HERRENKNECHT NEWS 11/2005

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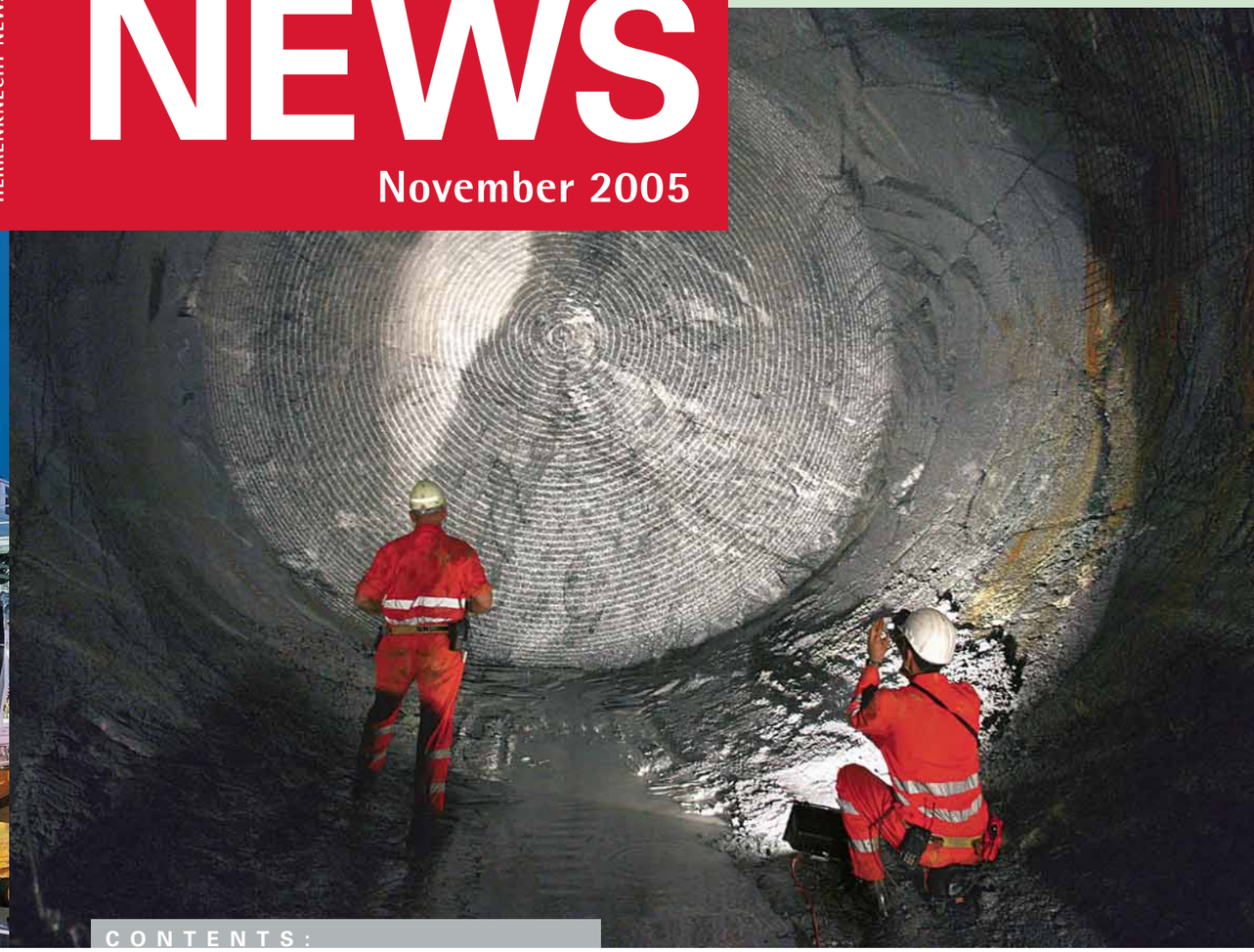
November 2005



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HERRENKNECHT HERRENKNECHT

Inspecting the cutter head of the Herrenknecht S-229 Gripper TBM in Amsteg, Gotthard Base Tunnel.

Dr.- Ing. E.h. Martin Herrenknecht, Chairman of the Board of Management of Herrenknecht AG.

Dear readers

In our globalized society we need bold visions and people with the courage to break new ground. Today, many things are changing more quickly and more profoundly. We must embrace this change and make use of it.

We cannot further improve conditions for humans and the environment without technological progress. Our hope rests with highly qualified engineers. We are facing huge challenges caused by shrinking energy and water resources, rapidly progressing urbanization and demands for limitless mobility.

Mechanical tunnelling technology is an excellent example of the way technical progress can open up new options so that construction and modernization of infrastructures underground can keep pace with complex demands. This edition of Herrenknecht News gives you an impression of where and how efficient tunnels and pipelines are being built all over the globe. Each breakthrough is a pioneering feat in the service of people, industry and the environment.

Bridging the gap between innovation and tradition is no easy task. Providers of machine technology must prepare their production and procurement for the future so that they can provide the highest level of quality, reliability and professional service at a reasonable price on any market. We must adapt our location policies to the demands of the market, for example Herrenknecht demonstrates this with its commitment in Asia.

Higher performance with lower budgets is not always the answer. When constructing tunnels and large-scale sewage systems, "as cheaply as possible" is never a good philosophy. Quality, safety, reliability and individual solutions come at a price. In the final reckoning, if we have remained within our budget and our schedule and if no harm has come to humans, buildings or the environment, then it will have been worth the price.





Contents.

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The Spanish Prime Minister José Luis Rodríguez Zapatero visiting the Pajares construction site on July 13, 2005 for the start of tunnelling work with the Herrenknecht S-287 Double Shield TBM.

For further information on metro projects in Spain, visit www.insidemadrid.de/die_Stadt/Metroplan/metroplan.html

TRAFFIC TUNNELLING – EXCELLENCE IN SPAIN.

Spain is one of the world's busiest arenas for powerful TBM giants. November 2005 saw the launch of what is currently the world's largest tunnelling shield (15.20 m) in Madrid (see page 6/7). The Herrenknecht S-300 Earth Pressure Balance Shield is set to drive a 3.7 km underground freeway tunnel in the middle of the capital. Smart Spaniards know that investment in modern infrastructures is the way ahead to a flourishing future. That's why they are taking the bull by the horns in tunnelling.

In 2004 alone, Spanish construction companies ordered 16 large tunnelling machines from Herrenknecht-10 Earth Pressure Balance Shields and 6 Hard Rock Machines. They will be used mainly for the construction of inner city metro and road tunnels as well as efficient tunnels for trans-regional railway projects. At one time, 10 large tunnelling machines for Spain were being assembled simultaneously in Schwanau in order to meet the delivery deadlines. Traffic Tunnelling is carried out at the highest engineering level in Spain. The two tunnels through the 28 km long Guadarrama mountain range north of Madrid were successfully completed within three years (see page 8). This is a perfect example of excellence in tunnelling through hard rock. Two Herrenknecht machines are beginning work on the construction of the 25 km Pajares railway tunnel. In section II of this project, the S-281 Double Shield will have to make a downhill journey with a gradient of 6.9 percent.

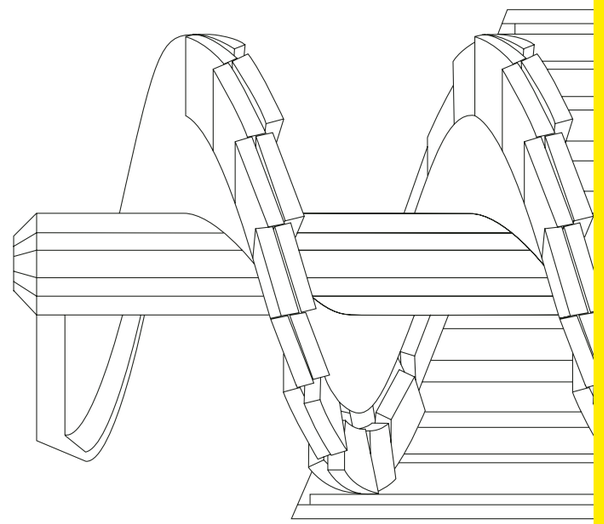
CURRENT PROJECTS IN SPAIN

	TUNNEL PROJECT	MACHINE DATA	CONTRACTORS
1	**Gijon: metro** "Metrotren" Tunnel length: 3,440 m Geology: clay, dolomite, limestone	**S-255, EPB Shield** Diameter: 10,550 mm Cutterhead power: 3,600 kW	Necso Entrecanales Cubiertas S.A.
2	**Pajares: railway** Tunnel lengths: S-281: 10,700 + 3,700 m S-287: 7,650 + 2,750 m Geology: sandstone, schist	**S-281, Double Shield TBM** Diameter: 10,160 mm Cutterhead power: 5,600 kW **S-287, Single Shield TBM** Diameter: 9,900 mm Cutterhead power: 4,900 kW	S-281: Dragados, ACS S-287: FCC Construcción S.A., Necso Entrecanales Cubiertas S.A.
3	**Le Perthus: railway** Tunnel lengths: 2 x 8,230 m Geology: granite, gneiss, granodiorite, schist	**S-286, S-296** **2 x Double Shield TBM** Diameter: 9,900 mm each Cutterhead power: 4,900 kW each	Dragados, Eiffage
4	**Barcelona: metro** Tunnel length: 8,200 m Geology: clay, sand, loam	**S-279, EPB Shield** Diameter: 9,370 mm Cutterhead power: 3,600 kW	U.T.E. Túnel Aeroport FCC Construcción S.A. Ferrovial-Agroman S.A. Obrascon Huarte Lain S.A. Scrinser, Copisa
7	**San Pedro: railway** Tunnel lengths: 2 x 8,917 m Geology: granite, gneiss	**S-270, S-275,** **2 x Gripper TBM** Diameter: 9,450 mm each Cutterhead power: 3,500 kW each	S-270: Obrascon Huarte Lain S.A. S-275: Marti AG
8	**Madrid: metro extension** Tunnel lengths: S-272: 3,000 + 2,000 m S-274: 3,500 m S-276: 6,000 m S-278: 4,000 m Geology, S-272: crystallized gypsum with clay and siltstone S-274: compacted sand S-276, S-278: sand, clay, gravel, silt	**S-272, EPB Shield** Diameter: 9,330 mm Cutterhead power: 2,800 kW **S-274, EPB Shield** Diameter: 8,900 mm Cutterhead power: 2,400 kW **S-276, EPB Shield** Diameter: 9,330 mm Cutterhead power: 2,000 kW **S-278, EPB Shield** Diameter: 9,330 mm Cutterhead power: 2,000 kW	S-272: Ferrovial-Agroman S.A. S-274: Sacyr S-276: Necso Entrecanales Cubiertas S.A. S-278: Dragados
9	**Madrid: metro** "Metronorte Tramo 2B" Tunnel length: 5,015 m Geology: compacted sand, sand	**S-280, EPB Shield** Diameter: 9,330 mm Cutterhead power: 3,200 kW	Obrascon Huarte Lain S.A.
10	**Madrid: metro** "Metronorte Tramo 1C and 2A" Tunnel length: 5,491 m Geology: compacted sand, loamy sand, alluvium	**S-295, EPB Shield** Diameter: 9,330 mm Cutterhead power: 3,200 kW	Necso Entrecanales Cubiertas S.A.
11	**Madrid: metro** "Nuevos Ministerios-Chamartin" Tunnel length: 2,600 m Geology: loamy, compacted sand	**S-299, EPB Shield** Diameter: 9,370 mm Cutterhead power: 3,600 kW	Ferrovial-Agroman S.A.
12	**Madrid: metro** Tunnel length: 6,000 m Geology: clay, sand, loam	**S-302, EPB Shield** Diameter: 9,370 mm Cutterhead power: 3,600 kW	FCC Construcción, S.A.

5 6 13 see pages 6 to 9

MADRID | SPAIN

	TUNNEL PROJECT	MACHINE DATA	CONTRACTORS
13	**Madrid: road** "Freeway M-30" Tunnel length: 3,650 m Geology: peñuelas and gypsum, massive gypsum, peñuelas green and grey	**S-300, EPB Shield** Diameter: 15,200 mm Cutterhead power: 12,000 kW + 2,000 kW	Necso Entrecanales Cubiertas S.A. Ferrovial-Agroman S.A.



MEGA MACHINE FOR MADRID.

For further information on the M-30 Project, visit www.roadtraffic-technology.com/projects/m30_madrid or order our information brochure and the M-30 animation.

Never before has a larger tunnelling machine been built: with an excavation diameter of 15.20 m, the Herrenknecht S-300 Earth Pressure Balance Shield for Madrid breaks all size records for mechanical tunnelling. The Spanish construction companies Necso Entrecanales Cubiertas S.A. and Ferrovial-Agroman S.A. ordered this machine in June 2004 to drive the 3,650 m north tunnel for the M-30 inner city freeway. After a construction time of only twelve months, our customers were able to give final approval for the ultimate XXL-TBM at Herrenknecht in June 2005.

With a torque of 125,268 kNm, this machine really is a TBM Titan. This force would theoretically be enough to lift a fully loaded 410 t Boeing 747 with a 30 m long lever. That means this mega machine has the greatest torque ever installed in a TBM. In order to maintain control of the largest drilling diameter in the world in high friction ground conditions Herrenknecht engineers have come up with a specially developed and unique cutting wheel concept for this project. It consists of an inner cutting wheel with a diameter of 7 m and an outer cutting wheel working on the same plane, with a maximum drilling diameter of 15.20 m.

