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## REVISIONS

Letter	DESCRIPTION	Prepared	Checked	Approved	Date
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# FUNCTIONAL DESIGN SPECIFICATION

# MPC-15kVP

TITLE;

FUNCTIONAL DESIGN SPECIFICATION

MPC-15kVP

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# 1. INTRODUCTION

The MPC-15kVP (*Multi Purpose Crane, 15,000 lb. Lift Capacity*) is an upgraded version of Forum's original MPC. The function of the MPC is to provide mechanical assistance in the BOP area. Generally, an installation consists of a pair of MPC's located on the port and starboard side of the cantilever and are configured as a right and left hand models to optimize access to the BOP storage areas. The MPC is utilized as a maintenance access basket when fitted with the supplied man basket. The rated lifting capacity is the net safe working load of 15,000 lbs (SWL) at the hook and is not de-rated based on arm extension.

The unit consists of 5 major components: the hoist system, the articulated boom, the king post, the vertical positioning system and the control system.

The hoist system is incorporated into the outer section of the articulated boom and consists of a hydraulically powered, heavy duty, DnV type approved gearbox coupled to a self-reeving wire rope drum. The hoist cable supplied is a non-rotational design with a 5:1 design safety factor and a 2:1 proof load against the SWL.


The articulated boom assembly consists of a main arm coupled to an outer hoist arm via a heavy duty planetary gearbox powered by a hydraulic motor to provide an elbow type rotary motion between the two.

The king post is pivotally attached to the articulated boom to provide vertical luffing action from horizontal to 75 degrees above the horizon. Luffing action is achieved via a hydraulic cylinder between the boom and the king post. The king post is also attached to the vertical carriage of the vertical positioning system via a pair of radial bushings and a thrust bearing to provide up to 320 degrees of slewing motion about its vertical axis and to support the dead weight of the MPC and the SWL. Slew motion is achieved using a hydraulically powered planetary drive attached between the king post and the vertical carriage.

The vertical positioning system facilitates MPC extended operations below and outside of the cantilever beams to allow hoisting equipment from the lower platform deck, outside of the cantilever area and deliver into the area under the drilling rig, between the cantilever rails. The MPC is moved between its upper and lower operating positions via a hydraulic cylinder and cable mechanism. Repositioning is to be done only with the MPC retracted and supporting no SWL.

The MPC is hydraulically powered and electrical over hydraulic controlled to provide fully proportional control of all the operating motions. The control system consists of one master control cabinets, two interface manifolds assemblies and two operator's stations, discussed later.

# 2. MOTION

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The MPC has movement at five locations allowing for flexibility. All motion is joystick controlled from the portable operator's station.

First, the entire crane can slew about its vertical axis through 320 degrees. Rotation limits are field adjustable with a mechanical cam system and are active when the MPC is operated manually from the hydraulic control manifold assembly. A hydraulic motor, brake, and gearbox are mounted between the king post and vertical carriage to accomplish the slew at full extension and carrying SWL. Rotation speed is proportionally controlled by the operator's joystick.

Second, the main arm can luff from horizontal to 75 degrees above. The luffing motion is accomplished with a hydraulic cylinder fitted with direct mounted load holding valves. The luffing motion is proportionally controlled by the operator.


Third, a hoist arm rotates relative to the main arm +/- 165 degrees allowing positioning of the hoist drum over the top of itself on itself. Again, a hydraulic motor, brake, and gearbox with proportional speed control is used.

Fourth, a hoist system is located on the end of the hoist arm. The hook is maximum of 11280 mm (37 feet) from the pivot point and has 10 meters (32.8 feet) of usable cable.

Fifth, the MPC is mounted to a rail system allowing the vertical repositioning of the MPC between the upper and lower operating positions. The rail system is not designed to accommodate repositioning with an operational load suspended by the MPC. The upper position allows access to the upper positions of the BOP stack and areas high in the well bay under the drill floor. In the lower position, the MPC is below the bottom of the rig's cantilever beams to allow the unit to slew to the out board side of the cantilever beams to assist in moving material from the platform deck into the well bay under the drill floor. The MPC is repositioned hydraulically with two cylinders and mechanically latched into operating position.

