

## UH 4 – A New Generation of E+M Drilling Rigs

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### **Introduction**

All over the world tool pushers are made of the same stuff, they always demand for bigger drilling rigs. When you ask a tool pusher whether he is satisfied with his rig, he always will answer: "No problem ... but it could be a little bit more powerful ..."

There are more and more cases where the driller's "suggestion" is well justified. The demands made on a state of the art drilling rig are high today. For instance there is an increasing request for repair of old water wells. Those jobs require a high torque allowing reaming and reworking of the existing well





There is also an increasing request for deeper wells. The typical thermal water well in Middle Europe has a depth of about 3.000 – 5.000 feet; this means a hook load of about 60 (metric) to (132,000 lbs).

The third new development is the increase of drilling works for mineral exploration. Core drilling up to depth similar to those for the thermal wells is more and more requested.

How to meet all these requirements with only one type of rig? In 2006 E+M designed the UH 4, which represents a new “family” of drilling rigs.

## 1. The design of the rig



The basic version of the rig was designed in 2006; the first two UH 4 drilling rigs were constructed and started up in the same year.



## The carrier truck



A principal demand on the design of the rig was, that the rig should be suitable for road traffic as a self-driving machine. Basic frame and derrick are mounted on a 4-axle Mercedes-Benz, Type "Actros". Meanwhile, a new design was made for a 5-axle Truck. With transport measurements of 12,30 m (40.3 ft) length, 2,55 m (8.37 ft) width and 4,00 m (13.12 ft) height and a weight of 33 (metric) tons (72,700 lbs) the truck is very mobile and licensed for the German traffic (StVZO) with a speed of 80 km/h (50 mph).

We checked whether the truck is compatible with the American traffic rules. It is possible to mount the rig on a truck chassis that is licensed for the American traffic (according to information of Mercedes Benz in Germany).



The power of the truck engine (of the E+M owned UH4) amounts to 408 HP while driving. Other types (e.g. 476 HP) are possible. To change to drilling operation, the power of the engine is controlled and delivered to the various rig components by a gearbox independent power take-off, a shaft drive and a power-drive transmission. By this transfer a resulting power of 230 kW (313 HP) is available for the drilling operations.

### Derrick and derrick extension

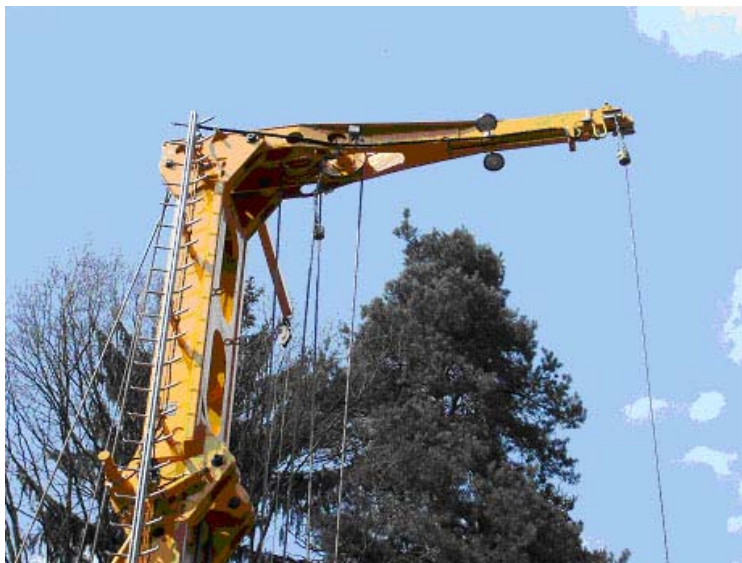


The derrick is designed for a crown load of 840 kN (84 tons) and a torque of 51,000 Nm (37,600 lbs\*ft). It is a very solid design; welding is done under well specified conditions by welding experts.

The feeding length (lifting height of the power swivel) is 7.6 m (25 ft). The height of the derrick itself is 12.4 m (40 ft). For the requirement concerning the installation of long casings, especially API casings, we designed a derrick extension. This extension included the total height is 16.4 m (54 ft).

This extension is fully operated by a hydraulic circuit and even for a maximum hook load DOES NOT need any supporting devices.