Three screw conveyors are integrated into the shield to guarantee controlled excavation and secure support at the tunnel face – another world first. From August to October 2005, this drilling giant was assembled in the launch shaft in downtown Madrid. The mega machine began tunnelling in November of this year. The total planned construction time for this pioneering Spanish project is 30 months.

For further information on the Guadarrama project, visit www.geodata.it /english/progetti/gallunghe/guadarrama or order our Double Shield TBM animation.

NO CONTEST IN THE SIERRA DE GUADARRAMA.

The Guadarrama tunnel project (railway tunnel), successfully completed in June 2005 north of Madrid, theoretically had the potential to be a genuine race. A competition between 2 German TBM manufacturers: Wirth from Erkelenz and Herrenknecht from Schwanau. In 2001, each of the two manufacturers was commissioned by two Spanish consortiums, each of a different make-up, to provide a Double Shield machine with a diameter of 9.51 m to build a twin-tunnel construction with a total length of 58 km beneath the Guadarrama mountain range. A total of four Double Shield TBM from Germany were used.

The Spanish customer organized the race course in such a way that, at the beginning of the tunnelling process in fall 2002, a Double Shield TBM from Schwanau and another from Erkelenz began constructing the tunnel at both the north and south ends. The two machines at each end were separated by a center distance of 30 m. In September 2002, the Herrenknecht machines were the first to advance into the mountain. They met with granite with a compressive strength of up to 160 MPa. The two Wirth Double Shield TBM began their tunnelling mission in October and November 2002 respectively. For approximately one year the Herrenknecht machines tunneled their way ahead of the competition. As pioneers in unknown territory they were the first to strike fault zones. The construction site teams were able to deal with these zones with the competing machine. In the second half of 2003, the Wirth machine at the southern end caught up. Finally, the tunnelling process at both ends turned into an exciting neck-and-neck race.

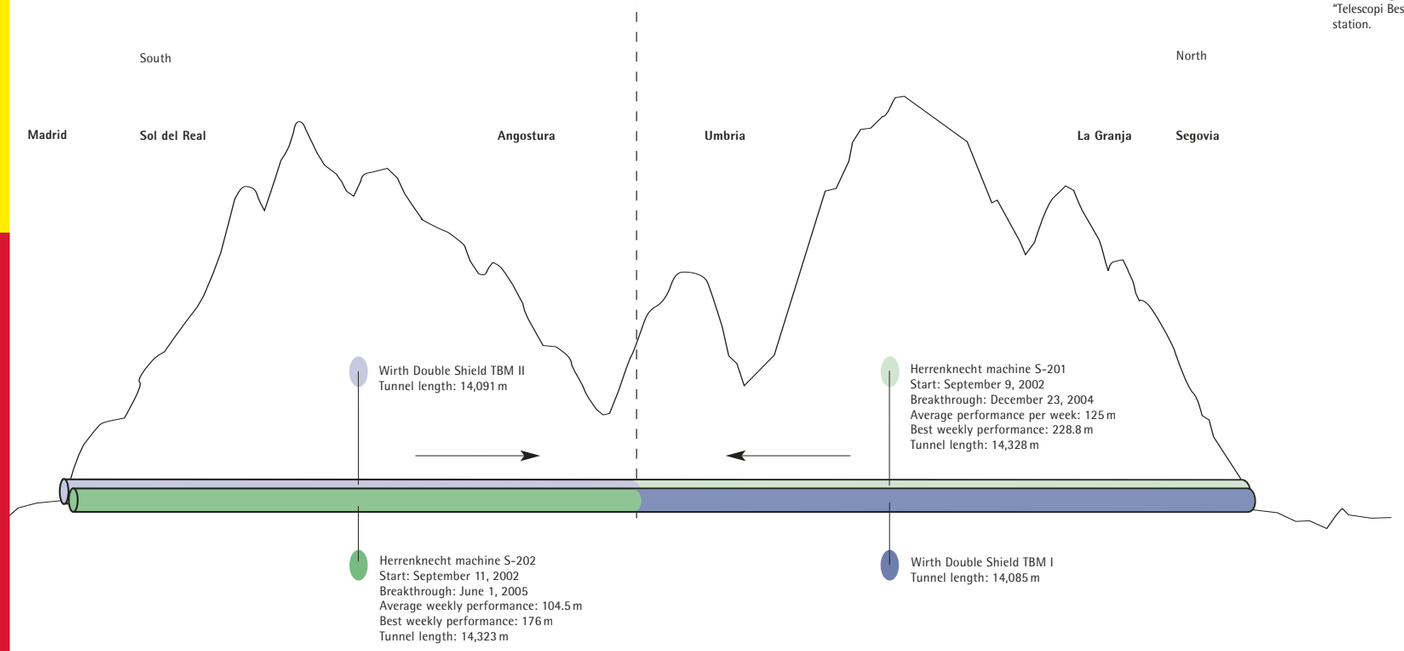
The first machine to cross the line was the north-end Herrenknecht Double Shield, which completed its 14,328 m on December 23, 2004. It had taken 28 months to construct the entire tunnel. The Wirth machine made breakthrough on January 11, 2005 at the northern end, having taken 27 months to complete the northern section, measuring 14,085 m.

On the southern side, the construction team working with the Wirth machine was ahead by a nose when it crossed the line. It reached the finish of the section on May 5, 2005 after 30 months and 14,091 m. The Herrenknecht machine on the south side reached the finish on June 1, 2005 after constructing 14,323 m of tunnel.

The TBM race in Spain did not turn out to be a duel between two German TBM manufacturers in the end. It resulted in the achievement of a remarkable record by the Spanish client and its contractors. In only three years they managed to build almost 58 km of tunnel with an excavation diameter of 9.51 m through the Sierra de Guadarrama mountain chain. This set a new benchmark for mechanical tunnelling through hard rock.

GUADARRAMA | SPAIN

	TUNNEL PROJECT	MACHINE DATA	CONTRACTORS
6	**Guadarrama: rilway** Tunnel lengths: S-201: 14,323 m S-202: 14,328 m Geology: granite	**S-201, S-202** **2 x Double Shield TBM** Diameter: 9,510 mm each Cutterhead power: 4,200 kW each	S-201: Comsa, Dragados Obras y Proyectos S.A., Necso Entrecanales Cubiertas S.A., Obrascon Huarte Lain S.A., (OHL) Sacyr S-202: ACS, FCC Construcción S.A., Ferrovial-Agroman S.A.



The Herrenknecht S-221 EPB Shield makes stage breakthrough at "Telescopi Besos" station.

ON THE RIGHT TRACK IN BARCELONA.

The Earth Pressure Balance Shield for Barcelona's metro line 9 is making good progress. With top weekly performances of up to 106.2 m, this colossus with a huge diameter of 12.06 m reached its first stage goal in June 2004 – the "Telescopi Besos" metro station. Following a short overhaul of the cutting wheel, the EPB Shield is now back at work under this densely populated Spanish metropolis. By mid-October 2005, the Earth Pressure Balance Shield had installed 1,558 lining segments and driven 2,805 meters of tunnel. By the end of 2006, a total of 10 kilometers of metro tunnel for line 9 between the airport and the neighboring towns of Badalona and Santa Coloma will have been completed.

BARCELONA | SPAIN

	TUNNEL PROJECT	MACHINE DATA	CONTRACTORS
5	**Barcelona: metro** "Line 9" Tunnel length: 10,000 m Geology: granodiorite, sand, clay, gravel, gravel with boulders	**S-221, EPB Shield** Diameter: 12,060 mm Cutterhead power: 4,000 kW	Necso Entrecanales Cubiertas S.A., ACS, Comsa, Dragados Obras y Proyectos S.A., Sorigue

Keeping the pressure on!

There is a tradition at Herrenknecht that trainees present their graduation certificate to the company founder and group management board chairman, Martin Herrenknecht. With a buffet and drinks, and for once not in their work clothes, the newly qualified professionals meet the "Big Boss". Rico Wurth attended such a meeting 10 years ago after completing his training as an industrial mechanic. Now 34 years old, Rico is an engineer and is responsible for final inspection in the factory and initial operation of hydraulic systems in large diameter machines.

Rico received a good grounding in his skilled vocational training and so he is able to tighten a screw correctly with a torque wrench. "But the boss is not allowed to see an engineer working with a wrench, because that's much too expensive," he admits, defining his own job. But he adds that the job has to be done, deadlines have to be met. That's why he could be seen a few days ago climbing down from a piece of equipment, covered in oil from head to toe. "But the problem was solved," he says in his defense. Somehow the end always justifies the means, even if that means risking pressure from above.

Rico is responsible for Traffic Tunnelling Machines with a diameter of 4.20 m and above, up to the current world's largest TBM with a diameter 15.20 m. He says he always finds the massive size and power of these machines phenomenal and he admits they make him feel like a little boy. That's why he returned to Herrenknecht after finishing university in 1999, this time as a mechanical engineer. He often speaks like a miner, using words like "methane bubbles" and "main aeration zone", miners' terminology for the ventilation system in a tunnel. It would be dangerous to view his machines as closed systems, he warns, probably also as a reminder to himself. "The machine must prove itself inside the mountain, that's all that counts," he explains clearly. In his university lectures he was taught nothing about mining. He acquired his knowledge about this subject in conversations with customers and by going down into tunnels himself. But man cannot live by technology alone, no matter how in love with technology he is.

"I like the fact that this is a down-to-earth company," Rico says about Herrenknecht. And he says that about a company whose equipment tunnels through the earth all over the world. Even as an engineer Rico did not want a 100 percent office job and a smart suit, unlike many of his classmates at high school or university, who chose jobs in which they were certain they would not have to get their hands dirty. Between 6 and 7 a.m., Rico puts on his overalls, safety boots and hard hat for a ten-hour working day. But before that he has a daily briefing over a cup of coffee with his team, consisting of 2 master mechanics, an engineering technician and another engineer. After their meeting they go out into the huge assembly halls and climb onto the giant machines to test their various functions. Customers are invited to Herrenknecht when machines are handed over and the complete system with all its functions is demonstrated. This is the best way to show to customers that they have invested their money wisely.

"Since the most important function cannot be tested, we try to simulate the mountain with measuring procedures as close to nature as possible," the engineer says, describing the method. He and his team are responsible for hydraulic systems, a fellow engineer tests the electrical systems to make sure they are functioning perfectly. Large diameter machines include up to 5 kilometers of flexible pressure tubing for the hydraulic systems.

Several dozen pumps must be adjusted to the nominal operating pressure and their synchronicity and correct arrangement checked. On average the team has three weeks for the final inspection of a machine. With pressures in the tubes of 250 to 500 bar, absolute precision and reliability are indispensable in their work. If even one screw connection is loose, serious consequences could follow. "My aim is to build up a department that functions faultlessly and where everyone knows their job perfectly," says the engineer. Rico Wurth feels responsible for his people and those working on completing the assembly of the machine while it goes through the testing phase. Time is money, even in the seemingly tranquil village of Schwanau in the Black Forest.

Rico's highest priority is perfection. "If I were in the customer's shoes, I can image I could be demanding," he describes himself. He wants to avoid as far as possible having to travel around the world to correct mistakes on machines. Rico wants to put the company ahead with a technically perfect product. He has committed himself to this aim, even if it means tightening every nut himself with a large wrench and even if that has to be behind the Boss's back.

HALFWAY AT THE GOTTHARD RANGE.

