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DRAFT Indian Standard

**WATER WELL DRILLING
PART 1 GENERAL REQUIREMENTS FOR HYDRAULIC RIGS
(DOWN-THE-HOLE HAMMER OR MUD ROTARY DRILLING)**

(Second Revision)

ICS 25.080.40; 73.020

**Diamond Core and Waterwell Drilling
Sectional Committee, MED 21**

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FOREWORD

(Formal clause to be added later)

This standard lays down the general requirements, for use as guidelines by the manufacturers and the users, for down-the-hole hammer hydraulic rigs.

Drilling techniques vary from formation to formation in construction of water wells of the various drilling techniques, down-the-hole drilling method is considered as most economical, faster and efficient in constructing tubewells in crystalline and hard rock formations. In hard rock areas, down-the-hole hammer drilling rigs have made considerable contribution towards the exploration of ground water and construction of domestic wells.

This standard was first published in 1986 and subsequently revised in 1991.

This standard is being revised again to keep pace with the latest technological developments and international practices. Also, in this revision, the standard has been brought into the latest style and format of Indian Standards, and references of Indian Standards, wherever applicable have been updated. BIS certification marking clause has been modified to align with the revised *Bureau of Indian Standards Act, 2016*. The following major modifications have been incorporated in this revision of the standard:

- a) The title and scope has been revised;
- b) The reference standards have been updated;
- c) The construction requirement has been revised;

- d) The requirement of control has been revised;
- e) Onsite tests have been added;
- f) Safety requirement has been added.

The other parts in this series under the general title ‘Water well drilling down-the-hole hammer rigs’ is given below:

Part 2 General requirements for pneumatic rigs

This standard is one of a series of Indian Standards relating to various types of drilling rigs. Other standards published so far in the series are:

- a) IS 7156 : 1974 General requirements for reverse circulation drilling rigs
- b) IS 7206 (Part 1) : 1986 General requirements for direct rotary drilling rigs: Part 1 With rotary table (*first revision*)
- c) IS 7209 : 1974 General requirements for blast hole drilling rigs; and
- d) IS 11830 (Part 2) : 1989 Water-well drilling — Down-the-hole hammer rigs: Part 2 General requirements for pneumatic rigs.

The composition of the committee, responsible for the formulation of this standard is given at (*to be added later*).

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

DRAFT Indian Standard

WATER WELL DRILLING
PART 1 GENERAL REQUIREMENTS FOR HYDRAULIC RIGS
(DOWN-THE-HOLE HAMMER OR MUD ROTARY DRILLING)
(*Second Revision*)

1 SCOPE

This standard covers the general requirements for hydraulic rigs [down-the-hole (DTH) hammer or mud rotary drilling] for water well drilling.

2 REFERENCES

The standards listed below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below.

<i>IS/ISO No.</i>	<i>Title</i>
402 : 1990	Cold chisels — Specification (<i>third revision</i>)
841 : 1983	Specification for steel hammers (<i>second revision</i>)
1161 : 2014	Steel tubes for structural purposes — Specification (<i>fifth revision</i>)
1480 : 1970	Specification for metric scales for general purposes (<i>first revision</i>)
1481 : 1970	Specification for metric steel scales for engineers (<i>first revision</i>)
2028 : 2004	Open jaw wrenches (spanners) (<i>fifth revision</i>)
2029 : 1998	Ring wrenches (spanners) — Specification (<i>fourth revision</i>)
2030 : 1989	Box spanners — Specification (<i>second revision</i>)
2062 : 2011	Hot rolled medium and high tensile structural steel — Specification (<i>seventh revision</i>)
2361 : 2002	Bulldog grips — Specification (<i>third revision</i>)
2594 : 2003	Hacksaw blades — Specification (<i>second revision</i>)
IS 3082 : 2008/ ISO 2936 : 2001	Assembly tools for screws and nuts — Hexagon socket screw keys (<i>third revision</i>)
3650 : 1981	Specification for combination side cutting pliers (<i>second revision</i>)
4003 (Part 2) : 1986	Specification for pipe wrenches: Part 2 Heavy duty (<i>first revision</i>)
4123 : 1982	Specification for chain pipe wrenches (<i>first revision</i>)
4189 : 1967	Firm-joint inside and outside calipers (<i>withdrawn</i>)
5169 : 1986	Specification for hacksaw frames (<i>first revision</i>)

6149 : 1984	Specification for single-ended open-jaw adjustable wrenches (<i>first revision</i>)
6430 : 1985	Specification for mobile air compressor for construction purposes (<i>first revision</i>)
7794 : 1984	Specification for manual portable grease guns (<i>first revision</i>)
9181 : 1988	Specification for c-clamps (<i>first revision</i>)
9242 : 1986	Rated pressure of air compressors (<i>first revision</i>)
9439 : 2022	Glossary of terms used in water well drilling technology (<i>second revision</i>)
IS/ISO 18758-1 : 2018	Mining and earth-moving machinery — Rock drill rigs and rock reinforcement rigs Part 1 Vocabulary

3 TERMINOLOGY

For the purpose of this standard, the terminology as given in IS 9439 and IS/ISO 18758-1 shall apply.

