# EXHIBIT B
# RCRV PISTON CORING DEPLOYMENT AND RECOVERY SYSTEM

## DESIGN REQUIREMENTS

# 000 GENERAL REQUIREMENTS

## 000.1 Introduction

This document is intended as a specification for the design of a Piston Coring Deployment and Recovery (PCDR) system for the new Regional Class Research Vessels (RCRVs) being built for the Academic Research Fleet and funded by the National Science Foundation.

The goal of this document is to describe the technical requirements for the PCDR System.

### 000.1.1 Intended Purpose

The PCDR System shall facilitate deployment and recovery of piston corers rigged to recover up to 50 feet of cored material through the stern A-frame on the vessel by transferring the entire piston corer from the A-frame centerline to the deck of the ship, inboard of the starboard rail.

The PCDR System shall be easily assembled and disassembled for transport. It is intended to be containerized and transportable by common carrier between domestic destinations and foreign ports and used on all three RCRVs.

The PCDR System is composed of the following components:

- Piston Coring Deployment and Recovery Mechanism (PCDRM)
- Two Davits (only one shown in Figure 1 for reference)
- Hydraulic Power Unit (HPU)

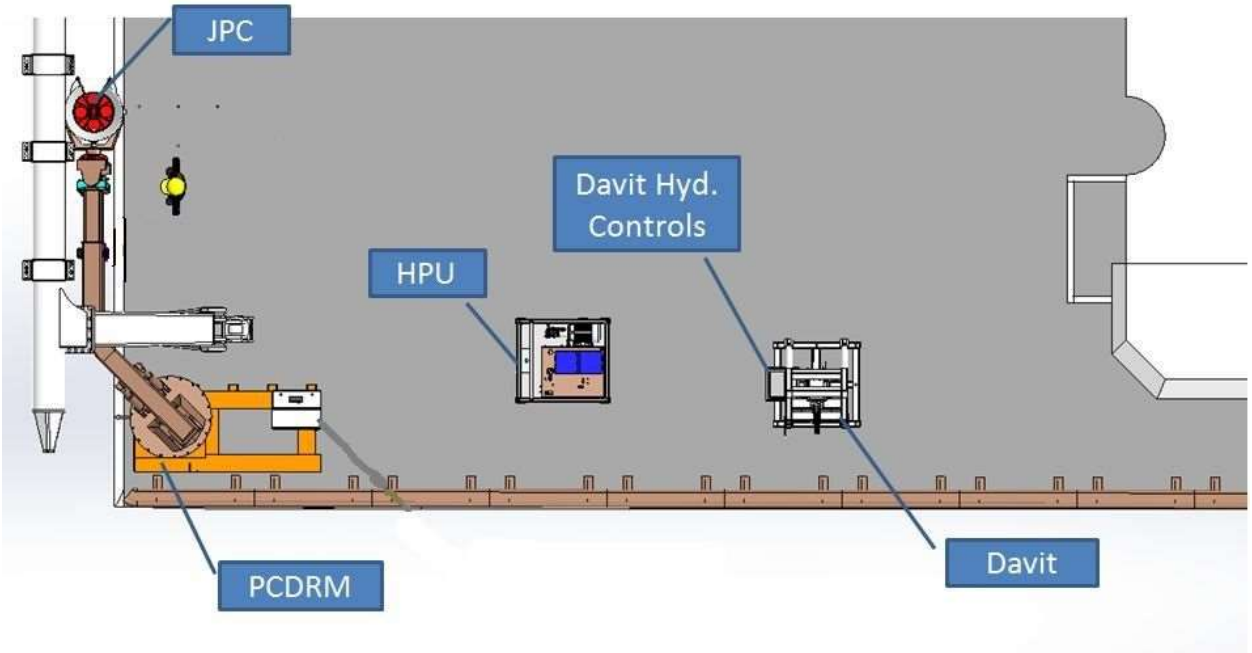



**Figure 1 Conceptual arrangement of PCDR System**

## 000.2 Acronyms

The Vendor shall interpret acronyms used throughout the specification as follows:

**JPC** Jumbo Piston Core

**PCDRM** Piston Coring Deployment and Recovery Mechanism, a machine to transport a piston corer from the side deck to the transom and back.

**RCRV** Regional Class Research Vessel

## 000.3 Definitions

The Vendor shall interpret terms used throughout the specification as follows:

**Owner** Oregon State University

**Vendor** Manufacturer of any of the PCDR System components.

**PCDR System** The group of machines that enable deployment and recovery of a piston corer, including the PCDRM, davits, and HPU.

**weight stand** The weight at the top of the piston corer that drives the core barrel into the seafloor.

**bucket** The cradle at the end of the PCDRM arm that carries the weight stand and core barrel to/from the side deck from/to the A-frame.

**core barrel** That part of the PCDR System that is driven into the seafloor and extracted with the core to the surface.

**davit** That part of the PCDR System that hoists the core barrel from Position 2 to Position 3 and back. The word ‘davit’ in this specification may refer to another form of machinery that conforms to the requirements listed, such as a telescoping boom.

**deck bolt grid array** The 24 inch on-center grid of deck sockets installed onboard US academic fleet vessels for mounting deck machinery. The sockets fit 1 inch-8 UNC bolts.

**Ruleset** UNOLS Research Vessel Safety Standards, U.S. Code of Federal Regulations, and either ABS or API Rules referenced in this specification which compliance with is required.

## 000.4 Contract Documents and References

### 000.4.1 General

This specification takes precedence over all drawings and Rulesets. Where a conflict arises between documents, the Vendor shall immediately request clarification from the Owner.

The figures in this specification are for reference only. They are included only to show intent, not the exact details of final construction. Final construction drawings shall be provided by the Vendor.

### 000.4.2 Reference Standards

- UNOLS *Research Vessel Safety Standards*, 10th Edition (July 2015).
    a. Including promulgated RVSS Appendix B approved 27 November 2018.
- 46 CFR 189.35, *Wet Handling Gear*, latest.
- ABS Rules for Building and Classing Steel Vessels Under 90m in Length, latest.
- ABS Rules for Building and Classing Underwater Vehicles, Systems and Hyperbaric Facilities, 2019
- API Offshore Pedestal-mounted Cranes, Specification 2C, latest.

### 000.4.3 Contract Drawing References

1. Gulf Island Shipyards, *General Arrangement*, Drawing No. 6096-070-001, Rev.J, 2018.
2. Gulf Island Shipyards, *Removable Bulwarks*, Drawing No. 6096-160-001, Rev.-, 2017.
3. Gulf Island Shipyards, *Steel Hull Structural Arrangement*, Drawing No. 6096-100-01, Rev.K, 2018.
4. Einhorn Engineering, *Bucket Concept General Arrangement*, Drawing No.RCR-00-D504, Rev.-, 2018.
5. Einhorn Engineering, Jumbo Piston Core Assy, drawing RCR-02-D500, Rev.-, 2018.
6. Triplex, *A-frame Stern Dimension Sketch*, Drawing No. 18729, Rev.08, 2017.
7. Triplex, *RV OSU Handling Equipment Hydraulic Diagram*, Drawing No. S1664, Rev.05, 2018.
8. Glosten, *R/V Clifford A. Barnes Boom Crutch & Foundation Maximum Capability Document*, no. 15134.01, Rev.-, 23 December 2015.
9. Glosten, 'RCRV PCDR System Rev.B.3dm,' 3D model of aft RCRV deck showing bolt grid, bulwarks and A-frame, July 2020.

10. Glosten, *PCDRS Transom Appurtenance*, Drawing No. 12100.06-611-01, Rev(-), June 2020.

Updated drawings will be distributed when available.

**END OF SECTION**

# 001 OPERATIONAL DESIGN REQUIREMENTS

All tension members and handling equipment shall be built to the design criteria and documented in accordance with 46 CFR 189.35, *Wet Handling Gear*.