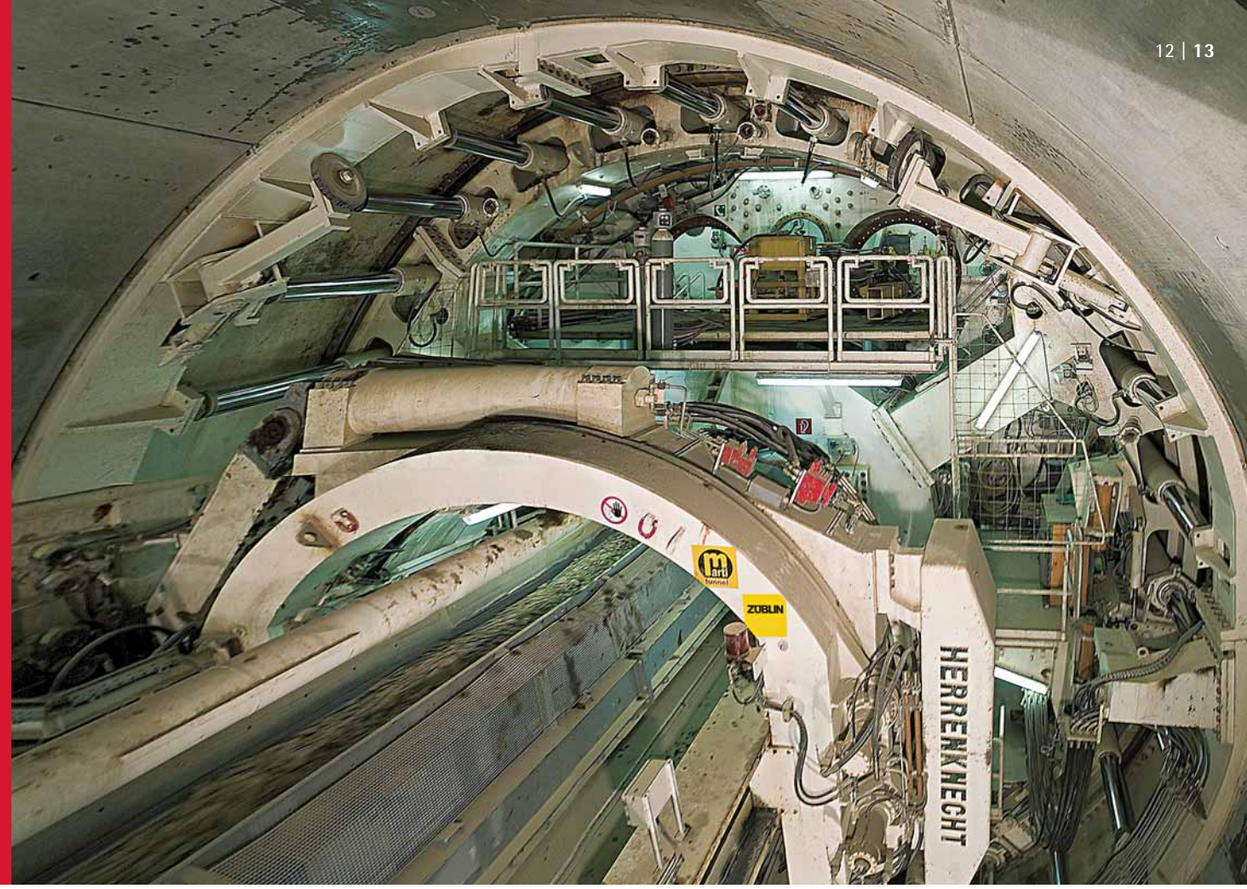
Tunnelling work is forging ahead on the longest traffic tunnel in the world, with 2 x 57 km. By mid-October 2005, the four Herrenknecht Gripper TBM had already completed 35.36 km of the 75 km of tunnel to be driven by Herrenknecht TBM. More than 52 percent of the 153.5 km of tunnels, shafts and adits for the base tunnel project commissioned by AlpTransit AG are now ready.

The Herrenknecht tunnelling giants in the north have now finished considerably more than half their route deep below the mountain. Best tunnelling performances of up to 40.1 m per day are a clear demonstration of this progress. The two "moles" on the south side are now approaching their goal, the Faido intermediate attack point. Here, too, far more than 65 percent of the 28.8 km to be driven have also been completed. Despite this excellent progress the project as a whole will remain a pioneering job until the very end. It is always possible that the mountain has more hidden secrets waiting for us.

GOTTHARD | SWITZERLAND

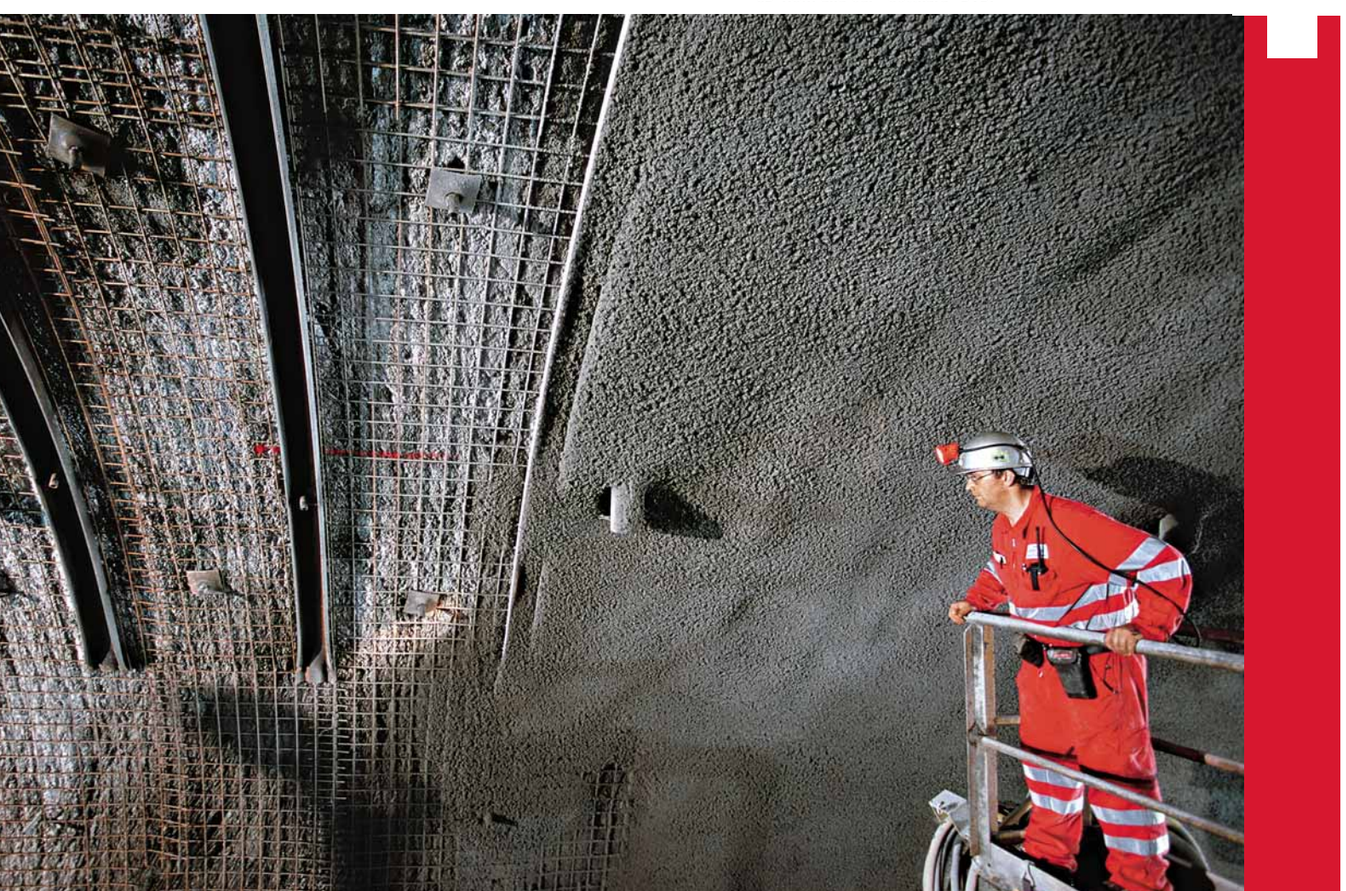
TUNNEL PROJECT	MACHINE DATA	CONTRACTORS
Gotthard: railway "Gotthard Base Tunnel" Section #554 Bodio-Faido Section #452 Faido-Sedrun Tunnel lengths: East tunnel, S-210: 13,955 m, 11,581 m West tunnel, S-211: 14,795 m, 12,220 m Geology: gneiss, granite, schist	**S-210, S-211** **2 x Gripper TBM** Diameter: 8,830 mm each (9,330 mm) Cutterhead power: 3,500 kW each	Zschokke Locher AG, HOCHTIEF AG, Alpine Mayreder Bau GmbH, CSC Impresa Costruzioni SA, Impregilo S.p.A.
Gotthard: railway "Gotthard Base Tunnel" Section #252 Amsteg-Sedrun Tunnel lengths: 2 x 11,350 m Geology: granite	**S-229, S-230** **2 x Gripper TBM** Diameter: 9,580 mm each Cutterhead power: 3,500 kW each	Murer AG, Strabag AG

For further information on the Gotthard Base Tunnel Project, visit www.alptransit.ch, www.tat-ti.ch, www.agn-amsteg.ch and www.herrenknecht.com or order our Gripper animation on CD-ROM and our "Gotthard" DVD.



February 2005: Ring No. 1940 installed in the west tube bore of the Islisberg tube.

Securing the east drive in the Amsteg section of the Gotthard Base Tunnel, 80m behind the Cutterhead.



PERFECT TEAMWORK AT ISLISBERG.

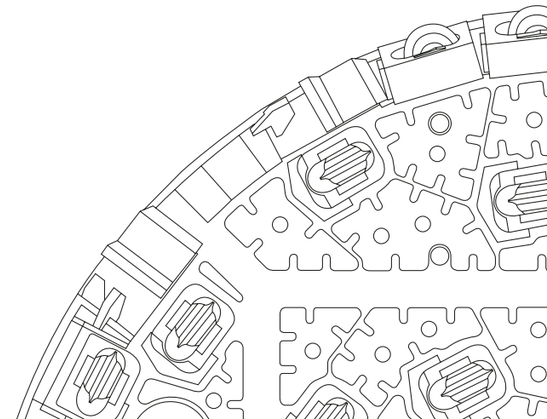
After only 54 weeks of single shift work, breakthrough for the 4,680 m west tube of the Islisberg Tunnel was achieved on April 21, 2005. From mid-June 2004, average weekly performances of 103 m were attained. The best performance in one week was 110 m. These figures can be credited to both the sophisticated technology of the Single Shield TBM and the highly coordinated and experienced tunnelling team.

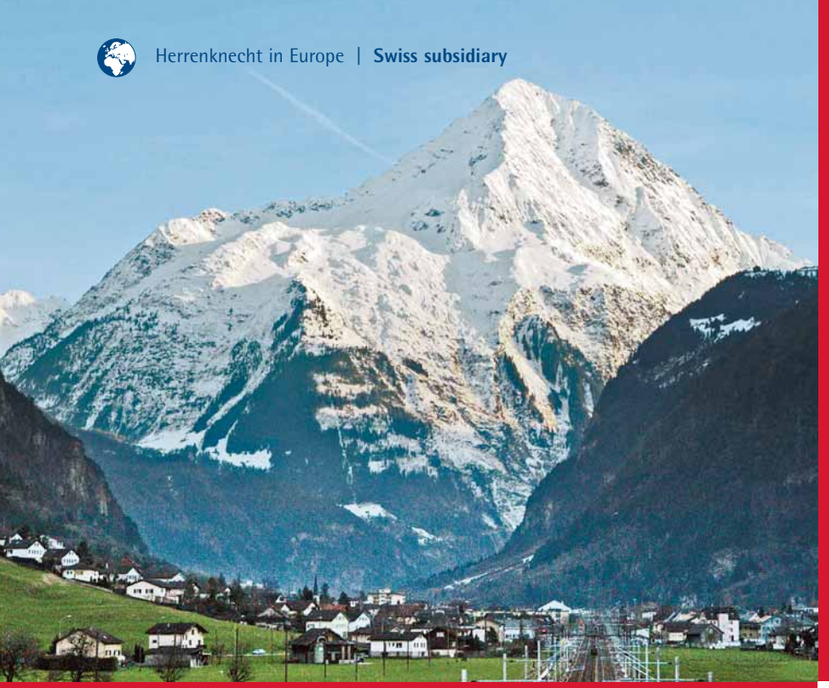
After repositioning and conversion of the 160 m long, 2,000 t tunnelling machine, the team began tackling the 4,645 km east drive at the beginning of July. The Herrenknecht S-256 TBM had already excavated more than 1,200 m of the east tube by mid-October 2005. After completion, the Islisberg Tunnel will be the longest underground portion of the western Zurich bypass which, from 2009, will reduce the city's burden of through traffic to and from central Switzerland.

ISLISBERG | SWITZERLAND

TUNNEL PROJECT	MACHINE DATA	CONTRACTORS
Islisberg Tunnel: road Tunnel lengths: 4,680 m, 4,645 m Geology: upper freshwater molasse (calcareous siltstone, fine sand layers)	**S-256, Single Shield TBM** Diameter: 11,805 mm Cutterhead power: 1,760 kW	Marti Tunnelbau AG, Ed. Züblin AG, Marti AG Construction company

For further information on the Islisberg Tunnel Project, visit www.islisbergtunnel.ch





A PORTRAIT OF THE SWISS.

More than 40 employees work for Herrenknecht in Switzerland.

The 1,200 m² Herrenknecht assembly facility in Amsteg at the Gotthard range.

From the Rütli Oath and William Tell to the Base Tunnel. The Swiss have many mountains and they love them all. But one of them has a special place in their hearts: the St. Gotthard mountain in the Canton of Uri, which rises 2,092 m above sea level. This affection is probably due to the fact that the earth out of which the mountain range in central Switzerland rises is full of history. It was not far from here, at Lake Lucerne, that the three emissaries of the original cantons Uri, Schwyz and Unterwalden swore their legendary Rütli Oath, on August 1, 1291. This eternal alliance in the battle against the Habsburgs was the cradle of the Swiss Confederation. But as if that weren't enough, not far from the lake in the hamlet of Altdorf the apple took its second starring role, after the Garden of Eden. 11 years after the swearing of the oath, according to legend, William Tell made his golden shot here. He hit the apple and saved his son. Some 800 years later, the Herrenknecht company came to the area and bought some land – a wise move since history always repeats itself. Today, the eyes of the world have again turned to the area around the St. Gotthard mountain. This time the location of the story is Amsteg.

Amsteg is a small village with a few hundred inhabitants. For the past few years, there has been a community of cabins at the edge of the village. This is home to some of the people working on the construction of the longest railway tunnel in the world (see p. 12). From 2015, high speed trains will pass through the two single-track, 57 km-long tunnels in record time. Amsteg, at the foot of the mountain range, is the site of one of the two intermediate attack points using Herrenknecht tunnelling machines, for the most important tunnel project in the world, the new Gotthard Base Tunnel.

