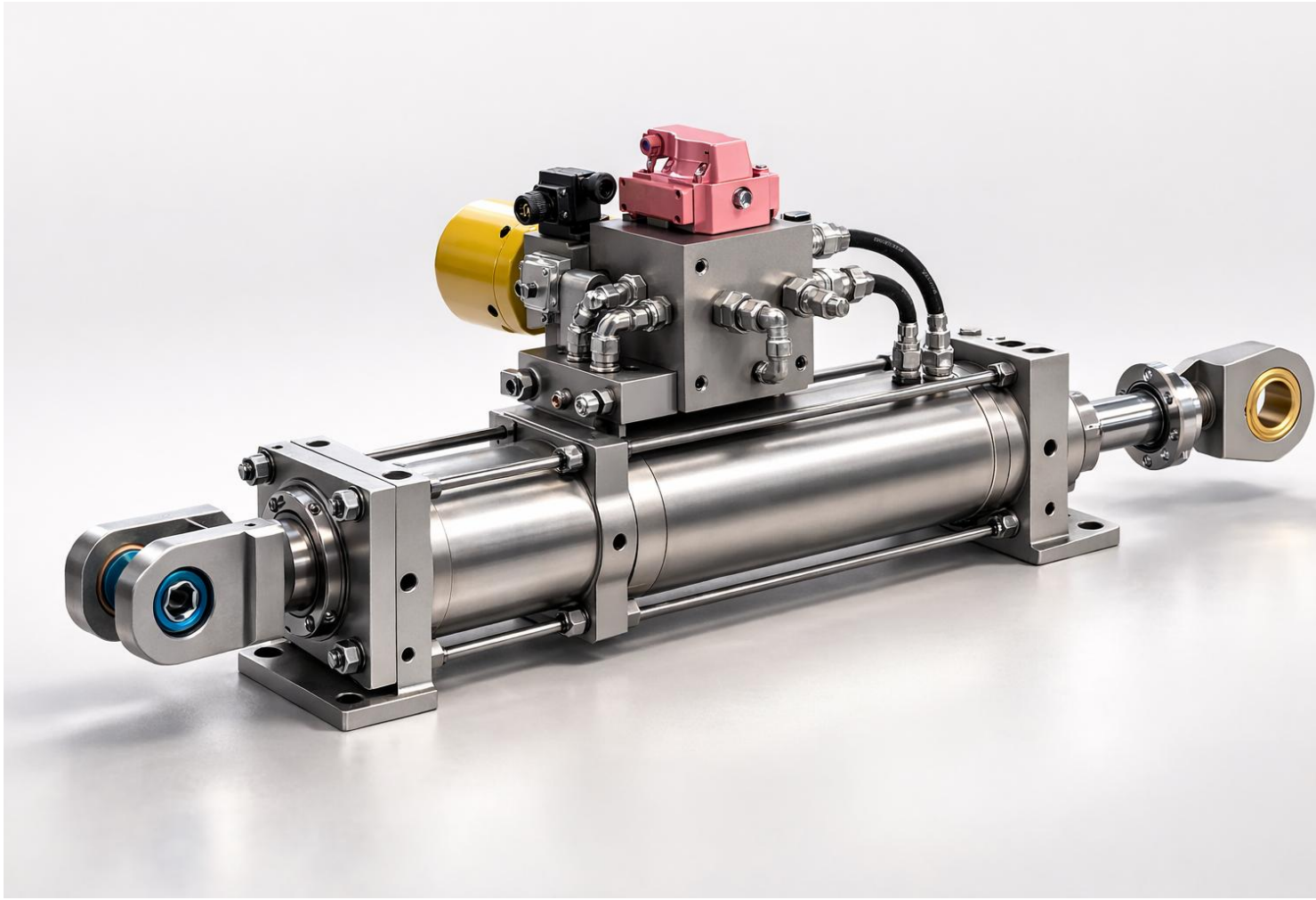
XSA SERIES

# Hydraulic Servo Actuator Selection Guide

## Low frequency · high frequency · customized dynamic loading

HYDRAULIC SERVO ACTUATORS



For structural loading, fatigue testing, vibration simulation and high-performance motion control