The PCDRM shall not interfere with A-frame operations. The A-frame leg locations during coring operations will be the outboard-most position as defined in Reference **Error! Reference source not found.**. The A-frame leg position during deployment and recovery operations is as indicated in Reference **Error! Reference source not found.** as the 'Deployment Retrieval position'.

Panama chocks, bolted deck fittings, and the aft bulwark shown in Reference 1 may be removed prior to system deployment as necessary. The starboard bulwarks shall remain in place during operations. Bolt-down aft deck appurtenances to assist in JPC rigging shall be installed at the transom. Figure 2 is indicative of these Owner-provided appurtenances, detailed in Reference 10.

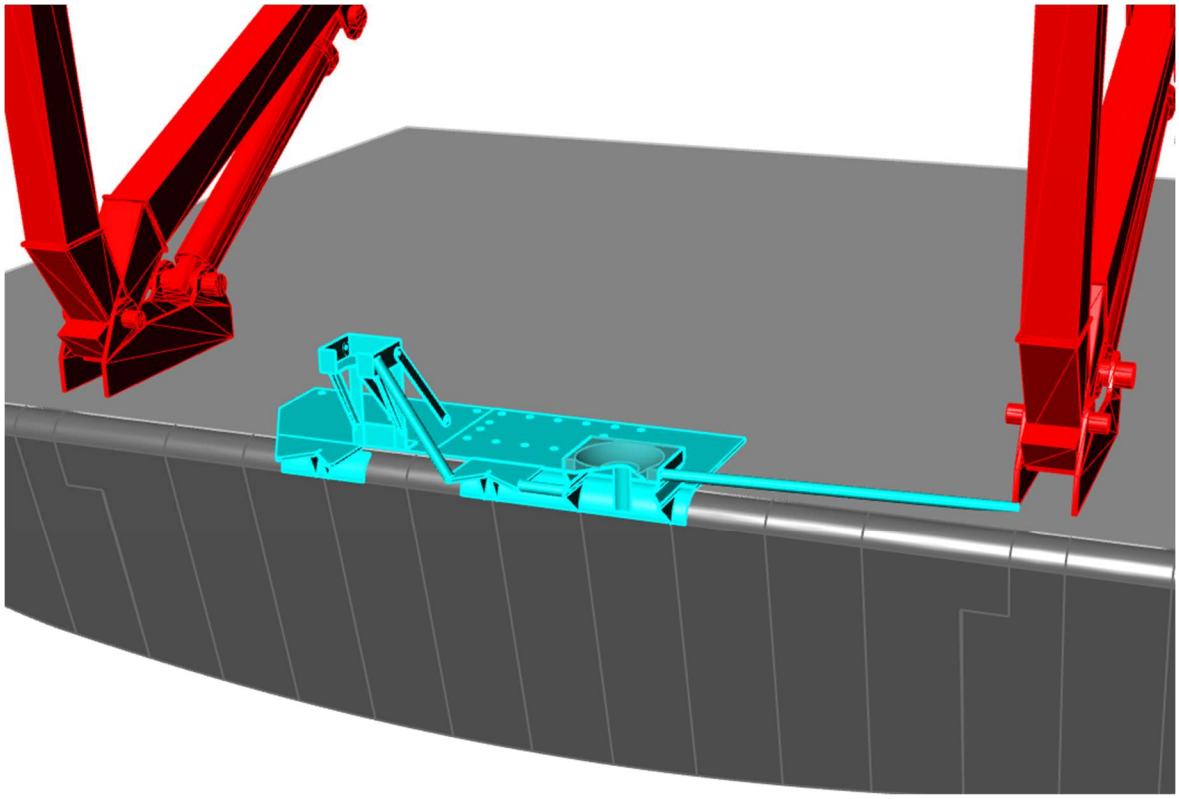


**Figure 2 Transom rigging appurtenances**

Reference **Error! Reference source not found.** is provided as guidance to the shape of the JPC, but the physical specifications of the jumbo piston corer for which the PCDRM shall be designed are listed in Table 1.

**Table 1 Design piston corer to be carried by PCDRM**

| Component | Minimum Rigged Pipe Length | Maximum Rigged Pipe Length | Design Total Weight |
|---|---|---|---|
| Jumbo Piston Corer (JPC) | 10 feet | 50 feet | 9,000 lbs |

## 001.1 Deployment and Recovery Operation

The PCDR System shall deploy a piston corer by moving it through four positions, illustrated conceptually in Figure 3 - Figure 6.

### 001.1.1 Position 1: Stowed inboard of starboard rail with core barrel horizontal and distal end of core barrel towards bow.

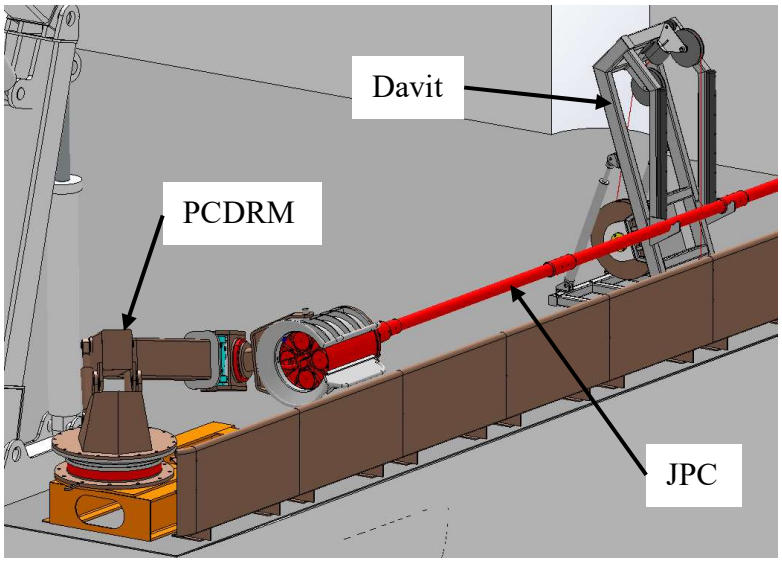



**Figure 3 Position 1, piston corer stowed on starboard deck**

When stowed in Position 1 during loading of liner and extrusion of cores, both sides of the entire secured piston corer from the weight stand to distal end of the core barrel shall be accessible from the Main Deck plating without climbing over machinery. A minimum clearance of 15” measured from the inboard edge of the bulwark handrails shall be maintained for passage on the starboard side of the core barrel. The core barrel shall be 36 – 45 inches above the deck.

Design shall allow vessel to be tied up to dock starboard-side-to when PCDR System is fully assembled and installed in the stowed position. Therefore, in the stowed position (Position 1) no system parts shall extend outboard to starboard beyond the ship’s starboard rub rail.

