

Technical Specification for XJ400 Service Rig (Double Drum)

1. General introduction

The rig is a double-drum, self-propelled rig. Rated horsepower of engine is 450HP/2100rpm. The maximum hook load is 225,000lbs (6 lines). The height of mast is 104'.

The whole rig consists of 7 parts: power system, carrier, drive system, drawworks system, mast and traveling system, controlling system (hydraulic, air, electrical), and accessories. The main configuration of each system is as follows.

1. Power system	2. Carrier
Engine: DDC S60 Transmission: M5610ARDB Fuel tank: 378.5L (100gal) Muffler and spark arrester (mount on the engine exhaust pipe outlet) Heat exchanger Engine hood (protection net at DS, engine belt guard at ODS)	Steering mechanism Frame, axles, front and rear suspension, etc Single seat cab Walkway and guardrail (DS side) Stairs to carrier Tool box (cabinet type, 1 set sliding-type, 2sets)
3. Drive system	4. Drawworks
Right angle gear box Input and output chain and drive shaft Guard cover of chain	Main drum & brake system (splash water cooling) Sand drum & brake system (splash water cooling) Air-actuated caliper disk brake (auxiliary brake) Turnover combined drawworks frame
5. Mast and traveling system	6. Controlling system (hydraulic, air, electrical)

Mast	Main oil pump, steering pump
Racking board	Telescoping cylinder, raising cylinder,
Crown block assy.	leveling jack
Folded type mast foundation	3t (6,600lbs) hydraulic winches
Clinometer of mast	Hydraulic oil tank
Load guylines (c/w bar type adjuster) and wind guylines	Air compressor (using Bendix D-2/SV-1 unload relief valve), air dryer
Mast red aviation lamp	Driller's console (air system 20-ways)
	Valves, pipelines, joints
	Battery box
	Crown saver
7. Accessories	
<ol style="list-style-type: none"> 1. Slings (used for transportation hoisting) 2. Heating devices (including preheater of engine, cab heater and defroster) 3. Simple platform on wellhead (the height can be adjusted) 4. Standpipe (41'6" in length) 5. Rod hanger 	

2. Technical standard and reference

- SY/T5610-1999 Types and Basic Specifications of Workover Rig
- API Spec 4F (2nd edition) Specification for Drilling and Well Servicing Structures
- API Spec Q1 (7th edition) Specification for Quality Programs
- API Spec 8C (4th edition) Specification for Drilling and Production Hoisting Equipment
- API Spec 7K (4th edition) Specification for Drilling Equipment
- SY5202-2004 Specification for Petroleum Workover Rig
- API Spec 9A (25th edition) Specification for Wire Rope
- GB1243.1-83 Roller Chain Drive
- GB5058-92 Design Specification for Electric Equipment in Explosion and Flood
Hazard Areas
- SY/T5957-94 Installation Requirements for Field Electrical System
- ISO9001-2001 Quality Control System
- HSE Health, Safety and Environment Control System

3. Main technical parameters

- Service depth 4533m (14,870') (2- 7/8" tubing)
- Workover depth 3626m (11,900') (2- 7/8" DP)
- Max. static hook load 102t (225,000lbs)
- Rated horsepower, engine 450Hp/2100rpm
- Height, mast 31.7m (104')
- Height, racking board (to the ground) 55' (16.7m)
- Height, simple platform (4', 8', 12' adjustable)
- Traveling system 3x4
- Drive type, carrier 10x4 (without front axle drive)
- Dia., wireline ϕ 26mm (ϕ 1")
- Traveling dimensions 17.5mx2.8mx4.27m
(57.4'x9.18'x14')
- Min. turning dia. 34m (111.5')
- Max. speed 72km/h (45mil/h)
- Total weight during transportation ~47.7T (105000LBS)
- Height, rod hanger 78'6"
- The finger beam of racking board shall be parallel with diving board.