### Extension Arm



For a better handling of drill pipes on the drilling site, E+M profited from its extension arm, designed and tested by E+M in former times. Of course, the UH 4 is also equipped with this helpful device. The extension arm is hydraulically folded in and outwards, there are no steel cables necessary. Other advantages:

Hydraulic two-point-interlocking of the extension arms during working conditions with position indicators for both locking cylinders.



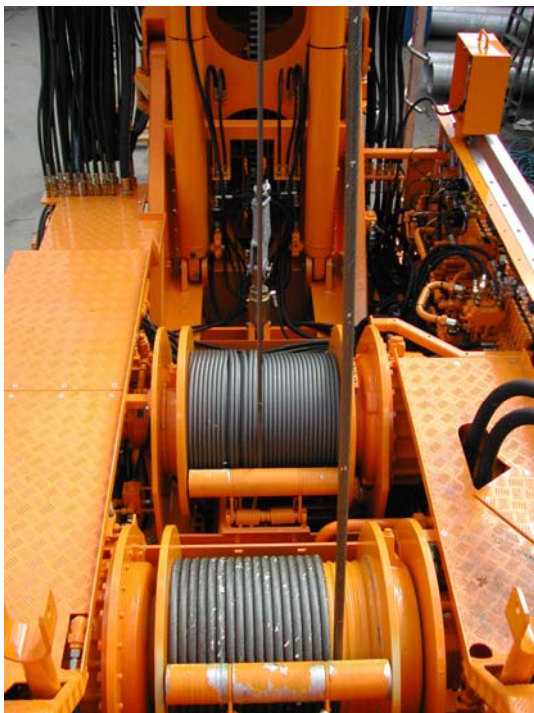
Truck operated lighting is installed at the extension arm and so allows a good visibility during operation.

Optionally additional truck operated halogen lightning can be installed at the arm for drilling operations during night shifts.

The extension arm is horizontally adjustable (movement max. 1,20 m / 4 ft) by means of hydraulic devices in order to optimise the positioning of the steel cable.

## 2. The principal components of the rig and accessories

### Winches



The winches are made by the German manufacturer "Zollern". Two winches are installed on the basic UH 4 version. The principal winch for the drilling operations is a Zollern Type ZHP 6.25, equipped with a steel cable of 22 mm (0.87 inch) diameter and allowing a maximum speed of 2.2 m/s (7.2 ft/s). The maximal traction of the single steel cable is 140 kN (14 tons / 30,900 lbs). By using the pulley block - a 4- roller multiplying-lever, a hook load of  $4 \cdot 140 = 560$  kN (56 tons / 123,500 lbs) results. The second (auxiliary) winch is a Zollern Type 6.22, equipped with a steel cable of 14 mm (0.55 inch) diameter allowing a maximal speed of 2.4 m/s (7,9 ft/s). The maximal traction of the cable is 40 kN (4 tons / 8,800 lbs). This winch operates in combination with the extension arm.



The auxiliary steel cable can also be positioned over the borehole center by means of an auxiliary pulley (inserted under the power swivel).



More winches can be mounted on the UH 4, for instance a second auxiliary winch for special operations (tool handling) or a special winch for core drilling.

Power swivel



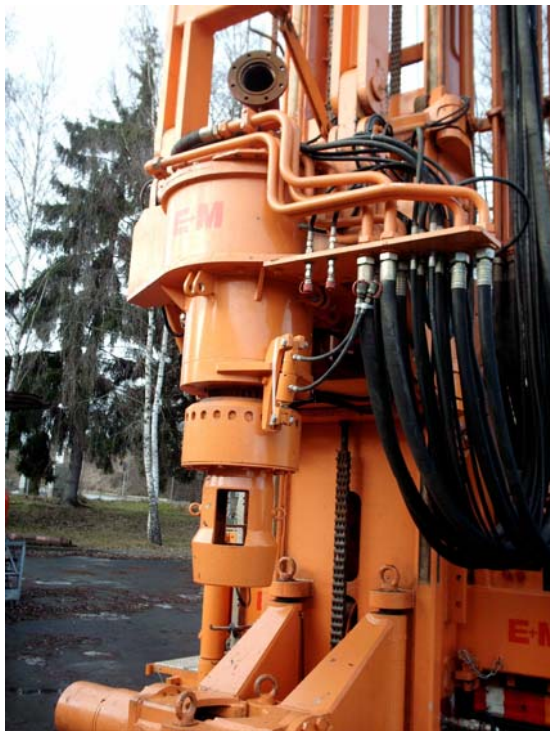
The power swivel of the rig was designed for two power ranges and difficult drilling works: (Tab. 1).

