermometer range: E2RL (400–1600°C) infrared thermometer
- ✧ Tempering thermometer range: TH40 (250–1400°C) infrared thermometer

9) Temperature Control Method

The temperature control system implements closed-loop control throughout the entire process of drill pipe heat treatment, including annealing heating and holding, quenching

heating and holding, and tempering heating and holding. Each process is equipped with an independent centralized control system.

The basic functions of the system include:

- ✧ Control of workpiece heating temperature and heating time
- ✧ Control of holding temperature and holding time
- ✧ Display of temperature variation curves during the heat treatment process

All data can be downloaded to a hard disk and printed via a print

10) Cooling Water System

Cooling water is critical for medium-frequency heating equipment. Insufficient water pressure, excessively high-water temperature, water interruption, or impurities in the water that block pipelines can cause damage to power components and inductors. The cooling water requirements for medium-frequency heating equipment are:

- ✧ Inlet water temperature: 5–30°C
- ✧ Water pressure: 0.4–0.6 MPa
- ✧ Outlet water temperature: ≤50°C
- ✧ Water flow rate: 8 units × 15 t/h = 120 t/h

The cooling system is to be provided by the user.

Cooling System Plan and Selection:

- ✧ For 8 medium-frequency power units: one closed cooling tower or equivalent cooling system (flow rate: 30 t/h)
- ✧ For 8 heating systems: one closed cooling tower or equivalent cooling system (flow rate: 50 t/h)
- ✧ For 3 quenching liquid systems: one cooling system or equivalent (flow rate: 60 t/h)

2.2.9 Weld Seam Grinding Device

Grinding of the inner and outer surfaces in the weld seam area.

The TY-6 drill pipe inner bore grinding machine is developed by our factory based on user requirements to reduce labor intensity, minimize dust hazards to employees, protect their physical and mental health, and improve work efficiency and grinding quality. It is an automated mechanical grinding device controlled by PLC, designed for

inner bore grinding of the transition zone after friction welding of special drill pipes, developed from the original manual **grinder.**

Equipment Composition:

The main machine includes an automatic inner grinding machine and a manual outer grinding machine. Auxiliary machines include conveying rollers, active rotating support rollers, loading/unloading racks (dust collection system to be provided by the user).

The equipment consists of a base, linear guide rails, worktable, grinding wheel, longitudinal, transverse, and vertical movement mechanisms, angle swing mechanism, grinding head spindle, main motor, electrical control system, and pneumatic control system. It features a reasonable structure, simple operation, reliable performance, long service life, and the ability to run continuously, significantly reducing labor intensity.

Equipment Operation Process Description:

After installation and checking air supply and lubrication, manually move the worktable to align the grinding rod with the drill pipe's inner bore center and weld seam position. Adjust the travel slide to the travel switch position, then manually return the worktable to the home position. Press the automatic button to start the cycle operation.

During outer surface grinding, the sanding belt automatically grinds the outer weld seam as well.

2.2.10 Magnetic Particle Inspection Device

This equipment is mainly used for wet magnetic particle inspection of seamless pipe ends.

The specialized magnetic particle inspection device for pipe ends in the complete set of equipment performs wet magnetic particle testing within the range of 0–400 mm from the pipe end to detect delamination defects and material cracks. It is an online dedicated inspection system capable of detecting transverse defects (material cracks) and longitudinal defects (delamination) on the bevel surface of the pipe end.

The system can operate in both automatic and manual modes as required, meeting the needs of online inspection and equipment adjustment. The main unit features a compact structure, simple operation, and easy adjustment.

2.2.10.1 Process Flow

Steel pipe material picking → Align one end → Magnetization → Flaw detection → Demagnetization → Discharging.

2.2.10.2 Equipment Process Technology Description

- ✧ Pick up the material and place the steel pipe on the alignment roller table.
- ✧ Start the alignment roller table to align one end of the steel pipe.
- ✧ Activate the transfer device to move the steel pipe to the support rack at the magnetization station.
- ✧ The magnetization trolley on the magnetic particle inspection equipment moves forward; the magnetic yoke/coil enters the pipe end to the magnetization position. The rotating rollers at the magnetization station rotate the steel pipe, the spraying system starts, and the magnetization system begins magnetic particle inspection of the pipe end.
- ✧ The transfer device moves the steel pipe from the magnetization station to the rotating roller table at the inspection station. The steel pipe rotates for flaw detection, and any defective pipe ends are marked.
- ✧ After automatic inspection is completed, the transfer device moves the steel pipe to the discharge rack.

2.2.10.3 Equipment Coating

- ✧ Before painting, all steel surfaces of the equipment have been cleaned of rust, oxide scale, grease, dust, dirt, salt, and other contaminants. The surfaces show no signs of re-rusting or contamination prior to painting.
- ✧ The following parts are not painted: areas in contact with or embedded in concrete, areas adjacent to refractory materials, inner surfaces of fully enclosed box structures, machined fitting surfaces, working surfaces, friction surfaces, inner surfaces of piping, valves, and flanges, stainless steel parts, steel wire ropes, anchor bolts and their base plates, electroplated surfaces, non-ferrous metal parts, plastic and rubber components, rails, gaskets, and other accessories.
- ✧ Paint type and color codes will be determined during design coordination. All equipment will be coated with two layers of anti-rust primer and two layers of finish paint.

2.2.10.4 Environmental Protection, Safety, and Industrial Hygiene

The equipment performance complies with all relevant national and governmental environmental protection regulations and standards. Design measures have been implemented to reduce operational noise, ensuring noise levels are below 80 dB, in accordance with GB12348-90 national standard. There is no leakage of harmful substances, and waste liquid discharge is effectively controlled.

Technical Parameter Description:

- ✧ Number of circumferential magnetic yoke coils: 2 sets, evenly distributed at 180°, arranged horizontally left and right
- ✧ Circumferential magnetization magnetic potential: AC 0–24000 AT (0–60 A, stepless adjustment via thyristor)
- ✧ Distance between circumferential magnetization poles: 200–420 mm
- ✧ Number of longitudinal coils: 2 sets
- ✧ Longitudinal magnetization magnetic potential: AC 0–24000 AT (0–60 A, stepless adjustment via thyristor)
- ✧ Magnetic core rod cross-sectional size: 75 × 75 mm
- ✧ Magnetization methods: Circumferential magnetization, longitudinal magnetization, composite magnetization
- ✧ Magnetization sensitivity: Clear magnetic marks on A-type 30/100 test piece
- ✧ Duty cycle: 100%
- ✧ Inspection length: Pipe end ≤ 400 mm
- ✧ Control modes: Automatic / Semi-automatic / Manual
- ✧ Magnetic yoke and coil movement: Pneumatic
- ✧ Magnetic yoke approach to pipe: Manual
- ✧ Magnetization mechanism center adjustment: Electric and manual jog adjustment; encoder positioning with a reduction motor and four sets of worm gear lifters mounted under the magnetic inspection trolley for adjusting center position for different workpiece sizes; manual adjustment via handwheel when needed
- ✧ Electrical protection level: ≥ IP54
- ✧ Time required to adjust workpiece specifications: ≤ 5 min for center distance adjustment when changing workpieces
- ✧ Demagnetization mechanism center adjustment: Manual
- ✧ Demagnetization method: Longitudinal AC step-down demagnetization from 15000 AT to 0, with stepless adjustment of voltage reduction rate
- ✧ Demagnetization time: 15 seconds (recommended)
- ✧ Demagnetization effect: Residual magnetism ≤ 10 Gs
- ✧ Ultraviolet illumination:
- CY-70L suspended UV lamp, 220 V, 700 W
- UV intensity: Adjustable between 2000–6000 μW/cm² at 380 mm from filter to pipe surface center

2.2.10.5 Technical Performance Description:

1) Main Unit Performance and Structure

The complete system consists of two independent sets of equipment, each dedicated to one end of the steel pipe. Each set includes the main inspection unit, electrical control system, and magnetic suspension liquid spraying/recycling system.

The main inspection unit comprises a moving trolley, frame assembly, circumferential magnetic yoke device, longitudinal coil/inner magnetic core device, and demagnetization device.

The electrical control cabinet is equipped with an air conditioner, with the OP display control panel on the left side; the cabinet houses the entire electrical control board.

The demagnetization device consists of a moving trolley, frame assembly, and demagnetization coil.

2) Inspection Process Flow

- ✧ The inspected steel pipe is conveyed from the previous station by the customer's transfer equipment. When the pipe reaches the magnetization station, the rotating rollers rotate the pipe, and the inspection unit's moving platform enters to automatically perform the following steps:
- ✧ The longitudinal coil, inner magnetic core, and circumferential magnetic yoke device have adjustable centers with encoder positioning. A reduction motor and four sets of worm gear lifters mounted under the magnetic inspection trolley enable vertical movement for adjusting the center position according to different workpiece sizes.
- ✧ The moving platform shifts forward pneumatically, and the yoke/coil enters the pipe end to the magnetization position.
- ✧ Magnetic suspension liquid spraying begins; each set of equipment is equipped with two automatic spray groups (inner and outer).
- ✧ The spraying and circulation system consists of a 200L storage tank, circulation pump, collection hopper, liquid delivery pipes, spray nozzles, filter screen, liquid

level gauge, and control valves. The system is operated via an OP panel.

- ✧ During spraying, the two sets of magnetic yoke coils (circumferential and longitudinal) are energized for magnetization. After completion, the moving platform retracts.
- ✧ The transfer device moves the steel pipe to the observation position on the rotating rollers for rotation and inspection.
- ✧ Finally, the transfer device moves the steel pipe to the demagnetization position, where the demagnetization device performs demagnetization.

2.2.10.6 Main Equipment Subsection Description

1) Inspection Machine Frame Assembly

Includes the base frame and pneumatic in/out trolley. The trolley is equipped with the circumferential magnetic yoke, longitudinal magnetization coil, inner magnetic core rod, and liquid spraying pipes. The base frame is fitted with trolley rails, pneumatic cylinders for trolley movement, and a collection hopper. The center height of the longitudinal magnetization coil, inner magnetic core rod, and circumferential magnetic yoke on the trolley can be electrically adjusted.

2) Magnetization Device Structure

The magnetization device consists of a circumferential magnetization unit (coil + magnetic pole) and a coil-type longitudinal magnetization unit. After the steel pipe is positioned, the circumferential yoke coil is energized to generate a circumferential magnetic field on the inner and outer surfaces of the pipe end, detecting longitudinal defects in the pipe end area. The longitudinal coil is energized to generate a longitudinal magnetic field on the inner and outer surfaces, detecting transverse defects in the pipe end area. An inner magnetic core rod is configured to enhance the longitudinal magnetic field on the inner surface. During normal operation, both magnetization directions work simultaneously (composite magnetization). The inner surface spraying system is mounted on the magnetic core rod.

3) Magnetization Power Supply

The complete equipment includes two circumferential magnetization power supplies and two longitudinal magnetization power supplies.

- ✧ Circumferential magnetization power supply: Adjusts the secondary voltage steplessly via a current adjustment module installed in the transformer primary

circuit to regulate circumferential magnetization current.

- ✧ Longitudinal magnetization power supply: Adjusts the secondary voltage steplessly via a current adjustment module installed in the transformer primary circuit to regulate longitudinal magnetization current.

4) Magnetic Suspension Liquid Circulation System

Each system consists of a circulation mixing pump, pneumatic ball valves, pipe connectors, filters, inner and outer spray pipes, a storage tank, and a collection hopper.

The spraying system includes spray nozzles for the outer surface of the pipe end and spray pipes for the inner wall. The bottom of the magnetic suspension liquid tank is conical, with a storage capacity of 200 liters and approximate dimensions of 0.85 × 0.65 × 0.5 m. Two mixing pumps are installed on the tank, each equipped with stainless steel stirring blades at the motor base.

The mixed magnetic suspension liquid is pumped and sprayed onto the workpiece, then collected through the collection hopper, filtered, and returned to the storage tank for recycling. The bottom of the tank is equipped with air agitation, and a drain hole is provided for easy liquid replacement.

Each spray nozzle has a flow adjustment device. External spray nozzles are positioned above the magnetization station, while internal spray nozzles are mounted on the inner magnetic core rod. All spray components are made of corrosion-resistant materials, and nozzle flow rates are adjustable. Blind holes in spray nozzles are fitted with connectors for easy cleaning to prevent clogging. An additional collection tray is installed at the observation position.

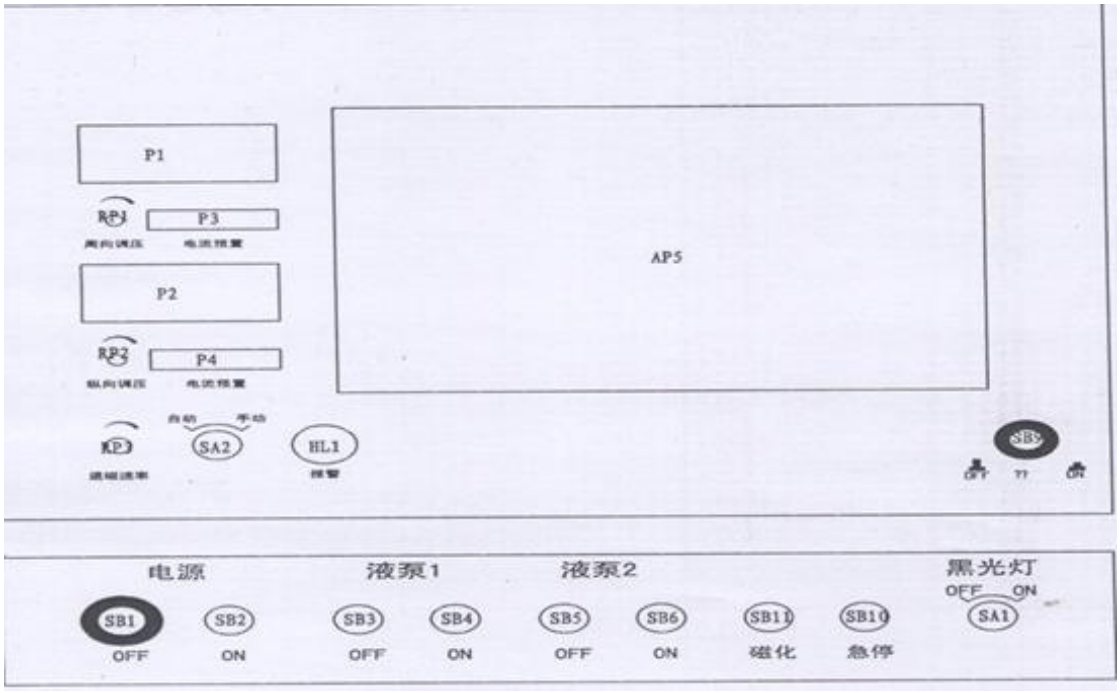
5) Electrical Control Equipment

The electrical control console is located behind the observation station. Inside, it houses the complete electrical control board, while the upper section is equipped with the operation panel. According to user requirements, the system can switch between automated control and manual control for the inspection process.

The equipment supports communication with upstream and downstream devices as well as secondary networks and comes with the corresponding software. Power supply to the equipment is controlled by the electrical cabinet, which includes the main power switch.

The control panel is equipped with a power switch, liquid pump switch, manual/automatic mode selector, circumferential magnetization ammeter and current

adjustment knob, longitudinal magnetization ammeter and current adjustment knob, magnetization button, emergency stop button, UV lamp switch, and a human-machine interface touchscreen.