The Swiss subsidiary of the Herrenknecht company is located close to the entry portal. Some 10 employees can be found here in this facility. "Most of the people are on the construction sites," explains Coni Scheifele, manager of the Amsteg subsidiary. After all, that's what they are here for, he adds, prepared to be wherever they are needed. That is precisely their job.

"One of the two machines in Amsteg got stuck," says Roman Eggel, describing a critical case. Parts of the face in front of the Cutterhead collapsed and trapped it. Such things can happen in difficult geological conditions. The mechanical engineer Roman Eggel, however, does not look for solutions to geological problems but rather considers how to look after the machine so that it will advance again after the clearance and securing work has been completed, thus keeping damage to a minimum. That is his job. When other problems arise, the tunnelling machine operators phone him and ask, for example, what the maximum limit for pressure increases is to pass through fault zones with as few problems as possible. The 33-year-old engineer has worked in tunnel construction for more than 10 years. He began his career working for a construction company, but joined Herrenknecht in 2000. "In both branches the aim is to complete a project successfully," he explains. Everyone must work together to achieve success. That's why everyone must pull together to free the trapped machine from its unfortunate position. Progress in tunnel construction is the only thing which determines whether an underground project is successful or not.

Herrenknecht's subsidiary in Amsteg was founded 10 years ago. It now employs more than 40 people – from fitters to engineers. The employees in the workshop are rebuilding worn disc cutters. It can happen that they have to put in weekend shifts when the Cutterheads strike particularly abrasive rock. The wear and tear of the discs is dictated to a great extent by geological conditions and not by the calendar of workdays and weekends. Most of these people's co-workers are in the tunnel making sure that the machines are available for use as much as possible by carrying out various daily maintenance tasks. With this preventive measure, they reduce the number of interruptions due to mechanical, electrical or hydraulic faults. Amsteg is responsible for maintaining five machines. Two at the north side of the Gotthard, two at the south side and one at the Islisberg Tunnel near Zurich. In addition, employees are also hard at work at the parent company in Schwanau and in Germany, Spain, Moscow and Kuala Lumpur. And customers in Switzerland also profit from their experience. The Swiss boss, Coni Scheifele also has a great deal of experience. This civil engineer has been in this underground business for more than 25 years.

"For 20 years I worked exclusively for a construction company on underground construction projects, before coming to Herrenknecht in 1999," recalls the 49-year-old. The company boss was looking for a subsidiary manager who speaks the customers' language, thinks like the customers and acts like a customer. That's why Coni Scheifele got the job. He has been working with the company at the Gotthard range for 10 years. That's a long time for two partners to get on with each other. "Such long-term working relationship can only reach a positive end if there is trust," says Coni, speaking from experience. And that's another thing this region is famous for. Neither the Rütli Oath nor William Tell's golden shot could have succeeded without trust.

Coni Scheifele, subsidiary manager of Herrenknecht Schweiz AG.

Launch shaft in the Vienna City Park, a listed monument. Precision counts in constructing the Wiental collector in a very tight space.

HELLO, AUSTRIA.

For many decades, tunnelling in Austria was dominated by the "New Austrian Tunnelling Method" (NATM). Now, however, tunnelling machines are also being used in Austria. Construction companies are attempting to establish mechanical tunnelling with five infrastructure projects.

In fall 2005, the first of two Single Shield TBM began work. From the west, they are driving two single-track, approx. 11 km-long sections of the **Wienerwaldtunnel** (Vienna Woods Tunnel). This construction project, with a total length of 13.35 km is part of the new Vienna-St Pölten route and is the first tunnel project in the country outside of major urban centers, being constructed with a TBM.

Herrenknecht TBM technology is also involved in the continuation of the 42.3 km improvement project. A Single Shield TBM made in Schwanau is driving three adjacent tunnel sections – the Reiserberg Tunnel, the Stierschweiffeld Tunnel and the Raingruben Tunnel – with a total length of 6.335 km, as part of the so-called **Perschling Tunnel Chain**.

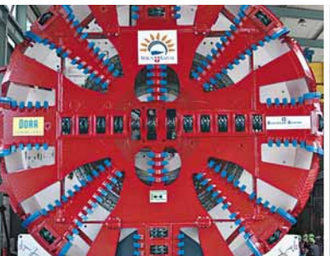
Construction of the **Wiental collector** began in August 2004. This 2.7 km sewage duct, which follows the route of the Vienna River, is being constructed by an Earth Pressure Balance Shield. This machine has been working its way successfully through silty-clay soil formations with disc cutters and soft-ground cutting tools. Breakthrough of this up to 36 m-deep route beneath the Vienna River was achieved in April 2005.

A Mixshield made in Schwanau, which had already driven the underground portion of metro line 1, is now being used in the extension of **metro line 2/5**. Work on constructing the 1,750 m tunnel began in December 2004. In August 2005, the Mixshield reached the target shaft. This route went through silt, sand and gravel at depths of up to 20 m below the groundwater level.

The construction team from Porr Tunnelbau GmbH were able to complete construction work for the **Graz cable tunnel** as early as December 2004. This 877 m cable tunnel runs beneath the Graz main railway station, providing it with an electricity supply. This project involved the use of a machine with partial face excavation, with a diameter of 3,680 mm.

For further information on the Wienerwaldtunnel Project, visit www.hl-ag.com/wien_st_poelten/wien_st_poelten.html

EPB Shield S-257, Wiental collector.



Mixshield S-277, Line 2/5, Vienna.

Single Shield TBM S-303, Wienerwaldtunnel.

Single Shield TBM S-319, Perschling Tunnel Chain.

Machine with partial face excavation with road header, Graz cable tunnel.

CURRENT PROJECTS IN AUSTRIA

TUNNEL PROJECT	MACHINE DATA	CONTRACTORS
Vienna: sewage "Wiental collector WSK-E" Tunnel length: 2,600 m Geology: loamy to coarse-grained silt with soil layers of fine sand to gravel	**S-257, EPB Shield** Diameter: 8,600 mm Cutterhead power: 2,600 kW	Porr Tunnelbau GmbH, Bilfinger Berger Bauges. m.b.H.
Vienna: metro "Line U2/5" Tunnel length: 1,750 m Geology: silty sand, gravel/sand with boulders, silt	**S-277, Mixshield** Diameter: 6,800 mm Cutterhead power: 440 kW	Bilfinger Berger Bau GmbH Porr Technobau und Umwelt AG
Vienna Woods: railway "Wienerwaldtunnel" Tunnel lengths: S-303: 10,731 m S-304: 10,738 m Geology: molasse, flysch	**S-303, S-304** **2 x Single Shield TBM** Diameter: 10,695 mm each Cutterhead power: 4,900 kW each	ARGE Wienerwaldtunnel: Porr Tunnelbau GmbH, Ed. Züblin AG, Bilfinger Berger Bauges. m.b.H., Bilfinger Berger AG, NL Tunnelbau, Hochtief Construction AG, Jäger Bau GmbH, Swietelsky Tunnelbau GmbH, Porr Technobau und Umwelt AG
Perschling Tunnel Chain: railway Tunnel lengths: 2,857 m + 1,370 m + 2,108 m Geology: marl, siltstone, sandstone	**S-319, Single Shield TBM** Diameter: 12,980 mm Cutterhead power: 3,200 kW	STRABAG AG
Graz: cable tunnel "Graz Cable Tunnel" Tunnel length: 877 m Geology: sand, gravel, sandstone	**M-941M** **MHSM2,** machine with partial face excavation with road header Diameter: 3,680 mm	Porr Tunnelbau GmbH

Aiming high, going far.

Christina Obergföll is a young, 23-year-old athlete from Mahlberg, 10 minutes' drive from the Herrenknecht TBM manufacturing plant. She set her sights high from an early age in her discipline, the javelin. Just like Dr. Martin Herrenknecht, which is why he has supported this athlete since 2000.

On the final day of the World Athletics Championships in Helsinki, on the evening August 14, 2005, she surprised the athletics world. Christina Obergföll threw the javelin farther than she ever had before in her young sporting career. She sent it flying with so much force that it soared no less than 70.03 m across the green Championships sports field. Christina, her trainer Werner Daniels, Martin Herrenknecht and the athlete's parents could hardly believe their eyes in Helsinki: it was a European record. At the end of the competition this huge throw brought Christina a silver medal and so she is the World Championship runner-up.

Helsinki changed the life of this young athlete to some extent, but down-to-earth Christina Obergföll herself has not changed. She has learned from her sponsor Martin Herrenknecht that you only remain at the top in a global competition when you never stop striving to improve.

The Katzenberg Tunnel construction site covers an area of 100,000 m² in the south of Baden-Württemberg.

KATZENBERG TUNNEL. GERMANY'S LONGEST UNDERGROU ND CONSTRUCTION PROJECT WITH MECHANICAL TUNNELLING.

When, in 2012, the first trains run on this new and improved route, the journey from Karlsruhe to Basel will be reduced from the current 100 minutes to just 70. These trains will sprint through southern Germany at top speeds of up to 250 km/h. The Katzenberg Tunnel will provide the residents of nearby towns with optimum noise protection.

2 x 8,984 meters. The Katzenberg tunnel has been designed as a twin tube tunnel. Two parallel, single-track tunnels are being driven just a few meters apart. Every 500 m a cross-cut connects the two tunnels. The geological conditions, with multiple layers of claystone, clay marl, marlstone with embedded limestone and sandstone, demand flexible machine technology.

Noise protection even during construction. The project is breaking new ground with regard to concern for the local environment. The 2.6 million cubic meters of excavated material are transported directly from the tunnel, via covered conveyor belts, to a quarry near the southern portal. This protects the surrounding towns and villages from the nuisance of construction vehicles by minimizing the number of truck movements to and from the site.

In 2003, Deutsche Bahn AG awarded this contract to the Katzenberg Tunnel Consortium following an EU-wide call for tenders. Shortly afterward, the contract was concluded with Herrenknecht AG to supply the two identical TBM for this trailblazing project in Germany. The first machine has been at work since May, the second since fall 2005. At the beginning of November 2005 the Herrenknecht S-264 TBM had already produced 776 m of tunnel, installing 388 ring segments.

The Katzenberg Tunnel is the largest single construction project in Deutsche Bahn AG's scheme for the construction and improvement of the Karlsruhe – Basel route. With a length of 2 x 8,984 m, the project is Germany's longest underground construction project with mechanical tunnelling. The Earth Pressure Balance Shields from Schwanau being employed in the construction of the railway tunnel between Bad Bellingen and Efringen-Kirchen are among the technically most sophisticated of their kind.

KATZENBERG | GERMANY

TUNNEL PROJECT	MACHINE DATA	CONTRACTORS
Katzenberg Tunnel: railway Tunnel lengths: 2 x 8,984 m Geology: limestone, sandstone, marl	**S-264, S-265, 2 x EPB Shield** Diameter: 11,120 mm each Cutterhead power: 3,200 kW each	Ed. Züblin AG, Wayss + Freytag AG, Marti AG, Jäger Bau GmbH

Dr. Martin Herrenknecht with Inken Öttinger, wife of the Minister President of the State of Baden-Württemberg, Günther Öttinger, at the naming ceremony of the TBM on October 28, 2005 at the Katzenberg Tunnel.

In the following two weeks the Herrenknecht S-265 machine installed 182 segmental rings, producing 228 m of tunnel.

BETTER THROUGH GERMANY.

Staying right on course. During the work to upgrade the city of Würzburg's sewage system, a gyroscopic navigation system once again proved its reliability. The "Universal Navigation System (U.N.S.)" guidance system, developed by Herrenknecht engineers, kept an AVN1200T right on course while driving 436 m of tunnel (see p. 38). With a difference in depth of 10.4 m, three horizontal and two vertical curves had to be tackled. At one point, changes in both vertical and horizontal direction had to be navigated simultaneously. In mid-June 2005, the machine, equipped with its gyrocompass and hydrostatic level, reached the target shaft precisely.

Speed beneath Brandenburg. In a construction time of only 16 days, a 444m tunnel was produced between the Brandenburg villages of Kienbaum and Börnicke in January 2004 with a Herrenknecht AVN1600TB. The stretch, which passes under a protected wetland area, is part of a 40 km high-pressure gas pipeline of Ruhrgas AG and Verbundnetz Gas AG. Despite extensive surveying work necessary because of considerable differences in levels and despite the installation of four intermediate jacking stations and outside temperatures of up to minus 15 degrees Celsius, the tunnel was driven in record time.

All-round nozzle system. An AVN1600TB with cutter discs specially developed by Herrenknecht engineers, was used for the 200 m tunnel under the River Ruhr near Essen-Kettwig. The machine, with an operating power of 160 kW, successfully worked its way through grey sandstone with a maximum compressive strength of 400 MPa, as well as through marl and gravel layers. The all-round provision of the machine with jet nozzles allowed good tunnelling results even in cohesive soils. In addition to the Cutterhead and ring chamber nozzles this machine was also equipped with high-pressure, low-pressure and invert nozzles.

HDD in the Wattenmeer. Mid-May 2005 saw the successful completion of horizontal drilling work to improve connections between the Mittelplate oil field and the Schleswig-Holstein mainland. Two Herrenknecht HDD Rigs were used in the mudflats of the Wattenmeer. Smooth operation of the machines meant that the work was completed well within the scheduled construction time of three months. 7,500 m of pipeline were laid in only two months – despite transport difficulties caused by the tides and wind speeds of up to 75 km per hour. Following completion of this project, an oil pipeline and a water supply pipeline now connect the Dieksand mainland station with Germany's largest oilfield.