4. Specification of main parts

4.1 Power system

The rig is powered by DDC S60 diesel engine for driving and operation (including the rig transportation and the drawworks hoisting). It is equipped with an oil pump through the engine PTO port to provide hydraulic power for steering assist mechanism of carrier. The air compressor is directly driven through the PTO port at the front of the engine to provide air source for the whole rig. Main oil pump is driven through the PTO on the transmission to provide hydraulic power for hydraulic systems, including leveling jacks, raising and telescoping cylinders etc.

4.1.1 Diesel engine

- Model DDC S60
- Horsepower 450hp/(2100rpm, C-rating)

- Type Six cylinder straight line 4 strokes
- Cylinder diameter×stroke 130mmx157mm

4.1.2 Transmission

TC-680 torque converter, M5610ARDB transmission, w/ a main oil pump PTO port. Hydraulic clutch engagement and gear shifting valve are air controlled and hydraulic shifted. The transmission oil is cooled through cooling water tank of diesel engine via heat exchanger.

- Model ALLISON M5610ARDB
- Gear ratio

1	2	3	4	5	Reverse
4:1	2.684:1	2.013:1	1.351:1	1:1	5.12:1

4.2 Carrier

The vehicle frame is fabricated from H type wide-flange sectional materials. The max. stress points are specially reinforced. Heavy-duty axles with wide wheelbase, 2 front axles and 3 rear axles, carrier with 10x4 drive. The first and second axles: 10t, steering axle. The third and fourth axles: 13t, driving axle. The fifth axle: 10t floating axle. The front two axles use 18-22.5 low profile heavy-duty wide tires (single tires), steel plate spring suspension. The rear three axles are 12.00-22.5 dual tires. All tires are tubeless with load ratings. The third and fourth axles use rigid beam counterbalance suspension and the fifth axle uses air suspension. Equipped with hydraulic assist steering. Cab is COE type with single seat. Equipped with inter-wheel and inter-axle locks. All controls of carrier are centralized in the cab.

Lower brake valve of cab is complete with guard to avoid the brake valve from being damaged by the tires. Guard covers are added for the headlamps.

Foldable walkway and handrails (from driller's operating place to drawworks) are installed at driller's side. The handrails and walkway frame are of rigid materials and the walkway is of fiberglass material. The carrier has integral stairs up to the deck at both sides and is equipped with 4 hydraulic leveling jacks with locking nuts.

- Min. ground clearance 340mm (1.12')
- Min. turning radius 17m (55.8')
- Approach angle 36°
- Departure angle 13°

➤ Max. climbing gradient	30%
➤ Max. speed	72km/h(speed limit 45km/h)
➤ Fuel tank	378.5L (100gal)
➤ Wheelbase	1300mm×5500mm×1370mm×1370mm (4,265'×18,000'×4,495'×4,495')
➤ Traveling dimensions	17.5m×2.8m×4.27m (57.4'×9.18'×14')

4.3 Drawworks system

JC400-S drawworks consists of right angle gear box, drawworks frame and shield, main drum and brake system, sand drum and brake system, auxiliary brake, overwinding crown saver, etc. All drawworks clutches are placed outboard for easy replacement of friction discs. Brake rims of main drum and sand drum are all one-piece forged by alloy steel with proper hardness and anti-wear & heat-resistant performance. Auxiliary brake is WPT air-actuated caliper disc brake (The control valve of disc brake should be 0~100psi).

4.3.1 Main drum and sand drum

Main drum body is complete with split Lebus groove jacket, w/ WPT PR0224 clutch. Sand drum is equipped with WPT PR0124 clutch. Brakes for main drum and sand drum are all band brakes (not including brake blocks) with brake rims cooled by splashing water. After finishing machining and assembly, main drum and sand drum should go through static balance test and dynamic balance test, air pressure test, water pressure test and strength test so as to ensure its service performance.