The system is equipped with a Siemens S7-1500 series PLC controller. The upper computer supports online program monitoring and modification using TIA Portal programming software version V15. The equipment can operate in automatic control mode. When the transfer device moves the steel pipe, which has been aligned at the end, to the magnetization station and receives the position sensor signal, the program automatically starts:

a) The trolley moves forward, and the spray nozzle applies magnetic suspension liquid.
b) The magnetic yoke and coil are energized to magnetize the pipe end.
c) After magnetization, the trolley retracts.

The transfer device then moves the steel pipe to the manual inspection station. When the pipe reaches the inspection position, a position sensor signal is given, and the rollers rotate the pipe at a variable speed controlled by a frequency converter. At this point, the operator manually checks the magnetic marks on the inner and outer walls of the pipe end. After inspection, the operator sends a completion signal. Upon receiving this signal, the transfer device moves the steel pipe laterally to the previous station. (Provision is reserved for automatic defect recognition; after automatic judgment, a signal will be sent for the transfer device to move the pipe.)

The control panel is equipped with a human-machine interface touchscreen. On this

screen, the operator can set circumferential and longitudinal magnetization current values, control spraying time and magnetization time via program settings, select magnetization modes, perform step-by-step manual control actions, and display the equipment's operating status.

6) Darkroom System

Ultraviolet light intensity ≥ 2000 μW/cm²; White light illumination ≤ 20 Lux.

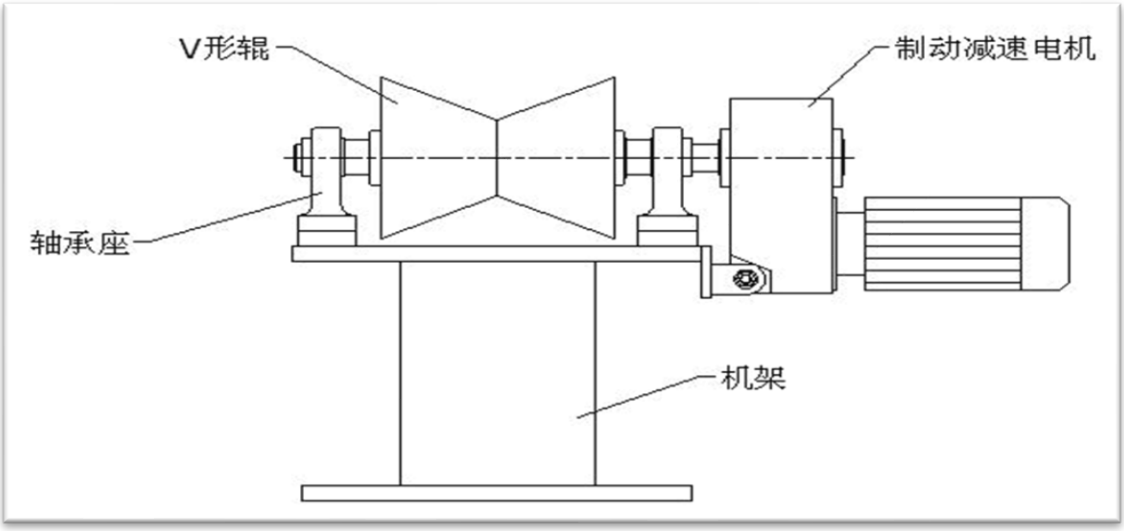
Auxiliary Equipment Performance and Structure Description

(1)Transfer Device

The transfer device moves the steel pipe sequentially between stations, including loading, end alignment, end magnetization/spraying, end observation (inspection), end demagnetization, and unloading.

(2) Alignment Roller Table

Each set includes alignment baffles and powered V-shaped rollers to achieve pipe end alignment. The powered V-shaped roller assembly consists of a frame, V-shaped rollers, a brake-equipped reduction motor, and bearing seats.

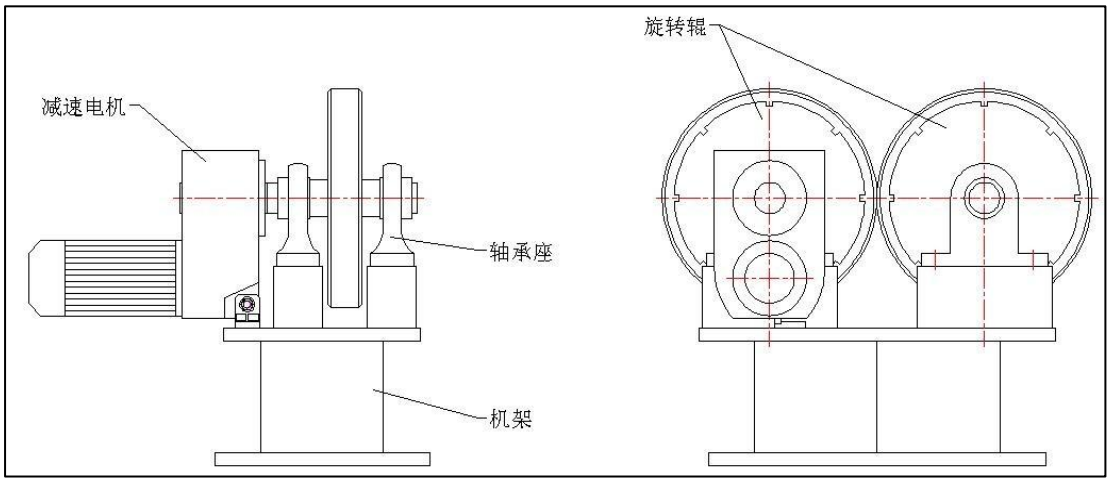


(3) Rotating Roller Table

Each set includes power-driven rotating rollers controlled by a frequency converter, allowing adjustable steel pipe rotation speed to ensure automatic flaw detection time for pipes of different specifications.

The power-driven rotating rollers consist of a frame, rotating rollers, a reduction motor,

and bearing housings.



2.2.11 Ultrasonic Testing Device

The equipment is designed to perform ultrasonic testing on weld seams to detect potential defects and ensure structural integrity. The system consists of a handheld ultrasonic flaw detector as the primary unit, providing precise and reliable inspection capabilities. Supporting this main unit are auxiliary components, including conveyor rollers for smooth material transfer, powered rotating support rollers to facilitate controlled rotation during testing, and dedicated loading and unloading racks to streamline the handling process. Together, these elements form an integrated solution for efficient and accurate weld seam inspection.

2.2.12 Single-End Finished Product Inspection

The equipment is designed to perform a secondary inspection of the pipe body and joints, focusing on coaxial alignment and overall appearance to ensure compliance with quality standards. The system incorporates auxiliary components that facilitate smooth handling and precise positioning during the inspection process. These include conveyor rollers for efficient material transfer, powered rotating support rollers to enable controlled rotation of the pipes, and loading and unloading racks for streamlined operations.

2.2.13 Greasing and Robotic Protective Cap Applicator

2.2.13.1 Internal Thread Greasing Device

The internal thread greasing device delivers thread grease from the injection pump to

the greasing head, which rotates at high speed to atomize and spray the grease onto the internal threads of the coupling matched with the steel pipe. This is our fifth-generation product, featuring a custom-developed quantitative servo oil supply system. The system is designed to prevent clogging and ensure stable, accurate grease delivery with minimal error, low failure rate, and reduced grease consumption. As a patented product of our company, it offers superior reliability and efficiency.

1) Equipment Composition and Technical Performance Description

The internal thread greasing device consists of a fixed base, lifting mechanism, servo feed system, greasing head and its drive unit, grease flow detection device or pressure relay detection device, grease supply system, quantitative grease supply system, and electrical control system.

✧ Fixed Base: Provides structural support for the entire greasing unit. The base frame includes protective features to prevent damage to the equipment body in case of

misalignment during side loading or unloading.

- ✧ Lifting Mechanism: Composed of guide shafts, a lifting unit, and a servo motor. It adjusts the greasing device to the appropriate working height when pipe diameters vary. Manual screw adjustment is adopted, and status information is accessible to the upper-level control system.
- ✧ Servo Feed System: Consists of a servo motor and an electric linear slide, responsible for axial movement of the greasing head. This system replaces the traditional hydraulic feed structure with a servo-driven solution, enabling digital control of the spraying feed process. It allows precise coordination with auxiliary roller rotation speed and other parameters, adjusting feed speed according to pipe specifications. This ensures accurate control of grease layer thickness, achieving optimal coating quality while reducing grease consumption by over 30%, effectively lowering operating costs.
- ✧ Greasing Head: Composed of a greasing shaft and head, designed to apply grease evenly across the entire thread length, covering 40 mm to 150 mm. Both coating thickness and length can be adjusted based on production specifications and grease type, meeting the required thread length standards.
- ✧ Greasing Head Drive Unit: Includes a servo motor, timing pulleys, and timing belts, driving the greasing head at high speed. The servo motor enables adjustment of linear speed according to grease type, ensuring optimal spraying performance. A photoelectric sensor at the end of the greasing head movement system detects the pipe end and signals the greasing head to start operation.
- ✧ Grease Supply System: Comprises oil supply pipelines, delivering grease to the greasing head and controlling flow to assist in uniform application.
- ✧ Servo-Based Quantitative Grease Supply System: Traditional pneumatic systems often suffer from intermittent supply and unstable pressure, causing uneven coating and excessive or insufficient grease application. The upgraded system incorporates a quantitative servo supply mechanism, ensuring stable pressure and controllable flow for consistent application.
- ✧ Automatic Heating System: Heats the grease in the pipeline before filtering and pumping it to the internal greasing head, ensuring smooth atomization and uniform film formation. If the machine stops for more than one hour, the first greased piece requires manual inspection, with an alert dialog displayed.
- ✧ Electrical Control System: Integrated into the protective ring connection cabinet

and managed by a unified PLC for overall control.

2) Process Flow

Pipe Alignment

Steel pipe is aligned against the positioning stopper at the previous station.

Transfer to Greasing Station

Pipe moves to the greasing station and rests on the V-shaped support in a stationary position.

Greasing Head Advances

Servo motor drives the greasing head forward from its initial position.

Pipe-End Detection

Photoelectric sensor detects the pipe end and sends a signal to start greasing.

Greasing Operation

Quantitative grease supply system starts delivering grease.

Greasing head motor rotates at high speed.

Greasing head continues advancing under servo control.

Preset Position Reached

Greasing head stops rotating.

Grease supply system shuts off.

Return to Initial Position

Servo motor drives the greasing head back to its starting point.

Quality Inspection

Greasing quality inspection device checks the coated pipe.

If defects or missed coating are detected:

- Signal sent to upper-level control system.
- Alarm triggered for manual intervention.

3) Technical Parameters of Internal Thread Greasing Device

No	Item	Specification	Remarks
1	Size	DSNT-7	
2	Oil Pipe Dia	Φ48.26 ~ 177.8mm	
3	Height Adjustable	150mm	自动调整
4	Oil head Moving Distance	300mm	
5	Position Accuracy	±0.05mm	
6	Oil Head Speed	6000rpm	可调
7	Oil Pattern	Inside Spraying	
8	Position Function	Yes	
9	Oiling Device Power	1.5Kw	
10	Oil tank Capacity	18 ~ 20L	

2.2.13.2 Robotic inner Protector Applicator System

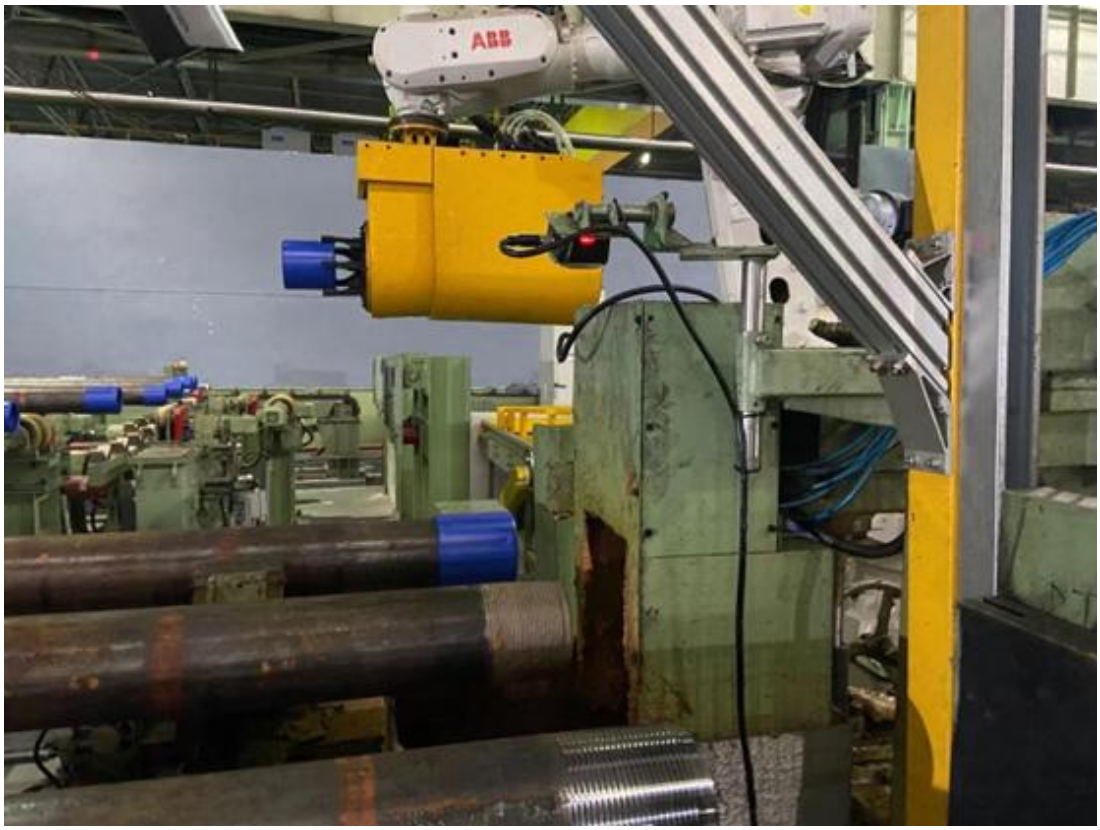
The internal protection rings are vertically arranged on the ring sorting unit. The screwing robot picks up one ring at a time and screws it into the coupling of the steel pipe, completing the protection ring installation process.

1) Automatic working process Flow

- ✧ The steel pipe is transferred by the lateral conveying mechanism to the reverse alignment station.
- ✧ At the alignment station, conveyor rollers move the pipe to the alignment stopper to ensure proper positioning.
- ✧ The pipe is then conveyed to the internal greasing station.
- ✧ The material detection sensor signals the control system when the pipe reaches the greasing station.
- ✧ The internal greasing unit moves rapidly to the designated position and performs thread greasing until completion.
- ✧ After greasing, the pipe is transferred to the protector screwing station.
- ✧ During transfer, the robot retrieves a protector from the sorting unit.
- ✧ The screwing station sends a material-ready signal to the control system.
- ✧ Upon receiving the signal, the robot activates the pipe-end detection system to locate the exact position.
- ✧ The robot adjusts its starting position based on the detected pipe-end location.
- ✧ The screwing process begins according to the programmed sequence until completion.
- ✧ After screwing, the torque and distance detection systems verify compliance with preset parameters. If both conditions are met, the system records the operation as qualified and releases the product. If not, the robot executes an NG (non-conformance) procedure:
- ✧ Unscrews the protector and retries up to two times.
- ✧ If still unqualified, the robot replaces the protector and attempts again.
- ✧ Persistent failure triggers an alarm and prompts manual intervention.
- ✧ The cycle repeats for the next pipe.