PROJECTS IN GERMANY

TUNNEL PROJECT	MACHINE DATA	CONTRACTORS
Würzburg, Rottendorferstrasse: sewage system upgrade Tunnel length: 436 m Geology: claystone, shell limestone, loam	**M-521M** **AVN1200T, double** Diameter: 1,720 mm Max. torque: 196 kNm	Braumann Tiefbau GmbH
Kienbaum-Börnicke: high-pressure gas pipeline Tunnel length: 441 m Geology: marshy ground, peat, sand, clay, boulders, groundwater	**M-595M** **AVN1600TB** Diameter: 1,970 mm Max. torque: 454 kNm	Gildemeister GmbH & Co. KG
Essen-Kettwig: connection to the "Ruhrdüker" sewage treatment plant Tunnel length: 200 m Geology: brown and grey sandstone with max. approx. 400 MPa	**M-974M** **AVN1600TB** Diameter: 1,940 mm Max. torque: 454 kNm	Wilhelm Epping GmbH
Mittelplate: oil and water Total drilling length: approx. 7,500 m Max. partial route length: 1,400 m	**HK400M** Max. tensile forces: 400 t **HK250T** Max. tensile forces: 250 t	Drilltec GUT GmbH

For further information on the Mittelplate project, visit www.mittelplate.de or order our HDD animation.

FASTER THROUGH BELLA ITALIA.

Ring construction under pressure. The city of Naples has chosen tunnelling technology made in Schwanau for the improvement of its metro system. The Metropolitana Napoli has commissioned an extension of its line 1. By 2010, this circle line will connect the city's airport with the metro network. Two EPB Shields (S-238/S-239) from Schwanau are driving the two 4,340 m tunnels. The TBM must dive up to 35 m below the groundwater level. Pressures of up to 4.5 bar are expected.

Reducing the pressure on Trento. A Herrenknecht S-251 Single Shield TBM has been working its way through the foothills of the Dolomites since mid-February 2004 in order to reduce the pressure of through-traffic on the city of Trento. This bypass scheme centers on two tunnels, each 2,760 m in length. The first of these tunnels was completed at the end of February 2005. The machine was then turned round and since the beginning of June 2005 it has been constructing the second tunnel, travelling in the opposite direction and by the end of September 2005 it had advanced 1,210 m.

Fully automatic metrobus. In the northern Italian city of Brescia, a fully automatic public transport system with a length of approx. 13 km is being created with the "metrobus". Some 6 km of tunnels run beneath the historic town center, which includes some fragile buildings. In November 2005, a Herrenknecht S-260 EPB Shield is due to begin drilling and installing lining segments for this two-lane tunnel (5.4 km) through water bearing, loose ground.

CURRENT PROJECTS IN ITALY

TUNNEL PROJECT	MACHINE DATA	CONTRACTORS
Naples: metro "Line 1" Tunnel lengths: 2 x 4,340 m Geology: clay, tuff	**S-238, S-239** **2 x EPB Shield** Diameter: 6,740 mm each Cutterhead power 1,200 kW each	G.T.B. Soc. Cons. AS r.l. (Società AEtl Della Morte S.p.A., Torno Internazionale S.p.A., Impregilo S.p.A., Grassetto S.p.A., Moccia di Giuseppe Moccia S.a.s., Carola S.p.A.)
Trento: road "Valsugana Trento North" Tunnel lengths: 2 x 2,780 m Geology: limestone, marble	**S-251, Single Shield TBM** Diameter: 12,055 mm Cutterhead power: 3,600 kW	TOTO Costruzioni Generali
Brescia: railway "Metrobus" Tunnel length: 5,400 m Geology: tuff, silt, clay, gravel	**S-260, EPB Shield** Diameter: 9,150 mm Cutterhead power: 2,000 kW	Astaldi S.p.A.
Genoa: railway "High Speed Line Genova-Ventimiglia" Tunnel length: 4 tunnels with total length of 12 km	**S-315, Single Shield TBM** Diameter: 11,780 mm Cutterhead power: 4,000 kW	Ferrovial-Agroman S.A.

High Speed in Genoa. Like many other countries, Italy is also upgrading parts of its railway network into high speed routes. The 137 km connection between Milan and Genoa is part of this project, which will eventually cross Italy in the shape of a "T" (from Venice to Turin and from Milan to Naples). Herrenknecht won the order from the construction company Ferrovial-Agroman S.A. to build the S-315 Single Shield TBM to drive four tunnels near Genoa with a total length of 12 km.

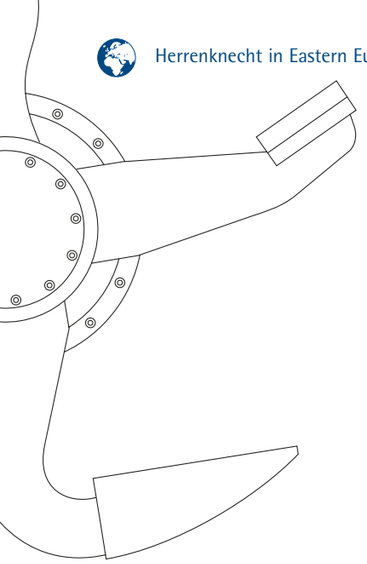
AVN1600TB with great performances in Brandenburg.

Successful and always on the right track: AVN1200T with U.N.S. guidance system.

Final handover of the AVN1600TB for the Ruhrdüker, Essen-Kettwig.

Two Herrenknecht HDD Rigs drill successfully under the Wattenmeer.

At the end of February 2005, the Herrenknecht S-251 Single Shield TBM completed the first section of the Valsugana Tunnel.



GOING EAST.

A Herrenknecht Mixshield is once again on a breakthrough mission; after it was used in the construction of the 4th Elbe River Tunnel, it went to work constructing the Lefortovo road tunnel in central Moscow. In May 2004, after being modified and overhauled, the S-250 machine began driving two tunnels beneath the "Serebryanyi Bor" (Silver Forest) nature reserve northwest of Moscow. Under the direction of the Russian construction company OAO Mosmetrostroy, breakthrough for the first tunnel was achieved on March 17, 2004 after a consistent run of excellent tunnelling performances.

After repositioning, "Elizaveta" is due to set off on another underground journey in autumn 2005. The two 1,505 m tunnels along the banks of the Moskva River are planned as two-storey tunnels. The upper storey of each tunnel will be available for three-lane road traffic. The lower storeys are reserved for the "Strogino" metro route, one for each direction. A further Herrenknecht Mixshield (S-290) is constructing a service tunnel between the two main tunnels to serve as a supply, ventilation and escape route. This project should be completed by 2007.

Tunnelling champion. St. Petersburg's sewage system is constantly being modernized and extended. A Herrenknecht AVN2000D Utility Tunnelling Machine has already driven more than 6 km of sewage tunnel as part of two projects in the "Venice of the North", in order to protect the Neva from flooding and to modernize the sewage system. The construction company STIS GmbH chose tunnelling technology made in Schwanau because of the complex, water-bearing ground such as silt, sand and loam containing many boulders of all sizes.

This Mixshield, which was specially adapted for this project, has been working its way through these complex geological conditions since autumn 2003, sometimes with performances worthy of a world record. Thus, a 909 m distance was driven in wintry conditions with temperatures down to minus 20 degrees Celsius, in only 5.5 weeks. In this project, the AVN2000D drove an average of 39 m of pipeline per day.

A Herrenknecht shaft sinking unit will also be employed as part of this large-scale project (see p. 39).

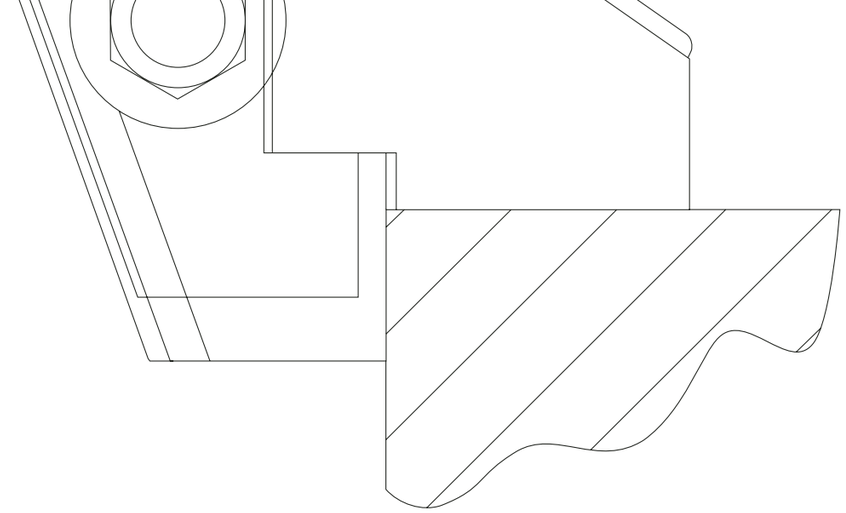
Energy for the Silver Forest Tunnel. Herrenknecht HDD Rigs reliably lay oil or gas pipelines and other supply lines underground using the trenchless method. Two lines, each 650 m in length, serve to supply the Silver Forest freeway and metro tunnel with energy. They were driven by an HK250TS through plastic loam and sand, approx. 8 m beneath the River Moskva. Subsequently, polyethylene pipes were pulled into the pre-reamed hole tube to serve as a duct and protection for cables. The project was successfully competed in June 2005.

Silver Forest Tunnel in Moscow: the Herrenknecht S-250 Mixshield once again achieved top tunnelling performances in the Russian capital.

CURRENT PROJECTS IN RUSSIA

TUNNEL PROJECT	MACHINE DATA	CONTRACTORS
Moscow: road and metro "Silver Forest Tunnel" Tunnel lengths: 2 x 1,505 m Geology: sand, clay, boulders	**S-250, Mixshield** Diameter: 14,200 mm Cutterhead power: 3,200 + 315 kW	OAO Mosmetrostroy
Silver Forest: service tunnel Tunnel length: 1,500 m Geology: sand, clay	**S-290, Mixshield** Diameter: 6,280 mm Cutterhead power: 450 kW	OAO Mosmetrostroy
Moscow: service tunnel for Silver Forest project Tunnel length: 2 x 650 m Geology: plastic loam, gravel, sand, no groundwater	**HK250TS** Diameter: 1,200 mm Installed power: 400 kW Max. torque: 90 kNm	Sentjabr
St Petersburg: sewage system Tunnel length: total > 6 km Geology: water, silt, fine and coarse-grained sand, loam, boulders	**M-794M AVN 2000D** Diameter: 2,525 mm Max. torque: 780 kNm	STIS GmbH

For further information on the St Petersburg project, order our AVN 2000 (St Petersburg project) animation.



Unbeatable EPB Technology in Poland. A Herrenknecht EPB1600 with muck skip drove four tunnels with a total length of 1.1 km as part of the construction of a new sewer for the Polish capital Warsaw. This reinforced concrete tunnel, constructed beneath one of Warsaw's main traffic arteries, serves as a sleeve pipe for the smaller sewage pipe. Beneath the groundwater level in geological conditions such as loam, silt, sand and rock, this EPB technology made in Schwanau obviously felt at home. With a Cutterhead optimized for improved machine performance, the tunnelling team achieved top daily results of up to 27.5 m.

Hungary: tried and tested teamwork. A Herrenknecht EPB2000 equipped with U.N.S. is constructing a sewage tunnel with a total length 3.45 km in Szeged, the fourth largest city in Hungary with around 165,000 inhabitants. This tunnel will connect a new sewage treatment plant with the existing sewage system. This mainly inner-city tunnel is being driven in seven drives, each with a length of approx. 500 m, through loam, sand and silt. The first two sections were completed in mid-July 2005. The newly formed construction site team achieved impressive tunnelling performances with maximum daily results of 37 m. The project is due to be completed by summer 2006.

Confident logistics for Azerbaijan. A Herrenknecht AVND1600 crossed the Kura River, the largest river in the Caucasus region, in extremely complex geological conditions and far from any infrastructure. With Pipe Jacking Technology, the tunnel crew laid two parallel reinforced concrete pipelines through constantly changing conditions, including sand, loam and gravel as well as many hidden boulders, to accommodate one oil and one gas pipeline. Despite the high logistical demands, the construction site team was able to complete these two sections, each with a length of 400 m, in record time by May 3, 2005, with its "round-the-clock" dedication and with top daily performances of almost 43 m.

WARSAW I POLAND

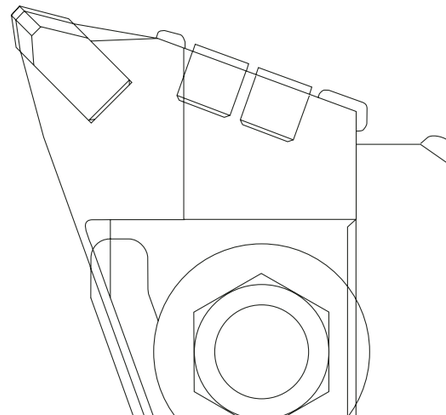
TUNNEL PROJECT	MACHINE DATA	CONTRACTOR
Cerniakowska: sewage project Tunnel lengths: total 1,100 m Geology: hard loam, soft loam, silt, sand, rock, groundwater	**M-933M** **EPB1600** Diameter: 1,970 mm Max. torque: 316 kNm	Hydrobudowa 9

SZEGED I HUNGARY

TUNNEL PROJECT	MACHINE DATA	CONTRACTOR
Szeged: sewage project Tunnel lengths: total 3,450 m Geology: loam, sand, silt	**M-743M** **EPB2000** Diameter: 2,420 mm Max. torque: 820 kNm	Alterra Építöipari Kft.