——Main drum

➤ Brake rim diameter x width	φ1070mm×310 (φ42"×12")
➤ Groove diameter x width	φ429mm×879mm (φ16.89"×34.6")
➤ Model, clutch	WPT PRO224 clutch
➤ Max. fastline pull	42,826lbs

——Sand drum

➤ Brake rim diameterx width	φ1070mm×210mm (φ42"×8")
➤ Groove diameterx width	φ324mm×1016mm (φ12.75"×38")
➤ Model, clutch	WPT PRO224 clutch

- Max. fastline pull 25,870lbs (when using 5/8" wirelines at the second layer)

4.3.2 Main drum brake system

It is lever mechanism and consists of steel band, counterbalance beam, location ring, adjustable screw bar, pull rod, brake shaft, brake handle shaft and brake handle (two-section type, w/ releasing device), etc. The wrap angle and brake force ratio of brake system are large for labor-saving and reliable brake. The ratchet and pawl mechanism is designed at the brake handle place of main drum brake system, which can make the brake handle lock at any position.

- Wrap angle, brake band 345°
- Brake force ratio (brake handle angle) 30.4 (30°)
- Brake handle force 112.5lbs

4.4 Mast and traveling system

4.4.1 Mast assy.

The mast is derrick type, □type, double section telescoping made of angle steel. Slant angle can be adjusted by adjustable screw bar on mast base (U-type plates added for pins at both ends of screw bar). It is equipped with 2-1/2" standpipe (2-1/2" steel pipe swedging into 2" steel pipe with 2" NPT at both ends, 5000psi). 3x4 strings are used (2x3 can also be used when light load). Complete with mast hinged pins as well as raising cylinder and telescoping cylinder hinged pins with lock blocks which prevent the hinged-pins from dropping off. Complete with automatic locking unit for mast upper and lower section, painted in red. The fingers on racking board are fitted with safety chains. Finite element calculation and analysis are performed on the whole mast under three combined working conditions to ensure the reliability in strength, rigidness and stability.

- Clear height 31.7m (104')
- Max. static load 102t (225,000lbs)
- Slant angle 3°~5°adjustable
- Capacity, racking board 4533m (14,870') (2- 7/8" tubing)
3626m (11,900') (2- 7/8" DP)
- Max. wind rate 110km/h (68mil/h)
- Capacity, rod hanger 6000m (19600')
4560 (14968')

4.4.1.1 Crown block

The crown block is of integral box structure and uses 3×4 lines. It consists of crown seat, crown frame, sheaves and safety handrails, etc (Crown sheave seat is welded with crown seat). Dynamic balance tests are performed on the sheaves. Sheave rope groove arcs are designed as per API 8C. Surface hardening treatment is performed on the rope groove to ensure the service life of sheaves. A kick-back post is set on the sheave seat to prevent ropes from jumping. Crown shaft has been heat-treated and defect-detected.

4.4.1.2 Mast foundation

Mast foundation is a bearing pedestal to support mast base and carrier rear jacks. It is designed with folded structure to enlarge the effective support area when lowering down. Mast foundation can be raised up and lowered down along with the adjustable jacks of mast base, so it can be transported with the carrier without exceeding the limited width when being raised up during transportation.

4.4.1.3 Delayed reaction racking board

Racking board uses rectangle steel tube as its frame and is connected to mast legs by hinged-pins with lock blocks. It is deployed with the extending of mast upper section and folded with the retracting of mast upper section. The platform is complete with backup diving board. The fingers are horizontal arranged with adjustable space. It is also equipped with protective chains to prevent DP or tubing slipping out of the fingers. There is an escape door on the front face of the handrails with a bracket for escape unit left in advance.

4.5 Driving system

The engine power is supplied to deck operation system and carrier driving system via drop box. The upper power takeoff port of drop box transfers the power to right angle gear box through drive shaft, and then to sand drum via chains, which is controlled by clutch to undertake bailing or swabbing. The power transferred to sand drum goes to main drum via chains, which is controlled by clutch to undertake lifting operation. The lower power takeoff port of drop box transfers the power to the rear axles of the carrier via drive shaft to realize the carrier traveling. Deck power and chassis power are controlled by the operating handle on drop box to ensure that it is not simultaneous for deck operation and carrier driving.

4.5.1 Right angle gear box

Right angle gear box mainly consists of input shaft, output shaft, big and small spiral cone gear, output bearing seat, box body, support, flange, sprocket and various bearings.