2.2.13.3 Outside Thread Oiling Device

The external greasing process adopts an atomized spray method. It begins with spraying the outer counterbore and end face. After this step, the feed module advances and, upon detecting the pipe end via sensors, initiates external thread spraying. The spray length is automatically adjusted according to the thread length. The feed module is servo-controlled to ensure precise positioning and movement. Additionally, the vertical lifting mechanism is driven by a servo motor, allowing convenient height adjustment when switching production lines.



2.2.14 Length Measurement, Weighing, Spraying & Marking

This system is designed to measure the length and weight of steel pipes and mark the measurement results on the pipe surface as required. The entire process is monitored and controlled by an industrial PC and PLC. The equipment includes a weighing unit, length measuring unit, marking unit, color ring painting unit, stamping unit, and a step-beam material transfer unit.

The system offers multiple operating modes and can record, store, and analyze production data, as well as print various reports as needed. Key features include:

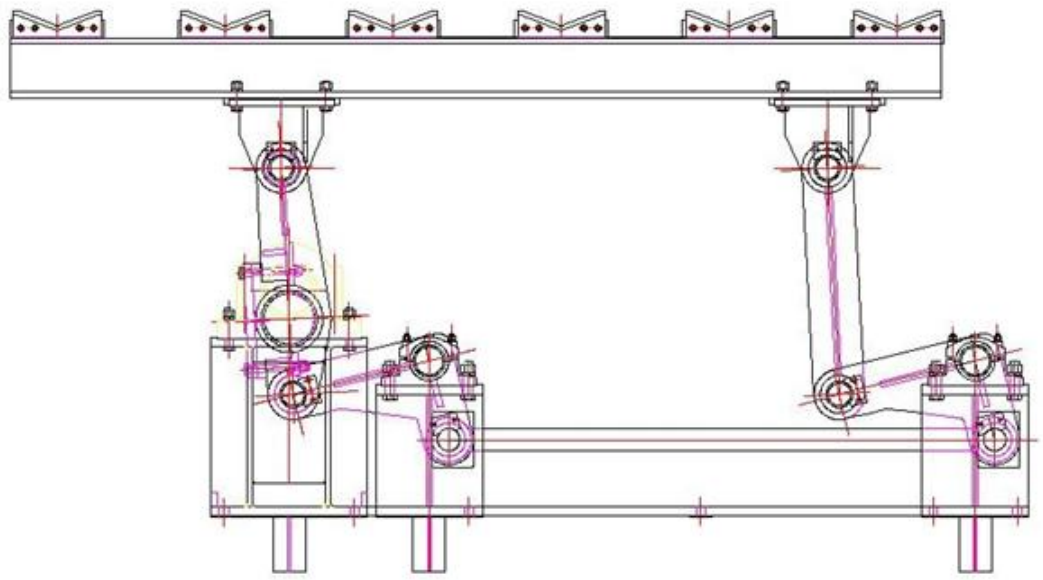
- **Parameter Management:** Manual presetting and modification of project, product,

and operational parameters.

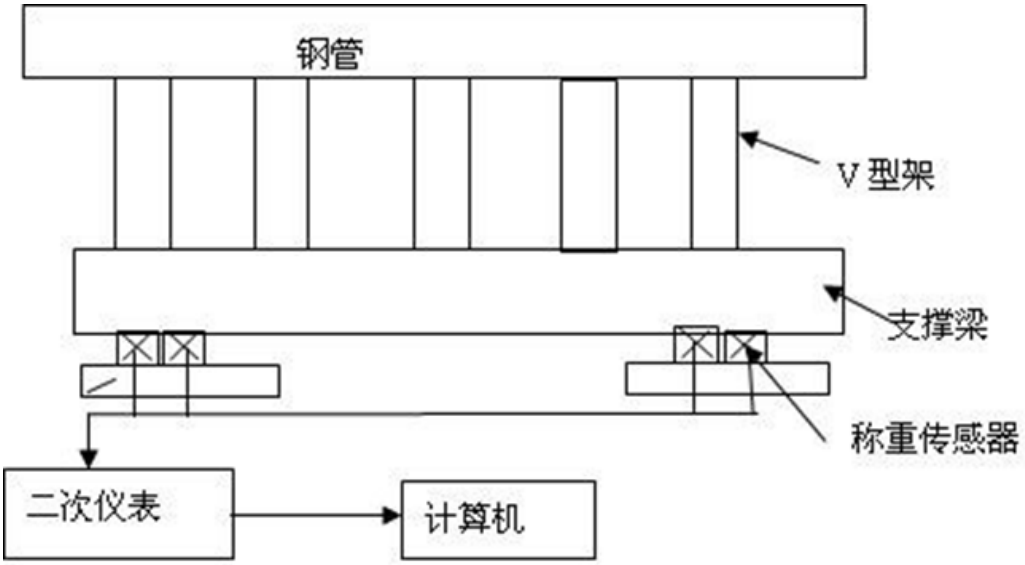
- **Automatic Quality Judgment:** Determines whether pipes meet specifications. Pipes failing length or weight checks trigger a non-conformance signal, and the system automatically executes the required process steps. It also sends point-to-point signals to subsequent stations.
- **Data Handling:** Automatic storage, display, statistical analysis, and printing of production data.
- **Operation Modes:** Supports both automatic and manual operation.
- **Maintenance:** Automatic and scheduled cleaning of spray nozzles.
- **Communication:** The system communicates with upper-level computers, transmitting essential operational and process information between upstream and downstream processes.
- **Weighing Sensor:** Equipped with Toledo sensors for high-precision weight measurement.

1) Equipment Composition and Technical Performance Description

✧ **Stepping Beam Material Transfer Device,** The stepping beam material transfer device is designed to move steel pipes in sequence through various workstations, including feeding, weighing, length measurement, color ring marking, spraying, stamping, and discharging. The entire system is powered by a 55 kW reduction motor, which is connected through a motor coupling equipped with a universal joint. To achieve the transfer motion, the device incorporates five linkage swing mechanisms configured with six teeth and seven workstations, ensuring smooth and precise material handling throughout the process.



- **Weighing Device:** The weighing device is composed of a weighing beam, load cells, a bridge-type signal processing circuit, a secondary instrument, and a signal acquisition card. The weighing beam is a box-shaped structure approximately 10 meters in length, equipped with five support brackets fitted with V-shaped blocks on its upper side. Beneath the weighing beam, four weighing modules are installed to serve as fulcrums, ensuring accurate and stable weight measurement.



Working Principle

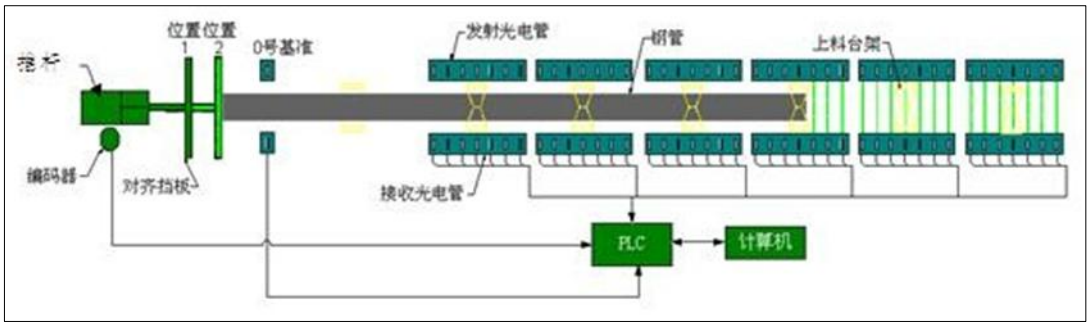
When the steel pipe is transferred onto the weighing device by the material transfer system, it is placed on five V-shaped support brackets welded to the weighing beam. The weight of the steel pipe generates an electrical signal from the load cells. This signal is conditioned by a bridge-type analog signal processing circuit and then transmitted to the secondary instrument. In the dedicated instrument, the signal is amplified and processed, converting it into an actual digital value. The data is then sent to the computer via the RS-232 port, where the computer performs digital signal acquisition, display, and printing functions.

Technical Parameters

- Single sensor capacity: 1100 kg
- Graduation value: 0.2 kg
- Electrical protection rating: IP68
- Digital display digits: 5 digits

- ✧ Display instrument protection rating: IP65
- ✧ Weighing accuracy: Maximum error 1/1000 (National Commercial Standard Grade 3)

✧ **Length Measuring Device** The length measuring device mainly consists of a ball screw assembly, alignment baffle, guide rods, servo motor system, 19 pairs of photoelectric through-beam sensors (grouped and installed inside protective housings), and a driven damping roller table.



Structural Overview

During installation, each pair of photoelectric sensors is mounted at equal intervals. The distance from the zero reference point to the first pair of sensors is measured precisely. The alignment baffle is mounted on a push rod composed of the ball screw assembly and guide rods, driven forward by the servo motor over a fixed distance. The encoder signals used for counting are collected from the servo motor.

Working Principle

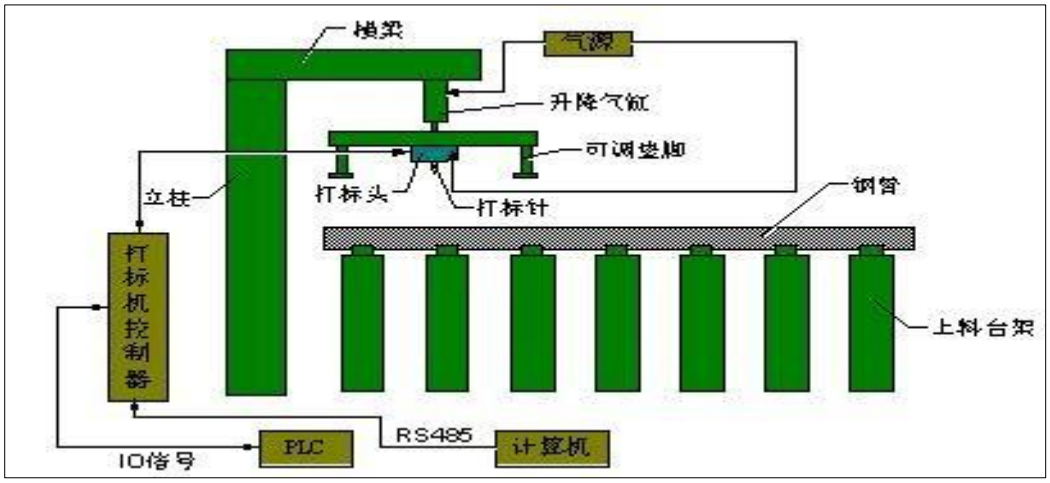
Under the drive of the push rod, the alignment baffle moves the steel pipe from “Position 1” to “Position 2” while recording the pulses generated by the encoder in the servo motor. Each time the pipe head passes a pair of photoelectric sensors, the encoder count resets and starts again. When “Position 2” coincides with the zero-reference point, the push rod stops, and the length measurement is complete. At this point, the distance from the last photoelectric sensor passed by the pipe to the zero-reference point, combined with the length calculated from the current encoder pulse count, gives the total length of the steel pipe.

Technical Parameters

Measuring range: 6–12 m

Measuring accuracy: ≤ ±2 mm

✧ **Printing Device** The complete printing system consists of a print head, print controller, paint and cleaning agent cabinet, mechanical components (including gantry frame, guide rails, gear-rack assembly, mobile carriage with variable-frequency reduction motor, lifting mechanism, print head protective housing, and V-shaped support), electrical components (such as pneumatic system, print head electrical protection, and servo controller), and control components (including computer coding and software system).



Workflow

The material transfer device moves the steel pipe onto the V-shaped support. The cylinder lowers the print head until the nozzle is positioned approximately 20 mm from the pipe surface (the initial distance is pre-adjusted via the lifting mechanism according to pipe specifications). The variable-frequency reduction motor drives the mobile carriage forward through the gear-rack assembly. Simultaneously, the print head mounted on the carriage operates, spraying data received from the upper-level computer onto the pipe surface. After printing is completed, the cylinder raises the print head back to its original position and performs automatic online cleaning.

Technical Parameters

- Printable characters: Any characters and graphics editable by computer
- Print dot matrix options: 5×5, 7×5, 10×10, 16×10, 16×16
- Character height: Adjustable from 15 to 50 mm
- Printing start distance: 300 mm from pipe end or programmable
- Dot diameter: Approx. 3 mm

- Printing speed: Up to 70 m/min
- Data capacity: Up to 524 characters per line
- Storage capacity: 100 preset strings
- Data communication: RS485, RS232
- Printing functions: Data, time, direction selection, counting, repeat counting
- Hotkey functions: Test print, cleaning
- Marking medium: Paint
- Marking color: White
- Medium container: 4 liters (standard)
- Power supply: 200–240 V, AC 50–60 Hz
- Ambient temperature: -6°C to 100°C
- Paint drying time: 6 seconds (surface dry)

✧ **Supporting Rack** The supporting rack consists of six V-shaped holders. The contact surfaces between the V-shaped holders and the steel pipes are lined with polyurethane plates to prevent damage and ensure stability. These racks are used to support workpieces at the marking and stamping stations, and the same structure is also applied at the weighing station.

✧ **Electrical Control System** The electrical system consists of weighing control, length measurement control, marking control, stamping control, monitoring computer, system PLC, and external communication via industrial Ethernet.

For the weighing section, the electrical system uses load cells to generate analog signals representing the steel pipe's weight. These signals are converted, amplified, and processed before being transmitted to the weighing transmitter, and then uploaded to the computer for further processing.

The length measurement section primarily includes a rotary encoder and detection components that provide length data.

The marking section is controlled by the system PLC. Printing speed is synchronized through encoder signals from the servo motor, ensuring precise and efficient marking operations.

The stamping section is also PLC-controlled. Characters can be input via the industrial computer or manually operated through the electrical box near the stamping station.

✧ **Software System**

The software system offers several key features and advantages:

- **Stable performance** ensuring reliable operation.
- **Comprehensive and practical functionality**, fully designed to meet actual production requirements.
- **User-friendly interface** with clear page divisions, minimizing the need to switch between multiple screens. The interface is entirely in Chinese, significantly reducing the risk of operational errors and shortening the training cycle for new operators.
- **Powerful database and reporting capabilities**, enabling real-time analysis of steel pipe data. Report formats and functions can be customized according to user-specific requirements.
- **High integration level**, incorporating external functions such as a calculator and marking character settings directly into the software, eliminating the need to switch applications and enhancing system security.