### 001.1.2 Position 2: Outboard of starboard rail with core barrel horizontal, distal end of core barrel towards bow.

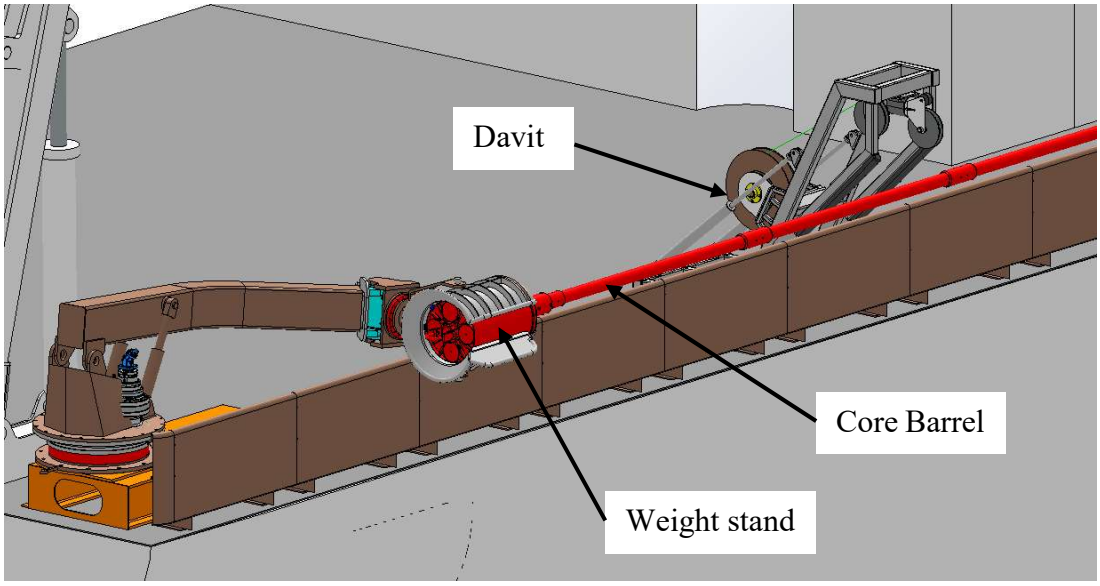



**Figure 4 Position 2, Piston Core outboard of sideshell, horizontal**

When moving between Position 1 and Position 2 on deployment, the weight of the core barrel shall be supported at approximately 22 feet from the base of weight stand to minimize deflection of the core barrel under its own weight. Typically, one davit shall be used to move the core barrel over the installed side bulwarks, Reference **Error! Reference source not found.**. A second davit installed further towards the JPC distal end is to be provided to meet this requirement for the full 50-foot core barrel. The bucket shall be moved outboard to clear the sideshell by at least 12 inches, the core barrel shall clear the sideshell by at least 27 inches.

### 001.1.3 Position 3: Outboard of starboard rail at stern quarter with distal end of core barrel toward seafloor.

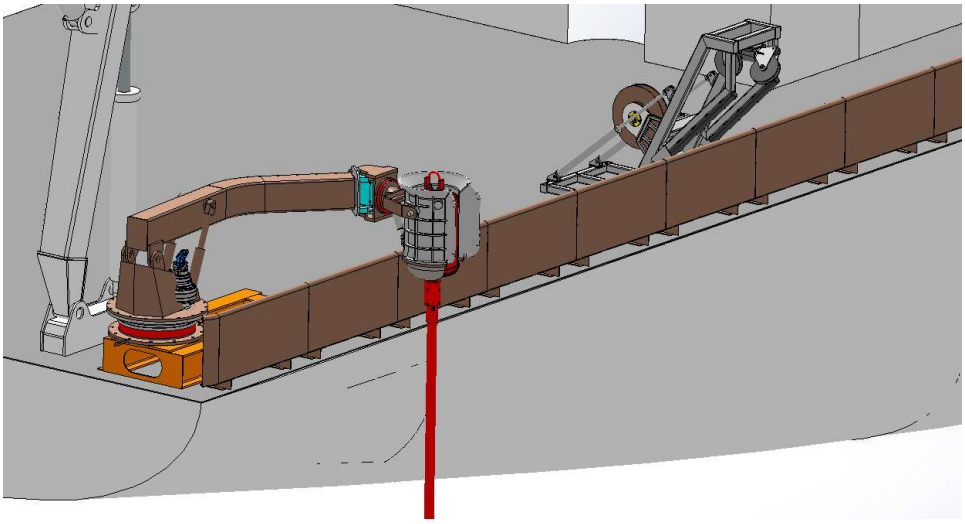


**Figure 5 Position 3, piston corer hanging vertical from transom corner**

Rotation between Position 2 and Position 3 on deployment shall be accomplished via gravitational force, with the first 15°-30° controlled by the davits rigged to the piston corer.

Decoupling of the piston corer from the davits prior to the final rotation between Position 2 and Position 3 shall be accomplished via a release mechanism provided by the Owner.

Upon reaching Position 3, the piston corer shall be oriented vertically.

Transit between Position 3 and Position 4 shall be aft around the starboard corner by rotating the PCDRM aft and to port.

### 001.1.4 Position 4: Bucket extended to fantail and ready for load transfer to pendant.

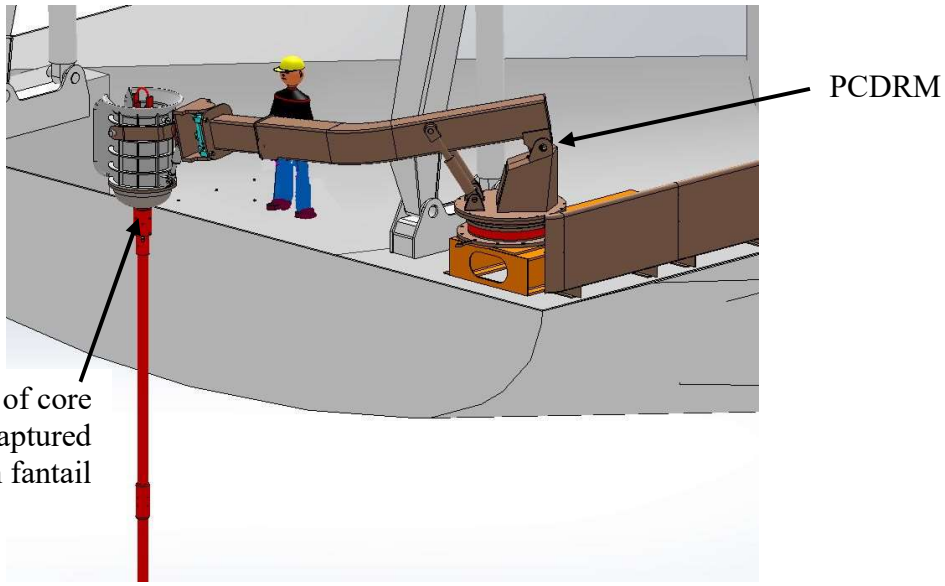



**Figure 6 Position 4, piston corer on the transom 3 feet starboard of centerline**

Position 4 is the PCDRM bucket resting on the bucket seat three feet starboard of vessel centerline. The bucket seat is defined in Reference 10. The bucket seat is designed to absorb vertical impact loads (Section 001.2) by deforming permanently when the PCDRM bucket is resting upon it. The bucket seat platform height will be no higher than 7" above the Main Deck surface. Figure 7 shows the detail of the PCDRM located at the bucket seat in Position 4.