KURA RIVER I AZERBAIJAN

TUNNEL PROJECT	MACHINE DATA	CONTRACTOR
Kura West River Crossing: oil and gas pipeline Tunnel lengths: 2 x 400 m Geology: full spectrum, from gravel and sand to loam, boulders	**M-929M** **AVND1600** Diameter: 1,970 mm Max. torque: 454 kNm	FlowTex Egypt



Herrenknecht–Talk in Munich.

Top experts and insiders from the sector spent two days at the bauma 2004 in Munich discussing current trends in mechanical tunnelling on the German and European markets. The key topics of this sector forum were "More service with lower budgets. Must safety suffer?" and "Traffic infrastructures of the future. Does Europe need new tender and partnership models?" Klaus-Peter Siegloch (German Broadcasting Corporation) moderated the talk sessions at the bauma booth of Herrenknecht AG. A number of their comments are timeless and relevant to the present.

1 "More service with lower budgets. Must safety suffer?"

Martin Bosshard (Basler & Hofmann): "Investments should be made continuously, so that know-how does not stagnate. Future tunnel and infrastructure projects are becoming increasingly complex. That is why it is so important not to lose know-how."

Prof. Dr. Martin Ziegler (STUVA, RWTH Aachen): "Far too often, decisions on infrastructure projects are political decisions. They are often far too heavily influenced by ideology rather than by facts."

Peter Teuscher (BLS AlpTransit AG): "One should not always ask about the economic profitability of such projects. One must also consider the positive influence of traffic and transport systems on the development of the national economy."

2 "Traffic infrastructures of the future. Does Europe need new tender and partnership models?"

Prof. Dr. Lothar Späth (Chairman of the supervisory Board of Herrenknecht AG): "We must allow the markets to decide which financing model is most appropriate. That will mean that some projects will fail, that is simply part of what the free market economy is about. It is a mistake to think that when things go wrong, the state will always pay. When things succeed, the private sector earns. Failure is a natural way of regulating the market."

Peter Zbinden (AlpTransit Gotthard AG): "We use our tax revenues for consumption today, for short-term training, short-term social contributions. But that means we are failing to invest in the future, for example in upgrading traffic and transport infrastructures, in road building and communication."

Albert Scheller (DB Projektbau): "The room to maneuver for new projects is very small or even non-existent. That is why politicians must make sure that we do not lag behind in the face of Europe's enlargement to the east."

Rolf Berger (4th Elbe River Tunnel Consortium): "The functional tender procedure for the construction of the Elbe River Tunnel was a success. Before a tender procure begins, there must be an intensive identification process for what should be built and under what conditions."

Klaus-Peter Siegloch (center) exploring innovative partnership models with talk guests Prof. Dr. Lothar Späth (2nd from right, and above), Rolf Berger (right), Peter Zbinden (left) and Albert Scheller (2nd from left).

NI HÅO IN CHINA.

Broad commitments in Guangzhou. New traffic and transport infrastructures in China's conurbations must almost necessarily go underground. This is because these large metropolitan areas are densely built up, space is at an ever higher premium and transport and traffic needs are increasing all the time. In Guangzhou alone, 18 EPB Shields from Schwanau have been or are still involved in the extension of the metro network, producing more than 30 km of tunnels in total.

Assembly in China. Herrenknecht has now begun assembling large tunnel boring machines outside Europe for the first time, in order to serve better the rapidly growing Asian market and to provide optimum support for our Asian customers. In a construction period of only five months a new assembly facility and an administration building were completed at the Guangzhou location in southern China. Even at the official inauguration at the end of April 2005, the plant was already working to full capacity. The 104 m-long and 22 m-wide building, equipped with state-of-the-art assembly technology, can accommodate three large tunnel boring machines during assembly at the same time.

A second manufacturing site is currently under construction in the "Nansha Development Zone" near Guangzhou. There, together with its Chinese joint venture partner, "GZEG", Herrenknecht will further increase its manufacturing capacity for the Asian market. Knowledge transfer abroad concentrates on the areas of steel fabrication and assembly. Schwanau remains the center of excellence for mechanical and production engineering. Electronics, control engineering, mechatronics and hydraulics are produced and further developed exclusively in Germany.

Si Tu Jian Quan (right), general manager of the Chinese joint venture partner GZEG, and Dr. Martin Herrenknecht at the laying of the foundation stone for a new steel production plant in the "Nansha Development Zone" near Guangzhou.

For further information on metro projects in Guangzhou, visit www.investguangzhou.gov.cn

Left:
assembled in China: two Earth Pressure Balance Shields for Singapore.

Right:
Dr. Martin Herrenknecht with his brother Dieter Herrenknecht (right) on their way to China.

CURRENT PROJECTS IN CHINA

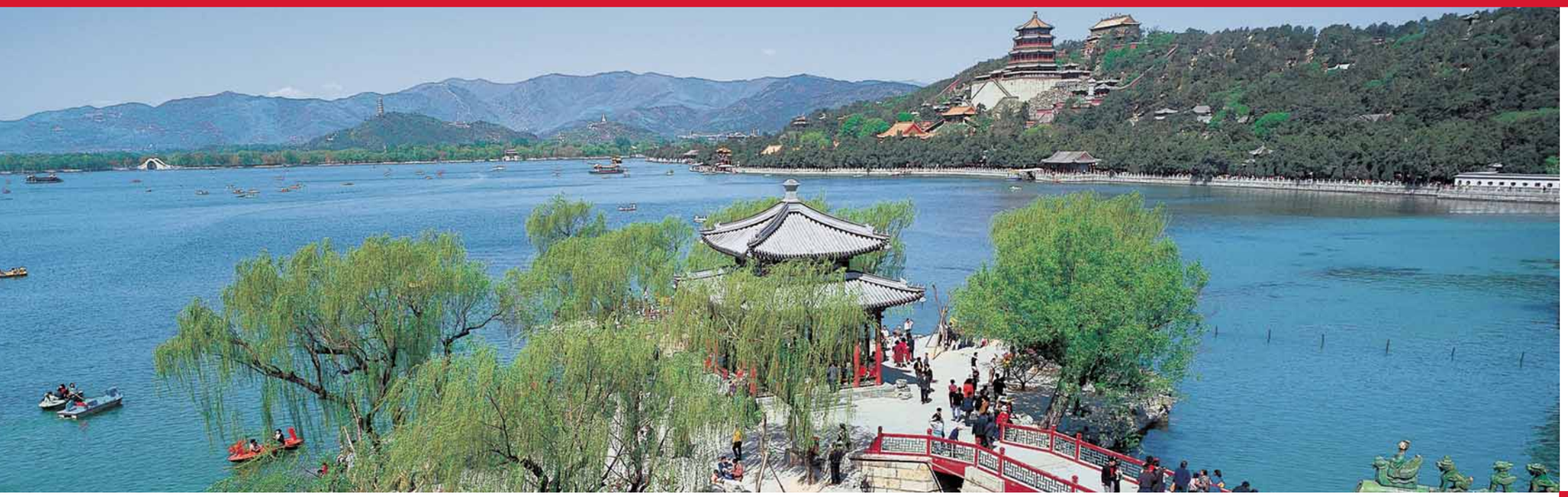
TUNNEL PROJECT	MACHINE DATA	CONTRACTORS
Beijing: Metro "Line 5", second stretch Tunnel length: 2,833 m Geology: silty, medium, gravelly sand, stone layer with fine sand, silt, clay	**S-169, EPB Shield** Diameter: 6,190 mm Cutterhead power: 630 kW	Beijing Urban Construction Group Co. Ltd.
Guangzhou: Metro "Line 3", Shiqiao to Panyu Plaza Tunnel lengths: S-242: 3,518 m, S-243: 3,500 m Geology: slightly weathered granite, sandstone, clay	**S-242, S-243,** **2 x EPB Shield** Diameter: 6,250 mm each Cutterhead power: 945 kW each	Guangzhou Municipal Dunjian, Underground Construction, Engineering Co. Ltd.
Guangzhou: Metro "Line 3", TianHe to HuaShi Station Tunnel lengths: 2 x 3,084 m Geology: sandstone, siltstone, clay, silt	**S-244, S-245,** **2 x EPB Shield** Diameter: 6,250 mm each Cutterhead power: 945 kW each	Guangzhou Municipal Dunjian, Underground Construction, Engineering Co. Ltd.
Beijing: Metro "Line 5" Tunnel lengths: 2 x 750 m, 2 x 650 m Geology: silty sand, loamy sand	**S-254, EPB Shield** Diameter: 6,250 mm Cutterhead power: 630 kW	Beijing Chang Cheng Bilfinger Berger Constr. Eng. Corp. Ltd.
Guangzhou: Metro "Line 4" Xiaoguwei to Xinzao Section Tunnel length: 1,467 m Geology: weathered, migmatitic rock, sand, clay	**S-261, EPB Shield** Diameter: 6,250 mm Cutterhead power: 945 kW	China Railway Tunnel Group Co. Ltd
Guangzhou: Metro "Line 4" Luntou to University Station Tunnel lengths: 2 x 3,950 m Geology: slightly to moderately weathered granite	**S-266, S-267,** **2 x EPB Shield** Diameter: 6,250 mm each Cutterhead power: 945 kW each	China Railway 13th Bureau Co. Ltd.
Tianjin: Metro Tunnel lengths: S-283 + S-284: 2,290 m each S-282: 2,100 m Geology: sand, loamy sand, sandy clay, clay, silt	**S-282, S-283, S-284,** **3 x EPB Shield** Diameter: 6,390 mm each Cutterhead power: 630 kW each	S-282: China Railway 18th Bureau Co. Ltd. S-283/284: China Railway 3rd Bureau Co. Ltd.
Beijing: Metro Tunnel lengths: S-285: 2 x 1,570 m S-291: 2 x 2,100 m + 2 x 680 m S-294: 2 x 1,074 m + 2 x 1,591 m + 2 x 700 m Geology: S-285: sand, loamy sand, sandstone S-291/294: soft soil, clay	**S-285, S-291, S-294** **3 x EPB Shield** Diameter: 6,250 mm each Cutterhead power: 630 kW each	S-285: China Railway 1st Bureau Group Co. Ltd. S-291: Beijing Uni-construction Group Municipal Eng. Co. (UCC) S-294: China Railway 16th Bureau Group, 2nd Enginering Co. Ltd.
Shanghai: road "Changjiang Under River Tunnel Project", Tunnel lengths: 2 x 7,170 m Geology: sand, clay, rubble	**S-317, S-318, 2 x Mixshield** Diameter: 15,430 mm each Cutterhead power: 3,500 kW each	Shanghai Changjiang Tunnel & Bridge Construction Development Co., Ltd.
Guangzhou: Metro "Line 5" Tunnel lengths: 2 x 1,682m + 2 x 586 m Geology: granite	**S-329, EPB Shield** Diameter: 6,250 mm Cutterhead power: 1,200 kW	China Railway 1st Group Co. Ltd.
Hong Kong: railway "Kowloon Southern Link KDB 200" Tunnel lengths: 2 x 1,100 m Geology: completely and moderately disintegrated granite	**S-335, Mixshield** Diameter: 7,990 mm Cutterhead power: 2,400 kW	Leighton Balfour Kumagai John Holland JV

海瑞克隧道设备

The Herrenknecht assembly facility in Guangzhou covers a total area of 2,288m² and is equipped with state-of-the-art assembly technology.

MICROS ARE GREAT.

HERRENKNECHT ASIA HEADQUARTERS.



Twice under the Yangtze. The East-West Pipeline project is China's second largest infrastructure project, after the Three Gorges Dam. This 4,200 km connection crosses beneath the Yangtze River twice. Two slurry TBM of the type AVN2440D drove the tunnels to carry the gas pipeline under Asia's longest river. The crossing near the city of Honghuatao in particular proved to be a great challenge. In extremely variable geological conditions, with groundwater pressure of up to 4 bar, the Mixshield with compressed air and bentonite tunnel face support was in its element and reached the target shaft precisely after driving 1,500 m of tunnel.

Tough stuff in Hong Kong. An AVN1800TB had to crack hard rock with strengths of up to 380 MPa. This Utility Tunnelling Machine drove a new, 1,606 m sewage tunnel through extremely hard underground beneath the tower blocks of Hong Kong. Small overburdens and curved routes made the undertaking even more complex. A total of 7 drives had to be completed. The toughest challenge was the last, and with a length of 404 m, longest individual section to be driven. On June 14, 2005 the machine reached the target shaft precisely, with slight settlement of only 5-10 mm, despite the difficult geological conditions. 3 Herrenknecht machines laid a total of 2.5 km of tunnel with diameters of 600 mm, 1,200 mm and 1,800 mm for the Wan Chai East and North Point Sewage Trunk Sewers Project.

