HRRS

Hard Rock Reentry System

OCEAN DRILLING PROGRAM

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Scientific Application

Hard rock environments have challenged existing coring technology in two ways: getting a hole started and keeping the hole open in brittle highly fractured formations. The Hard Rock Reentry System (HRRS) was developed to install casing with reentry capability on a sloping or rough hard rock seafloor, where bare rock spud-in or standard reentry cone and casing installations are not practical. The HRRS is crucial for starting holes at hard rock sites with unstable upper hole conditions (e.g., mid-ocean-ridge basalts) because the HRRS simultaneously advances casing while drilling the hole. The HRRS increases the probability of starting a hole and deepening it to recover core for scientists to study the formation and diagenesis of the ocean crust.

Tool Operation

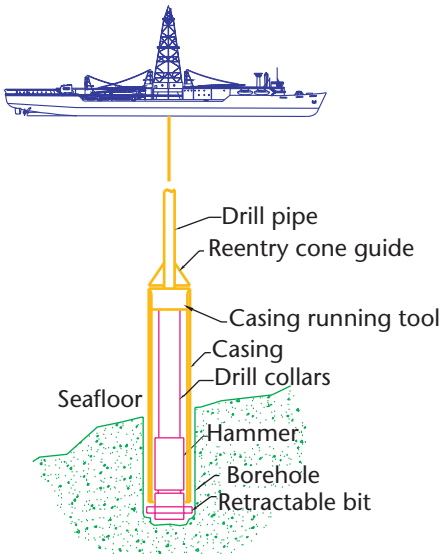
A few joints of 13⅜ in. casing are advanced with the bit when the HRRS (or hammer-in-casing mode) is used. The HRRS consists of a fluid hammer (FH), underreamer or ring/pilot bit, and a casing running tool to install the 13⅜ in. casing. The rig pumps provide hydraulic pressure through the drill string to power a downhole FH, which drives a percussion bit. Seawater is circulated down the pipe, through the FH, and back through the casing to the seafloor to clean the fine cuttings from the hole. When the casing is set, the FH is released and withdrawn, leaving a cased hole for coring. An HRRS reentry funnel, which is slightly different from the usual free-fall funnel, is installed by free fall from the ship after the casing is set. The FH can also be used with a flat-face bit to drill a hole without installing casing.

Design Features

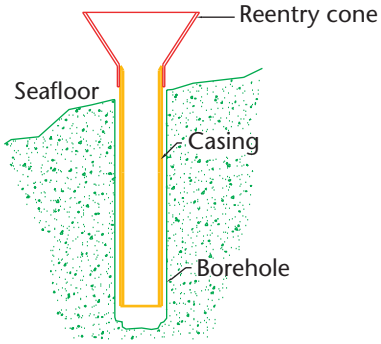
1) Bare Rock Spud on Slopes

Both the HRRS (to install casing) and the fluid hammer with a flat-face drill bit (to drill ahead) are capable of initiating a bare rock spud on a slope with hard rock or rubble cover.

Benefit: Operations can be initiated on unstable or sloping surfaces that previously thwarted efforts to start a hole using conventional drilling and casing techniques.



HRRS drilling in



Completed HRRS installation after free-fall deployment of HRRS reentry cone

Schematic of the HRRS in the Hammer Drill-In-Casing mode. The hammer drill is run inside the casing and simultaneously drills a hole and advances the casing. A reentry cone is free-fall deployed, and the hammer drill is withdrawn from the casing leaving a reentry installation.

2) HRRS Casing

The HRRS simultaneously drills a hole and runs casing.

Benefit: Unstable upper formations are isolated by casing as they are drilled, which means less time is spent on reaming and hole cleaning, stuck pipe problems due to hole collapse are reduced, and hole cleaning is improved by preventing enlargement of the seafloor hole.

3) Nested Casing

The 13⅜ in. HRRS hammer-in-casing uses a standard 13⅜ in. Drill-Quip (DQ) casing hanger.

Benefit: Allows later installation of a conventional 10¾ in. casing with a standard DQ hanger.

4) High Rate of Penetration

The fluid hammer with a flat-face drill bit may have a higher rate of penetration than a rotary bit when drilling in hard rock.

Benefit: Useful for drilling noncased holes in hard rock with minimal or no sediment cover for logging and instrumentation. The time spent on the hole is reduced when casing is not set.

HRRS Specifications

Fluid Hammer

SDS Digger Tools model 260 FH, 10.23 in. (260 mm) diameter, requires a closing force of 3300 lb and a flow rate of 595 gpm to operate. If the closing force is not 3300 lb or greater, the fluid hammer stops drilling, but circulation can be maintained.

SDS 260-mm fluid hammer and under reamer bit.

Bit Types

HRRS Underreamer Bits: drill a 14¾ in. (375 mm) hole and close to a 12¼ in. diameter to retract through the 13⅜ in. casing. These bits are used with the HRRS to set casing.

HRRS Ring Bit: 15 in. (381 mm) diameter ring bit is welded to the 13⅜ in. casing and run with a 12¼ in. pilot bit. The ring bit is left in the hole because it is welded to the casing, but the pilot bit is recovered. These bits are used with the HRRS to set casing.

Flat-Face Drill Bit: 12¼ in. (311 mm) diameter bit for drilling with the fluid hammer (i.e., not used to set HRRS casing).

Casing: 13⅜ in. with Atlas Bradford "STL" flush joint connections to minimize hole friction.

Additional Equipment

Drill Collars

9½ in. outer diameter required for closing force.

Pulsation Sub

Supplemental tool to reduce fluid pulsations from the fluid hammer.

Jet Sub

Flushes the annulus above the fluid hammer inside the casing. The primary flow path to remove the fine cuttings is upward through the casing.

Running Tool

Engages the bearing assembly below the hanger to prevent casing from rotating.

Reentry Funnel

Deployed by free fall after hammering-in-casing to provide reentry capability.

Typical Operating Range

Requires use of the Active Heave Compensator to control weight on bit to ~10,000 lb to keep the fluid hammer in drilling mode.

Hammer operates at 25–30 Hz with 595 gpm at 2200 psi.

Casing length is formation dependent, but typically 30–60 m.

Limitation

HRRS is not suitable for use in soft sediments (see Drill-In-Casing System tool sheet).