Main Functions of the Upper-Level Monitoring Program

- Input and storage of system parameters
- Display of dynamic steel pipe data in text and graphical formats
- Processing of length and weight data, including metric/imperial conversion, actual/theoretical weight conversion, and digit precision selection
- Transmission of marking and stamping data, with options for theoretical or actual weight marking
- Editing of special characters and graphics for marking
- Random printing of steel pipe data
- Database and reporting functions
- Communication and interactive control with PLC
- Communication and control of marking and stamping machines
- Fault detection with audio-visual alarms
- Communication via Profinet; interface developed using the latest Siemens TIA Portal version

- Connectivity with factory MES systems, supporting upload of production data (e.g., specifications, output, working hours) to the client's MES system in collaboration with the MES integrator

Main Functions of the PLC Automatic Control Program

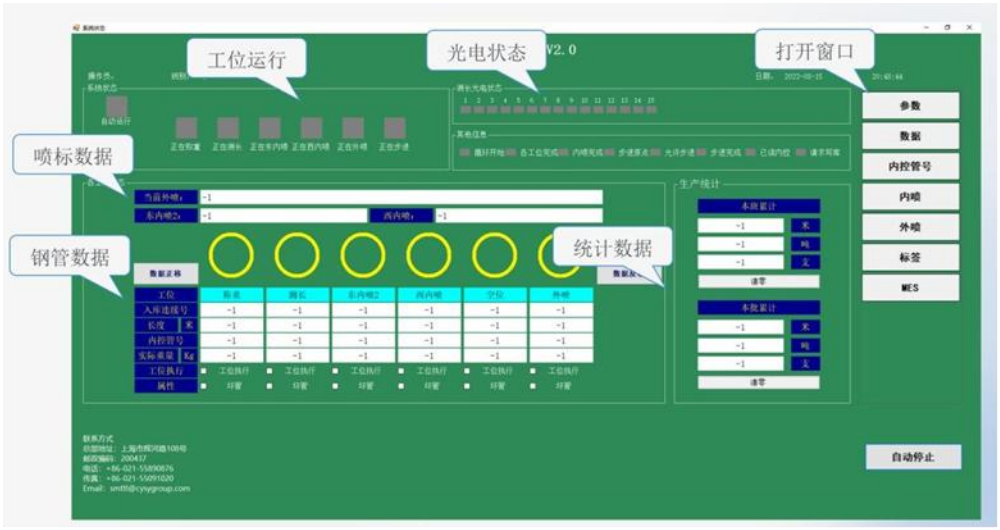
- Automatic operation of individual devices based on upper-level logic decisions
- Independent control of devices in manual/maintenance modes
- Reading sensor signals and processing or transmitting them to the upper-level system
- Electrical protection based on sensor signals
- Response to direct input from the control panel
- Full automation in conjunction with the upper-level system in automatic mode
- PLC system I/O reserve not less than 25%

✧ **Process Flow of the Equipment**

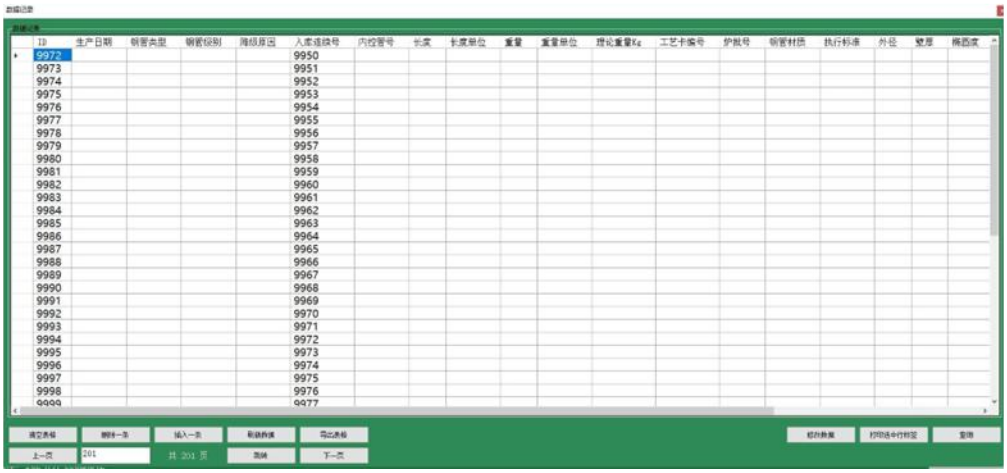
- The steel pipe enters the input roller table and waits for material handling.
- The material transfer device moves the steel pipe from the input roller table to the weighing station.
- Once the steel pipe stabilizes at the weighing station, its weight information is uploaded to the computer for storage and processing. The stabilization time at the weighing station is ≤ 5 seconds, and the weighing cycle time is ≤ 6 seconds.
- The material transfer device moves the steel pipe from the weighing station to the length measuring station. The length measuring mechanism is activated, and the length data collected via PLC is uploaded to the computer for calculation, storage, and processing. The measuring mechanism then returns to its initial position, completing the measurement cycle. The length measuring cycle time is ≤ 11 seconds.
- The material transfer device moves the steel pipe from the length measuring station to the marking station.
- During the transfer process, the computer integrates the information and

generates the marking code, which is transmitted to the marking controller. Upon arrival at the marking station, the print head is lowered to the designated start position, and marking begins until completion. After marking, the print head is raised and prepared for the next operation.

- The material transfer device moves the steel pipe from the marking station to the stamping station. The stamping machine lowers pneumatically until the stamping needle is 3 mm from the pipe surface, then begins stamping. After completion, the stamping machine rises and returns to its starting position, ready for the next pipe.
- The material transfer device moves the steel pipe from the stamping station to the output roller table, completing the entire process of length measurement, weighing, and marking for one steel pipe.


工位运行
光电状态
打开窗口
喷标数据
钢管数据
统计数据
参数
数据
内控管号
内喷
外喷
标签
MES
自动停止


钢管在线数据
各工位参数
合同参数设置
光电位置
保存

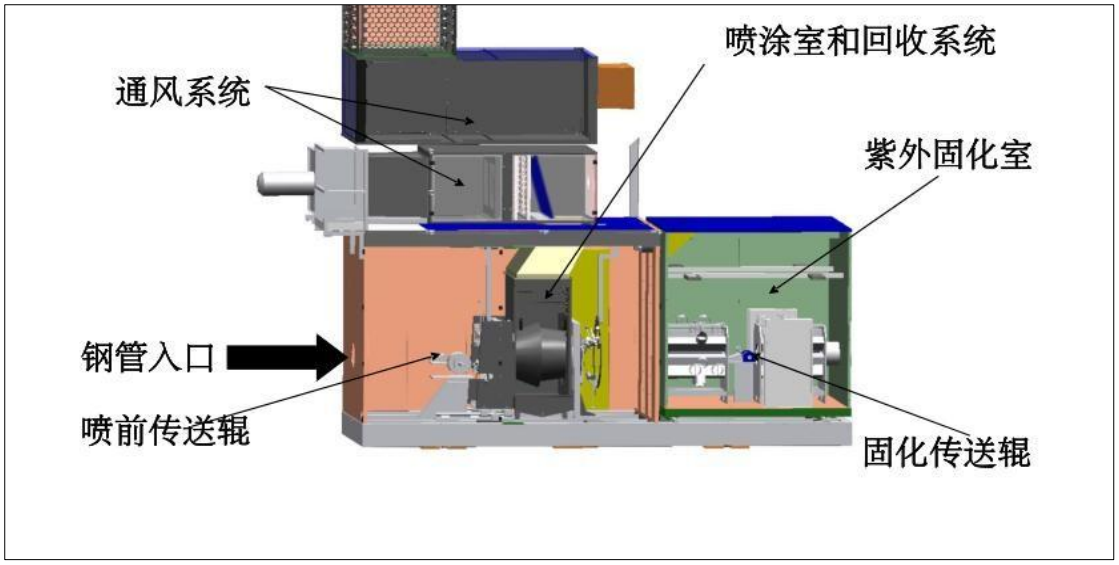


2.2.15 UV Coating and Curing Device

1) The Process Description of the UV Coating and Curing

Each cut steel pipe is conveyed individually through the roller table to the oil coating (UV painting) unit. Upon detecting the pipe's entry, sensors transmit the signal to the coating control system, which activates the diaphragm pump to deliver coating material to the curtain coater for uniform application on the pipe surface. A doctor blade regulates the film thickness. When the pipe exits, sensors send a departure signal to the control system, triggering the light shield to close. The coating process for the single pipe is then completed, and the system remains on standby awaiting the next pipe

2) Equipment Function Description



The equipment consists of the following main components: main frame, spray chamber with ring-type spray gun assembly, coating recovery system, roller conveyor system, light-shield gate, UV lamp housing, coating storage and delivery system, ventilation system, VOC catalytic treatment unit (covering exhaust from coating, curing, marking, and color banding), and a control system.

- Main Frame: Provides overall lifting of the equipment and automatic alignment with the pipe center.
- Spray Chamber & Ring-Type Spray Gun Assembly: Ensures optimal positioning and angle of spray guns for uniform coating.
- Coating Recovery System: Recovers unused UV coating for reuse.
- Light-Shield Gate: Prevents UV radiation leakage from the curing chamber into the spray chamber.

- UV Lamp Housing: Cures the UV coating on the pipe surface into a solid film.
- Coating Storage & Delivery System: Supplies coating material to the spray guns.
- Ventilation System: Handles exhaust and recovery of heat from UV lamps and atomized coating.
- VOC Catalytic Treatment Unit: Treats exhaust gases generated during coating, curing, marking, and color banding processes.
- Control System: Controls spray switches and flow rates, monitors UV lamp operation and runtime, and provides statistics on pipe throughput, UV coating consumption, and energy usage.

3) Description of Equipment Composition and Technical Performance:

The UV coating equipment consists of the following main sections: roller conveyor, rust removal unit, dust removal unit, coating system, coating recovery and circulation system, curing unit, exhaust system, control system, and monitoring system.

Roller Conveyor

Utilizes V-type rollers for conveying. All V-type rollers from the curing chamber outlet onward are rubber-coated.

Rust Removal System

Employ motor-driven cloth wheels to remove surface dust and rust. The system includes two lifting frames with 12 cloth wheels arranged in a ring on both sides. Frame height and wheel-to-pipe distance can be manually adjusted according to pipe size.

Dust Removal System

Uses an 11KW bag filter to create negative pressure within the rust removal system, preventing dust leakage into the workshop. Air is filtered through bags before discharge.

Coating System

Comprises a temperature-controlled coating tank, diaphragm pumps, valves, curtain coater, doctor blade, manual blade replacement system, coating circulation filtration system, support rollers, UV-resistant piping, instruments, control cabinet, and accessories.

- Temperature-Controlled Tank: Stainless steel with thermal oil jacket, equipped with level and temperature control.
- Pumps: Diaphragm pumps for supply and recovery, installed on the tank cover (one active, one standby).
- Filtration: Includes curtain coating and doctor blade circulation filters, both stainless steel bag filters.

- Curtain Coating System: Features a coating chamber and ring with 10 spray heads for full 360° coverage of pipes up to 406mm diameter.
- Doctor Blade System: Maintains film thickness between 10–30μm. Includes work, transfer, and preparation positions for blade stability and quick replacement.
- Blade Replacement System: Equipped with overhead rail, electric hoist, and storage rack for rapid manual replacement, ensuring production continuity.

Curing System

Curing chamber solidifies the coating and includes air supply, exhaust, and curing components.

- Air Supply: Provides fresh air to maintain cleanliness and remove UV lamp heat.
- Exhaust: Removes excess heat and air to ensure continuous lamp operation.
- Curing Unit: Contains 10 UV lamps with individual exhaust ducts and polished stainless-steel reflectors. Lamp frames slide on rails for easy replacement.
- Light Shield: Automatic pneumatic gate between curing and coating chambers prevents UV leakage and enhances coating recovery.

Control System

Utilizes Siemens PLC and sensors for process coordination, automatic detection of pipe entry/exit, fault alarms, and shutdown. Tracks pipe count, coating consumption, and energy usage.

Monitoring System

Video monitoring system observes equipment operation and coating quality, including cameras and display units.

4) Main Technical Parameters of the Equipment:

- **Pipe Outer Diameter Range:** Φ60.32 ~ Φ127 mm
- **Pipe Length:** 6 ~ 12 m
- **Coating Method:** Longitudinal conveying, automatic spraying
- **Coating Material:** UV paint
- **Coating Position:** Within 30 mm from the pipe end face
- **Coating Color:** Transparent / Semi-transparent / Black
- **Coating Thickness (Dry Film):** 25 ~ 35 μm

- **Pipe Conveying Speed:** 0.5 ~ 1.0 m/s, adjustable and uniform
- **Coating Quality Requirements:** The coating surface must be smooth, free of dents, bubbles, delamination, and other defects, with no missed areas.

2.2.16 Bundling and Collection Device

1) Equipment Function Description:

The equipment automatically calculates the number of pipes per row based on pipe diameter, then performs row formation and stacking. After stacking is completed, the system automatically bundles the pipes. The bundled pipe packs are conveyed to the transverse transfer chain for buffering, facilitating subsequent storage and transportation.

2) Process Flow:

Online material receiving → Automatic alignment, counting, and sorting → Automatic stacking (electromagnetic type) → Automatic hexagonal bundle formation → Automatic transverse transfer cart → Bundling → Finished product storage rack.

3) Description of Equipment Composition and Technical Performance:

The automatic stacking and bundling system consists of the automatic row-forming and stacking unit, automatic shaping unit, pipe bundle conveying unit, automatic bundling unit, transverse transfer chain, electrical control system, and pneumatic system.

Pipe Transverse Transfer Device

Moves pipes horizontally from the feeding position to the stacking station.

Automatic Counting and Grouping System

Automatically counts and sorts pipes, forming a single-layer group according to preset quantities to facilitate stacking.

Electromagnetic-Suction Stacking Unit

After one layer is grouped, a bidirectional cylinder positions the layer. Multiple sets of electromagnets then lift, transfer, and place the pipes into the stacking frame (vertical and horizontal motions controlled by gear–rack linear guides).

Layers are stacked from bottom to top until a full bundle is completed.

Technical Features:

- Electromagnetic grippers provide accurate sorting and stacking with programmable control of layer count and pipe quantity.
- Servo-driven positioning ensures stacking accuracy.
- Equipped with a rectifier cabinet and energy-storage battery for fast magnetization/demagnetization; demagnetization is assisted by an anti-residual magnetism device.
- Light curtain sensors provide safety protection.
- Electromagnetic handling ensures firm adhesion and rapid demagnetization.

Fixture-Type Receiving Rack (Hexagonal Forming)

When a bundle is completed, one side is released, and the shaping transfer cart moves the hexagonal bundle outward. The receiving rack retracts and prepares for the next bundle, enabling continuous, efficient operation.

Automatic Transverse Transfer Cart

Transfers the fully formed hexagonal pipe bundle (hexagonal dimensions adjusted manually) to the manual strapping machine.

Bundling Machine

The pneumatic lifting bundling head and fixed guide channel perform circumferential automatic strapping once the pipe bundle arrives at the bundling position.

The number of parallel straps along the pipe length is programmed through the conveyor system bus.

Electrical Control System

Includes power distribution, motor drives, frequency converters, and servo systems.

Composed of AC cabinet, PLC cabinet, speed control devices, and operator console.

Touch screen provides HMI functions for status display, parameter setting, and adjustment.

The entire system is PLC-controlled, ensuring high automation and easy operation.

4) Main Technical Specifications

Steel Pipe OD Dia	Φ60.32mm～Φ127mm
Pipe Length	6～12m
Pipe Arrangement	Hexagonal or Square

Temperature	≤150℃

Appendix3: Scope of Design, Supply, Construction, and Handover

1 Scope of Work

With the cooperation of Party A (the Owner), Party B shall complete the load commissioning and trial production of the entire production line, ensuring that the system reaches the designed capacity and performance indicators, meets all technical requirements specified by Party A (the Owner), and guarantees the completeness of the project.

