TDI-BROOKS PISTON CORER

The TDI-Brooks Auto T-Bar instrument measures the progressive resistance of a soil column to a cylindrical rod (shaped as an upside-down **T**) as it is pushed down the soil column at a constant rate. The instrument is shown at right, with its T-bar protruding from the bottom.

OVERVIEW

The TDI-Brooks 3-inch-diameter piston coring (PC) system consists of various hardware assemblies designed to be safely and robustly fastened together into a working core rig and deployed to the seabed for extracting a piston core. Such a core rig can be assembled to be 10 to 40 feet long and is 3 inches in barrel ID. An example of a core rig ready for deployment is shown in **Figure 1.**

Figure 1) TDI-Brooks 3-Inch Piston Coring Rig

The core barrel assembly is made up of selected lengths of core barrel sections, connecting collars, a core liner inside the barrel assembly, a core catcher, a core cutter, and set screws to hold the barrel assembly together. The barrel length can be adjusted in 5-foot increments by adding 5 or 10-ft barrel sections and connecting collars. The rig shown in **Figure 1** has a barrel that is 20-ft long, using one 10-ft barrel section and one 5-ft barrel section, and with the uppermost 5 ft of barrel built inside the core head. The extended piston corer (XPC) employs an additional barrel section and a longer triggerpendant.

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The deployed core rig comprises component assemblies of the core head, the core barrel, the piston, and the trigger system. The core head assembly is made up of a 2,000 lb lead-weighted core head with nosepiece and a coupling with which to attach lengths of core barrel sections. It also has a lifting flange assembly that attaches to the trigger system. The trigger assembly is made up of the trigger pendant, trigger arm, pendant clamp, trigger weight, trigger wire, and trigger wire connecting system.

The main winch, main-line coring rope, and the PC coring A-Frame are used for deploying and retrieving the 3-in. piston core rig on TDI-Brooks vessels. In addition to the deployed hardware, several assemblies are mounted to the vessel working deck to manage the deployment and retrieval of the coring rig. These assemblies include the main sheave from a starboard or port-side coring A-Frame, as well as core-head and trigger tugger winches with their hydraulic power pack.

We also have a deployment system for use on 3rd-party vessels not having a provision for a side-mount A-frame. This system includes a stern deployment track in addition to the kit described above. A schematic with dimensions is shown in **Figure 2**. A photo of the system in operation on a 3rd-party vessel is shown in **Figure 3**