<u>1. Range</u>	<u>1. Range</u>
<u>Max. torque, right / left</u>	<u>33,200 / 37,600 lbs.ft</u>
<u>Rotational speed</u>	<u>0 ... 33 min<sup>-1</sup></u>
<u>2. Range</u>	<u>2. Range</u>
<u>Max. torque, right / left</u>	<u>11,100 / 12,500 lbs.ft</u>
<u>Rotational speed</u>	<u>33 ... 100 min<sup>-1</sup></u>

Tab. 1 Torques of the power swivel of the UH 4 /45

The power swivel was designed for big air volumes, to operate for instance a big sized DTH hammer. The power swivel produces a counter pressure of 80 kN (8 to) and a lifting force of 200 kN (20 to). The driller controls/adjusts the power transmission by feed slide, feed cylinder and chain drive.

Power swivel for coring



The standard power swivel is designed for large diameter holes. For other drilling operations, e.g. deep core drilling up to 1.500 m (5.000 ft), the power swivel can be changed easily in a short time. The power swivel designed for deep drilling has the following technical data

<u>1. Range</u>	<u>1. Range</u>
<u>Max. Torque, right / left</u>	<u>19,300 / 22,500 lbs.ft</u>
<u>Rotational speed</u>	<u>0 ... 48 min<sup>-1</sup></u>
<u>2. Range</u>	<u>2. Range</u>
<u>Max. Torque, right / left</u>	<u>10,300 / 12,100 lbs.ft</u>
<u>Rotational speed</u>	<u>0... 91min<sup>-1</sup></u>
<u>3. Range</u>	<u>3. Range</u>
<u>Max. Torque, right / left</u>	<u>2,700 / 3,100 lbs.ft</u>
<u>Rotational speed</u>	<u>0... 367 min<sup>-1</sup></u>

Tab. 2 Design power swivel UH 4 for deep (core) drilling



### Combination of power swivel and pulley block



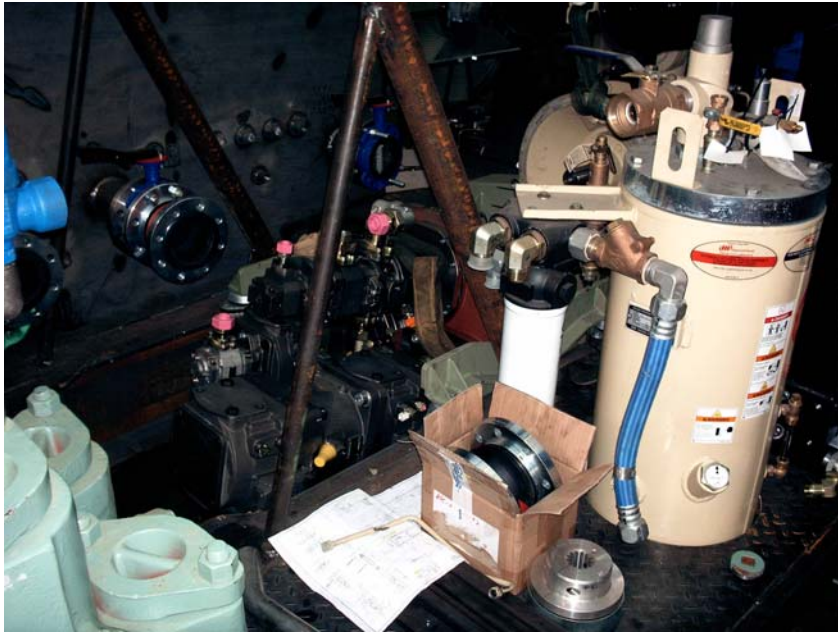
For higher loads, it is possible to combine the power swivel with the 4-roller multiplying-lever. By combining these 2 components - both connected by means of a yoke - a tractive force of 76 tons (168,000 lbs) can be obtained.