1.1 Scope of Work for Party A

Party A is responsible for the detailed design of the entire production process and for providing all related facilities and auxiliary conditions, including but not limited to the following:

- Design and supply of the plant building, including but not limited to civil works, construction, and fabrication of the workshop building.
- Design and supply of workshop pipelines, including water, air, power, cables, and hydraulic lines.
- Design and supply of the power distribution system, including the low-voltage distribution system from the low-voltage switchgear (excluding the switchgear itself) to equipment power connection points, cable installation, cable trays, and electrical control systems.
- Design and supply of utility rooms/electrical rooms inside the workshop, including building structure, architecture, HVAC, and lighting.
- Design and supply of auxiliary stations, such as circulating water treatment, water supply and drainage systems, compressed air systems, dust removal systems, environmental protection facilities, and environmental monitoring.
- Design and supply of workshop telephone, communication, and surveillance camera systems.
- Design and supply of workshop piping and instrumentation systems, including

process instruments (instruments for air compressors only), automation system design, supply, and installation.

- Design and supply of the fire protection system, fire-fighting equipment, fire acceptance, and design of safety channels and safety facilities.
- Design and supply of equipment foundations and steel structures, including cable trenches, hydraulic and pneumatic trenches, platforms, ladders, etc.
- Design and supply of lighting systems inside the plant, including general lighting and localized enhanced lighting.
- Design and supply of the grounding system for the plant.
- Selection, supply, inspection, and certification of special equipment, including pressure vessels, safety valves, cranes, and instrumentation.
- Overall project management, including quality, safety, environmental protection, schedule control, energy conservation, occupational health, safety assessment, environmental/ safety/ occupational health/ fire inspection coordination, labor protection, documentation, security, and epidemic prevention (if applicable).
- Supply of equipment flushing oil and initial filling oil.
- Fabrication and installation of safety facilities, including railings, walkways, guards, covers, protective shields, etc.
- Implementation of epidemic prevention measures (if applicable) and management of safety and civilized construction measures.

1.2 Scope of Work for Party B

Based on the relevant documents, technical requirements, and project scope provided by Party A (the Owner), Party B shall complete the overall design, foundation design, equipment and material supply, installation, commissioning, trial production, performance guarantee testing, and final acceptance of all production line equipment included in this project. The scope mainly includes, but is not limited to, the following:

- This project is an EPC (Engineering, Procurement and Construction) general contracting project. Party B shall assume full technical responsibility for the entire production line and ultimately deliver a high-quality project that fully meets the expected performance indicators required by Party A (the Owner).
- Responsible for the supply, installation, standalone equipment commissioning, and no-load linkage commissioning of all process equipment within the production line

scope, as specified in the handover schedule.

- Responsible for the programming, supply, commissioning, trial run, and ramp-up to full capacity of the control system within the project scope.
- Responsible for personnel training; standalone equipment performance acceptance; performance guarantee testing and acceptance; project acceptance and final completion acceptance; and all procedures required for delivery and handover.
- Responsible for the coloring/marking of pipelines and piping within the project scope.

The engineering design quality shall meet national and industry standards as well as the requirements of customer internal specifications. Construction and installation works shall meet the current national or industry quality inspection and acceptance standards.

Party B shall undertake all responsibilities specified in the technical documents of this project, including receiving materials, unloading, onsite security, site management; fabrication and installation of steel structures; equipment installation and commissioning; cooperating with Party A (the Owner) in thermal load testing, and all other work that shall be undertaken by Party B from the design phase through to the achievement of stable production

2 Interfaces of the EPC General Contract

2.1 Boundary Interfaces for Utilities, Media and Signals

The connection points for water supply, drainage, power supply and other utilities are shown in the general layout drawing.
Party B is responsible for all utility pipelines within the interface boundary.

2.2 Water Supply and Drainage Interfaces

2.2.1 Water Supply

The main water supply interface for the project's industrial fresh water shall be provided at the location designated by Party A (the Owner) (refer to the general layout). Party B is responsible for pipeline connection from this point.
Valves, flanges and other components at the interface point shall be procured, installed and commissioned by Party B.

2.2.2 Drainage

A rainwater–sewage separation drainage system shall be adopted.

- **Domestic sewage and septic tank effluent** shall be the responsibility of Party A (factory building designer).
- **Rainwater drainage** shall be designed and provided by Party A.
- The **phosphating drainage point** is located 1 meter from the phosphating wastewater treatment facility.
- **Hydraulic press wastewater, cutting fluid wastewater, and NDT wastewater** shall be collected onsite and treated by Party A.

2.3 Power Supply Interface

Transformers, low-voltage switchgear and distribution boxes for this project shall be provided by Party A (the Owner).
Party B is responsible for the power supply connection **from the outgoing switch of the distribution box to each equipment power point**.
The handover interface shall be at the **outgoing side of the distribution box switch**.

2.4 Compressed Air Interface

The compressed air interface point shall be located **1 meter above the column** inside the workshop building, and a shut-off valve shall be installed at the interface.

2.5 Requirements for Digitalization and Intelligent Manufacturing

Party B shall cooperate with Party A (the Owner) to realize the following digital and intelligent functions:

2.5.1 Unified management of product information
2.5.2 Unified management of automatic processing and inspection program codes
2.5.3 Production line process management
2.5.4 Production line equipment management
2.5.5 Operator and personnel management
2.5.6 Production task and logistics information management
2.5.7 Energy consumption management
2.5.8 Safety management
2.5.9 Full-process material management from raw material receiving to product dispatch
2.5.10 Visualization management of the production line

3 Exclusions from Party B's Scope of Work

- Work items explicitly defined as excluded from Party B's responsibilities in the "Work Scope Division Table".
- Safety assessment, environmental impact assessment, occupational health assessment, fire-fighting review and acceptance, and engineering supervision.
- Civil construction works, including foundations, trenches, and pits of any type.
- Design and construction of the plant building, electrical room, air compressor station, office areas, etc.
- Construction of lightning protection and grounding systems (except for special ground equipment required by the supplied equipment).

4 Other Requirements

Removal and Disposal of Demolition and Construction Waste

Following the principle of "who generates it, who is responsible," Party B shall be responsible for the removal, transportation, and proper disposal of all waste generated during the dismantling, transportation, and installation of steel structures and equipment.

This includes, but is not limited to, rock wool, coating residues, refractory materials, grease, non-metallic liners, and construction debris.

All waste shall be disposed of or discharged in accordance with the requirements of Party A (the Owner) and must comply with environmental protection regulations and the requirements of the competent environmental authorities.

Inspection and Testing Fees

All inspection and testing costs related to equipment, materials, and construction shall be fully included in Party B's project quotation.

Commissioning Spare Parts and Tools

Party B shall provide a sufficient quantity of consumable spare parts required for commissioning, as well as one complete set of production tools necessary for performance guarantee testing and final acceptance.

Design Review Requirements

Basic design documents must be reviewed and approved by Party A (the Owner) before

detailed design can commence.

Detailed design documents must also be reviewed and approved by Party A before manufacturing and construction activities may proceed.

No			Item	Unite	Qty	Design			Supply		Engineering		
						Base data	Basic Design	Detailed Design	B	S	Foundation Constructio	Installation	Commissio ning
		—	Drill Pipe Line										
		1	De-Bundle and Loading Device	Set	1	S	S	S		●	B	B	S
		2	Dill pipe end facing machining lathe	Set	1	S	S	S		●	B	B	S
		3	Pipe End Machining Lathe	Set	1	S	S	S		●	B	B	S
		4	Friction Welding Machine	Set	1	S	S	S		●	B	B	S
		5	Coaxially Inspection Device	Set	1	S	S	S		●	B	B	S
		6	Weld Seam Annealing Device	Set	2	S	S	S		●	B	B	S
		7	Weld Seam Flash Removal Lathe	Set	2	S	S	S		●	B	B	S
		8	Weld Seam Quenching Device	Set	2	S	S	S		●	B	B	S
		9	Weld Seam Tempering Device	Set	3	S	S	S		●	B	B	S
		10	Weld Seam Grinding Device	Set	4	S	S	S		●	B	B	S
		11	Magnetic Particle Inspection Device	Set	1	S	S	S		●	B	B	S
		12	Ultrasonic Testing Device	Set	1	S	S	S		●	B	B	S
		13	Single end Finish Product inspection	Set	1	S	S	S		●	B	B	S
		14	Greasing and protector applicator	Set	1	S	S	S		●	B	B	S

		15	Measurement, weighting, marking	Set	1	S	S	S		●	B	B	S
		16	UV Coating and Curing Machine	Set	1	S	S	S		●	B	B	S
		17	Bundle and Collecting System	Set	1	S	S	S		●	B	B	S
		18	Auxiliary Equipment for the line	Set	1	S	S	S		●	B	B	S
		31	Electrical Control System	Set									
		32	pneumatic system	Set									
		33	Lubricating System	Set									
		34	Central Hydraulic Station	Set									
		35	MES System										
		36	Single Pipe Tracking System										
		37	Workshop Supervision System										
		38	Center Control System										
		39	5G Remote Control and Maintenance										
		二	Embedded foundation parts, piping, and cables										
		1	Embedded Parts& Level Plate	Set	1	S	S	S	●		B	B	B
		2	Embedded/chemical anchor bolt	Set	1	S	S	S	●		B	B	B
		3	Intermediate compressed air piping	Set	1	S	S	S	●		B	B	B
		4	circulate water or cooling water piping	Set	1	S	S	S	●		B	B	B
		5	Cable	Set									

		5.1	Cable from the operation console to the terminal box			S	S	S	●	B	S	S	S
		5.2	Cables from the operator console to the robot body and main equipment			S	S	S		●	B	S	S
		5.3	380 VAC power cable to the main power cabinet			S	S	S	●		B	B	B
		6	From the utility pipeline network to the TOP point			B	B	B	●		B	B	B
		三	Commissioning Materials										
		1	Commissioning Materials	Set		B	B	B	●		B	B	B
		2	Pipes for load testing	Set		B	B	B	●		B	B	B
		3	Onsite consumable material	Set		B	B	B	●		B	B	B
		四	Engineering and Construction	Set									
		1	General Layout Plane			S	S	S		●	B	B	S
		2	Foundation			S	S	S	●		B	B	B
		3	Electricals			S	S	S	●		B	B	B
		4	Telecommunications			S	S	S	●		B	B	B
		5	Installation			S	S	S	●		B	B	B

B = Party A (Owner); S = Party B

Definition of TOP: Within 1 meter outside the equipment body. The fluid piping on the equipment body is to be provided by Party B and installed before shipment.

Unless otherwise specified, the design or supply responsibilities of both parties shall be handed over at the TOP point.

Principles for TOP points of different media:

• Compressed Air TOP point: Interface located 1 meter from the main unit.

• Cooling Water TOP point: 1 meter upstream of the heat exchanger interface.

• Power Cable TOP point: Communication and control cables from the MCC room to the field junction box shall be supplied and installed by Party A. Power cables from the MCC room to the power consumption point shall also be supplied and installed by Party A.

• Hydraulic Piping TOP point: 1 meter upstream of the hydraulic valve station interface. Piping from the valve station to the equipment room shall be the responsibility of Party B.

Appendix4: Design Coordination and Design Review

The design work of this project and the provision of related technical documents, files, and information are divided into two stages: the Basic Design Stage and the Detailed Design Stage.

During both the Basic Design Stage and the Detailed Design Stage, 1 to 4 design coordination meetings shall be held. The design coordination meetings may be combined with design review meetings or conducted independently. The design review shall be carried out in the form of meetings.

For details, please refer to Appendix 4-1.

No	Item	Time	Site	A Party Personnel	B Party Personnel	Type	Content
一	Kick-off Meeting	3 days after contract signing	Depending on	Depending on	Designer	Meeting	Technical exchange
二	Basic Design Coordination and Review						
1	Process and Mechanical Design	50 days	Depending on	Depending on	Designer	Meeting	Discussion and Review of the Basic Scheme, Process, and Equipment Parameters, etc.
2	Electrical Equipment and Software	50 Days	Depending on	Depending on	Designer	Meeting	Discussion and review of the basic scheme and equipment parameters, etc.
3	Utility Systems	50 days	Depending on	Depending on	Designer	Meeting	Discussion and review of the basic scheme and equipment parameters,

							etc.
三	Detailed Design Coordination & Review						
1	Process & Mechanical Design	90 days	Depending on	待定	Designer	Meeting	Discussion and review of the detailed scheme and equipment structure
2	Electrical Equipment and Software	90 Days	Depending on	Depending on	Designer	Meeting	Discussion and review of the detailed scheme and equipment structure
3	Utility Systems	90 days	Depending on	Depending on	Designer	Meeting	Discussion and review of the detailed scheme and equipment structure
4	Detailed Equip list	90 Days	Depending on	Depending on	Designer	Meeting	Discussion and review of the scheme and parameters
5	Execution	90 Days	Depending on	Depending on	Designer	Meeting	Discussion and review of the detailed scheme and schedule

The detailed design (or basic design) confirmed and approved by both parties shall serve as the basis and foundation for Party B to carry out the construction (shop) drawing design.

Design issues discussed between the liaison personnel representing Party A (the Owner) and those representing Party B shall be recorded in the Design Liaison Minutes signed

by both parties, which shall form part of the design basis.

Appendix5: Document Delivery and Supply Schedule

1 Preliminary Design Stage

- Within 60 days from the date of contract signing, Party B shall submit the Basic Design Documents to Party A (the Owner), in **two hard copies** and **one electronic copy (PDF)**.
- Within 45 days from the date of contract signing, Party B shall submit the **overall project network schedule** to Party A (the Owner).

2 Construction (Shop) Drawing Design Stage

Upon completion of the construction drawing design for this project, Party B shall provide the following drawings and documents (including but not limited to).
Unless otherwise specified, quantities refer to **two hard copies**:

- Equipment foundation construction drawings (including trenches, pits, etc.)
- Equipment and piping installation drawings
- Electrical & instrumentation interlock control diagrams and functional specifications
- Communication, monitoring, instrumentation automation, and electrical conduit/cable routing drawings
- Communication, monitoring, instrumentation automation, and electrical equipment drawings / schematic diagrams / program diagrams
- Utility system equipment and pipeline installation drawings
- Civil construction drawings for all structures within the contract scope (including architectural and structural drawings)
- Workshop process layout drawings
- Drawings required during project implementation and the overall index of construction design drawings
- Project design network schedule

3 Construction and Installation Stage

Including but not limited to the following documents:

- Construction network schedule
- Construction commencement report
- Construction survey form
- Hazard identification form
- Construction organization design
- Safety and fire-protection agreement
- Foundation inspection records
- Hidden works inspection and acceptance records
- Equipment manuals
- Equipment factory acceptance/quality certificates
- Installation and operation instructions for equipment
- Installation and inspection standards for non-standard equipment (listed in the general notes of the drawings)

4 Commissioning Stage

Including but not limited to the following documents:

- Commissioning instruction manual
- Software operation manual
- Commissioning schedule plan
- Commissioning report
- Equipment no-load test certificate
- Equipment no-load linkage test certificate
- Load linkage test application form
- Equipment load linkage test certificate

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5 From Start-up to Performance Achievement Stage

Including but not limited to the following documents:

- Operation instruction manual
- Guaranteed value test operation manual
- As-built drawings (two blue-print sets + one PDF electronic set; all modifications

must reflect design changes and actual site conditions)

- Project completion acceptance certificate
- Handover acceptance certificate
- Technical procedures, operating procedures, equipment maintenance procedures, and safety procedures
- Operating instructions
- Maintenance manual
- Equipment manuals and certificates
- All program backups required for operation and two sets of software installation packages (portable hard-disk type)
- Manufacturing drawings or procurement specifications for spare parts
- Licensed software
- Various construction and acceptance records / hidden works records
- Certificates of construction materials and factory inspection test reports

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6 Other documents shall be provided as agreed by both parties.