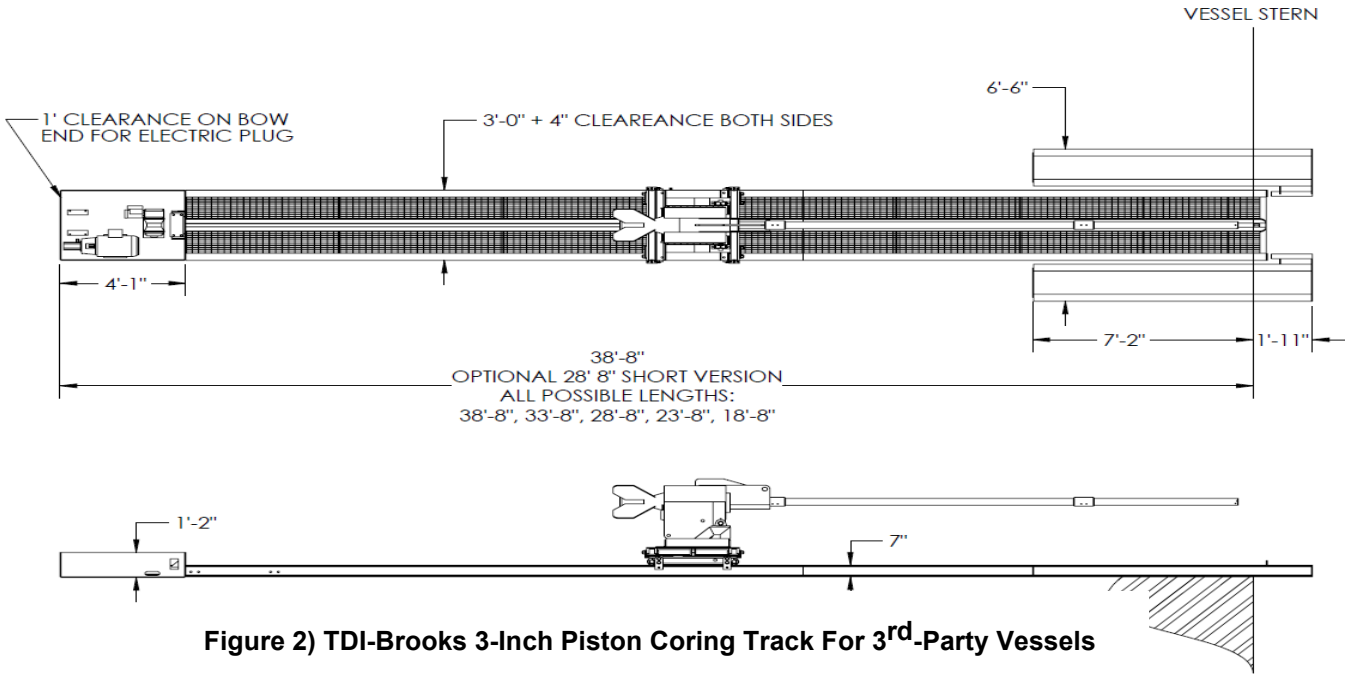

Figure 2) TDI-Brooks 3-Inch Piston Coring Track For 3rd-Party Vessels

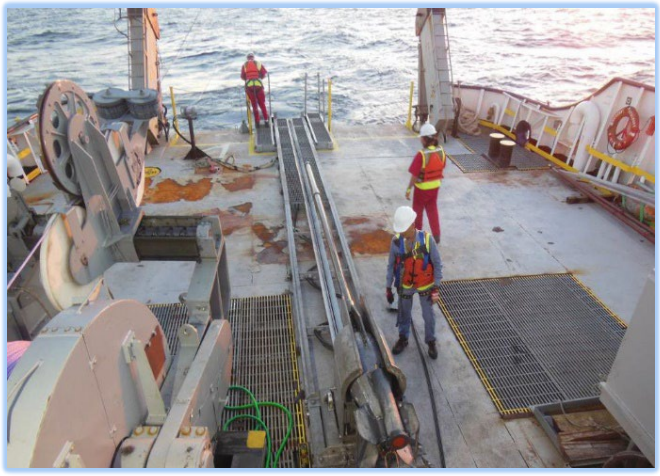

Figure 3) TDI-Brooks 3-Inch Piston Coring Track On A 3rd-Party Vessel.

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A piston corer uses a free fall of the coring rig to achieve the desired initial force on impact, and a sliding piston inside the core barrel to reduce inside wall friction with the sediment and to assist in the rapid evacuation of displaced water from the top of the corer. These elements act in concert to maximize core recovery. It uses a trigger assembly to release and allow the corer to free-fall with the core barrel tip starting just above the seabed. The impact speed of the piston corer into the bottom is independent of the winch payout speed. Proper pendant and trigger wire lengths, as well as stopping the winch payout upon trigger, are critical for the proper action of the piston within the barrel. The sequence of piston coring events is shown in **Figure 4**.

