# 7. PERFORMANCE OF THE ODP PRESSURE CORE SAMPLER ON LEG 124E SEA TRIALS[1]

Thomas L. Pettigrew[2]

## INTRODUCTION

The pressure core sampler (PCS) project is a continuation of the development of a tool to retrieve core at near *in-situ* pressure. The PCS was developed by the Ocean Drilling Program (ODP) to replace the Pressure Core Barrel (PCB), which was designed during the Deep Sea Drilling Project (DSDP).

The main differences between the two tools are as follows.

| Feature | PCS | PCB |
|---|---|---|
| Working pressure | 10,000 psi | 5,000 psi |
| Actuation | Hydraulic | Mechanical |
| Pressurized core length | 32 in. | 6 m |
| Unpressurized core length | N/A | 1.8 m |
| Compatibility | APC/XCB | RCB only |

Note: N/A = not applicable; APC = advanced hydraulic piston corer; XCB = extended core barrel; RCB = rotary core barrel.

The reduced sample length was requested by interested scientists to aid handling in the pressurized state.

The PCS tested on Leg 124E was a prototype of phase 1 in the development of the tool. The prototype tool was designed to test the new concept and to recover core under near *in-situ* (hydrostatic) pressure by means of gas and water sampling. Phase 2 of the development will produce a tool capable of direct access to the core under pressure. That will be accomplished by transferring the core under pressure to another pressure vessel with special ports for scientific testing.

## SHORE-BASED TESTING

Due to unforeseen delays in the design and fabrication of the PCS, the tool was not ready for testing until just prior to shipping for use on Leg 124E. The tool was assembled and tested at the ODP Test Facility (TFAC) at Texas A&M University, College Station, Texas. The shore-based testing involved the following procedures.

The actuation mechanism of the PCS is activated hydraulically by pumping against an activation ball. The activation ball is held in the (modified XCB) latch on top of the tool and is released by picking up on the pulling neck with the standard wireline and sinker-bar assembly, allowing the weight of the tool to shift the ball-retaining collet. Pressure is then applied to the tool via the drill string by the rig pumps to activate the mechanism and close the pressure chamber.

The PCS latch was assembled and the actuation ball drop mechanism tested by placing the latch assembly in a vise, and then using a hoist to pull on the pulling neck and shift the ball-retaining collet. A load cell was used to measure the force required to shift the ball collet. The shifting force is controlled by the XCB latch-spring force plus the secondary latch-spring force and was designed to be less than the total weight of the tool (approximately 300 lb). The test revealed a shifting force of approximately 350 lb, which is below the total weight of the tool and was determined to be acceptable.

By using a hoist, the latch assembly was pulled through a typical ODP drill-string tool joint held in a vise. This was done to determine if the pulling neck would shift as a result of friction of the latch dogs retracting as they pass through the tool joint. The test revealed that the pulling neck did not move, and therefore that the activation ball remained held inside the latch.

The accumulator subassembly above the accumulator piston was pressure-tested to 10,000 psi for 15 min with no indications of leakage. This test was repeated three times, each time with no indication of leakage.

The accumulator piston was pumped back and forth through the accumulator barrel to check for free movement. Each time the piston moved freely.

Pressure was applied below the disconnect valve in the manifold mandrel to the ball valve. Immediately the sample port valve on the manifold mandrel began to leak. Upon disassembly of the valve, a cut O-ring was found and replaced, and pressure integrity was achieved. The pressure in the tool was increased as follows:

| Pressure | Time | Results |
|---|---|---|
| 2000 psi | 5 min | No leaks |
| 4000 psi | 5 min | No leaks |
| 6000 psi | 5 min | No leaks |
| 8000 psi | 5 min | No leaks |

The accumulator shut-off valve was closed, and the disconnect valve was opened, to introduce pressure across the accumulator sub-manifold mandrel connection. The pressure in the tool was increased as follows:

| Pressure | Time | Results |
|---|---|---|
| 2000 psi | 5 min | No leaks |
| 4000 psi | 5 min | No leaks |
| 6000 psi | 5 min | No leaks |
| 8000 psi | 5 min | No leaks |

The accumulator shut-off valve was opened to introduce pressure to a point below the accumulator piston. The pressure in the tool was increased as follows:

| Pressure | Time | Results |
|---|---|---|
| 2000 psi | 5 min | No leaks |
| 4000 psi | 5 min | No leaks |
| 6000 psi | 5 min | No leaks |
| 8000 psi | 5 min | No leaks |

The pressure was then increased slowly from 0 to 10,000 psi to test the 10,000-psi burst disk. When the pressure reached 10,000 psi, it was held approximately 15 s, at which time the burst disk ruptured and released the pressure.

[1] Harding, B. W., Storms, M. A., et al., 1990. *Proc. ODP, Init. Repts.*, 124E: College Station, TX (Ocean Drilling Program).

[2] Shipboard engineering and scientific parties are as given in the listing of participants preceding the contents.

## SEA TRIALS ON LEG 124E

The PCS was first tested on Site 772, the first site drilled. The water depth was approximately 1600 m.