**Chengdu Xinhai Fluid Control Equipment Co., Ltd.**

www.xinhaifluid.com

# 01 Product positioning and series division

The XSA series are hydraulic servo actuators for closed-loop force, displacement and speed control. The products are divided into LF low-frequency series and HF high-frequency series according to dynamic tasks. Project-based configuration is used to combine rated force, stroke, speed, feedback, valve group and installation interface.

| series | Main tasks | Job characteristics | scheme partition |
|---|---|---|---|
| XSA-LF | Static, quasi-static, low-frequency cycle, long-stroke loading | Large stroke, large thrust, moderate speed | Below 20 Hz |
| XSA-HF | Fatigue, resonance search, vibration simulation, high-speed motion reproduction | Small/medium stroke, high flow, low friction, high bandwidth | 20-100 Hz project design |

## Application areas

- Auto parts, suspension, axles, bushings and road spectrum reproduction.
- Loading of aerospace structures, rudder surfaces, landing gear and airborne mechanisms.
- Material and component fatigue, structural durability, static strength and cycle life tests.
- Performance testing of rail transit, engineering machinery, metallurgical equipment and hydraulic components.
- Single-axis or multi-axis coordinated loading, force/displacement hybrid control and simulation platform.

**Selection instructions: Frequency is not an independent parameter. The frequency ranges in the catalog must be used in conjunction with amplitude, load, oil source flow, valve bandwidth and mounting stiffness.**

# 02 System composition and control chain

| module | Main components | Selection effect |
|---|---|---|
| hydraulic actuator | Cylinder barrel, piston rod, low friction bearings and seals | Output force, stroke, speed and dynamic stiffness |
| Valve control components | Servo valve, valve block, accumulator, unloading/safety valve | Determine flow capabilities and dynamic response |
| Measurement components | LVDT/magnetostrictive displacement, load sensor, pressure sensor | Form a closed loop of position, force and pressure |
| Power components | Hydraulic pump station, filtration, cooling, energy storage and pipelines | Provides pressure, peak flow and fluid quality |
| control components | Real-time controllers, drives, data acquisition and protection interlocks | Waveform generation, closed-loop control, monitoring and reporting |

**The dynamic performance of the whole machine is determined by the actuator, servo valve, oil source, pipeline, controller, test piece and reaction frame. The system frequency cannot be estimated using only the rated parameters of the cylinder.**

# 03 Four core selection quantities

| parameter | definition | must be stated at the same time |
|---|---|---|
| Rated force F | Continuous push/pull force under specified pressure differential and temperature conditions | Direction, static/dynamic, peak duration, safety factor |
| Effective itinerary S | The total displacement range allowed | Center position, offset, buffer zone, installation length |
| Peak speed v | Maximum instantaneous speed in the waveform | Continuous duration, direction, valve pressure drop and flow rate |
| frequency f | Repetition frequency of periodic motion | Waveform, amplitude, load, control error and number of cycles |

## Quick calculation of sinusoidal motion

**If the displacement $x=A\cdot\sin(2\pi ft)$, then the peak velocity $v_p=2\pi fA$ and the peak acceleration $a_p=(2\pi f)^2A$. Peak flow $Q_p=A_e\cdot v_p$ ; when $A_e$ is expressed in $m^2$ and $v_p$ is expressed in m/s, $Q_p=60000A_ev_p$ (L/min). The single rod structure is calculated according to the effective area of the rodless cavity and the rod cavity respectively. The theoretical hydraulic pressure is calculated based on the pressure of the two chambers and the effective area. The actual available force is deducted from friction, back pressure, valve pressure drop and inertial force.**

| Example (sine) | Amplitude A | frequency f | peak speed | peak acceleration |
|---|---|---|---|---|
| Long travel low frequency | 50 mm | 2 Hz | 0.63 m/s | 7.9 m/s² |
| Mid-trip updates | 10 mm | 20 Hz | 1.26 m/s | 158 m/s² |
| small amplitude high frequency | 1 mm | 100 Hz | 0.63 m/s | 395 m/s² |