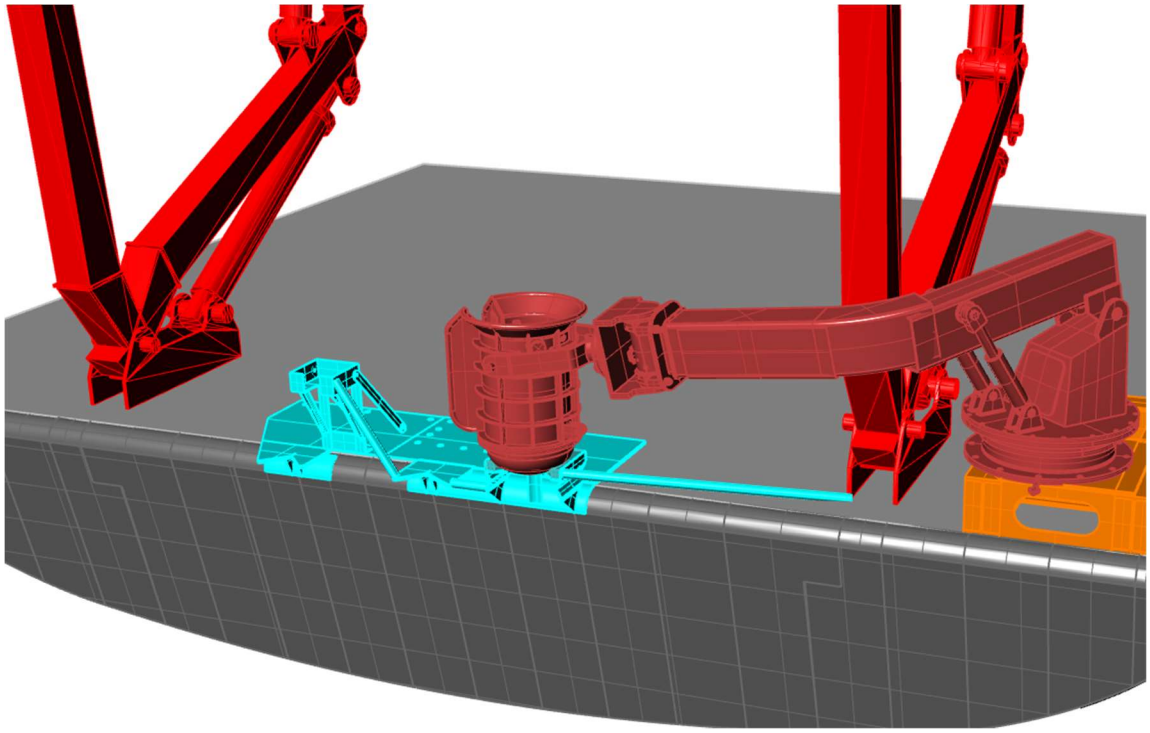


**Figure 7 PCDRM in Position 4 seated in Owner-provided bucket seat**

While the piston corer is in Position 4 on the fantail, the PCDRM shall allow the preparation and attachment of a pendant and trigger arm. The top of the bucket shall be no higher than 5 feet above the aft Main Deck when seated in the bucket seat. The bucket shall be located over the fantail to allow the core barrel to touch the transom. Access to the top of the weight stand by a person standing on the aft deck shall be maintained.

Recovery of the piston corer (Positions 4 to 1) shall be the reverse of deployment except that the davit(s) shall be used to raise the core barrel fully from Position 3 to Position 2. Attachment of the davit recovery line(s) to the vertical core barrel shall be accomplished by the Owner.

## 001.2 Operational Environment

The PCDR System shall be deployed on RCRV class vessels for use in marine environments.

The PCDR System shall be capable of withstanding the dynamic forces produced by the motion of the ship in a seaway. The dynamic forces shall be calculated based on the accelerations shown in Table 2. Load Case acceleration loads are to be applied at the same time, evaluated in both directions in combination except for the Impact Position 4 load case.

When in Position 4 (see Section 001.1.4), the PCDRM shall be capable of withstanding a vertical impact load due to the weight stand dropping into the bucket.

**Table 2 Design Loads**

| Load Case Sets | PCDR System status | Longitudinal &Transverse Accelerations | Vertical Acceleration | Impact Energy |
|---|---|---|---|---|
| Operational (Sea State 5) (8 directional combinations) | Fully operational | 0.4g F/A + P/S | 1.3g up/down | - |
| Survival (Sea State 7) (8 directional combinations) | Stowed | 0.6g F/A + P/S | 1.5g up/down | - |
| Impact Position 4 – drop (1 combination) | Fully operational | | 1g down | 42,500 ft-lbs acting down |

The PCDR System will be routinely exposed to seawater spray and parts of the system may be submerged for brief periods. PCDR System components that are located beyond the Main Deck edge may be exposed to slamming loads. A slamming pressure of 0.4 psi shall be applied to the underside projected area of all components projected beyond the Main Deck edges.

The operational air temperature range shall include normal temperatures for polar and tropical regions and shall be -9°C to 38°C.

The PCDR System will be stored in an uncovered state when on shore and will be exposed to marine weather and ultraviolet radiation.

**END OF SECTION**

## 002 MATERIAL AND CONSTRUCTION STANDARDS

The PCDRM and davits shall be designed and manufactured to one of the following Rulesets:

- Section 18 Handling Systems of the ABS Rules for Building and Classing Underwater Vehicles, Systems and Hyperbaric Facilities, latest
- API Specification 2C Offshore Pedestal-mounted Cranes, latest

Materials, equipment, and workmanship involved in the construction shall be new and of a quality conforming to "first-class marine practice" for use on vessels in ocean service. By "first-class marine practice" it is meant that the build is to a standard or level which leads to: 1) long service life, 2) lower maintenance cost, 3) ease of operation by shipboard personnel, 4) increased reliability in service, and 5) availability of spare parts and or service from the manufacturer.

The PCDR structural system components shall be constructed of steel. All external construction seams shall be 100% continuously welded to reduce possible areas for corrosion by seawater intrusion.

The variety of fastener sizes and types shall be minimized throughout system to reduce the number of tools necessary for maintenance and repair. Fasteners shall be 316 Stainless Steel wherever possible. Bolts and washers used for securing the devices to the deck shall be 316 stainless steel 1 inch-8 UNC wherever possible. Other bolt alloys shall be acceptable when proven necessary with calculations. Dissimilar metals shall be galvanically isolated.

Surface preparation and finish after welding shall consist of bead blasting and the following paint specifications: Ameron Dimetcote 302H Primer 3 mil, Amerlock 2 Primer 5 mil, Ameron PSX 700 Top Coat 3 mil. Final colors TBD.

All materials which cannot be coated, or where coatings are subject to damage or wear, shall be constructed of marine grade, corrosion resistant materials such as 316L stainless steel, or suitable nickel-chromium-molybdenum alloys. Examples include but are not limited to fasteners, washers, cylinders, rods, shafts, bearings, gears, Zerk fittings, hose fittings, and supports.

**END OF SECTION**

# 003 FUNCTIONAL SPECIFICATIONS

## 003.1 PCDR System

The PCDR System is comprised of three elements as follows in this section. The PCDR
190 System shall be arranged on the aft starboard deck corner per Figure 8 - Figure 10. The system footprint on the deck plating shall be minimized.