### 3. OPERATING SPEEDS

Motion	Maximum Speed	Pressure Required	Flow Required
Slew	0 to 0.5 rpm	2500 psi (172 bar)	50 GPM (189 liter/min)
Luff	0 to 120 deg/min	2500 psi (172 bar)	
Elbow Rotate	0 to 1 rpm	2500 psi (172 bar)	
Hoist	0 to 2 ft/sec (61 cm/sec)	2500 psi (172 bar)	

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Typical use has the operator functioning one motion at a time. Operating multiple joysticks at one time will require a power unit capable of supplying pressure and flow for both functions. The power unit design is outside the scope of this project.

#### 4. CONTROL SYSTEM

As the typical MPC installation uses a pair of MPC's, one port side and one on the starboard side, the control system consists of a single master control cabinet capable of controlling one or two MPC units, dual interface manifold assemblies and dual operator's panels, one each dedicated for either MPC. The master control cabinet is a stainless steel enclosure for mounting in a non-hazardous, environmentally controlled area. It contains the I/O and controller modules to control one or two MPC's assemblies.


The interface manifold assembly is suitable for mounting in a zone 2 hazardous area and consists of a hydraulic valve bank with Ex(d) rated proportional solenoids for control of the MPC functions integral with an enabling/isolation valve section, an IP67 Ex(e) junction box for marshaling the multi-conductor from the master control cabinet, operator's panel and from the proportional solenoids, a hydraulic filter and pressure regulating valve, thus enabling use with the existing rig's ring-main hydraulic power unit system. The enabling/isolation valve blocks the MPC from the hydraulic power supply when the unit is not in operation and when a system ESD has been activated. The interface manifold assembly is to be located by the customer as close to the MPC assembly as possible.

The operator's station is IP66 and rated for use in a zone 1 hazardous area and uses two intrinsically safe joysticks for individual proportional control of each axis. The vertical operating position is controlled with a 3-position, spring centered selector switch. It also contains a ESD pushbutton and a enable selector switch. The Operator's Panel is podium mounted for use around the BOP area and connected to the junction box on the interface manifold assembly via a quick connector.

Emergency stop pushbuttons are located on each of the MPC assemblies and in the Operator's Panel.

#### 5. MAN BASKET

A man basket is to be supplied for attaching to the MPC, allowing for safe personnel access to areas within the crane's reach. It is mounted via quick attachment to the end of the articulated boom assembly and controlled from within the basket using the integral basket control station. The basket is designed for a 500 Lbs combined personnel/equipment load and based on a 5:1 minimum factor of safety per DnV requirements. The man basket is pivotally attached to the mount provided at the end of the articulated boom assembly. The hoisting function of the MPC

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is disabled when the man basket is in use.

The man basket control station consists of three, single axis joysticks for control of the slew, luff and elbow, an assign pushbutton, and an ESD pushbutton. It also includes an IP66, guarded foot switch which must be depressed by the operator in the basket to allow any motion of the arm. The man basket control station is housed in an IP66 stainless steel enclosure and permanently affixed to the man basket. It is rated for operation in a zone 1 hazardous area.

Upon installation of the man basket onto the MPC, a connector cable from the man basket control station is manually attached to its mating receptacle on the end of the articulated boom. Once this connection between the boom and the man basket control panel is made, the main operator's station is disabled and cannot be used to operate the arm. In an emergency, the locked guard over the manual operator's on the hydraulic control valve (part of the interface manifold assembly) can be unlocked and the arm controlled manually from this station. This is done to insure that while manned, the positioning of the man basket can only be done by the man in the basket.


## 6. MOUNTING

The MPC-15kVP multi-purpose crane is designed to mount on the inside of the cantilever beams, under the drilling module of a Kfels Super "B" jack-up drilling rig. There is to be one unit on the port side and a second on the starboard side. The mounting is accomplished via 6-bolting pads on the back of the rail assembly inside the vertical positioning system. The mating pads on the cantilever side of the interface are not provided with the MPC. The pads must be designed to accept the maximum operational loads per the general arrangement drawing.