**The above calculation example only illustrates the kinematic relationship and does not mean that any model can achieve this working condition. The peak acceleration is proportional to the amplitude and proportional to the square of the frequency; the actual capability must be confirmed by combining the moving mass, load, valve, oil source and control error.**

# 04 XSA-LF low frequency servo actuator

The LF series is designed for static to low-frequency cyclic loading, with priority covering larger thrust, longer strokes and continuous endurance tasks. The structure can be in the form of single or double rods, equipped with displacement sensors, load sensors and proximal valve blocks.

| project | Solution configuration entry |
|---|---|
| frequency partition | Below 20 Hz; specific indicators are confirmed according to amplitude, load, moving mass and oil supply conditions |
| Force level entrance | 10 / 25 / 50 / 100 / 250 / 500 / 1000 kN; push/pull force and pressure basis are calculated according to the project |
| Entrance to the total trip | 50 / 100 / 150 / 250 / 500 mm; special stroke customization |
| Fuel supply conditions | 21 / 28 MPa system is optional; the allowable pressure and available force of the actuator are as per the confirmation diagram and technical agreement |
| Structural form | Single rod/double rod; flange, clevis, ball hinge or base mounting |
| feedback configuration | Built-in displacement sensor; load sensor external or coaxially integrated |
| Applicable direction | Static strength, quasi-static loading, low-cycle fatigue, structural durability, long-stroke motion simulation |

## Design focus

- The large stroke working condition calculates the rod stability, guide span, sealing speed and end buffer.
- Unbalanced loads and lateral forces are borne by external guides, ball hinges or special supports to prevent the piston rod from bearing bending moments.
- Continuous cycle tasks simultaneously calculate oil temperature, filtration capacity, cooling capacity and seal life.
- For large flow conditions, the proximal valve block is preferred and the high-pressure hose is shortened to reduce liquid column compression and pipeline losses.

# 05 XSA-LF project selection matrix

| Plan code | Force level entrance kN | Total stroke entrance mm | Combination status | Typical objects |
|---|---|---|---|---|
| XSA-LF10 | 10 | 50 / 100 / 150 | Project configuration | Structural parts, valve parts, small mechanisms |
| XSA-LF25 | 25 | 50 / 100 / 150 / 250 | Project configuration | Component fatigue, light structural loading |
| XSA-LF50 | 50 | 100 / 150 / 250 | Project configuration | Auto parts, structural durability |
| XSA-LF100 | 100 | 100 / 150 / 250 / 500 | Project configuration | Axles, suspensions, engineering components |
| XSA-LF250 | 250 | 100 / 250 / 500 | Project configuration | Heavy components, structural loading |
| XSA-LF500 | 500 | 100 / 250 / 500 | Enhance configuration | Large structures, static strength loading |
| XSA-LF1000 | 1000 | 100 / 250 / 500 | Enhance configuration | Large structures and high load testing |

## Combination rules

- The speeds listed in the table are program entries and do not mean that all rated force/stroke combinations can be achieved at the same time.
- The dynamic pulling force is calibrated based on oil return back pressure, friction, valve pressure drop and inertial force; the peak force shall not replace the continuous rated force.
- When using a single rod structure, the thrust, pulling force and flow rate of the two chambers are different; when two-way symmetrical performance is required, a double rod structure is used.
- Long strokes and high compression loads require piston rod stability and installation hinge point verification.

# 06 XSA-HF high frequency servo actuator

The HF series is targeted at high-cycle fatigue, vibration, resonance search and high-speed motion reproduction. The solution is based on the symmetrical structure of double-output rods, low-friction guide, built-in displacement feedback, proximal servo valve and short oil circuit; when the lateral load is high, a hydrostatic support structure can be used.