4 FUNCTIONS AND CONSTRUCTION DETAILS

4.1 Functions

This type of drilling rig is used to construct tubewells for water supply and exploration purposes in hard rock formations. In down-the-hole (DTH) hammer drilling method, the hole is drilled by a bottom bit actuated by a pneumatic hammers connected to series of drill tubes termed as drill string. In this system compressed air, after passing through the drilling string, actuates the hammer. The hammer delivers successive blows at a high frequency to the bit which breaks/crushes the formation to smaller fragments. The cuttings so formed are brought out by the compressed air through the annular space. Along with compressed air, lubricating oil is also pumped for lubricating the various parts of the DTH hammer and other distribution valves. The whole string is rotated at a slow speed which can be varied depending on the formation while the hammer is actuated to deliver successive blows at high frequency. The rotating action of drill string with the impact action enables the down-the-hole hammer rig to drill through the hard rock formations for constructing a well.

4.1.1 The rigs may be provided with rotary drilling arrangements for negotiating softer overburdens, if required.

4.1.2 The rig may be provided with simultaneous casing lowering method for negotiating the geological unstable formation, if required.

4.2 Constructional Details

4.2.1 Hoisting System

4.2.1.1 Hoisting system consists of mast, top head rotation drive, pull-up and pull-down system, rod changing device, rod break-out system, and mast raising cylinders. The necessary accessories may be provided.

4.2.1.2 Mast

It serves the dual purpose of handling the drill rods, casing pipes and guide traverse of the top drive gear box. The mast shall be constructed either from steel conforming to IS 2062 or steel tubes conforming to IS 1161 and shall be capable of being lowered to horizontal position for easy transportation. All members shall be electrically welded with no cracks. A ladder shall be provided. The mast shall give clear working space and height to handle the drilling string and shall be able to accommodate the top drive mechanism and pull down system.

Mast shall be raised and lowered by double acting hydraulic cylinders equipped with safety devices including over centre/check valves. The mast shall be provided with weather-proof LED lighting arrangement for night operation.

4.2.1.3 Top head rotation drive

The top head rotary unit shall be capable of producing enough torque to the drill string to drill to its designed capacity. Provisions shall be made for floating action in the rotary head by floating spindle/floating sub for drill pipe thread protection and shock absorption. It shall be able to operate both at low and high speeds. The low speed varying up to 40 rev/min are used for DTH operations and higher ranges up to 100 rev/min are selected for rotary operations. The motor/motors used shall be capable of giving necessary torque required for the rated drilling capacity. It shall be very sturdy and shall be able to absorb sudden shock loads occurring during drilling operations.

4.2.1.4 Pull down/pull back/hold back system

The pull down/pull back/hold back system shall be provided to impart adequate load on the bit for efficient drilling and adequate power for lifting out the drill string from its rated depth. It also regulates the feed rate during drilling operations. This may be provided by hydraulically operated chain or cable.

4.2.1.5 Drill rod handling system

Loading and unloading of drill pipe shall be done using carousel or through automatic drill rod changing system. The drill rod handling system should be ergonomically designed with arrangement for fast make up and break out of drill string.

4.2.1.6 Mast raising cylinders

The raising or lowering of the mast to be carried out either by one or two mast raising cylinders. Adequate safety valves shall be provided.

4.2.1.7 Hydraulic jacks

Minimum four hydraulic jacks of suitable capacity may be provided for quick levelling of the rig, designed to support the entire mass of the rig. A pilot operated check valve shall be provided for holding of load.

4.2.1.8 Auxiliary hoisting system

Hydraulically operated auxiliary hoisting system of adequate capacity for handling sufficient number of drill pipes, casing pipes, and handling tools may be provided with the rig.

4.2.2 Hydraulic Break-Out Wrench

This is provided on the rig for breaking of the drill joints or tightening the drill pipes as required.

4.2.3 Hydraulic System

In order to operate the different hydraulic equipment, one or more reliable hydraulic pumps of adequate capacity and pressure shall be mounted on the rig to be operated by suitable prime mover. The hydraulic pumps may be of gear, vane or piston type. Necessary directional control valves may be provided for controlling the different hydraulic devices. Pressure gauges shall be installed to indicate the pressure used by the main system. Hydraulic system shall be protected by incorporating adequate capacity filters. A hydraulic oil cooler may be provided when considered necessary to prolong the life of the hydraulic oil and the system components to enable continuous working of the rig.