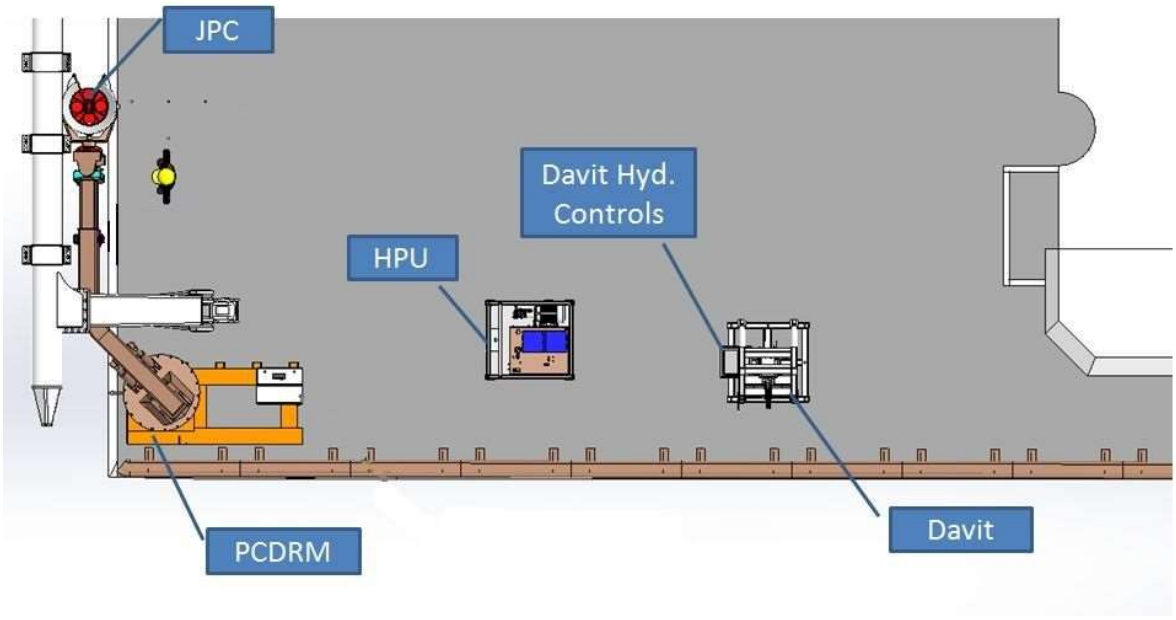
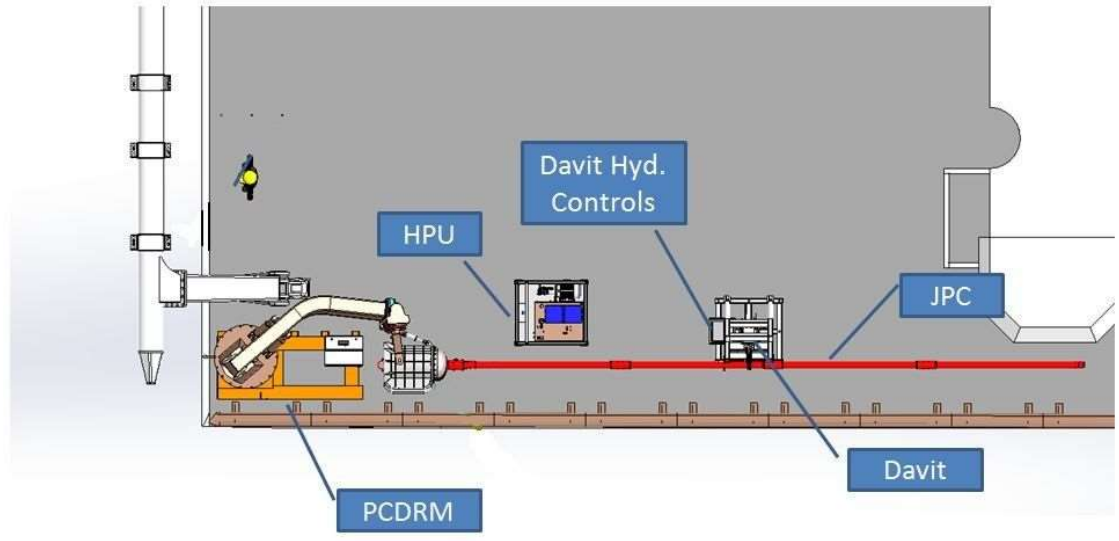



**Figure 8 Arrangement of PCDR System with PCDRM in Position 4**




195 **Figure 9 Arrangement of PCDR System with PCDRM in Position 1 (stowed)**

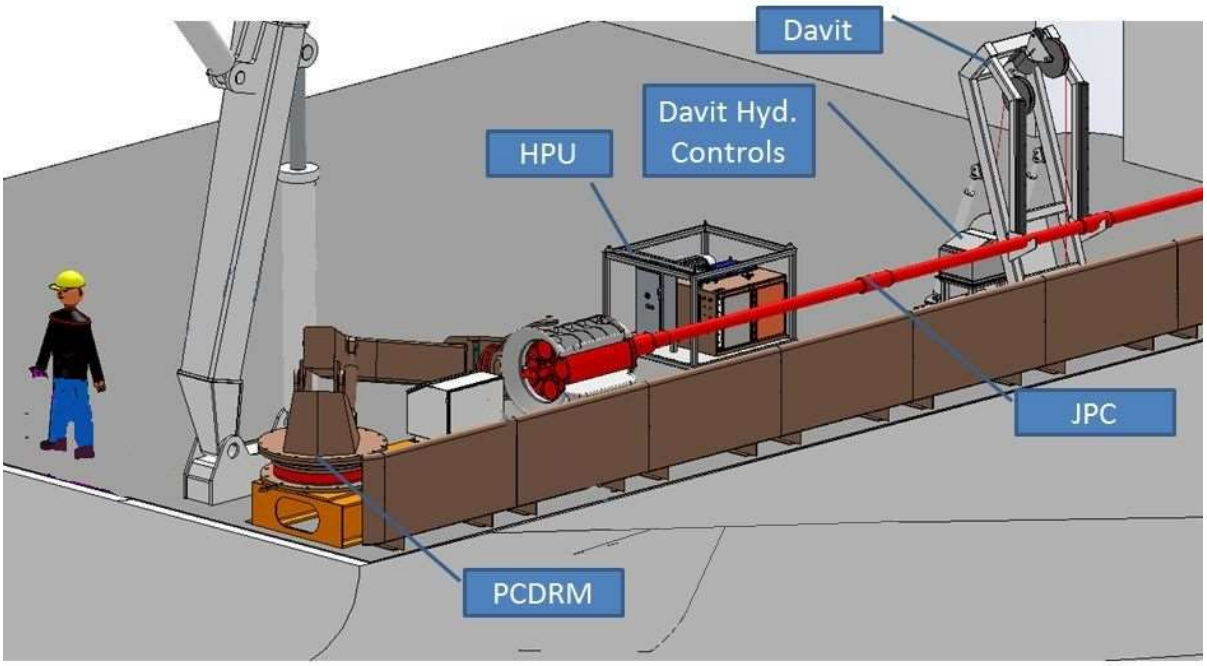



**Figure 10 Arrangement of conceptual PCDR System on aft starboard deck (stowed)**

Design shall minimize moving parts and use central lubrication whenever possible to simplify lubrication maintenance. Where central lubrication is not possible, Zerk fittings shall be utilized for greasing moving parts. Zerk fittings shall be extended with hoses and consolidated in a central accessible location to facilitate lubrication.

Electrical power is to be 480 VAC. 480 VAC receptacles are located at the existing main crane base (Frame 64, 30A, 100A, 225A), and at the base of each existing A-frame leg (30A).

Design shall, to the greatest extent possible, facilitate routine maintenance and repair of the system at sea using a portable set of standard shipboard tools. Commercial off-the-shelf components shall be used wherever possible. Where specialized tools are required, these shall be provided by the Vendor. Any wearable component that is not commercially available shall be provided as part of the Spare Parts Kit.

Every component of the PCDR System shall be secured to the RCRV main deck using only the 24 × 24 (inch) deck bolt grid array as described in Reference **Error! Reference source not found.**. This grid array will determine placement and geometry of the individual components of the PCDR System. The maximum pull-out force on any single deck socket shall not exceed 6,000 lbs. unless analysis is provided justifying higher loads. The maximum loads on deck plating shall be distributed such that the maximum deck bearing pressure is less than 2,000 psi in all load conditions.

The max combined weight limit for the PCDR System (PCDRM, davits, and HPU) shall be 20,000 lbs. Monetary incentives shall be negotiated by the Owner based on how far

under the maximum combined weight limit the PCDR System is when accepted as delivered.

### 003.1.1 PCDRM

The primary motive element of the PCDR System is the PCDRM, a swing arm with a bucket as shown in Figure 11. The PCDRM shall include a slewing gear and pinion drive actuation to rotate the machine from Positions 1-4. The PCDRM footprint shall be kept to a minimum at the aft starboard corner.

The Vendor shall design and provide the PCDRM.