Appendix6: Guaranteed Value Acceptance and Assessment Method

1 Purpose, Scope and Classification of Evaluation

Purpose

This Annex is formulated to verify the capacity and functionality of the design, equipment, and facilities supplied by Party B.

During commissioning and trial operation, the items listed in this Annex shall be evaluated as the basis for acceptance.

Scope

The evaluation shall cover all items within the EPC scope, including the overall system, subsystems, and individual equipment.

Satisfactory evaluation results shall serve as the basis for acceptance.

Classification

The evaluation is divided into:

- **Functional evaluation**, and
- **Acceptance evaluation**.

2 Functional Evaluation (Trial Run)

Functional evaluation (trial run) includes cold-state single-equipment commissioning and linkage commissioning.

Upon completion of single-equipment and linkage commissioning, both parties shall sign the Equipment Acceptance Certificate.

Trial run shall be carried out after Party B completes the installation of the single equipment.

The purpose of the trial run is to verify whether the equipment performance matches the descriptions in the contract annexes, conduct functional confirmation, and prepare corresponding documents.

Any remaining issues that do not affect startup and operation shall be listed item by item and resolved as soon as possible.

When all items pass inspection and the trial run is completed, both parties shall sign the Equipment Acceptance Certificate.

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3 General Conditions for Guaranteed Value Testing and Acceptance

✧ Testing and acceptance of the guaranteed values shall be carried out only after stable production is achieved, and the system shall operate continuously and stably for **no less than one month**.

The specific duration shall be mutually agreed by both parties, but shall not exceed **six months after production start-up**. Testing shall be conducted by personnel from both parties in accordance with a jointly prepared plan and procedure.

✧ The necessary conditions for acceptance (including power supply, documentation, methods, etc.) shall be jointly confirmed by both parties.

✧ During testing, testing instruments/equipment shall be provided by Party B, and all related devices must be in proper working condition.

✧ Each item of functional acceptance shall be evaluated independently.
If conditions permit, multiple items may be evaluated simultaneously.
The specific evaluation method shall be mutually agreed upon by both parties.

✧ If delays occur during single-equipment testing due to Party B's responsibility, the commissioning period shall be extended accordingly.
The extension shall not exceed **one month**; any further delay shall be subject to the penalty provisions in the contract.

✧ Upon completion of testing, both parties shall jointly verify all results and sign the Certificate of Compliance for the Equipment Performance Test.

✧ Equipment, instruments, and meters requiring testing during trial production must meet performance indicators **before the trial production ends**.

✧ This acceptance also includes evaluation of the process technical manuals, safety operating procedures, equipment operation and maintenance manuals, etc., provided by Party B.

✧ Any matters not covered herein shall be resolved through consultation between the parties and shall be executed in accordance with design drawings, relevant documents, national or industry standards.

Where drawings or documents contain specific requirements, such requirements shall prevail.

4 Equipment Quality Assurance

✧ Party B guarantees that all equipment supplied to Party A is brand-new and of excellent quality.

✧ Except for reused equipment, all newly supplied equipment (including wear parts) shall have a warranty period of 12 months, starting from the date when the equipment passes installation, commissioning, and acceptance.

✧ Project construction shall comply with the latest national standards and codes.

5 Technical Warranty

The technical Solution and process provided by Party B for this project shall be advanced, mature, reliable, economical, and practical.

All technical indicators and Solution shall comply with relevant national policies, laws, regulations, standards, codes, and applicable industry rules.

6 Performance Guarantee

The testing and acceptance of the guaranteed values shall be carried out only after stable production is achieved, and after all related equipment, instruments, and devices have reached their required performance indicators and are in good working condition.

The specific testing schedule shall be mutually agreed upon by both parties, but the final deadline shall not exceed six (6) months after production start-up.

All guaranteed values shall be tested within a continuous period of one (1) month after the tested unit (or system) has reached full-load stable operation.

The product quality and the types/specifications to be tested are shown in the table below.

Table of Product Quality and Test Specifications / Varieties

No	Grade	Size /mm		
		OD	W.T	Length
1		60.32	7.11	8200
2		114.3	8.56	8200
3		127	9.12	8200

Note: Three specifications shall be selected from the above table for testing. The Buyer may also select alternative specifications based on market needs.

Hourly production capacity shall be accepted according to Table 6-1. If the tested pipe length differs from the values in Table 6-1, the acceptance value may be calculated proportionally.

Party B shall submit a testing plan two months in advance, including analysis, testing methods, and required instruments.

Functional evaluations may be carried out individually or, if conditions permit, combined.

If any data fails to meet the guaranteed values due to Party B, Party B shall correct the issues free of charge. Party B may conduct up to two additional tests within one month after the first test. If the guaranteed values are still not met, Party B shall compensate Party A.

Other evaluations shall be conducted in accordance with the commercial contract.

7 Guaranteed Values of the Process System

7.1 Guaranteed Engineering Performance Indicators

After the production line has successfully completed commissioning and has operated in trial production for one month, the Supplier shall request the Buyer to carry out performance guarantee testing for production output and product quality.

The specific schedule for the performance guarantee test shall be mutually agreed upon by the Supplier and the Buyer.

The performance guarantee testing shall be completed within one month.

The Supplier and the Buyer shall jointly prepare the testing procedure and determine the exact testing time.

Based on all test data obtained during the comprehensive testing, each production indicator shall be evaluated and accepted accordingly.

The detailed acceptance requirements are as follows:

7.1.1 Functional Acceptance of Complete Single-Unit Equipment

The main items and indicators for the functional acceptance of complete single-unit

equipment shall be as shown in Table 6-1.

No	Item	Quality	Standard	Production（p/h）
1	Pipe End Machining Lathe	Working Accuracy Standard	Dimensional tolerances shall comply with API Spec 7-2001.。	1.05 times the capacity of the friction welding equipment.
2	Weighing, Measuring, Marking / Pipe Body Spray Marking Unit	No damage to pipe body; spray marking must be clear, correct, and accurately positioned	Length accuracy: ≤ ±2 mm; Weighing accuracy meets National Commercial Standard Grade 3	1.05 × capacity of friction welding equipment
3	Medium-Frequency Induction Heating – Annealing, Quenching & Tempering Unit			1.05 × capacity of friction welding equipment
4	Coating Unit	No runs, no missed spray, no scratches; circumferential film thickness unevenness ≤ 10 μm; pollutant emissions compliant	无	1.05 × capacity of friction welding equipment
		10μm；		
5	Stacking & Bundling Unit	The normal stacking height is 3.4 m without bundle loosening	Gauge spacing tolerance: ±30 mm; the steel strapping and buckle shall be free from cracks; the steel strap used shall withstand a tension greater than 6000 N.	1.05 × capacity of friction welding equipment
6	Other Auxiliary Equipment	Meets relevant national standards; no negative impact on pipe surface quality		1.05 × capacity of friction welding equipment

7.1.2 Integrated Line Operation Capacity Acceptance

The integrated line operation acceptance shall be conducted by continuously operating the production line for 4 hours or continuously producing 100 pieces.

If the comprehensive hourly production cycle of the line reaches ≥ 85% of the friction welding equipment's 100% rated hourly capacity, the integrated operation acceptance shall be deemed passed.

7.2 Performance Guarantee Value Acceptance Method

Basic conditions for acceptance:

- ✧ The equipment must meet the requirements of the load test run and be capable of producing qualified products.
- ✧ After completion of the load test run acceptance, the factory shall conduct a one-month trial production, after which performance testing begins.
- ✧ A joint acceptance team consisting of the supplier and the purchaser shall be established to organize, lead, and coordinate testing.
- ✧ Both the supplier and purchaser shall assign professionals to prepare the test report.
- ✧ The supplier and purchaser shall carry out testing and measurement for each performance-guarantee item according to the requirements and methods specified in the test report.
- ✧ The supplier shall compile the test and measurement data, submit the test acceptance report, and obtain signatures from both parties for confirmation.

7.3 Acceptance and Evaluation Timeline

The first month after engineering test run is considered the trial production period.

The second to third month constitutes the performance guarantee acceptance period.

Acceptance shall be organized one month after the test run. If any acceptance item fails to meet the required indicators due to reasons attributable to the supplier, the supplier shall be responsible for corrective actions and shall complete them within 60 days.

The final acceptance testing procedure shall be prepared by the supplier and confirmed

by the purchaser. During the acceptance period, the supplier shall submit a written application, and a joint performance acceptance committee consisting of both parties shall be established. Upon successful acceptance, both parties shall sign the performance acceptance documents, marking the completion of project acceptance.

Appendix7: List of Wear Parts and Spare Parts

After the detailed design review of this project is completed, Party B shall provide a list of vulnerable and consumable spare parts, which will be procured separately by Party A (the Owner).

Appendix8: Personnel Dispatch and Training by Both Parties

1 Personnel Deployment by Both Parties

1.1 Scope and Content of Personnel Deployment Services

This project is constructed under an EPC (Engineering, Procurement and Construction) general contracting model. During project execution, the overall service objective of Party B is to provide full-process services within Party B's supply scope, delivering to Party A (the Owner) a plant design that enables effective control of investment, construction schedule, construction quality, smooth commissioning, stable production, and complete environmental protection measures. Party B shall provide lifetime technical consulting services for this project.

1.2 Design Stage

✧ After completing the construction design drawings, Party B shall dispatch design personnel to the site to conduct design clarification.

✧ During on-site construction, design liaison work shall be carried out by Party B's on-site representative, with overall coordination handled by the chief site representative.

✧ Party B shall strictly implement the mutually agreed reasonable design schedule with Party A (the Owner) to ensure construction quality and project progress.

1.3 Equipment Manufacturing Stage

To ensure project quality, construction progress, and smooth commissioning—and to take full responsibility for the quality of supplied equipment—both parties shall dispatch experienced technical personnel to supervise quality and progress during the manufacturing and processing of all equipment within Party B's supply scope.
Before equipment leaves the factory, both parties shall jointly form a product quality inspection team to conduct comprehensive inspection and acceptance at the manufacturer's site. Equipment shall be packaged and shipped only after passing inspection.

1.4 Construction and Installation Stage

During construction and installation, Party B shall dispatch experienced technical and management personnel to the site to provide technical services, construction support, and project management. Party B shall:

• Provide technical assurance, guidance, and supervision for all contracted items according to applicable standards.

• Interpret relevant drawings, technical specifications, and technical issues.

• Participate in inspecting and resolving issues encountered during construction and installation.

For imported equipment, Party B shall arrange foreign technical and management personnel to provide corresponding on-site services.

1.5 Individual Equipment and Integrated Commissioning

Based on the test-run plan, Party B shall dispatch commissioning personnel according to the test items and conduct commissioning in accordance with the operation manual. Party B shall document all commissioning records. During commissioning, Party B has the obligation to brief Party A's (the Owner's) production personnel on relevant information.

Technical service personnel shall be present during individual equipment and integrated system commissioning for all major equipment.

1.6 Commissioning, Trial Production, Acceptance Evaluation, and Normal Operation

During commissioning and trial production, Party B shall assign the project manager and relevant technical personnel to guide the start-up of all units. At the early stage of start-up, Party B's technical personnel shall participate in key production posts, providing timely solutions and corrective measures for production issues.

Party B has the obligation to train and guide the operating personnel of Party A (the Owner).

During acceptance evaluation, Party B shall fully cooperate with Party A (the Owner). After the final project acceptance, Party B shall, upon Party A's request, dispatch technical personnel to assist in production guidance and problem-solving.

If any equipment supplied by Party B experiences issues during the warranty period, Party B shall dispatch relevant technical personnel to the site within 48 hours for repair or replacement and provide necessary technical services.

1.7 Warranty Period

During the warranty period for all equipment (including wear parts), Party B shall dispatch experts to provide technical services for any problems arising during production, based on Party A's requirements.
For quality issues caused by Party B, Party B shall be responsible for rectification and bear the associated responsibilities.

1.8 Customer Service Visits

After project completion, acceptance, and handover to the Owner, Party B shall organize design personnel and relevant personnel of the construction contractor to conduct regular customer visits, understand the operational status of the plant, and promptly address any remaining or newly identified issues.

2 Personnel Training

2.1 Preparation of Training Plan by Party B

To ensure that Party A's (the Owner's) operators are competent in production operation, maintenance, and overhaul during normal production, Party B shall prepare a training plan for Party A. The plan shall include training requirements, schedule, methods, content, and locations.

Prior to construction, during the design stage, Party B shall provide preliminary technical training for electrical and computer maintenance personnel. Chinese documentation shall be provided for PLC systems, drive systems, computer systems, and instrumentation.

2.2 Training Plan and Organizational Measures

Party B shall be responsible for training Party A's personnel in process technology, equipment management, operations, and maintenance to ensure the successful completion of the project.