| project | Solution configuration entry |
| --- | --- |
| frequency partition | 20-100 Hz project design; frequency must be defined in groups with amplitude, load, moving mass, valve and error |
| Force level entrance | 5 / 10 / 25 / 50 / 100 / 250 kN; available dynamic forces calculated per project |
| Entrance to the total trip | 10 / 20 / 50 / 100 / 150 mm |
| Fuel supply conditions | 21 / 28 MPa system is optional; the allowable pressure and available force of the actuator are as per the confirmation diagram and technical agreement |
| Structural form | Double rod symmetrical structure; low friction or static pressure support solution |
| Valve control configuration | Single, dual or three-stage servo valve; proximal valve block and accumulator |
| feedback configuration | High response displacement sensor, fatigue grade load sensor, dual chamber pressure measurement |
| Applicable direction | High cycle fatigue, modal excitation, vibration simulation, road spectrum and load spectrum reproduction |

## high frequency boundary

- High-frequency indicators must be written as "frequency + amplitude + load + waveform + control error".
- High frequency and large amplitude are first limited by peak speed, valve flow, hydraulic power and liquid column resonance.
- The natural frequencies of the test piece, fixture and reaction frame should avoid the test bandwidth. The installation gap will directly reduce the control quality.
- Continuous high-frequency operation requires adequate cooling, filtration and oil return back pressure management.

# 07 XSA-HF project selection matrix

| Plan code | Force level entrance kN | Total stroke entrance mm | Combination status | Typical objects |
|---|---|---|---|---|
| XSA-HF05 | 5 | 10 / 20 / 50 | Project configuration | Materials, small parts, modal excitation |
| XSA-HF10 | 10 | 10 / 20 / 50 / 100 | Project configuration | Bushings, connections, lightweight components |
| XSA-HF25 | 25 | 20 / 50 / 100 | Project configuration | Suspension parts, structural fatigue |
| XSA-HF50 | 50 | 20 / 50 / 100 | Project configuration | Automotive parts, aerospace structures |
| XSA-HF100 | 100 | 20 / 50 / 100 / 150 | Enhance configuration | Heavy-duty components and durable construction |
| XSA-HF250 | 250 | 20 / 50 / 100 | Enhance configuration | High load dynamic and fatigue testing |

## High frequency solution classification

| configuration level | Structure and Valve Control | Applicable tasks |
|---|---|---|
| HF-S | Low friction double rod + single servo valve | General high cycle fatigue and dynamic loading |
| HF-D | Low friction double rod + double valve/high flow valve block | Higher speed or larger flow rate |
| HF-HB | Hydrostatic support + proximal valve block + accumulator | Continuous high speed, side load or high fidelity waveforms |

**The target operating frequency band of the HF series is 20 ~ 100 Hz. Contract performance is defined in groups of frequency, amplitude, load, moving mass, valve configuration, oil source conditions and control error; above 100 Hz a dedicated high frequency scheme is used.**

# 08 Structure, installation and interface

| Options | code | illustrate |
|---|---|---|
| single shot | SR | Different sliding areas, suitable for universal loading and compact installation |
| double rod | DR | The effective areas of the two cavities are symmetrical and suitable for two-way dynamic control. |
| low friction guide | LR | Suitable for general dynamic and fatigue tasks |
| static pressure bearing | HB | Suitable for high speed, continuous reciprocation and high side loads |
| Front/rear flange | F1/F2 | Rigid installation, coaxiality must be ensured |
| Ball hinge/earring | SP/CV | Release small angle installation errors and reduce lateral forces |
| Base/trunnion | FB/TR | Suitable for structural test stands and swing installations |

## Installation principles

- The actuator axis, load sensor and specimen force line remain coaxial.
- Stiffness, clearances and natural frequencies of reaction frames, clamps and connections are incorporated into the system design.
- The hose should have room for movement and be reliably supported. It is prohibited to allow the oil port to bear the weight and bending moment of the pipeline.
- The piston rod does not serve as an external guide; an independent guide is provided when lateral movement occurs.
- A control margin is retained at both ends of the stroke, and the test waveform must not hit the mechanical end position for a long time.