4.2.4 Compressor

The compressor of DTH rig shall be either mounted on the rig or on separate carrier. The air pressure used shall be in accordance with IS 9242 with an air delivery rate sufficient for efficient working of drilling. Regulating valves may be incorporated in the system for instantaneous supply and cut-off the air. Non-return valves shall be incorporated to prevent the loss of pressure and protect the equipment from back pressure. The compressor may be single/multi-stage, piston, rotary or screw type depending upon the operating pressure and air delivery ratings. The prime mover of the compressor shall preferably be diesel operated engine of adequate capacity for continuous operation.

4.2.5 Air Line Lubricator

Air line lubricator of sufficient capacity to withstand maximum working pressure may be provided to lubricate the various parts of the down-the-hole hammer tool and other rotary parts by injecting pressurized oil in the air system to prevent wear and tear of the parts of the hammer. The arrangement for controlling lubricating oil to be provided in the control panel.

4.2.6 Water Injection Pump

Water injection pump of suitable capacity hydraulically driven, shall be provided for dust control and to help flushing of semi-moist clay or similar formation. The pump shall be capable of variable delivery of minimum 15 l water per minute at pressure adequate to overcome the compressed air pressure for injection of water. Water with drilling foam may also be used to increase the flushing capacity.

4.2.7 Lighting System

The rig shall have provision for lighting system to illuminate adequately the entire rig and the working area for carrying out the drilling operations during the night.

4.2.8 Prime Mover

The rig operation shall be powered either by truck engine or by separate independent diesel engine of adequate power complying to latest pollution norms. The engine(s) should be continuously rated engines conforming to minimum requirements of IS 10002 and shall be easily accessible for simple repairs.

4.2.9 Global Positioning System (GPS) Arrangement

A GPS arrangement shall be provided on rig equipment to locate coordinates.

5 CONTROLS

The control panel should be located conveniently for maximum visibility and ease of operation. The control panel should be provided with all gauges for hydraulic oil pressure and temperature, engine oil pressure and temperature, air discharge pressure and temperature, and water temperature. The control levers/knobs for rig operation should be ergonomically designed and provided. The control panel should be provided lockable doors with folding type working platform. Arrangement for emergency shut down of rig should be provided in the control panel.

6 MOUNTING

All the above units put together comprise one DTH unit. The whole system shall be mounted on a steel welded structure forming a welded foundation for the entire machinery. This structure in turn may be mounted on a self-propelled road worthy truck or suitable carrier of adequate capacity having sufficient wheel base, or on a trailer chassis with pneumatic wheels with tow bar arrangements for shifting by tractor or truck. The total length width and height shall conform to the statutory motor vehicles rules and regulations and other relevant orders.

7 ROTARY MODE

In case the rig is designed for mud rotary drilling operations also, a reciprocating or centrifugal type mud pump of adequate capacity with independent prime mover may be provided for carrying out the mud rotary drilling.

8 DRILLING TOOLS AND ACCESSORIES

A complete set of operating equipment and tools as specified in **8.1** to **8.5** may be provided as part of agreement between the purchaser and the supplier.

8.1 Drill Pipes

In case of DTH drilling, the drill pipes are used to transport the air for actuating the hammer tools and flushing out the cuttings as well as for imparting rotational motion. Larger diameter pipes are used for reducing the annular area thereby increasing the flushing efficiency and increasing the penetration speeds. The tool joints and the drill pipes shall conform to the specified requirements.

8.2 Down-the-Hole Hammers

The hammer tool is used to impart the necessary percussive motion to the bit for penetrating through the formation. The DTH hammer normally operates at 6 to 24 bar air pressure depending upon the capacity of the compressor provided with the rig. The hammer shall be able to deliver

necessary blows at a frequency ranging from 600 to 1 600 per minute depending upon the compressor and hammer design. The hammers shall necessarily be provided with a check valve to prevent the water from entering into the hammer when air supply is shut off.

8.3 Bits

The down-the-hole hammer drilling rigs may be provided with required size of rock roller bits and button bits/cross bits to drill through the over burden. For drilling hard rock formations, suitable button, cross and reamer bits may be supplied with the rig depending on the capacity of the DTH drilling rig and the hammer supplied.

8.4 Essential Accessories

The following essential accessories may be supplied with the rig:

- a) Pencil bit grinder;
- b) Template;
- c) Fishing magnet;
- d) Bit detaching chuck;
- e) Centralizer half bushing (split design);
- f) Spanner for breaking the joint;
- g) Wrench for opening pipe drives;
- h) Wrench for opening hammer assembly;
- j) Bit breaker;
- k) Drill and handling tool;
- m) Dust control cover;
- n) All types of subs connecting the drill string;
- p) Recovery taps;
- q) C-clamps conforming to IS 9181;
- r) Hoisting plug for drill pipe;
- s) High pressure delivery hose for compressor; and
- t) High pressure delivery hose for water injection pump.