Party B shall take full responsibility for training effectiveness. Experienced personnel shall be assigned to conduct training, and adequate conditions shall be provided to ensure that, after system handover, trained personnel can independently perform daily management, operations, maintenance, and repair tasks.
Training mainly includes:
• Theoretical training
• Key equipment training
• Operational training

2.3 Theoretical Training

Through lectures delivered by experts and professional engineers, trainees shall be introduced to the basic theory of casing production processes, process design procedures, and relevant plant design knowledge, enabling them to meet the requirements of daily production management.
Theoretical training covers four parts:
• Casing production process and dispatching organization
• Equipment operation for each post
• Electrical automation (including instrumentation)
• Equipment maintenance

2.4 Key Equipment Training

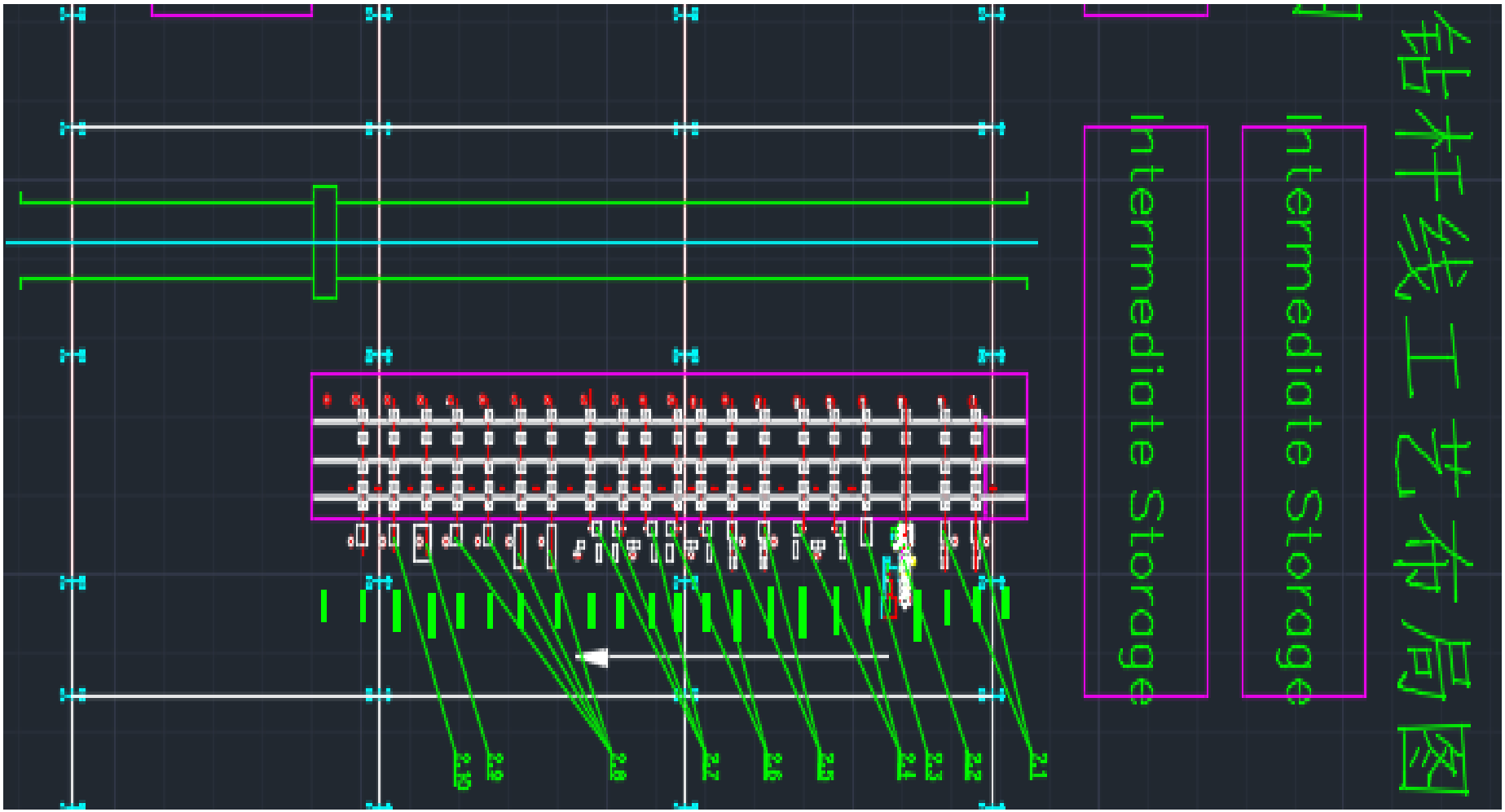
Trainees shall visit major equipment manufacturers to study and understand equipment structure and performance, enabling them to acquire general knowledge of equipment operation, repair, and maintenance.

Appendix9: Project Schedule

After the basic construction of the project undertaken by Party A (the Owner) is completed and the conditions for trial operation of production are met, Party B shall, in accordance with the overall project schedule, prepare a project network schedule corresponding to the detailed design stage, equipment manufacturing stage, construction stage, individual equipment commissioning stage, and no-load integrated commissioning stage.

The project network schedule prepared by Party B shall become effective only after review and approval by Party A (the Owner).

Appendix10: General Layout Drawing



Appendix11: Standards for Design, Manufacturing, and Quality Control

1 Standards for Design, Manufacture and Installation

The design, installation, and construction of this project shall comply with the current national and industry codes, regulations, procedures, and standards. In the absence of applicable national or industry standards, the standards mutually agreed upon by both parties shall apply.

All laws, standards, and specifications referenced in this chapter shall be interpreted according to their latest valid editions. Any omissions in the list of standards shall be governed by the applicable national or industry standards currently in force

Main Chinese standards and specification documents for tubing, casing, and related couplings include (but are not limited to):

序号	标准号	标准名称
	一 设计标准	
1	GB50010-2002	混凝土结构设计规范
2	GB50017-2003	钢结构设计规范
3	GB50016-2006	建筑设计防火规范
4	GB50222-2001	建筑内部装修设计防火规范
5	GB 50187-93	工业企业总平面设计规范
6	GB 50116-98	火灾自动报警系统设计规范
7	YB/T4125-2005	冶金企业火灾自动报警设计规范
8	GB50060-1992	3 ～ 110 kV 高压配电装置设计规范
9	GB50217-94	电力工程电缆设计规范
10	GB50054-1995	低压配电设计规范
11	GB 50057-2000	建筑物防雷设计规范
12	GB 50251-94	输气管道工程设计规范

13	GB50140-2005	建筑灭火器配置设计规范
14	GB 13495-92	消防安全标志
15	GB 15630-1995	消防安全标志设置要求
16	GB6222-2005	工业企业燃气安全规程
17	GB50052-1995	供配电系统设计规范
18	GB50055-1993	通用用电设备配电设计规范
19	GB50019-2003	采暖通风与空气调节设计规范
序号	标准号	标准名称
20	GBZ1-2002	工业企业设计卫生标准
21	GB16297－1996	大气污染物综合排放标准
22	GB50019－2003	采暖通风与空气调节设计规范
23	GB 5083-1999	生产设备安全卫生设计总则
24	GBJ 87-85	工业企业噪声控制设计规范
25	GB50406-2007	钢铁工业环境保护设计规范
26	GB5083-1999	生产设备安全卫生设计总则
27	YBJ52-88	钢铁企业总图运输设计规范
28	YB9081-97	冶金建筑抗震设计规范
29	GB50414-2007	钢铁冶金企业设计防火规范
30	GB 50316-2000	工业金属管道设计规范
31	JGJ81—2002	建筑钢结构焊接技术规程
32	GB/T50068-2001	建筑结构可靠度设计统一标准
33	GB50009-2001	建筑结构荷载规范
34	GB50003-2001	砌体结构设计规范
35	GB50007-2002	建筑地基基础设计规范
36	GB50011-2001	建筑抗震设计规范
37	GB50018-2002	冷弯薄壁型钢结构技术规范
38	GB50021-2001	岩土工程勘察规范

39	GB40503.1-1993	固定式钢直梯
40	GB50051-2002	烟囱工程设计规范
41	1998.版本	中华人民共和国消防法
	二 设备制造标准	
1	GB7932—2003	气动系统通用技术条件
2	GB8923-1988	涂装前钢材表面锈蚀等级和除锈等级
3	GB14711-1993	中小型旋转电机安全通用要求
4	GB/T10069.1～3-1998	旋转电机噪声测定方法及限值
序号	标准号	标准名称
5	GB/T1032-1985	三相异步电动机试验方法
6	GB1971-1980	电机线端标志与旋转方向
7	GB/T4942.1-1985	电动机外壳防护分级
8	GB9616-1999	Y 系列三相异步电动机技术条件
9	JB/T8097-99	泵的振动测量与评价
10	JB/T8098-99	泵的噪声测量与评价
11	GB/T13274-91	一般用途轴流通风机技术条件
12	GB/T13275-91	一般用途离心通风机技术条件
13	JB/T8690-1998	工业通风机 噪声限值
14	JB/T8689-1998	通风机振动检测及其限值
15	GB6067-85	起重机械安全规程
16	GB/T3811-2008	起重机设计规程
17	GB/T5905-1986	起重机试验规范和程序
18	GB/T14405-93	通用桥式起重机
19	GB/T14407-93	通用桥式和门式起重机司机室技术条件
20	GB/T10183-1998	桥式和门式起重机制造及轨道安装公差
21	JB4315-86	起重电控设备

22	GB4628-84	桥式起重机圆柱车轮
23	ZBJ80007.1～3-99	起重机用铸造卷筒
24	GB10051.1～5-88	起重吊钩
25	GB/T12224-1989	钢制阀门一般要求
26	GB/T1047-1995	管子和管路附件的公称通径
27	GB/T1048-1990	管道元件公称压力
28	GB2555-1981	一般用途管道法兰连接尺寸
29	GB/T3181-1995	漆膜颜色标准样本
30	GB / T37400.1-2019	重型机械通用技术条件 产品检验
31	GB / T37400.2-2019	重型机械通用技术条件 火焰切割件
32	GB / T37400.3-2019	重型机械通用技术条件 焊接件
序号	标准号	标准名称
33	GB / T37400.4-2019	重型机械通用技术条件　铸铁件
34	GB / T37400.5-2019	重型机械通用技术条件　有色金属件
35	GB / T37400.6-2019	重型机械通用技术条件　铸钢件
36	GB / T37400.7-2019	重型机械通用技术条件　铸钢件补焊
37	GB / T37400.8-2019	重型机械通用技术条件　锻件
38	GB / T37400.9-2019	重型机械通用技术条件　切削加工件
39	GB / T37400.10-2019	重型机械通用技术条件　装配
40	GB / T37400.11-2019	重型机械通用技术条件　配管
41	GB / T37400.12-2019	重型机械通用技术条件　涂装
42	GB / T37400.13-2019	重型机械通用技术条件　包装
43	GB / T37400.14-2019	重型机械通用技术条件　铸钢件无损探伤
44	GB / T37400.15-2019	重型机械通用技术条件　锻钢件无损探伤
45	GB / T37400.16-2019	重型机械通用技术条件　液压系统
46	GB / T37400.17-2022	重型机械通用技术条件　锻钢件补焊

47	GB / T37400.18-2023	重型机械通用技术条件　开式齿轮传动系统
48	JB/T6996-2007	重型机械液压系统 通用技术条件
49	GB/T7932-2017	气动 对系统及其元件的一般规则和安全要求
50	GB/T4879-1999	防锈包装
51	GB12348-2008	工业企业厂界环境噪声排放标准
52	GB/T10095.1-2022	圆柱齿轮 ISO 齿面公差分级制 第 1 部分：齿面偏差的定义和允许值
53	GB/T10095.2-2023	圆柱齿轮 ISO 齿面公差分级制 第 2 部分：径向综合偏差的定义和允许值
54	GB/T13924-2008	渐开线圆柱齿轮精度 检验细则
55	JB/ZQ4170-2006	焊接设计规范
56	GB986-1988	埋弧焊 焊缝坡口的基本形式和尺寸
57	GB985-1988	气焊、手工电弧焊及气体保护焊 焊缝坡口的基本形式与尺寸
58	GB/T5900.1-2021	机床主轴端部与卡盘连接尺寸 第 1 部分：圆锥连接
序号	标准号	标准名称
59	JB/T6105-2007	数控机床液压泵站 技术条件
60	JB/T6609-1993	机床零件用钢及热处理
61	JB/T8491.1～4-2008	机床零件热处理技术条件
62	GB7233-1987	铸钢件超声探伤及质量评级方法
63	JB/T9218-1999	渗透探伤方法
64	JB/T9217-1999	射线照相探伤方法
65	GB/T15822-1995	磁粉探伤方法
66	GB8923-1988	涂装前钢材表面锈蚀等级和除锈等级
67	GB11345-1989	钢焊缝手工超声波探伤方法和探伤结果等级
68	GB3323-1987	钢熔化焊参接接射线照相和质量分级

69	GB/T2970-1991	中厚钢板超声波检验方法
70	GB/T9061-2006	金属切削机床通用技术条件
71	GB5226.1-2008	机械电气设备 第1部分：通用技术条件
72	GB/T15760-2004	金属切削机床安全防护通用技术条件
73	GB/T43415-2023	重型机械 铸件设计要求
74	API Spec 5B 16 EDITION, DECEM8ER 2017	Threading,Gauging,and Inspection of Casing, Tubing, and Line Pipe Threads
75	API SPEC 5CT 11 EDITION, DECEM8ER 2023	套管和油管
76	APISpec 5L:2018	管线钢管(Line pipe)
77	GB/T 9711-2023	石油天然气工业 管线输送系统用钢管
78	GB/T 9253-2022	石油天然气工业套管、油管和管线管螺纹的加工、测量和检验
	三 施工及验收标准	
1	GB50235-97	工业金属管道工程施工及验收规范
2	GB50221—1995	钢结构工程质量检验评定统一标准
3	GB50252—1994	工业安装工程质量检验评定统一标准
4	YB4147-2006	冶金建筑工程施工质量验收规范
5	YB9237—1992	冶金电气设备安装工程质量检验评定标准
序号	标准号	标准名称
6	JB4730—1994	压力容器无损检测
7	GB50204—2002	混凝土结构工程施工质量验收规范
8	GB50205—2001	钢结构工程施工质量验收规范
9	GB50209—2002	建筑地面工程施工质量验收规范

10	GB50210—2001	建筑装修工程质量验收规范
11	GB50231—1998	机械设备安装工程施工及验收通用规范
12	GB50243—2002	通风与空调工程施工质量验收规范
13	GB50254-259-1996	电气装置安装工程施工及验收规范
14	GB50202－2002	建筑地基基础工程施工质量验收规范
15	GB50236—1998	现场设备、工业管道焊接工程施工及验收规范
16	YBJ217—1989	冶金电气设备工程施工及验收规范
17	GB50259—1996	电气装置安装工程电气照明装置施工及验收规范
18	GB50093-2002	工业自动化仪表工程施工及验收规范
19	GBJ131—1990	工业自动化仪表工程质量检验评定标准
20	JGJ94-94	建筑桩基技术规范
21	JGJ79-2002	建筑地基处理技术规范
22	JGJ81-2002	建筑钢结构焊接技术规程
23	GB50204-2002	混凝土结构工程施工质量验收规范
24	GB50203-2002	砌体工程施工质量验收规范
25	GB50205-2001	钢结构工程施工质量验收规范
26	GB50202-2002	建筑地基基础工程施工质量验收规范
27	JGJ82-2002	钢结构高强度螺栓连接的设计、施工及验收规程
28	YB99254-95	钢结构制作安装施工规程
29	YB/T9256-96	钢结构、管道涂装技术规程
30	CECS28:90	钢管混凝土结构设计与施工规程
31	DLGJ154-2000	电缆防火措施设计和施工验收标准
32	[1999]154	压力容器安全技术监察规程
33	GB40503.3-1993	固定式工业防护栏杆安全技术条件
序号	标准号	标准名称
34	GB40503.4-1993	固定式工业钢平台安全技术条件
35	GB50207-2002	屋面工程质量验收规范

36	GB50210-2001	建筑装饰工程施工及验收规范
37	JGJ59—99	建筑施工安全检验标准
38	JGJ81-2002	建筑钢结构焊接规程
39	JGJ82-91	钢结构高强度螺栓连接设计、施工及验收规范
40	JGJ104-97	建筑工程冬季施工规程
41	JGJ/T114-97	钢筋焊接网混凝土结构技术规程
42	GB50278－98	起重设备安装工程施工及验收规范
43	GBJ97-87	水泥混凝土路面施工及验收规范
44	JTJ013－95	公路路基设计规范
45	JTJ033－95	公路路基施工技术规范
46	JTJ034－2000	公路路面基层施工技术规范
47	GB50166-1992	火灾自动报警系统施工及验收规范
48	GB50243-2002	通风与空调工程施工及验收规范
49	GB50268-97	给水排水管道工程施工及验收规范
50	YBJ217-89	冶金电气设备安装工程施工及验收规范
51	YBJ224-91	块体基础大体积混凝土施工技术规程

2 General Requirements for Equipment and Process Provided by Party B

2.1 Product Requirements Provided by Party B

Party B shall ensure that all supplied products meet the following requirements:

✧ Comply with the national industrial policies for oil and casing processing.

✧ Adopt advanced, mature, and reliable process technologies and equipment widely applied in China.

✧ Select appropriate process routes to achieve optimal economic efficiency.

✧ Provide a layout that is reasonable and compact to minimize land use and reduce investment.