Input and output shafts are made of premium alloy steel to ensure sufficient strength.

- Gear ratio 21:37

4.5.2 Guard cover

All exposed rotating parts on deck surface are protected by guard cover.

The guard of drive shaft on deck is of box type net structure, from engine hood to water tank pedestal. Hinged guard door can be opened at any time, easy for maintenance of drive shaft, drop box and right angle gear box. Checkered steel plate is floored on the upper plane of the guard which is used as walkway for the operators.

4.5.3 Drive belt or chain

Right angle gear box→Sand drum	1 1/2" Double chain
Sand drum→Main drum	1 1/2" Double chain

4.6 Control system

The controls for the operating system of the whole unit are centralized in hydraulic control panel and driller's console for centralized control. The system control is set near the driller's console of the carrier. Important operation and controls are multiple protected. Key components of hydraulic and air system are all imported from USA. All connections and pipelines are of national standard and supplied by specialized manufacturer with well-known brand. All pipelines, including hydraulic, air and lubrication, are fixed, arranged in order and labeled with obvious classification marks.

4.6.1 Hydraulic system

The hydraulic system is powered by hydraulic pump driven by PTO on Allison transmission. The hydraulic system mainly consists of operating mechanism including mast raising cylinder, mast telescoping cylinder, carrier leveling jack, carrier power steering cylinder, hydraulic winch, etc. and hydraulic control components, hydraulic control panel, hydraulic pipelines, oil tank, filter and pressure regulating valve, etc.

4.6.1.1 Main oil pump

Main oil pump is gear oil pump and installed on the PTO of hydraulic torque converter. PTO is of hydraulic multiple friction disc structure, which controls engagement and disengagement of main oil pump under the uninterrupted condition.

- Displacement, oil pump 165L/1800r/min (44gal/1800r/min)
- Working pressure 14Mpa (2000psi)

4.6.1.2 Hydraulic oil tank

Liquid level and temperature gauge are installed at the side of the hydraulic oil tank. The inner chamber of oil tank can be divided into 3 chambers by two spacer plates. Oil suction port and oil return port are respectively located at different chambers of both ends so that the oil in the oil tank has enough cooling time. Oil discharge port is set in the oil return chamber in order to wash out the wastes at the bottom of the oil tank while discharging and cleaning.

Two cover plate inlets with seal rings are set at the upper of the oil tank for cleaning oil tank. A hydraulic air filter is installed on the inlet cover at the oil return port, which can be used as oil-filling filter and air breather valve.

A self oil suction filter is installed at the oil suction port. Oil suction barrel of the filter is immersed in the oil at the lower part of oil tank with one end exposed outside the tank. Filter is equipped with self-sealing valve, bypass valve and signal messenger for pollution or blockage of filter element, through which the pollution condition of the filter element can be observed outside the oil tank. When cleaning or replacing filter element, just open the end cover of the filter end take the filter element out. Self-sealing valve of the filter is closed automatically to prevent oil in the oil tank flowing out. Pipelines outside oil suction port are fitted with ball valves. Close the ball valves when repairing the pipelines of hydraulic system to prevent the oil flowing out.

An oil return filter is equipped at the oil return port of oil tank and used to remove the wastes in the oil of hydraulic system pipelines to keep the oil returning to oil tank clean. The oil return filter is equipped with bypass valve and signal messenger for pollution and blockage of filter element, through which the pollution condition of the filter element can be observed so as to clean or replace the filter elements at the appropriate time. Pipelines outside the oil return port are fitted with check valve, which will be closed automatically when repairing the pipelines of hydraulic system to prevent oil in the oil tank flowing out.

- Capacity 883L (233gal)

4.6.1.3 Hydraulic winch (w/ line arranging unit and protective net)

- Model YJ-3
- Max. hoisting capacity 3t (66000lbs)
- Dia., wireline $\Phi 14.5\text{mm}$ ($\Phi 9/16''$)
- Line capacity 262'

4.6.2 Air system

Air system is used for deck and carrier control, mainly consisting of air compressor, pressure regulating valve, dryer, atomized lubricator, control valve, air tank and driller's console etc. The air system is powered from air compressor driven by engine belt pulley, w/ dryer and pre-heater, suitable for operation in cold climate.