### Mud Pump (Option)



As an option it is possible to install a mud pump on the rig. The 5 axle truck version we designed recently is equipped with a mud pump type Gardener Denver GD 5" x 6".

## Hydraulic Installations



The drilling rig UH 4 runs fully hydraulic. The power is distributed to all rig components (winches, power swivel, feed cylinder, casing advancer/connector, tongs, etc.) by hydraulic circuits.

The hydraulic pumps are powered by the engine of the truck; they are connected by an auxiliary shaft drive. 7 hydraulic pumps are installed on the PTO (gear box) of the rig, referring to 18 hydraulic circuits. The result of this design is a very safe system. In case of breakdown of one circuit, another hydraulic pump can replace the missing circuit in the meantime.

### The manipulation of the rig

For time saving maintenance a central lubrication unit (option) for wearing parts, e.g. bearings, rolls, slide ways may be helpful.



control desk

The central control unit of the hydraulic rig is the control desk. Manometers show e.g. actual drilling parameters as torque, counter pressure, hook load. The rig functions are controlled by hydraulic control levers.

### 3. Special Features and varieties

#### Explosion safe equipment



Deep drilling works, for instance the construction of wells for exploitation of thermal water, impose a lot of conditions, to which the rig has to suite. Those conditions are the use of proofed drilling rods, special mud treatment technology, explosion safe equipment of the drilling rig and suitability for directed drilling. The drilling rig UH 4 is able to accomplish all these requirements.



### Martin Decker load indicator

Drilling rigs – in particular those for deeper boreholes – should be equipped with a drilling data recording device. For safe and economic drilling, it is always necessary to know the exact weight of the pipe string. For that reason, a Martin Decker weight indicator is installed at the control desk. This weight indicator shows the weight exactly +/- 50 kg (110 lbs). It has also a recording stylus, which enables the control and evaluation of drilling works.

### Drilling data recording

It is possible to register digitally during drilling operations the principal drilling data, e.g.

- Rotational speed of the power swivel
- torque
- weight on bit
- mud pressure

These data can be evaluated on the computer for further investigations.