HDD in the fast lane. China's huge and rapidly growing consumption of energy means ever more efficient distribution systems are necessary to transport oil and gas from their distant sources to power plants and industrial centers in the country's energy-hungry conurbations. Seven Herrenknecht Horizontal Drilling Rigs are currently being employed, in particular for the trenchless laying of oil and gas pipelines. Since 2003, a total of 31 km of pipeline have been laid under rivers, roads and other obstacles, in 35 projects. This included maximum individual drilling routes of 1,700 m through extremely varied geologies.

PROJECTS IN CHINA

TUNNEL PROJECT	MACHINE DATA	CONTRACTORS
Honghuatao: protecting tube for gas pipeline "Yangtze River Crossing" Tunnel length: 1,500 m Geology: weathered sandstone, sand, clay, gravel	**M-659M** **AVN2440D** Segmental Lining Diameter: 3,145 mm Max. torque: 620 kNm	COGBP China Petroleum Material and Equipment Corporation
Hong Kong: sewage "Wan Chai East and North Point Sewage Trunk Sewers" Tunnel lengths, total: 1,606 m Geology: granite, soft soil, boulders	**M-729M** **AVN1800TB** Diameter: 2,150 mm Max. torque: 554 kNm	Fine Projects Ltd. Leighton Kumagai

Tough guy: hard rock Cutterhead of the M-729M for Hong Kong.

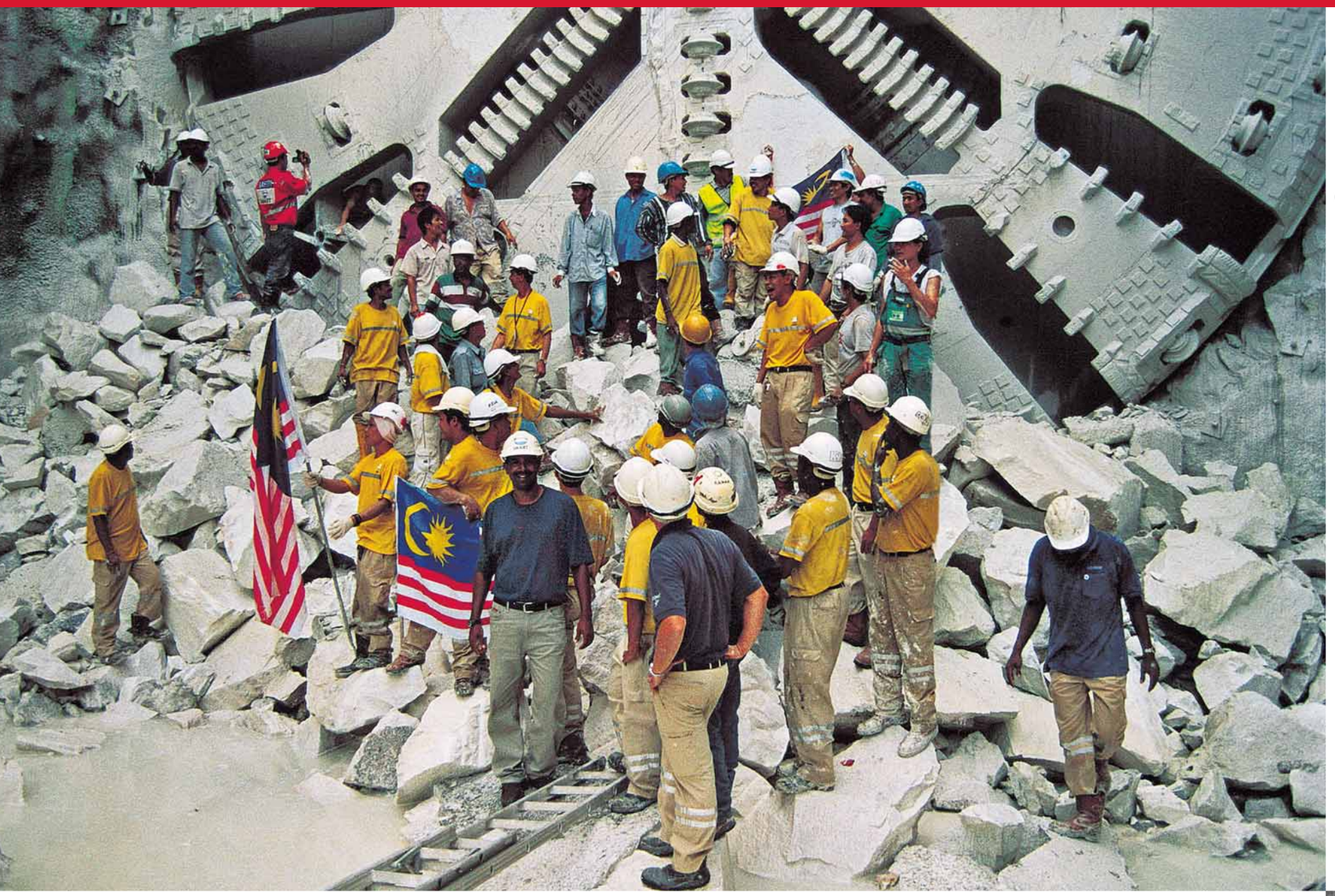
The Asian market. Asia is one of the most important sales markets for Herrenknecht. Asia already accounts for one third of the company's annual incoming orders – and that figure continues to grow. This means that the Asian region is the most important market in the world together with Europe for tunnelling technology. In order to consistently expand Herrenknecht's leading market position in Singapore, China, India, Malaysia, Thailand and Australia, the company founded headquarters in Singapore in October 2004 – "Herrenknecht Asia Headquarters Pte. Ltd.".

The new headquarters will coordinate the activities of other Asian subsidiaries and set up and develop a sales network for the growth markets in India, Vietnam, Korea, Laos and Indonesia. However, the "Herrenknecht Asia Headquarters Pte. Ltd." is not only a hub for sales and marketing of tunnelling technology. It will also be a research and development center in Asia and will take advantage of its closeness to customers and projects to produce market-oriented technical solutions.

Award ceremony at the opening of the Asia headquarters in Singapore. Dr. Martin Herrenknecht with Teo Ming Kian, chairman of the Singapore EDB (Economic Development Board).

Mission accomplished: breakthrough of the last of five EPB Shields for the Deep Tunnel Sewage System in Singapore in January 2005.

DUAL USE FOR KUALA LUMPUR.



Breakthrough:
the Herrenknecht S-253 Mixshield reached the South Junction Box intermediate stage at the beginning of June 2005 after 1,812 m of tunnel (1,066 ring segments).

SMART TUNNEL I KUALA LUMPUR

TUNNEL PROJECT	MACHINE DATA	CONTRACTORS
Kuala Lumpur: road and water "SMART Tunnel" Tunnel lengths: 5,400 m + 4,050 m Geology: limestone, marble, sand	**S-252, S-253** **2 x Mixshield** Diameter: 13,210 mm each Cutterhead power: 4,000 kW each	S-252: Wayss & Freytag AG S-253: MMCEG-Gamuda Joint Venture

Tunnels are serving ever more complex needs. Two Herrenknecht Mixshields are currently working on one of the world's most unusual tunnel projects in Kuala Lumpur. Beneath the densely populated Malaysian capital, a 9.5 km tunnel system is being built, which will provide relief for the city in two ways. For most of the year the tunnel will reduce the traffic burden. During the monsoon, however, it will channel the huge amounts of water which repeatedly overwhelm the city, and protect Kuala Lumpur from flooding.

Intermediate targets safely met. Since July and September 2004 respectively, the two Herrenknecht Mixshields have been tunnelling in opposite directions, one northward and one southward, having set off in one launch shaft. The SMART Project (Stormwater Management and Road Tunnel) is due to be completed by the end of 2006. On their journey underground, the Mixshields are confronted with variable geological conditions. The first intermediate targets have now been met safely. December 2004 saw the celebration of the first breakthrough of the TBM S-252. Its identical twin reached the first target shaft at the beginning of June 2005.

A trailblazing construction. The SMART Tunnel is built on three stories. Traffic flows along the top two decks, separated according to direction, with two lanes each. The cavity beneath these two decks inside this tunnel, which slopes from north to south, is always available as a water overflow channel. A 3 km-long portion in the middle third of the tunnel route is used as an additional bypass whenever water levels become critical. When flood waters reach a critical height, initially the lower road level is closed to traffic in this section of the tunnel, and if necessary the upper level is also closed to traffic.

For further information on this topic, visit www.smarttunnel.com.my

IN THE SHADOW OF THE HIMALAYAS.

Teamwork Tunnelling in India, too: demand is rising for Herrenknecht Horizontal Drilling Rigs on the Subcontinent.

Expansion in India. Herrenknecht Horizontal Drilling Rigs are used all over the world – in particular for the trenchless laying of oil and gas pipelines. When obstacles stand in the way of a pipeline route, more and more construction companies are turning to HDD equipment made in Schwanau. With pullback forces of 60 to 400 t, the maxi and mega rigs can lay pre-fabricated pipelines with diameters of up to 1.60 m for a distance of approx. 3,000 m through various ground. Trailer Rigs are particularly popular as they can be easily and cheaply transported over large distances.

India is now developing into an expanding HDD market. Two HDD Rigs made in Schwanau are currently being employed on the subcontinent. A trailer-based, 250t rig successfully completed two river crossings at the end of March 2005. As part of a second pipeline project, 11 crossings with a total length of 4,044 m are due to begin, also with a Trailer Rig.

HDD RIGS IN INDIA

TUNNEL PROJECT	MACHINE DATA	CONTRACTORS
Tamil Nadu: oil "Chennai-Madurai-Tiruchirapalli-Pipeline" Drilling length: 906 m, 1,060 m Geology: solid clay, sand	**HK250T, HDD Rig** Diameter: 560 mm Max. torque: 90 kNm Installed power: 400 kW	ESSAR Construction Ltd.
Oil "Paradeep-Haldia-Pipeline" Drilling length: 11 drillings, total 4,044 m Geology: sand, clay	**HK250T, HDD Rig** Diameter: 762 mm Max. torque: 90 kNm Installed power: 400 kW	N.R. Patel & Co. Ltd.

UTILITY TUNNELLING DOWN UNDER.

Pipe jacking over long distances. Southeast Melbourne is one of the fastest growing regions in Australia. In order to guarantee that the development of the sewage system can keep pace with this growth, the Pakenham-Narre Warren Sewage System is under construction. Since May 2004, a Herrenknecht EPB1500 Micromachine has driven 8 km of a pipeline with a total length of 10 km, at a depth of 6 to 12 m through sand and clay. By mid-July 2005, some 5.4 km of this sewage pipe had been completed. The project is due to be finished by June 2006.

Retractable trailblazer. HDD Rigs require "stable" geological conditions in order to do their work. For the construction of a gas pipeline whose route passed first through sand and gravel and later through hard rock, a retractable Herrenknecht AVN800XC proved to be the right trailblazer. This pipe jacking machine first drove a 230 m protecting pipe in unstable geological conditions until it reached the hard rock, when it was recovered through the jacket pipe. Subsequently the HDD Rig was able to begin tunnelling "in peace".

Reaching the target precisely to the millimeter. On the morning of February 14, 2005 an AVN1200TB arrived at the target shaft in Brisbane precisely to the millimeter. In only four weeks, the machine had burrowed 320 m beneath a busy road through extremely variable geological conditions. Even a 170 m-long curved route did not put it off course – thanks to the U.N.S. guidance system (see also overleaf). This pipe jacking project is one of three support distances for a new sewer in the Coronation Drive area. As this involved a busy traffic artery in Brisbane, trenchless construction was a must.

AUSTRALIA

TUNNEL PROJECT	MACHINE DATA	CONTRACTORS
Melbourne: sewage "Pakenham-Narre Warren Sewage System" Tunnel lengths: total 8,000 m Geology: sand, clay	**M-900M, EPB1500** Diameter: 1,810 mm Max. torque: 237 kNm	Georgiou-Winslow Joint Venture Pty Ltd.
Brisbane: sewage "Heroes Avenue" Tunnel lengths: 70 m, 260 m, 320 m Geology: weathered schist, abrasive quartzite	**M-892M, AVN1200TB** Diameter: 1,505 mm Max. torque: 258 kNm	McConnell Dowell Constructors
Otway Bay: gas Tunnel length: 230 m Geology: sand, gravel	**M-955M, AVN800XC** retractable Diameter: 1,110 mm Max. torque: 90 kNm	Malcolm Mac Cormick

For further information on Utility Tunnelling in Melbourne, visit www.southeastwater.com.au/sewl/index.asp?link_id=27.1173

Whether in Melbourne, Sydney or Brisbane, Herrenknecht Utility Tunnelling Systems prove their value down under.