4.6.2.1 Air compressor

- Rated displacement 700L/1250r/min (185gal/1200r/min)
- System working pressure 0.83~0.93Mpa (120~135psi)

4.6.2.2 Air reservoir

Air reservoir is equipped with safety valve (with overpressure automatic exhausting function), shockproof pressure gauge, scum cock, check valve and two-way output port. One passage is used to provide air source for rig and the other is used to inflate the tires. It is fabricated by a dedicated factory with safety manufacturing license issued by National Safety Department.

- Capacity 155L (41gal)

4.6.3 Driller's console

The driller's console is equipped with various control valves and instruments, which can centrally control gear-shifting of hydraulic transmission, engagement of main drum, engine throttle, shutdown, and offloading of oil pump, etc.

4.6.4 Electrical system

The electrical system consists of driving lighting system and operation lighting system. The driving

system is powered from battery and silicon rectification alternator driven by the engine, mainly including engine start-up, lights and signals of monitoring gauges, lights and sounds when driving. The operation lighting system is used for engine, drawworks, mast and wellhead illumination. A red aviation lamp is set on top of mast. The wires are protected by steel tubes. The carrier is equipped with electric start-up main switch (main power switch). The tail lamps and clearance lamps are diode LED lamps. Headlights are fitted with protective guard covers.

➤ Power source, carrier 12V DC

Note: The electrical wires, plugs, sockets and cored steel tubes are not provided on the mast.

4.7 Accessories

4.7.1 Simple working platform

The simple working platform is adjustable in height. During operation, one side of the platform is hinged to multi-hole adjustable spreader bar welded on mast base through pin shaft, and the other side is lifted by two wirelines from mast racking board. During transportation, the wirelines should be loosened, and the platform should be folded vertically along the adjustable spreader bar.

The middle section should be made into sliding walkway, 28" in width and fixed by pins. Equipped with inward foldable walkways quipped at both sides, 24" in width. New chain clamp seat is used during transportation.

Note: The wireline diameter of simple platform is 3/8" with 3/8" chains.

4.7.2 Rod hanger

Rod hanger mainly consists of hanger, control pipelines, cylinder, sheaves, wirelines, pedal valve (Rexroth PD40041-5354). The hanger is fixed above the racking board, and the rods can hang on it. Pedal valve is used to control cylinder to lift rods.

Note: Clamping collars are used for the wirelines of racking board and rod hanger.

4.8 Miscellaneous

4.8.1 Paint

1. Carrier and drawworks	Red (B01)
2. Handrails	Yellow (NxR5)
3. Mast and wheels	White
4. Axle and simple platform	Black

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5. Crown Red (R03)
 6. One side of racking board painted with SJ sign and the other side painted with Dragon sign.
 7. Lock block of mast lower section painted in red.

4.8.2 Other requirements

1. Add movable walkway around raising cylinder.
2. The air inlet of air compressor shall be located on the air supply line of air filter at the opposite side.
3. The ground wires of alternator and engine should be connected together.
4. Add one (1) pressure gauge and one (1) hand wheel pressure regulating valve in the driller's box to display and adjust the pressure of air slip. Leave the installation position for two valves in advance. The installation size of interface should be the same as the working condition selection valve on driller's box.
6. It is not allowed to install the pressure regulating valve of main drum clutch on the driller's box.
7. The vertical tool box should be installed in the middle of the carrier.
8. Line-passing unit shall be added on the mast Y-base.
9. The pin heads of all shackles shall be complete with cotter pins.
10. Use lifting eyes and 3/8" chains to fix mast foundation during transportation.
11. Add handrails at the front end of walkway pedal.
12. Use bolts to connect and fix the front end of engine hood and mast front support.
13. The substructure and walkway handrails shall be 42" higher than the platform.
14. Use Kingston relay valves.
15. Applied antirust agent on the mast before delivery.