## **4. Application examples of the rig**

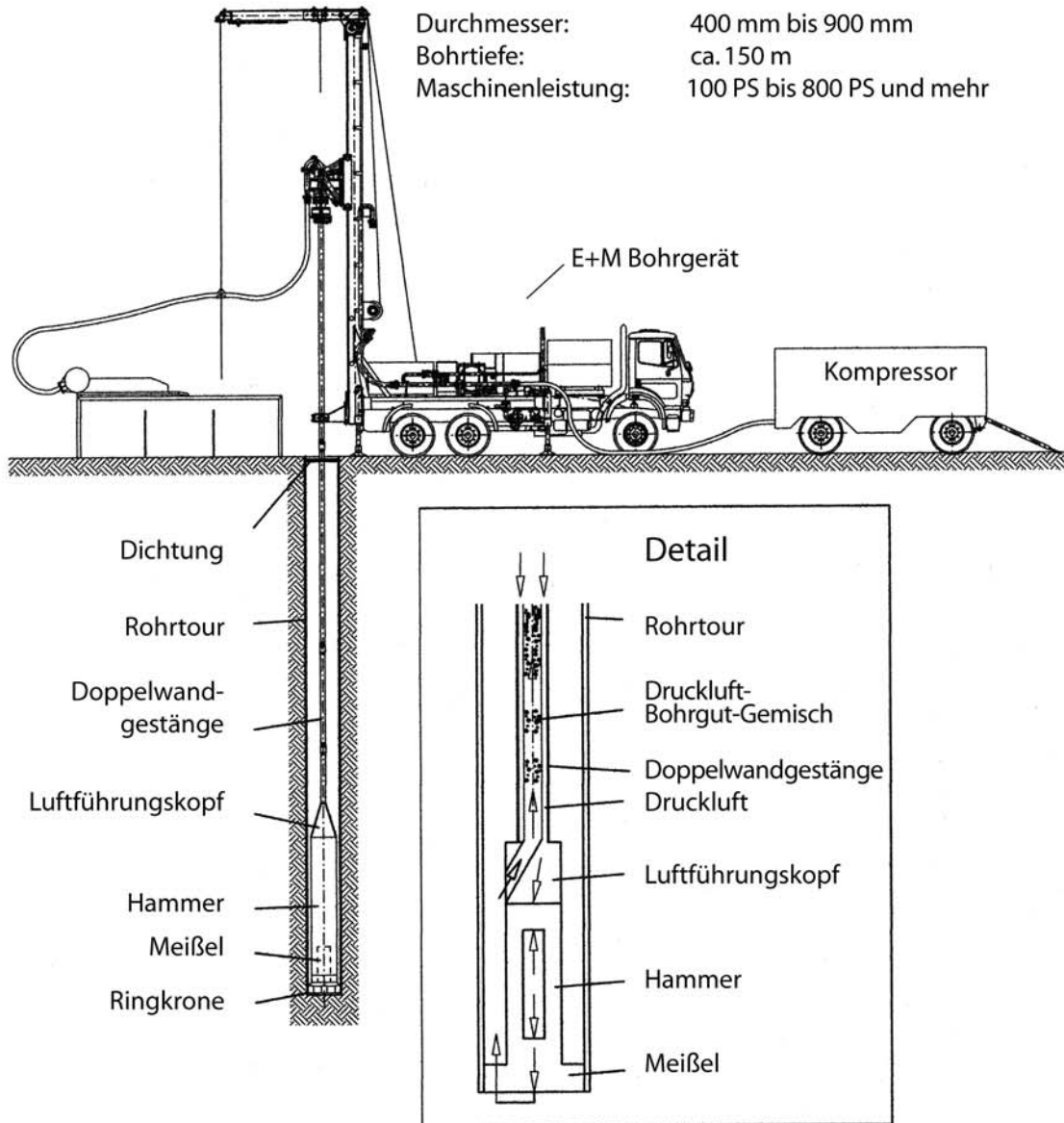
### Large diameters DTH hammer drilling



The development of the DTH hammer drilling technology in reverse circulation enabled to use this system for large diameters.

The technology is particularly suitable for hard rock formations, for instance in problematic strata (change of strata, fractures and caverns, low-lying water levels etc.), which require an additional working casing, as an overburden drilling system applied in unconsolidated strata with boulders.

## Neues Großloch-Hammerbohrverfahren mit indirekter Austragsrichtung



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The hammer is working with a reverse air circulation system, which means, that the cuttings are loosened by the hammer and transported to the surface in an air stream inside a double-walled drilling rod. The hammer is powered by air compressors; the

compressed-air is pressed down to the DTH hammer in the annular space of the double-walled drilling rod.

The system consists of the hammer, which powers the button bit and a ring bit. The ring bit has two functions:

- It is the casing shoe of a working casing and the connecting element to the button bit, which can be separated by a locking system.
- It has inserts of carbide, as the button bit has, and is working as a drilling tool.



Drilling rods and casing advance parallel and so the temporary working casing stabilises the borehole and guarantees an exactly vertical borehole. It can be removed from the borehole after reaching the final depth. It is also possible to continue the drilling works with a smaller diameter (inside the working casing) with or without a second casing string (e. g. with another drilling system).

Advancing the temporary working casing requires sufficient torque and the power swivel has to be designed accordingly – like the UH 4.



## Reverse Air circulation drilling



In 2007 we completed a large diameter borehole in Ronneburg / Thuringia for the Company WISMUT, a former mining and exploration company. The decisive challenge for the success of the project was to drill directly into a tunnel of a former underground mine. After we installed the surface casing 1500 and 1200 mm (60 and 47") to 35,30 m (116 ft) we drilled a test borehole with a diameter of 12 ¼" – later reamed to 17 ½" - as a target drilling up to the tunnel depth at 209,50 m (687 ft). These works were carried out with a special equipment for vertical drilling.

## Drilling Site Ronneburg



The test hole really stroke the tunnel and was reamed to a diameter of 1160 mm (45") to a depth of 170 m (558 ft). We installed a casing string 914 x 12,5 mm casing (36 x 0.5") up to 170 m (558ft). The borehole was continued with diameter 850 mm (33") up to the top of the tunnel. The final borehole equipment consisted of a stainless steel casing 612 x 10 mm (24 x 0.4") with a bar iron screen in the tunnel, cemented with a packer.

Due to the necessary torque and the weight of the casing the drilling works required a powerful rig. That's why the drilling rig UH 4, constructed by E+M, did that job.