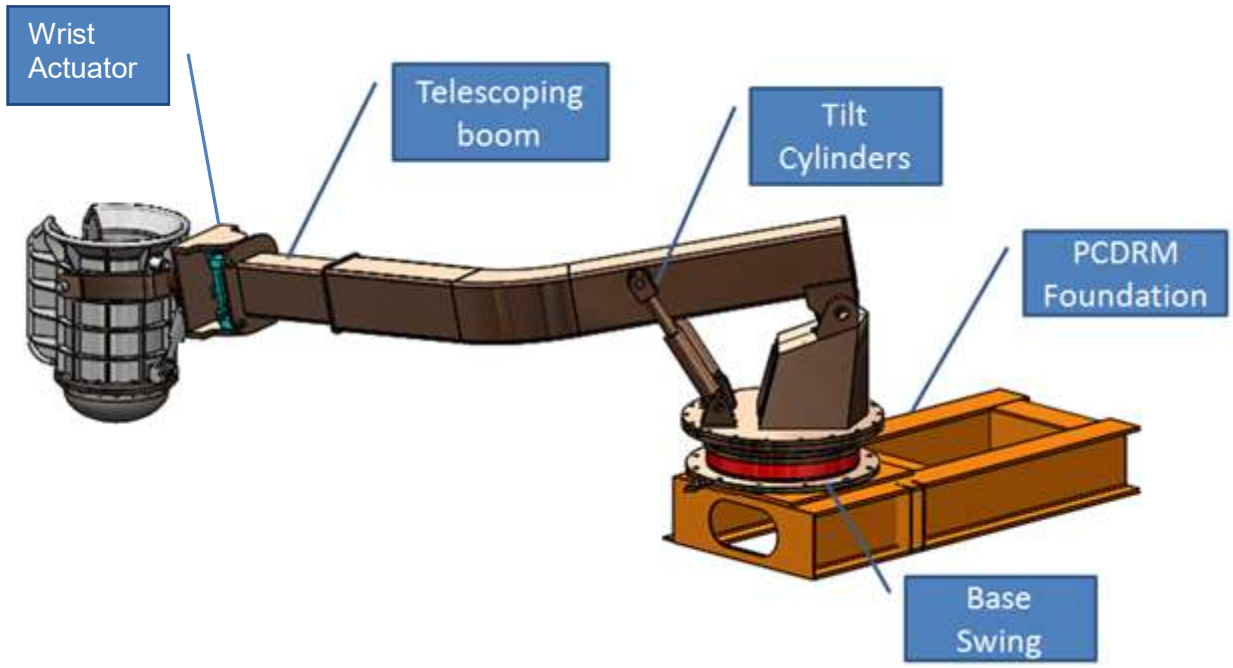



**Figure 11 Isometric View of PCDRM concept in Position 4**

Maximum weight: The combined PCDRM and foundation shall weigh no greater than 15,000 lbs. such that the existing ship's crane can be used to move the assembled PCDRM and foundation system from the dock to its operational position on the main deck.

The PCDRM main boom shall be constructed such that when in Position 4 and when the A-frame is situated for the JPC load transfer, it sits in the Owner-provided bucket seat. Physical stops or limit switches shall be installed to prevent over-rotation past Positions 1 and 4.

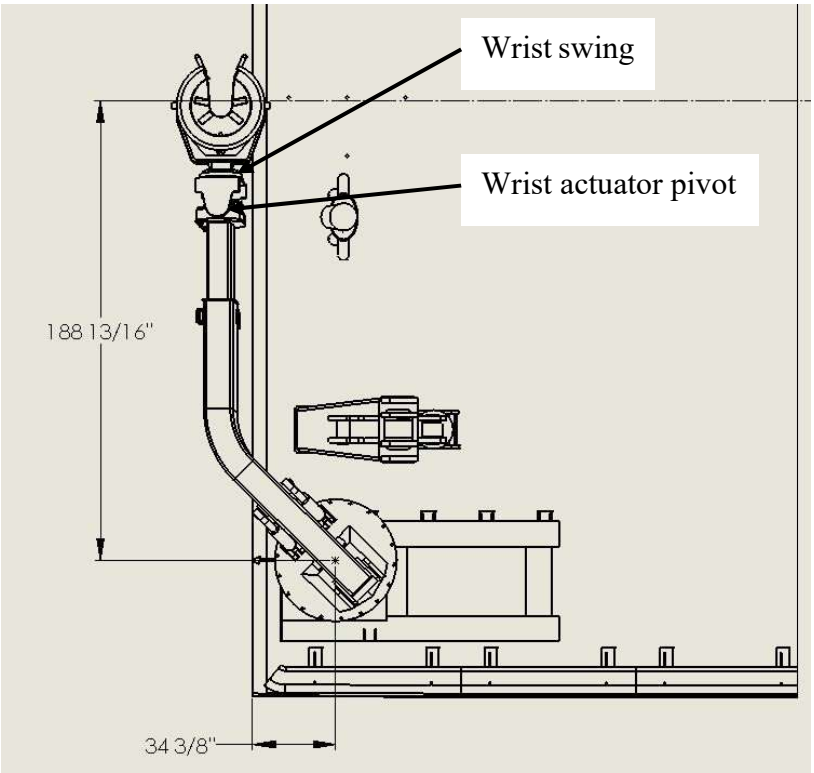



**Figure 12 PCDRM showing aft deck arrangement and notional PCDRM pivot center dimensions from CL and transom**

The wrist actuator shall align the core barrel with ship's fore and aft direction. This actuator shall rotate ~180 degrees (nearly +/- 90 degrees from equilibrium) and be rated for the A-frame JPC transfer loads as defined in section 001.2. The wrist swing shall include a manual or hydraulic lock to prevent bucket movement at the horizontal Position 1.

The bucket shall be mounted on a gimbal at the end of the PCDRM wrist and shall enclose and retain the JPC weight stand. The gimble shall rotate freely with buffer stops at +/-5 degrees from the equilibrium plumb position when hanging vertically. Bucket dimensions shall resemble those of Reference **Error! Reference source not found.**.

Bucket runners shall be marine grade polymer surfaces to protect the coating system when the JPC contacts the bucket.

Bucket guide plates shall be flared surfaces at the upper opening and the slot to guide the JPC into the bucket while the JPC is hanging from the A-frame sheave as shown in Figure 13.

The bucket shall have an integrated spring-loaded pin (normally closed) that locks the JPC into the bucket at Positions 1 & 2. It shall include a locking feature to hold the pin open. PCDRM controls shall include an indicator showing the bucket lock status.

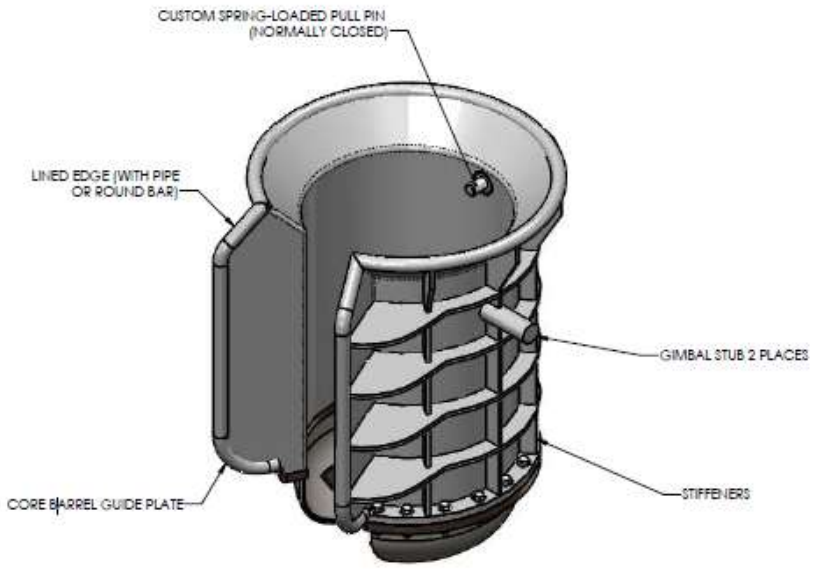



**Figure 13 Concept bucket general arrangement**

See Reference **Error! Reference source not found.** for conceptual PCDRM geometry.