Shipboard preparation began with complete disassembly and cleaning of the PCS tool. The tool was then redressed, reassembled, and checked by hydrostatically testing the ball valve, manifold, and accumulator below the accumulator piston to 5000 psi. No leaks were found. The accumulator above the accumulator piston was pressure-tested with nitrogen using the back-pressure regulator valve to increase the pressure to 6000 psi. The accumulator pressure was bled down through the nitrogen-supply manifold to 4000 psi and left overnight. No leaks were found. The accumulator pressure was bled down further to an accumulator-charge pressure of 1800 psi.

The PCS was deployed by pumping it to bottom with 50 strokes per minute (spm; 250 gpm) from the rig pumps. The bottom-hole assembly (BHA) was positioned just above the mud line at 1528 m, and the hydrostatic pressure was calculated at 2218 psi. Once the tool was in place in the BHA, the pressure drop across the tool was determined as follows:

| Strokes (spm) | Flow (gpm) | Pressure (psi) |
|---|---|---|
| 10 | 52 | 20 |
| 20 | 103 | 45 |
| 30 | 155 | 125 |
| 40 | 207 | 230 |
| 50 | 259 | 380 |
| 56 | 289 | 400 |

The sinker-bar assembly was deployed and latched onto the pulling neck of the PCS tool. The tool was picked up to release the actuation ball and set back down. The rig pumps were engaged, and the drill-pipe pressure was brought up to 300–350 psi and held for 30 s to actuate the closing mechanism. After actuation, the tool was retrieved. Once the tool was on deck, the internal pressure was checked via the integral-pressure transducer. The captured pressure was found to be approximately 2380 psi, although the exact pressure could not be determined. However, the readout was thought to be within ±200–300 psi.

The problem was threefold. First, the in-line amplifier used to amplify the transducer signal was found to be shorted out. A makeshift signal-amplifying circuit was built aboard ship to replace the amplifier. Second, the transducer was calibrated against a pressure gauge with limited accuracy. Third, the transducer was not thermally stable, and, after being at approximately 40°F at the seafloor, it took at least an hour to warm up and give a stable reading.

The tool was reassembled and deployed again a short time later at a depth of 1678 m. It again was pumped down with 50 spm (259 gpm). The first attempt at cutting a core began with the bit rotating at 10–15 rpm and a circulation of 15–20 spm (77–103 gpm). The tool was actuated with 400–500 psi and then retrieved. The internal pressure was measured at approximately 500 psi. The pressure was bled off, and the sample chamber opened. A gray claystone core was found from the top of the core catchers to the top of the core barrel, a distance of approximately 26 in.

Examination into the reasons the tool did not maintain full hydrostatic pressure began. The accumulator, which had not been checked between runs, was now checked. The accumulator was found to be pressurized to 1800 psi, 200–300 psi below desired charged pressure. Upon disassembly, the accumulator piston was found in a partially stroked position and was thought to have been the cause of the problem. The PCS was completely redressed for the next deployment.

The next deployment came at Site 773 (the original ENG-1 site) in 1871 m of water. The accumulator was charged to 2100 psi, and the tool was deployed again using 50 spm (258 gpm) to pump it to bottom. Another attempt at cutting a core was begun using 60-rpm bit rotation, 30-spm (155-gpm) circulation, and 10,000 lb of weight on the bit. The tool was actuated using 400–500 psi and retrieved. The internal pressure was determined to be approximately 2720 psi.

Several gas samples were taken through a makeshift sampling manifold, and the internal pressure was verified with an in-line pressure gauge. The gas samples revealed mostly air with traces of methane and carbon dioxide. The air came from the large volume of the manifold, which was not purged before taking the samples.

The tool was disassembled, and the core sample removed. Two pieces of basalt approximately 3/4 in. in diameter were found on top of approximately 8 in. of gray claystone core. Two larger pieces of basalt were wedged in the throat of the bit, causing a core jam.

## CONCLUSIONS

The first sea trials of the PCS were successful from an engineering standpoint. Full hydrostatic pressure was retrieved on two of the three deployments, and the cause of the lost pressure on the other deployment was determined. The tool functioned exactly as designed—i.e., actuation ball dropping, hydraulic actuation, ball valve closing, accumulator function, rig-floor operations, etc.

It appears as though the accumulator may be the weak link in the tool. Special attention must therefore be given the accumulator in terms of redressing after each deployment to ensure proper operation.

## PROBLEMS TO BE SOLVED

1. As mentioned previously, the accumulator was the cause of lost pressure on one run and appears to require complete redressing after each deployment.
2. All three deployments were made into a claystone, which plugged the jets in the PCS cutting shoe each time.
3. The core is very difficult to remove from the small-diameter core tube without excessive disturbance.
4. The trash-barrier seal on the core-catcher guide caused excessive drag on the cutting shoe, impeding core-tube rotation, and had to be left out. This allowed claystone to partially extrude into the waterway behind the cutting shoe inside the tool. This extrusion did not hamper the function of the tool in any way.

## RECOMMENDATIONS

The PCS will need many more deployments in different formations and depths to analyze the tool fully. However, based on the Leg 124E sea trials, the following recommendations are made.

1. An attempt must be made to improve circulation to the cutting shoe.
2. An alternate core tube, possibly of a different material such as composite plastic, should be designed that allows easier access to the core.
3. The existing O-ring trash-barrier seal should be replaced, perhaps with a teflon O-ring to reduce the drag on the cutting shoe.
4. Because the concept performed as designed, the phase 2 design, which allows for core transfer into another pressure vessel under pressure, should proceed.

**Ms 124E-107**