The MPC booms connects back to a king post that is mounted at the top and mid-section to the positioning carriage and interfaces to the vertical rail system. The vertical rail system is bolted to the interface points provided on the inside of the rig's cantilever beams for operational support. The positioning carriage is slidable mounted and captured by the rails and provides the ability to move the MPC between the upper and lower operating positions via hydraulic cylinders. Once in operating position, the carriage is mechanically locked to the rails system to isolate the hydraulic cylinders from the operating loads. Installation of the mounts is not included in the scope of supply.

## 7. SAFETY SYSTEMS AND INTERLOCKS

The hydraulic driven components responsible for the five types of operational motion all have an automatically activated system to stop motion with the absence of hydraulic pressure or in case of hose breakage. Motors on the hoist assembly, the elbow of the articulated boom assembly and the slew on the king post have spring applied fail safe disk brakes while the luffing and vertical positioning cylinders use a counterbalance system directly connected to the

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hydraulic ports of the respective cylinder assembly.

The man basket, when supplied, has an interlock switch to prevent the elbow motion of the articulated boom assembly from contacting the man basket, forcing it out of plane.

The operator's panel is a podium mounted unit that can be positioned around the decks in the well bay allowing the operator to have the best view of the work zone.

When the remote control is disconnected or when emergency operation is required with the man basket installed and control is passed to the manual valve bank on the interface manifold assembly, the operator must manually depress and hold the hydraulic enable valve handle before moving the valve handle controlling the desired function. This spring biased, normally closed enable valve will have to be held open while the desired valve function is actuated, making this a two handed operation to prevent unintentional shifting of a function control valve at the interface manifold assembly. Additionally, the manual valve bank will be enclosed with a lockable guard that must be opened by a responsible person before gaining access to the hydraulic control valves for manual machine operation.


Emergency stop buttons are located at the interface manifold assembly, the operator's panel and the man basket control panel. Hitting the E-stop at any location will stop the machine regardless of which control station was in use.

Safe limitation of the lifting effort is to be accomplished by valve pressure limiters for the hoist system. However, with a boom type crane like the MPC, the load holding capacity of the hoist system can be exceeded if the operator attempts to lift the attached load with the luff cylinder or the elbow, depending on geometry of the arm during the operation being performed. Therefore, only the hoist system is to be used to lift a load and it is the responsibility of the operator to be aware at all time of the potential for overload and be conscious of the weight of the object connected to the crane's load line. and rotate functions. The luffing cylinder and slewing motor will be allowed to see pressure limited by the inlet section relief and also a load sense relief. The flow rating of the valve spools are specific to the actuator being controlled with the valve section and each port has an individual maximum flow limitation.

There is no safety feature built into the MPC to avoid collisions with the deck, structure, or other equipment in the area. It is the responsibility of the operator to monitor and be aware of the potential of collision between the MPC and the surrounding structure.

## 8. DESIGN CRITERIA

As required by the customer's purchasing information, the MPC can be furnished certified to American Bureau of Shipping (ABS) to Mobile Offshore Drilling Unit (MODU) rules or the ABS Certified Drilling System rules (ABS-CDS). For MODU certification, ABS will perform a review of the electrical system in the hazardous area and will render a letter stating such. For ABS CDS, ABS will perform a complete design review, electrical and mechanical, and during construction, perform survey and witnessing as required and will render an inspection report.


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The design approval letter and inspection report are deliverables. Finally, three copies of the standard manufacturing data book and the certificate of conformance are deliverables. Forum will retain the original data book.

The MPC-15kVP is designed in accordance with the applicable requirements of API-2C, Specification for Offshore Pedestal Mounted Cranes and AISC Design Guides for Steel Construction. Fabrication procedures are in accordance with AWS D1.1.

Lifted load considered for analysis will be static with load factors applied as required by ABS and API-2C. Also, for analysis, the crane is free of environmental loads including the effects of wind, snow, and ice. Finally, there will be no loading from the vessel's list or trim. Design service temperature is considered to be 32°F (0°C).

The man basket is designed and reviewed for compliance with ASME B30.23-2005, Personnel Lifting Systems.

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