### 003.1.2 Davits

The Vendor shall provide two interchangeable davits integrated to work in tandem with the PCDRM to deploy and recover the piston core between Positions 1 and 3. The davits shall be attached to the Main Deck using only the deck bolt grid array. The design pick location shall be nominally 20 feet from the bottom end of the weight stand in Position 1 with the intention of centering the pick point on the second joint of the core barrel. Table 3 lists the required design parameters for the davits.

**Table 3 Davit design parameters**

| Speed | Line break load and angles | Minimum Articulation Outboard | Minimum Line length |
|---|---|---|---|
| 100 feet per minute line in/out, at maximum operational load | 5,000 lbs at maximum extension outboard, note CFR requirement for supporting structure to be at least 1.5 to yield at line breaking load | 72 inches from inboard stowed position to outboard lifting (between Positions 1 & 2) | 50 feet |

The davits shall be arranged such that they do not interfere with the installed bulwarks, Reference **Error! Reference source not found.**, when recovering the piston core between Positions 2 and 3. The core barrel supported at the davits shall be raised at least 24 inches above the top of the bulwark to account for the sagging of the distal end of the long core barrel. When stowed or in operation, the davits shall not extend farther inboard than 13' feet off vessel centerline.


**Figure 14 Example davit B, can act as core stand when stowed at Position 1**

The davit winch drums shall level wind evenly. The winch drum shall have the capacity to store each davit pendant and rigging: 50 feet of ¼" diameter stainless steel pendant cable, 3/8" Crosby pin shackles, and Nicopressed thimbles.

The davits shall include a fair-leading sheave system that will rotate as the cable angle changes from hanging vertically for Position 2 to roughly 45 degrees off vertical for Position 3. The system will have enough clearance to pass all the pendant rigging without damage.

### 003.1.3 Hydraulic Power Unit (HPU)

The Vendor shall provide an HPU to power the PCDRM and the davits. The HPU shall be independent, electrically powered and skid mounted.

The hydraulic system shall be designed to allow powering from the ship's hydraulic take-off as well. See Reference **Error! Reference source not found.** for hydraulic specifications and available pressure and flow at the take-off.

Figure  shows a concept hydraulic system one-line. A single HPU is depicted to power both the davits and the PCDRM system. Alternatively, the davit system may be served by a dedicated HPU or utilize the electrical resources available on the aft deck.

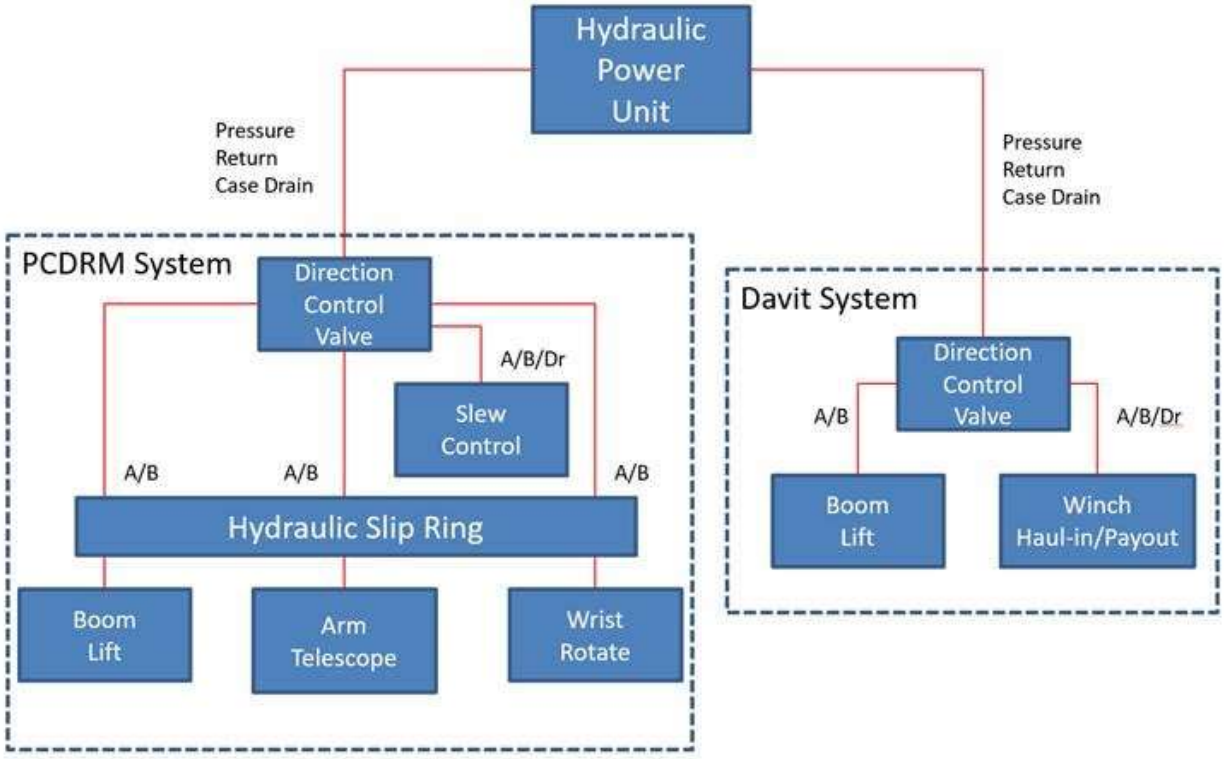



**Figure 15 Concept hydraulic one-line diagram for PCDR System**

All hydraulically powered PCDR System components shall use RSC Bio Solutions FUTERRA HF 32, the same as the vessel's hydraulic system.

The provided HPU shall have the capacity to drive actuator speeds per

Table 4 while in the design load condition at SS5.

**Table 4 Required Actuator speeds for PCDR System**

| Actuator | Required speed under full load |
|---|---|
| Slewing gear | 8 degrees/sec |
| Boom lift cylinders | 2 degrees/sec |
| Wrist actuator | 30 degrees/sec |
| Boom telescoping | 4 in/sec |

The HPU will be operated on the weather deck and thus must incorporate design features and construction to ensure its reliability and long life for this type of exposure.

The HPU shall operate on three phase, 480 VAC electrical power supplied from the host vessel. The electric motor to be IEEE 45 standard. All electrical enclosures shall meet or exceed the NEMA 4X rating. All control cable connections shall utilize subsea type connectors to be immune from corrosion and contamination.

The hydraulic system and power unit shall have a maximum system pressure of 3,000 psi. The HPU shall have a sealed reservoir system so no air exchange occurs with the surrounding environment and shall have filtration for all outgoing and incoming fluid.

Electrical and hydraulic components shall be rated to IP67 or better. The HPU tanks, fittings, fixed piping, exposed pipe supports, fasteners and clips, and quick disconnects shall be corrosion resistant constructed from type 316L stainless steel. Effort is to be made to maximize the usage of 316L stainless steel hydraulic tubing lines and minimize hose lengths.

All hoses shall be Parker 487 Global Core series or equivalent and terminated with stainless steel female swivel JIC fittings. The HPU circuit design shall incorporate Eaton Aeroquip FD89-2000 series stainless steel quick disconnect fittings to allow connection to an external hydraulic source for emergency situations. Hoses shall be stainless steel armored, and suitable for the marine environment, including protection from UV, impact damage and corrosion damage. Hydraulic hoses shall be contained or routed in such a manner to minimize snagging and tripping hazards on the deck of the ship.

### 003.1.4 Controls

Control of the PCDRM shall be via a wireless control chest pack with a second wired chest pack for backup. Control of the davits shall be a wireless chest pack with local controls at the machine for backup. The davit control valve station shall be located at the davit, and the PCDRM control valve station can either be located at the PCDRM (preferably) or in the HPU if accessing the valves is not possible at the PCDRM.