2.2 Requirements for Control System and Control Room

✧ The automation level shall be improved and manual operations minimized. To achieve this objective, reliable instruments and control equipment matching the system requirements must be selected. All equipment selection shall comply with Party B's unified planning.

✧ Automation programs shall be designed reasonably to ensure safe and reliable operation of all sensors and control devices.

✧ The dedusting system fans shall be precisely controlled through an automated system, ensuring the reliability of all sensing and control elements.

✧ All Level-1 and Level-2 systems shall adopt a fully redundant design. Interfaces between Level-2 and Level-3 networks shall be designed according to the requirements of Party A (the Owner).

✧ High-efficiency and energy-saving equipment shall be adopted for this project. Equipment and products must meet China's Level-1 energy efficiency standard, particularly transformers, motors, pumps, air conditioners, lighting fixtures, etc.

2.3 Equipment Quality Control and Requirements

All selected equipment brands shall have proven performance, stable operation, and successful application records in domestic casing-processing production lines.

2.3.1 Warranty Period

Except for reused equipment, all equipment (including wear parts) shall have a warranty period of **no less than 12 months**, starting from the date when installation and commissioning are accepted as qualified. If the manufacturer provides a warranty longer than 12 months, the manufacturer's warranty shall apply.

2.3.2 Warranty Responsibilities

During the warranty period, for any quality issues arising from design, equipment, construction, installation, or commissioning, Party B shall resolve them promptly and free of charge, and shall assume all direct economic losses incurred.

2.3.3 Reused Equipment

Party A (the Owner) shall provide complete documentation of all reused equipment. Party B shall be responsible for the foundation and utility design for the reused equipment, ensuring full integration with the new production line and promoting stable

operation.

2.3.4 Color Coding, Signs, and Markings

Colors, identification markings, and signage for buildings, pipelines, vessels, equipment, and facilities in this project shall comply with the project's color-coding standards.

3 Equipment Supervision and Inspection

3.1 Manufacturing Supervision

To ensure the quality and performance of the equipment, Party B shall dispatch experienced technical personnel and invite Party A (the Owner) to jointly supervise and inspect the supplied equipment. Party B shall assign specialists to supervise the manufacturing process of key equipment.

3.2 Supervision at Manufacturing Site

During manufacturing of key equipment, Party B shall organize and Party A shall dispatch personnel to the manufacturer's site to supervise manufacturing quality, ensure compliance with the quality system, monitor processes, raw materials, and purchased components, and strictly control equipment quality.
After completion of key equipment, the equipment shall undergo quality acceptance. Any issues found shall be corrected by the manufacturer under Party B's responsibility until fully qualified.

3.3 Non-standard Equipment Manufactured Onsite

For non-standard equipment fabricated on-site, Party B shall organize and Party A shall dispatch technical personnel to confirm fabrication methods, technical standards, inspection procedures, and processing equipment. Materials shall be verified when necessary. Semi-finished and finished products shall undergo strict inspection, and a scientific quality-management system shall be implemented.

3.4 Confirmation for Packing of Key Equipment

Key and special equipment may only be packed after confirmation by Party B's technical personnel and under their supervision.

3.5 Inspection upon Delivery

Upon equipment arrival, both parties shall jointly conduct unpacking inspection. After confirmation, the equipment shall be signed off and kept by Party B. All packing documentation shall be collected, organized, and compiled by Party B. Copies shall be provided, and originals shall be included in the final handover documents submitted to Party A (the Owner).

3.6 Transportation Damage Responsibility

Any damage, loss, or shortage occurring during transportation shall be borne by Party B.

3.7 Regulatory Approvals for Installation

After arrival and before installation, Party B shall assist Party A (the Owner) in handling inspections or approvals required by government authorities (e.g., hoisting equipment, pressure vessels, radio equipment). Related fees shall be borne by Party A.

4 Equipment Inspection

4.1 Nature Inspection

Inspection performed by inspectors is a verification activity and does not relieve the manufacturer of its obligations and responsibilities for equipment quality.

4.2 Factory Test Runs for Major Equipment

Factory test runs of important equipment shall be organized by Party B, with Party A, the supervising unit, and installation unit invited to participate.

4.3 Joint Factory Inspection

For equipment requiring joint factory inspection, Party B shall organize and issue written notice to Party A (the Owner) indicating inspection items and schedule. Party A shall dispatch personnel on time. Both parties shall conduct the inspection at the manufacturer’s site and sign the inspection report.

4.4 Documentation

Party B shall provide quality certificates and inspection/test reports for all supplied equipment, at Party B’s cost.

4.5 On-site Inspection Does Not Reduce Party B’s Responsibility

Any inspection conducted by Party A at the manufacturer’s site shall not substitute for on-site inspection after arrival and shall not reduce Party B’s responsibilities.

5 Equipment Painting, Packaging, and Transportation

5.1 Domestic Equipment Transportation

All domestic complete-set equipment transportation shall be arranged by Party B. All transportation charges, including secondary loading/unloading and insurance, shall be borne by Party B.

5.2 Packaging Requirements

Equipment packaging must be strong, reliable, and suitable for transportation, ensuring no damage during multiple handling, loading/unloading, and storage. Protective measures such as moisture-proof, rain-proof, rust-proof, shock-proof, anti-breakage, anti-deformation, and anti-corrosion shall be applied as required.

Packaging shall meet the following:

(1) Load capacity of packaging boxes for mechanical equipment (including motors) ≥ 2 t/m²;
(2) Load capacity for instrument/electrical equipment packaging ≥ 1 t/m²;
(3) Outer packaging shall use wood as the primary material.

Packaging shall comply with **GB/T 13384-2008 – General Technical Requirements for Packaging of Electromechanical Products**.

5.3 Marking Requirements

All loose items in the same box/bundle shall be clearly marked with the corresponding sequence numbers from the packing list and assembly drawings.
For equipment requiring multiple boxes, each box shall be numbered (e.g., “Box 1/5”).
Accessories and special tools shall be placed inside Box No. 1 of that equipment.

5.4 External Markings on Packaging Boxes

Two adjacent sides of each packaging box shall display:

– Shipper
– Consignee
– Contract No.

– Destination station/port
– Equipment name, area, box No.
– Gross/net weight
– Center of gravity / lifting points (for >5 t)
– Dimensions (L×W×H, cm)
– Handling marks: “Fragile”, “Keep Dry”, “This Side Up” etc.

5.5 Loose/Bundled Items

Loose or bundled items shall carry metal labels with markings identical to Section 5.4.

5.6 Reused Equipment Transportation

Transportation of reused equipment shall be arranged by Party A. Unloading, secondary handling, and storage at site shall also be handled by Party A.

5.7 Anti-corrosion and Painting

Anti-corrosion and painting shall comply with the color-coding standards required by Party A.

6 Equipment Storage

Equipment and materials supplied by Party B shall be stored properly by Party B, with Party A assisting in providing necessary storage space.

6.1 Electrical, instrument, and high-value mechanical equipment shall be stored in warehouses built or rented by Party B.

6.2 Ordinary mechanical equipment shall preferably be stored directly in the designated areas at the construction site to reduce secondary handling.

6.3 All equipment must be clearly labeled and stored separately under “Qualified”, “Pending Inspection”, and “Non-qualified” categories.

6.4 All costs related to storage, maintenance, and secondary handling of equipment under this contract shall be borne by Party B.

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7 On-Site Acceptance and Management

7.1 Within ten days prior to installation, Party B shall organize both parties to conduct

unpacking inspection and sign the certificate. Party A shall sign only for arrival time and appearance condition; responsibility for missing or defective items remains with Party B.

7.2 During acceptance, manufacturer's quality certificates (especially for special equipment), drawings, manuals, shipping lists, packing lists, weigh bills, and transport documents shall be verified first.

7.3 On-site acceptance mainly covers quantity and appearance inspection. Internal quality and performance inspection shall be conducted during installation and commissioning jointly by the installation contractor, inspection personnel, and relevant authorities.

7.4 Appearance inspection includes checking for packaging damage, deformation, breakage, contamination, corrosion, moisture damage, and dimensional defects.

7.5 If any shortage, damage, or non-conformity is found during unpacking, Party B shall promptly repair, replace, or replenish the equipment to avoid delaying project progress.

7.6 After handover prior to installation, Party A shall be responsible for storage of reused equipment.

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8 Equipment Documentation

When special arrangements for documentation apply, such arrangements shall prevail. If no special agreement exists, the following applies:

– Commercial documents such as shipping lists, packing lists, and weight lists shall be kept by Party B.

– Technical documentation such as certificates, drawings, manuals, lubrication instructions, and spare-parts lists shall be stored and recorded by Party B.

Technical documentation shall include:

– General assembly drawings
– Foundation and load drawings
– Drawings of wear parts
– Operating and maintenance manuals
– Control requirements
– Lubrication manuals
– Lists of wear parts and spare parts

All documentation shall be provided in **1 electronic copy** and **3 hard copies**.

Party B shall ensure proper custody of all documentation until final handover, after which all documents shall be delivered completely to Party A (the Owner).

Appendix12: List of Major Subcontractors and Suppliers

1 Requirements for Subcontractors and Suppliers

To ensure reliable operation of the upgraded equipment, the grade and quality level of newly purchased equipment shall not be lower than that of the suppliers listed in the table below.

The recommended suppliers are enterprises with long-term cooperation and good reputation with Party B and Party A (the Owner). They are provided for reference during bidding only and shall not be considered as designated suppliers. The final shortlist of approved suppliers and materials shall be jointly determined by Party A (the Owner) and Party B.

2 List of Major Subcontractors and Suppliers

序号	类别	供货商品牌	备注
	一、机械件		
1.1	滚动导轨	Rexroth、Schneeberger、Hiwin、南京工艺、汉江机床	
1.2	滚珠丝杆	Shuton、Ipirange、Hiwin、南京工艺、汉江机床、KSK、THK、山东博特精工	
1.3	齿轮减速机	SEW、宁波东力、江苏国茂、上虞东星、万鑫精工、欧邦、博能传动、江苏金象	
1.4	精密行星减速机	Newstart、Koldban、青岛盈可润、Apex、Faston、钛科玛格、太弗传动、鋒樺傳動	
1.5	联轴器	KTR、R+W、江阴南方、柯瑞艾特、武汉正通、乐清大昌、无锡万向、河北冀皓、广东光之大、乐清联轴器	
1.6	万向节联轴器	江阴南方、乐清联轴器、上海茂德、泰尔重工、武汉博威	
1.7	链条	山东聚鑫、浙江恒久、诸暨链条、诸暨特种	
1.8	皮带	Gates、Optibelt、济南安耐、宁波伏龙、MITSUBOSHI	
1.9	拖链	Igus、沧州艾森特、武汉南星、上海江川	
1.10	主轴及进给轴承	SKF、Schaeffler、TIMKEN、NSK、NADELLA	

1.11	其它滚动轴承	哈轴、瓦轴、洛轴、McGILL、NTN	
1.12	TOOL TURRET 刀塔	DSrobot、Sauter、台湾六鑫、Duplomatic、烟台环球	
1.13	液压卡盘	DSrobot、台湾佳贺 AUTOGRIP、韩国三千里 Samchully、台湾千岛 Chandox	
1.14	气动卡盘	ROHM、 Autoblok SMW、烟台众合	
1.15	排屑器	烟台博森、烟台重阳、烟台杞阳	
1.16	普通或变频电机	皖南电机、宁波东力、浙江德东、兰州电机、大连电机、厦门精研、上海南洋	
1.17	制动器	焦作中海重工、焦作金箍	
1.18	称重传感器、称重模块	METTLER TOLEDO、常州赛德	
1.19	油漆喷印机	上海竹阳、Marktec	
1.20	气动打标机	武汉嘉铭、新光数控、Telesis	
	二、液压件		
2.1	液压缸	Parker、扬州永发、扬州永恒、扬州永祥、济南浩阳、济南鲁鑫、扬州洪力	
2.2	液压泵	Rexroth、Atos、北京华德、Justmark、启动高压、Eaton、宁波恒力、江苏欧盛	
2.3	液压马达	Danfoss、Northman、Eaton、Rexroth、意宁液压、贵州力源、Vickers、宁波旋球、RONZIO	
2.4	电机泵组	Justmark、朝田	
2.5	常规液压阀	Atos、北京华德、Rexroth	
2.6	比例阀	Atos、Parker、Rexroth、Vickers	
2.7	电子/压力/温度开关、温度传感器	Atos、Rexroth、Hydac、Buehler、Barksdale、DYNISCO、朝晖、和利时、川仪、蓝德	
2.8	过滤器	无锡海卓力克、Leemin、常州威肯，中船 707、泰克	
2.9	螺杆泵	黄山工业泵、天津工业泵、海林柯	

2.10	蓄能器	宁波奉化江口精仪、浙江奥莱尔、Buccma、HYDAC、BSD	
2.11	流量开关	Banna、宝德、易福门、Arksdale	
2.12	压力传感器	DNYSICO、森纳士、Atos、Rexroth、Hydac	
2.13	密封圈	Parker、Hallite、Carco、广研院密封所、广东东晟密封	
2.14	高压胶管	济南天贶、济南四方	
2.15	液压泵站	DSrobot、济南英和液压、青岛海斯特、济南浩阳	
	三、气动件		
3.1	气缸、电磁阀	AIRTAC、SMC、FESTO、烟台未来、济南杰菲特	
3.2	通用气动材料 General Pneumatic Material	AIRTAC、SMC、FESTO、烟台未来、济南杰菲特	
	四、电气件		
4.1	接近传感器、光电传感器	Balluff、Turck、Sick、Omron、Euchner、P+F、Banner	
4.2	位置编码器、位移传感器	Omron、Siemens、Heidenhain、fanuc、P+F、光洋、NOVA	
4.3	CNC CONTROL PACKAGE CNC 数控系统	Siemens、fanuc	
4.4	Spindle Motor 主轴电机 & Spindle Drive 主轴驱动	CTB、Siemens、fanuc	
4.5	Servo Motor 伺服电机 & Servo Drive 伺服驱动	Siemens、fanuc、Inovance	
4.6	PLC	Siemens、fanuc、Inovance	

4.7	变频器	Siemens、Inovance	
4.8	光栅尺	Heidenhain、fagor	
4.9	常规低压电气供应商 General Electrical Suppliers	Schneider、Siemens、ABB	
	五、润滑件		
5.1	润滑泵	BijurDelimon、浙江流遍、红鸟、启东润滑、启东江海	
5.2	润滑元器件	BijurDelimon、浙江流遍、红鸟、启东润滑、启东江海	
	六、冷却系统		
6.1	水泵	南方泵业、云海泵业、双轮集团	
6.2	CONTROL CABINET COOLING 控制柜冷却装置	同飞股份、雷博	
	冷却液过滤装置	烟台杞阳、烟台博森	
	七、机器人		
7.1	六轴工业机械臂	DSrobot、ABB、Kawasaki、Kuka、Fanuc、Yaskawa、埃斯顿、埃夫特	
7.2	工业视觉	Hikvision、Mech-Mind、Cognex、Keyence、Banner	
7.3	末端夹具	DSrobot、Schunk、SMC、JRT	
	八、网信设备		
8.1	交换机	Siemens、欧柏、Hikvision、MOXA、华为	

8.2	PROFINET 接头及网线	Siemens、三格电子、深圳钡铼	
8.3	工控机	研华、联想、Dell	
8.4	触控一体机	Siemens、研华、信捷、昆仑通、威纶通	