8.5 Small Tools

The following small tools may be supplied with the drill rig:

- a) Pipe wrenches, of nominal size 150, 600, and 900 mm conforming to IS 4003 (Part 2);
- b) Chain pipe wrenches conforming to IS 4123;
- c) Grip wrenches;
- d) Pliers conforming to IS 3650;
- e) Screws jack (s) of suitable capacity;
- f) Adjustable wrenches conforming to IS 6149;
- g) Ring spanner set conforming to IS 2029;
- h) Double ended open jaw spanner set conforming to IS 2028;
- j) Box spanner set conforming to IS 2030;

- k) Grease gun conforming to IS 7794;
- m) Caliper set (inside and outside);
- n) Scale conforming to IS 1480 or to IS 1481;
- p) Chisels conforming to IS 402;
- q) Feeler gauge;
- r) Hexagonal socket keys conforming to IS 3082;
- s) Hacksaw frame conforming to IS 5161 with blade conforming to IS 2594;
- t) Steel hammer conforming to IS 841; and
- u) Wire rope clamps conforming to IS 2361.

9 INFORMATION TO BE SUPPLIED BY THE PURCHASER

The following information shall be furnished by the purchaser at the time of enquiry and order:

- a) Geological history, in general, of the location of sites, and mean sea level (MSL), where holes are to be drilled;
- b) Maximum depth and diameter to be drilled;
- c) Mast height;
- d) Capacity of winch;
- e) Maximum size of casing to be lowered;
- f) Type of mounting (truck/trailer); and
- g) Any special features to be incorporated.

10 INFORMATION TO BE SUPPLIED BY THE MANUFACTURER/SUPPLIER

10.1 Following information shall be supplied by the manufacturer/supplier at the time of delivery:

- a) Type and capacity of drilling operations in respect of DTH and rotary system;
- b) Maximum diameter and depth that can be drilled by DTH and rotary system of drilling;
- c) Overall dimensions, front axle-load, rear axle load, make and model of the chassis, wheel base in case of trucks, towing arrangement particularly in case of trailer;
- d) Air compressor : make, model, type of mounting, specified pressure, specified quantum of air delivered and type of cooling (*see* IS 6430);
- e) Number of cylinders provided for raising mast;
- f) Number of hydraulic jacks provided for levelling and their capacity;
- g) Capacity of the hydraulic pump, its speed in rev/min, discharge, maximum pressure and tank capacity and hydraulic line diagram;
- h) Prime mover;
- j) Top drive mechanism: power ratings, torque capacity and rotational (rev/min) rating;
- k) Any special features for absorbing the drilling vibrations;
- m) Pull down system: capacity, chain feed or cable feed;
- n) Lifting capacity;
- p) Water injection system: discharge capacity and working pressure, type of prime mover;
- q) Air line lubricator, capacity and its working pressure;
- r) Drill rods: size, thickness, length, and weight of the drill pipe;

- s) Hammer model and bit size with catalogue;
- t) Sketch diagram of power transmission system;
- u) Recommended servicing system;
- v) Dimensions of the mast in down position such as overall height, length, and width (*see 6*);
- w) Operating instructions manual and spare parts catalogue;
- y) Trouble shooting and remedy chart for all the major components; and
- z) Construction and pressure rating of hoses.

10.2 The above information, except information at **10.1** (u), (w), and (y) shall be furnished with tender documents.

11 ONSITE TEST

The objective of testing of the drilling rig is to conform the various parameter of the rigs as per its capacity.

11.2.1 Test Duration

During the onsite testing, the rig shall be continuously operated for 12 h in actual field for min 2 bore holes of the rated capacity.

11.2.2 Observation during the Onsite Test

During the period of test, observation shall be carefully made in regard to the following:

- a) The hydraulic system shall be operated and checked for its rated capacity;
- b) The performance of the rig shall be recorded at regular interval as deemed fit by the buyer;
- c) The performance of the pump in respect of the consistent delivery and pressure shall be recorded at various depths as deemed fit by the buyer. The performance of the pump shall be checked for different deliveries at different rpm and pressures;
- d) The fuel consumption per day may be recorded; and
- e) The rotation of the rig shall be verified and recorded for minimum and maximum rpm as claimed by the manufacturer.

11.2.3 Onsite compliance

If the requirement of **11.2.2** is fulfilled the machine can be said to conforming to the onsite test.

12 SAFETY

Following safety measures shall be ensured:

- a) All rotating parts shall have guard protection;
- b) High pressure hydraulic hose pipes shall be covered with safety shocks or spiral guard;
- c) Emergency switches shall be fitted at all corner of drills; and
- d) Battery cutoff switches may be fitted in circuit.