## Interface information

**The project confirmation drawing provides installation dimensions, rod end thread/flange, oil port, valve block direction, sensor interface, zero position and effective stroke. The overall dimensions of customized products are subject to the project confirmation drawing.**

# 09 Feedback, servo valves and safety components

| components | Basic configuration | Matching direction |
|---|---|---|
| Displacement feedback | Built-in LVDT or magnetostrictive sensor | Dual channels, special range, high temperature/explosion-proof |
| force feedback | Fatigue Grade Load Cell | Higher precision, overload protection, coaxial integration |
| pressure measurement | A/B cavity pressure measuring port | Dynamic pressure sensor, differential pressure calculation |
| servo valve | Choose by traffic and bandwidth | Single valve, double valve, three-stage valve, digital interface |
| valve block | Proximally integrated oil supply, return and pressure measurement | Energy storage, overflow, flushing, bypass |
| Security protection | Hardware emergency stop, unloading and independent overtravel protection | Controller soft limit, mechanical buffer |

## Valve flow accounting

First calculate the peak speed and peak flow of the actuator based on the waveform, and then select the rated flow based on the actual pressure difference across the valve. High-frequency tasks also require checking the valve's amplitude-frequency/phase-frequency characteristics, valve core stroke, oil temperature changes and oil return back pressure.

- The servo valve should be as close as possible to the actuator to reduce the volume of the compressed oil column.
- When the peak flow is compensated by the proximal accumulator, the average flow rate and heat balance of the oil source still need to be accounted for.
- The sensor range should not only cover the peak value, but also ensure the effective resolution of the working range.
- Safety protection is independent of the host computer software and adopts hardware emergency stop, unloading and stroke protection.

# 10 Hydraulic power and oil requirements

| project | Selection requirements |
|---|---|
| Oil supply pressure | Determined according to rated force, valve pressure drop and pipeline loss; commonly used 21/28 MPa |
| flow | Simultaneously calculate average flow, peak flow and multi-channel simultaneous coefficients |
| filter | High-pressure filtration is set upstream of the servo valve; cleanliness is implemented according to the highest requirements in the valve and system |
| temperature | Oil temperature stability directly affects viscosity, leakage, friction and control gain; configure cooling/heating |
| Store energy | Used for peak flow, pressure stabilization and pulsation suppression, not a substitute for safe pressure relief |
| Oil return | Control back pressure, avoid cavitation and ensure smooth oil return to valves and actuators |
| pipeline | Short, straight, and high stiffness; symmetrical arrangement and proximal valve block are preferred for high-frequency channels |

## Debugging sequence

**1. Complete pipeline flushing, filter inspection and oil cleanliness confirmation.**

**2. Exhaust low pressure and verify the displacement, force, pressure and limit signal direction.**

**3. Low-gain jog to confirm movement direction, friction, leakage and mechanical interference.**

**4. Increase the pressure, speed and control gain step by step, first without load and then with load.**

**5. Use project waveforms to verify tracking error, phase, temperature rise, peak pressure, and protection functions.**

# 11 Model code and ordering instructions

### Model example: XSA-HF50-DR-S050-HB-DV-LC50-F1

| Field | Example | meaning |
|---|---|---|
| series | LF / HF | low frequency/high frequency |
| force level | 50 | 50 kN scheme force level; actual push/pull force is determined by pressure and effective area |
| Rod type | SR / DR | Single Output Rod/Double Output Rod |
| total trip | S050 | The total effective stroke is 50 mm, that is, the center position is ±25 mm |
| support | LR / HB | Low friction / hydrostatic bearing |
| valve control | SV / DV | Single servo valve / double servo valve |
| force sensor | LC50 | 50 kN range load sensor; range must not be lower than the protocol peak force |
| Install | F1 / F2 / SP / CV / FB / TR | Front flange, rear flange, ball hinge, clevis, base or trunnion |

## Parameters confirmed with the project

- Rated/peak thrust and pull forces, allowable duration, stroke and zero position.
- Target waveform, frequency, amplitude, speed, number of cycles and allowable control error.
- Supply and return pressure, peak/average flow, oil temperature and cleanliness.
- Rod end, cylinder mounting, valve block orientation, sensor electrical interface and cable length.
- Ambient temperature, anti-corrosion, explosion-proof, protection level and delivery test items.