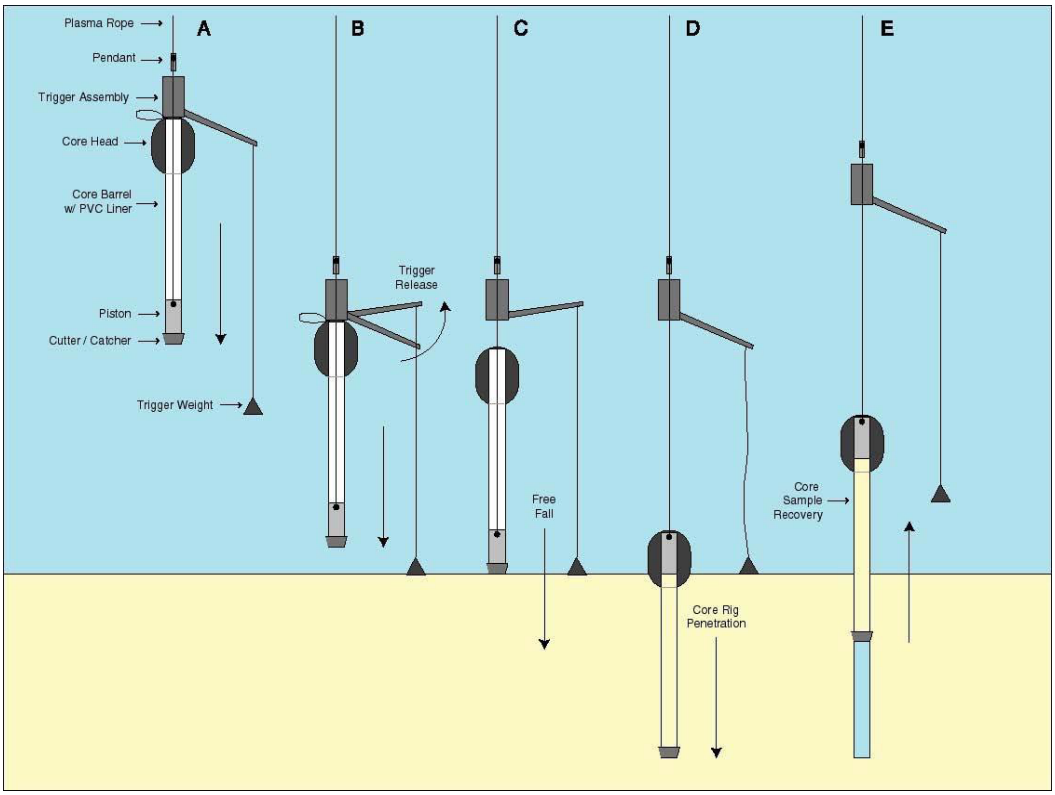

Figure 4) Schematic Of A PC Or JPC Operation At The Seabed

Referring to the schematic**:** As the corer nears the bottom (**A**), the winch payout speed is slowed and preparations are made to stop the payout at the instant of release. As the trigger weight impinges the seabed (**B**) the weight is released from the trigger arm, and the trigger arm begins to rise with respect to the rig. At this point, the core barrel tip is still above the seabed. When the trigger arm has risen through its full travel (**C**), the corer is mechanically released to free-fall down through the seabed. At this point, the barrel tip of the corer is just above the seabed, as programmed by the proper length of the trigger wire. The moment of release is noted by the Winchman as a sudden drop in main line tension. At the instant of release the payout of the winch is stopped, thus fixing the length of coring rope out. The corer separates from the trigger assembly and free-falls through the seabed, penetrating the upper several meters of sediment. When the falling core rig reaches the end of its pendant slack, the internal piston stops moving downward along with the core rig (**D**) and becomes fixed with respect to its height about the seabed. The still-falling core barrel then creates suction (much like a syringe and its plunger) between the piston and the soil entering the barrel, enhancing the distance the soil sample will move up the barrel.

The length of the trigger wire, the length of the pendant, and the halting of the rope payout are in concert such that the main rope becomes taut just as the core cutter at the bottom of the barrel comes within a few inches of the seabed. This results in a core with about a few inches of water head between the bottom of the piston and the soil surface inside the liner. When downward momentum of the core has stopped with complete penetration, a slow pullout on the winch is begun. At the initial stage of pullout, the piston slowly moves to the top of the core barrel in response to the Winchman's tension on the core wire. The piston has a built-in check valve so that water can pass through it when it

is moving at slow speed (**E**). It fetches up against the stop in the core head, and the corer is pulled from the seabed.

Retrieval after pullout can proceed as fast as the winch is capable. Winch speed is typically 60 to 80 meters of line per minute. The piston prevents washout of the sample from the top, and the core catcher prevents the sample from backing down out of the barrel tip. In extremely sandy areas, if core material is lost during the retrieval process, typically a “sock” is put in the core cutter to act as a one-way valve, and re-sampling at the site is performed in an attempt to obtain greater recovery.

A picture of the core rig barrel end with the cutter and catcher removed to show the internal piston protruding is shown at left in **Figure 5**. The core liner inside the barrel is visible. At right the installed cutter/catcher/piston assembly is shown. To rig the PC system, a load-tested PC pendant is inserted with one end hanging out the bottom of the core barrel and the other end hanging out the top of the core head. A piston pin is installed to connect the bottom end of the pendant to the piston (the pin is barely visible in the photo), and then the piston, catcher, and core cutting shoe are mounted to the bottom end of the core barrel with set screws.