Broadcast frequencies and channels used for the wireless control chest packs are to be approved by Owner.

Proportional type directional control valves for the PCDRM and the davits shall have manual control handle overrides housed in a stainless steel NEMA 4X cabinet and readily accessible during coring operations. Each enclosure shall have a latching door that can be opened to provide sufficient access to operate the valve handles.

## 003.2 Assembly and Shipping

The PCDR System shall be able to be disassembled and shipped in-gauge on one standard ISO 20-foot shipping flat rack or in-gauge on a standard semi-truck trailer bed (no wider than 8.5 feet).

All PCDR System components as well as the assembled system shall be equipped with balanced lifting points resulting in horizontal bolt faying surfaces and easing system deployment. Balanced lifting shall be achieved using an equal length bridle.

The PCDR System components shall incorporate forklift pockets to facilitate handling.

**[Optional Item]** All system lifting points shall be flush or removable to eliminate tripping and entanglement hazards.

## 003.3 Safety

The PCDR System shall conform to safety standards for use aboard UNOLS vessels as outlined in UNOLS *Research Vessel Safety Standards* 10th Edition (July 2015) and applicable updates.

Emergency shutdown means shall be available at each of the control stations.

At all times when the piston corer is captured by the PCDRM, the weight stand shall be secured in the bucket via a locking system as detailed in Reference **Error! Reference source not found.**.

In the event of a failure of any system component during deployment or recovery, the system shall hydraulically lock and hold loads in position. The system shall arrest movement at any position except the JPC rotation between Positions 2 and 3. Redundant components and counterbalance valves shall be utilized to ensure personal safety with a single component failure. A failure modes and effects analysis shall be performed.

A redundant mechanical lock shall be engaged at Position 1 to prevent movement of the PCDRM.

**[Optional Item]** A purely mechanical backup system shall be incorporated that would allow manual recovery of the PCDR from Position 4 to Position 1 assisted only by the ship's crane to allow lifting the core barrel from Position 3 to Position 2. The mechanical backup system shall be stand-alone and shall be manually operable using personnel only. Provisions, such as properly placed padeyes and hydraulic bypass valves, shall be provided to allow manual movement by the use of small, owner-provided 'tugger' winches.

**END OF SECTION**

# 004 REQUIRED DELIVERABLES

The PCDR System shall be provided with the documentation and spares described in this section.

## 004.1 Design Meetings

Vendor shall provide check-in meetings remotely or in-person with the Owner's representatives. Design meetings shall include progress reports on design decisions, schedule, and budget. The purpose of these meetings is to clear up any questions that arise and keep the Owner apprised of the progress. 3D model demonstrations shall be provided during each meeting. Design meetings are to be held at the design kick-off, 50% completion, 90% completion, and 100% completion.

## 004.2 Test Procedures

Test procedures for the PCDRM and davits shall be developed and written by the Vendor for yearly testing onboard the vessel by the Owner. Testing of the PCDR System shall be done using 125% of the resultant loads from the Operational condition in Table 2, Section 001.2. Cable angles and test loads shall conform to the worst-case engineering operational angles and loads as determined by the Vendor.

Test procedures for the PCDRM and davits shall be provided by the Vendor as specified in Section 005.1.

## 004.3 Maximum Capability Documents (MCD)

The Vendor shall provide MCDs for the PCDRM and davits at the Operational environment listed in Table 2, Section 001.2. The MCD for each piece shall reflect the capabilities of that piece of equipment including capabilities in excess of the requirements listed in this Specification. An example MCD is included as Reference **Error! Reference source not found.**. The SWL and DLT if applicable shall be reported in the MCD and stenciled onto the component. The MCD shall be delivered prior to fabrication.

The Safe Working Load (SWL, or Safe Working Tension as appropriate) shall be defined as the maximum weight of the jumbo piston core the PCDRM and davits can functionally manipulate in the Operational environment defined in Table 2, Section 001.2 while maintaining a minimum safety factor of 1.5 on the yield strength of any part of the component.

The Design Line Tension (DLT) shall be the nominal breaking strength of the line entering the water. The davits shall comply with 46 CFR 189.35, *Wet Handling Gear*.

## 004.4 Pre-Fabrication Deliverables

### 004.4.1 Calculations

The Vendor shall be responsible for all necessary engineering calculations to produce the design. Calculations for a weight estimate and the MCD shall be presented to the Owner's Representative for review and comment prior to start of fabrication. Any calculations to be submitted to the Regulatory Bodies shall be provided to the Owner's Representatives for review and comment two weeks prior.

All calculations required to design and build the equipment and components shall become the property of the Owner.

### 004.4.2 Working Drawings

Prior to start of fabrication of the equipment, the Vendor shall provide the following working drawings for review and comment by the Owner's Representative:

- Equipment arrangement drawings.
- Equipment parts list including third-party part information.
- Construction detail drawings that include material types and drawings for each individual part of the equipment.

Working drawings shall be provided in native format and in PDF format.

### 004.4.3 Digital and Scale Physical Model

A 3D digital model of the full system operation will be delivered at the end of full design. This will be for design demonstration and verification as well as post-delivery outreach.

A 1/10th scale physical model of the equipment shall be constructed and include all the elements necessary to demonstrate satisfactory operation to their full inboard and outboard positions for deployment and recovery. The model will integrate into the RCRV shipyard supplied 1/10 th scale physical model supplied by the RCRV shipyard. The Physical Model shall be delivered by the end of full design.


Figure 16 RCRV shipyard supplied 1/10 th scale physical model

## 004.5 As-Built Deliverables

### 004.5.1 As-built Drawings

The Vendor shall provide final revisions of all working drawings and models, termed as-built drawings and models, that represent the final as-delivered equipment. The arrangement drawing, parts list, weight estimate, and construction detail drawings and models shall be provided as part of the as-built drawing package. Drawings and or models of any custom parts on the spare part list shall be provided as part of the as-built package.

To support long-term maintenance, construction detail drawings shall be of sufficient detail to fabricate any individual part or groups of parts. As-built drawings and models shall be provided electronically in PDF, DXF, and native formats.

### 004.5.2 Technical Manuals, Instruction Books, and Equipment Manuals

The Vendor shall provide technical manuals for all equipment furnished by the Vendor. The technical manuals shall contain instructions for operation, installation, maintenance, and repair, and a parts list.

## 004.6 Spares

A spare parts list shall be compiled of items that require periodic replacement for maintenance.

The Vendor shall provide a Spare Parts Kit including off-the-shelf and custom parts that will be replaced in the order of regular maintenance.

A recommended long term and/or long lead-time spares list for items beyond the regular maintenance requirements.

**[Optional Item]** The Owner will negotiate additional cost on the extents of the custom parts included in the Spare Parts Kit.

**END OF SECTION**

# 005 TESTING, TRAINING AND TRIALS

The Vendor shall perform the testing required in this section.

## 005.1 Factory Acceptance Tests (FAT)

The PCDRM, HPU, and davits FAT shall be conducted by the Vendor individually or in coordination at a suitable facility. FAT shall include static load testing to 125% of the resultant loads from the Operational condition in Table 2, Section 001.2, dynamic load testing, wireless and local operation, and emergency operation and safety device testing. Cable angles and test loads shall conform to the worst-case engineering operational angles and loads as determined by the Vendor. FAT test procedures shall be submitted to the Owner for review and approval 30 days prior to testing.

A suitable temporary tension member shall be used for load testing. Tension members delivered with the system shall be new and shall not be used for load and overload testing.

Periodic in process shop inspections may be organized with the contractor during production.

## 005.2 Training and Trials

The vendor shall develop a training plan for approval that will include hands-on training by contractor representatives for vessel loading and setup, full system operations including the at sea trials. This will include no less than 8 hours of shoreside training and one day trip for at sea trials.

**END OF SECTION**