# 12 Customer selection data sheet

| project | Customer fills in |
|---|---|
| Application/test piece | _____ |
| control mode | □Force □Displacement □Speed □Pressure □Mixing control |
| waveform | □Sine/Triangle: Frequency____ □Square wave: rise time____, duty cycle____ □Random spectrum: frequency band____, PSD/RMS____ □Time domain: sampling rate____, peak value____, duration____ |
| Rated force/peak force | Push force ____ kN; pull force ____ kN; peak duration ____ s |
| Displacement | Total stroke ____ mm; working amplitude ±____ mm; offset ____ mm |
| Dynamic indicators | Frequency ____ Hz; Peak speed ____ m/s; Peak acceleration ____ m/s²; Allowable error ____ |
| mobile system | Specimen mass ____ kg; fixture mass ____ kg; total moving mass ____ kg |
| structural boundary | Specimen stiffness____; reaction frame stiffness/natural frequency____; installation clearance____ |
| Cycles and time | Total cycle ____; continuous operation ____ h; duty cycle ____ % |
| Hydraulic conditions | Oil supply ____ MPa; oil return ____ MPa; flow rate ____ L/min; oil temperature ____ ℃ |
| Installation interface | □Flange □Ball hinge □Earring □Base □Trunnion; Drawing/3D model: □Yes |
| Sensor/Valve | Displacement_____; force_____; servo valve brand/interface_____ |
| environment and regulations | Temperature ____ ℃; Protection/explosion-proof_____; Applicable standards _____ |

# 13 Delivery scope and acceptance

| stage | Delivery content |
|---|---|
| Plan confirmation | Selection data sheet, system block diagram, interface conditions, risk boundaries and technical protocols |
| Design confirmation | Outline installation drawing, hydraulic principle, sensor/valve configuration, electrical interface |
| Manufacturing inspection | Critical dimensions, pressure resistance, leakage, friction, sensor calibration and action inspection |
| Dynamic verification | Perform force/displacement tracking, frequency response or specified waveform tests according to technical protocols |
| On-site delivery | Installation guidance, exhaust debugging, parameter setting, operation training and acceptance records |
| Random data | Certificate of conformity, use and maintenance instructions, confirmation drawings, spare parts list and test records |

## Acceptance Boundary

- Acceptance conditions for rated force, stroke, speed and frequency are defined in groups in the technical agreement.
- System-level dynamic indicators need to specify the test piece, fixture, oil source, controller and installation boundaries.
- Fatigue tasks specify cycle times, load spectra, shutdown conditions and allowable maintenance items.
- The final product parameters, appearance, interfaces and acceptance values shall be subject to the technical agreement and confirmation drawings between the two parties.

## Contact Xinhai Fluid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|---|---|
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# 14 Technical data sources

The series division and selection method of this sample refer to the following public technical information, and are reorganized based on the engineering calculation of the hydraulic servo system. Model numbers and trademarks of friendly companies do not constitute our company’s product models.

| source | Technical topics used for this sample |
|---|---|
| MTS DuraGlide 244 Hydraulic Actuators | Specifications and configuration methods of dynamic actuators such as 15-1000 kN, 100-500 mm, etc. |
| MTS DuraGlide Hydraulic Actuators | Application division of Series 201 low frequency, Series 244 high frequency and Series 248 hydrostatic bearings |
| MTS Series 242 Hydraulic Actuator | Low load actuator, displacement sensor, low friction seal and servo valve flow rate |
| Moog Electrohydraulic Servo Actuators | Product architecture of single rod, double rod, low load and hydrostatic support actuators |
| SHENLEAD HF series linear hydraulic actuator | More than 100 Hz small piston high frequency solution and load sensor, servo valve, valve block and other configurations |
| Shanghai Lixin high response servo valve | Examples of pressure, flow and frequency response parameters of high-response servo valves |

## URL index

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https://www.shlixin.com/cn/Proportional-Servo-Valve/511.html

**Version description: V1.5 is the project selection guide. The listed force levels, strokes and frequency bands are used to establish the engineering configuration; contract performance, dimensions, interfaces and acceptance conditions are uniformly specified in the technical agreement and project confirmation drawings.**