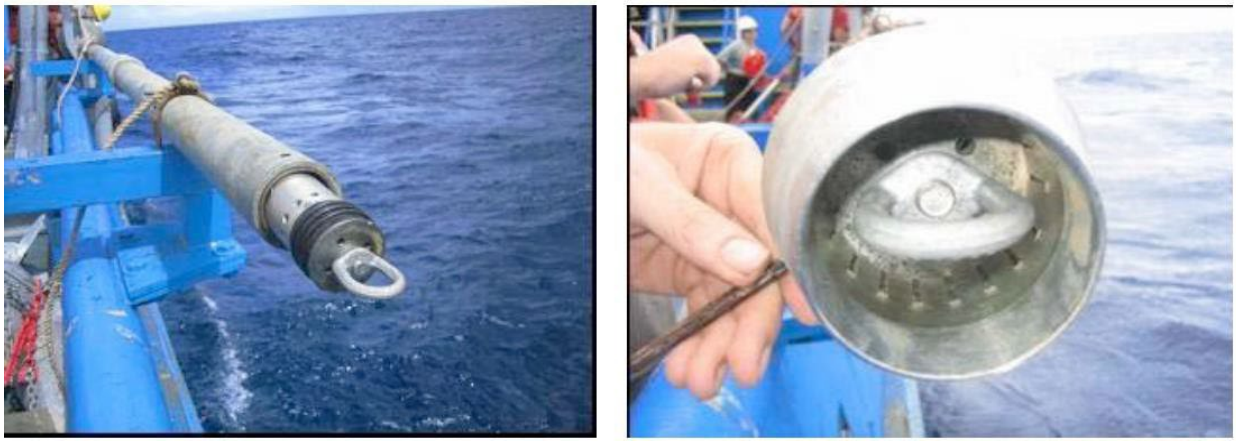

Figure 5) Barrel End Of The PC Rig With Piston Showing

The trigger assembly is attached to the top 3 ft section of the pendant by clamping the trigger assembly bar on the pendant, and then properly configuring and securing the trigger assembly to the core head assembly. The system is rigged in such a way that the pendant wire rope will come out of the core head with the proper amount of extra loop available, as dictated by the core barrel length and soil strength at that location. This results in programming a free-fall loop in the pendant of precise distance.

All of the described lifting/rigging gear is regularly load tested and inspected. The main coring rope have a load- tested and inspected Tuck eye splice termination woven into its loose end. The pendant is connected to this termination using a pendant pin. This assembly is designed to roll through the sheave and heel block. For this reason, a rope thimble is not used in the termination loop, because the roll-thru-the-sheave acts with the thimble to incrementally cut and wear the rope over time.

The main winch, main coring rope, and the port A-Frame are used for deploying and retrieving PCs. In addition to the deployed hardware, several assemblies are mounted to the vessel working deck to manage the deployment and retrieval of the coring rig. These include the track/bucket/heel-block assembly, the main sheave from the port A-Frame, and the core head and trigger tugger winches with their hydraulic power pack.

Safety precautions are paramount in our coring procedures and are regularly reinforced through safety meetings, JSAs, toolbox meetings, and other elements of our Safety Management System.

The following is a summary of our PC sample processing procedures:

Upon core retrieval, the core liner is removed, carefully carried and placed in the processing trough, and cut into 3- foot lengths. The core liner is marked with a water proof marker into 3foot long lengths, starting with the top section. For PCs, the top section is a 3-ft section because the top-most sediment is very soft and a short section is difficult to handle and to measure for soil strength. (*NOTE: these cores will virtually always have one short or long "odd" section, due to recovery length not being an exact multiple of 3 ft. The short section of a JPC will be the top section, whereas the odd section of a PC will be the bottom section*.) Each section is numbered with a Section Number and an arrow pointing to the top.

The bottom end of the section is capped immediately after cutting. The top and bottom of the liner section are marked as outlined in a **Field Sediment Testing Protocol**. This information is recorded immediately in the Core log. Any smell of hydrogen sulfide (rotten egg smell) is noted on the log.

A digital photograph is taken and a visual description of each section is recorded. Lab testing as outlined in the **Field Sediment Testing Protocol** is performed and the top of the core section is capped. Top and bottom caps are securely taped to the liner. The core sections are stored and secured in a vertical position with the deeper portion of the section on the bottom. The core sections are stored in a manner to minimize individual movement with vessel heave, pitch, and roll. After completion of the coring activities, the core sections are delivered to the onshore geotechnical testing laboratory in a timely, uninterrupted manner