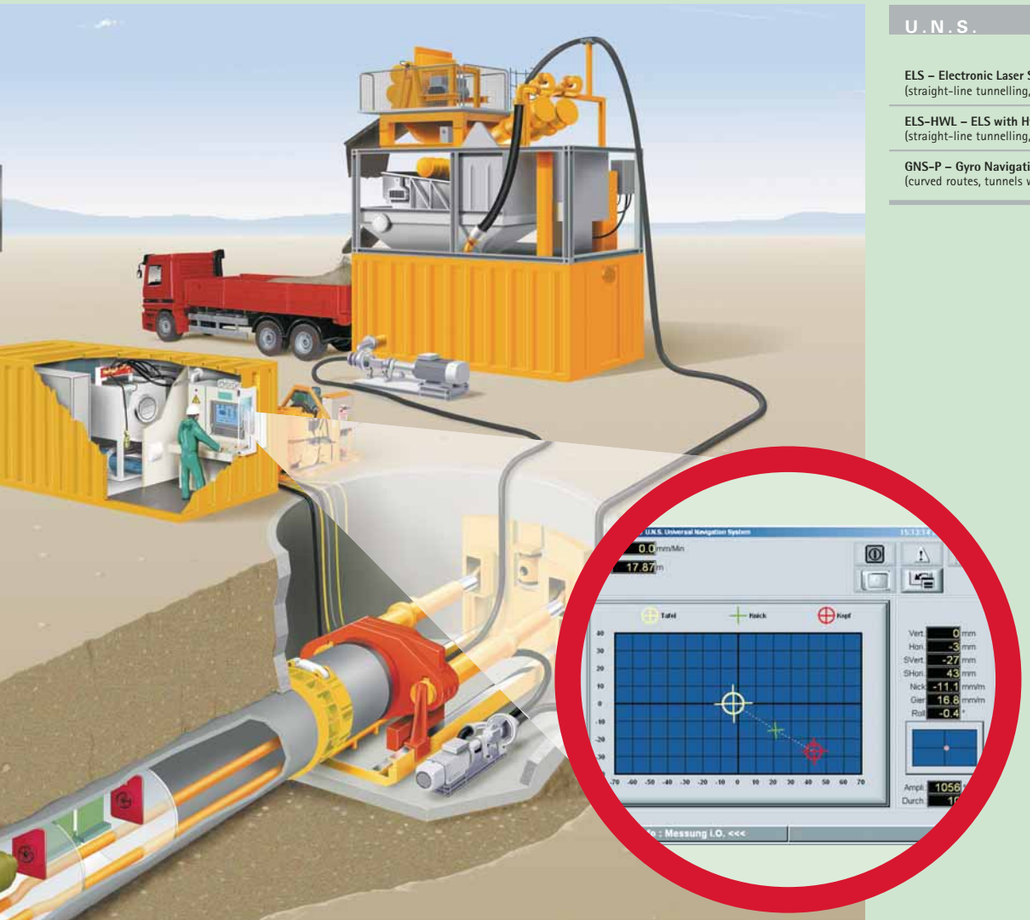
Integrated, flexible Navigation Technology.

Herrenknecht development engineers have developed a system platform – the Universal Navigation System "U.N.S." – which can be adapted to the demands of each pipe jacking job. Independently of the tunnel length, diameter or route, this modular system can be easily adjusted to fit the conditions on site.

U.N.S. is offered in three modules:

- For straight-line tunnelling and tunnel lengths of up to 200 m the "ELS" module (Electronic Laser System) guarantees an on-target breakthrough.
- The "ELS-HWL" module (Hydrostatic Water Levelling) with an electronic hydrostatic water level reliably indicates the precise vertical position of the TBM and guarantees straight-line tunnelling up to 400 m.
- The "GNS-P" module (Gyro Navigation System for Pipe Jacking) was developed for precise tunnelling in curves. A north-seeking gyrocompass reliably indicates the precise tunnelling direction. Together with the vertical data from the "HWL" module, the exact 3D position of the machine can be calculated.

Adaptations and extensions are possible at any time for machines which are equipped with U.N.S. The system always remains user-friendly since the user interface does not change.



U.N.S.

ELS – Electronic Laser System
(straight-line tunnelling, length < 200 m)

ELS-HWL – ELS with Hydrostatic Water Levelling
(straight-line tunnelling, length < 400 m)

GNS-P – Gyro Navigation System for Pipe Jacking
(curved routes, tunnels with diameter 1,200 mm)

Three pioneer projects in mechanical shaft sinking.

The german Federal Minister of Research, Edelgard Bulmahn (left) visiting the construction site on the Indonesian island of Java with Werner Suhm, Member of the Board of Management. A Herrenknecht VSM2500 Shaft Sinking Unit drove an access shaft for a water exploitation project to a depth of 100 m.

Herrenknecht AG has extended its range of Utility Tunnelling products with innovative shaft sinking equipment. The development of this technology, which is used in the construction of launch and target shafts for Microtunnelling, shaft construction for inner-city metro stations and in the construction of the foundations for off-shore or high-rise structures, is pursued intensively in Schwanau.

Java. As part of a research project of the Federal Ministry of Education and Research (BMBF), a 100 m-deep shaft with a diameter of 2.5 m was bored down to a subterranean cave on the Indonesian island of Java with a specially developed vertical drilling machine. The Herrenknecht VSM2500 Shaft Sinking Unit drilled through faulted karst limestone to create a vertical access shaft to a subterranean river system. This shaft construction was the important first step towards the creation of an underground barrage which will be able to store some 400,000 m^3 of water, providing enough water for 75,000 people.

Kuwait. A second Shaft Sinking Unit was put to use successfully in Kuwait. It was developed in collaboration with the customer, KBC Greenline. The VSM8000 Shaft Sinking Unit produced five launch and target shafts for Microtunnelling projects as part of one of the world's largest sewage schemes. This region, where proximity to the Persian Gulf means the groundwater level is only 3 m below the surface, presents a particular challenge for Shaft Sinking Technology.

St. Petersburg. The third reference project is due to start in February 2006 in the Russian city of St. Petersburg. Here, a specially designed VSM7700/5500 Shaft Sinking Unit will start constructing eight shafts as part of a large-scale project. These shafts, with diameters of 5.5 to 7.7 m, will serve as connections for the existing sewage system. In this extremely technologically demanding project shafts must be sunk to a depth of 85 m below the groundwater level with outside temperatures down to minus 20 degrees. In addition, the geological conditions, with hard loam layers and rock boulders of more than a meter in diameter, will pose great challenges for this innovative machine technology.

SHAFT SINKING PROJECTS

TUNNEL PROJECT	MACHINE DATA	CONTRACTORS
Java (Indonesia) Geology: karst limestone	**M-862M** **VSM2500** Shaft diameter: 2.50 m Shaft depth: 100 m	German Ministry of Education and Research project, coordination: Institute for Water Resources Management at the University of Karlsruhe (Technical College)
Kuwait: "Shuwaikh Sewer Project" Geology: sand, cemented sand, loam, limestone	**M-840M** **VSM8000** Shaft diameter: 8,80 m Shaft depth: 4 shafts, 15 to 27 m deep	KBC Greenline
St. Petersburg (Russia): sewage/extension of main collector Geology: sand, clay, boulders	**M-945M** **VSM7700** Shaft diameter: 6.20 to 8.40 m Shaft depth: 5 shafts, up to 85 m deep	STIS GmbH

For further information on this topic, order our Shaft Sinking Equipment animation.

NO SAND IN THE WORKS.

"The palm island Jumeirah" safe Utility Tunnelling off the coast of Dubai.

A forward-looking project for Saudi Arabia. Saudi Arabia is investing in the future. That is why the country's longest pipe jacking project, with a length of 7 km, is currently being realized in Jedda. A sewage tunnel is being produced with an AVN2500D beneath the suburbs of this large city. This is a demanding project in view of the heavily water-permeable geology consisting of sand and loam, and a groundwater pressure of up to 2 bar. Further sewage projects are in the planning phase.

Beneath the "8th wonder of the world". Two artificial palm tree-shaped islands off the coast of Dubai made of rocks and sea sand: these constructions are already being described as the "8th wonder of the world". They are made up of a 5 km-long "trunk" and 17 "palm fronds", protected by a crescent-shaped breakwater. Work began in 2001. Now the infrastructure is being installed. A Herrenknecht AVN2500D is part of the team. It is driving an approximately 600 m-long tunnel for various supply lines, including electricity, telephone and water, for the island Jumeirah 2. They lead in a gentle curve from one of the palm branches to the protective ring through sand, coral and limestone.

SAUDI ARABIA

TUNNEL PROJECT	MACHINE DATA	CONTRACTOR
Jedda: sewage Tunnel lengths: total 7,000 m Geology: sand, loam, 2 bar groundwater pressure, high water permeability, route is approx. 20 m deep throughout	**M-569M** **AVN2500D** Diameter: 3,115 mm Max. torque: 780 kNm	Abul Jadayel Est.

DUBAI

TUNNEL PROJECT	MACHINE DATA	CONTRACTOR
Dubai: protection tunnel "The Palm Islands Jumeirah" Tunnel lengths: 2 x approx. 600 m Geology: sand, coral, limestone	**M-950M** **AVN2500D** Diameter: 3,025 mm Max. torque: 780 kNm	Al Naboodah Engineering Services (L.L.C.), Dubai

TECHNICAL MILESTONES

1984 Development of trenchless slurry mechanical tunnelling which is used in groundwater in all European geologies.

1986 First use of the AVN N2 Micromachine in Berlin.

1989 Successful application of Microtunnelling technology in a pipe-arch project in the USA. Through an arch of interlocked small-diameter casings, short, large-diameter tunnel passages were built under railway embankments and roads.

1992 2.5 km of pipeline were laid in only 100 days beneath Germany's Wattenmeer, in an environmentally friendly way, without intermediate shafts.

1994 Herrenknecht Microtunnelling Technology entered the Russian market.

1995 Much business for Microtunnelling equipment: Up to 70 Herrenknecht Micromachines are employed at times in Germany alone.

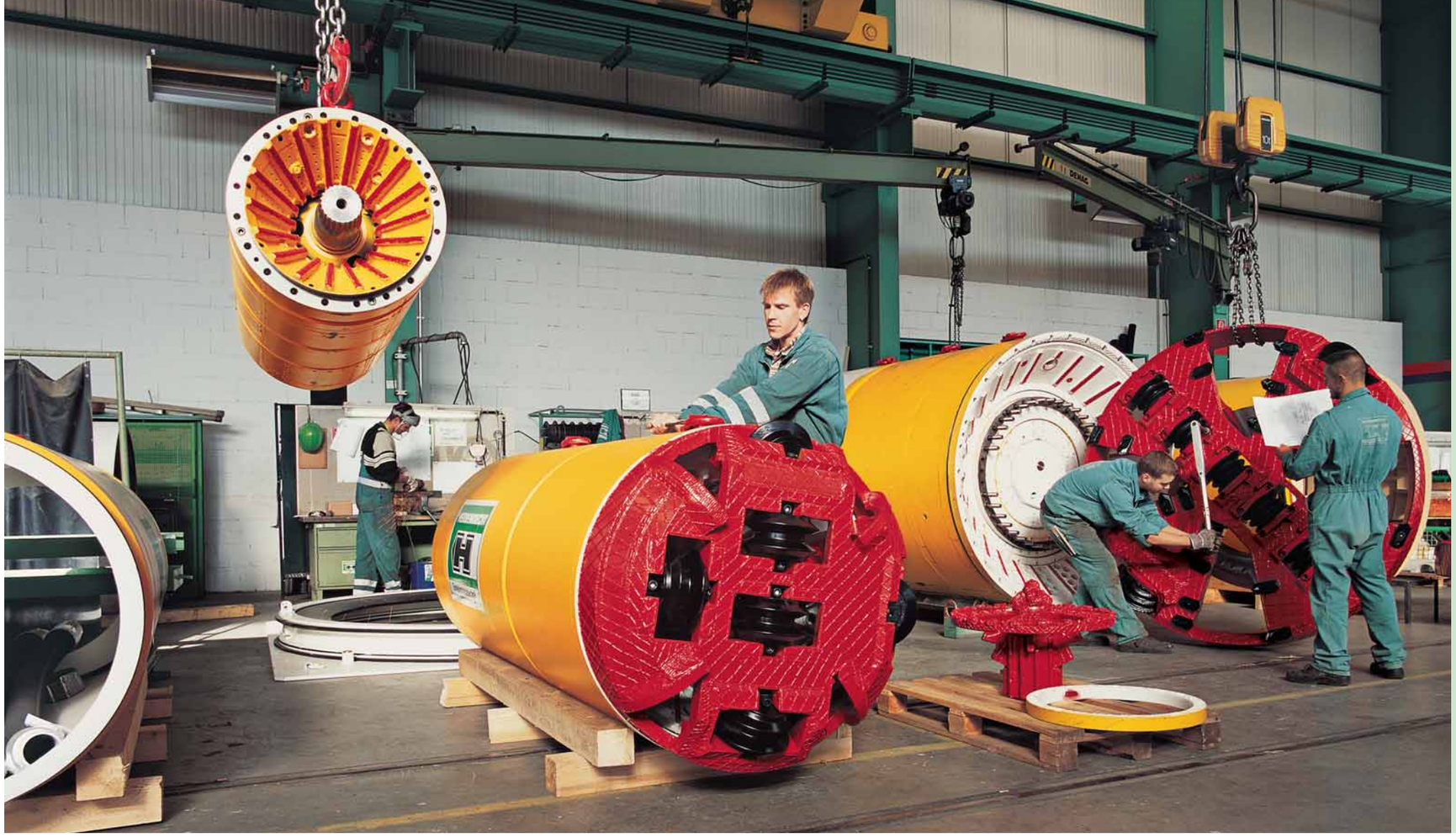
1996 Debut of Hard Rock Tunnelling in Singapore. Here in this Asian Tiger state, a Utility Tunnelling System was used, which, for the first time, allowed excavation tools to be replaced from inside the machine.

1999 The open-center drive units of the AVN1200T series allow access to the Cutterhead to exchange tools during long tunnel drives in rock.

2001 Entry into the market for heavy horizontal drilling rigs with pull forces up to 400 t for the directionally controlled laying of oil and gas pipelines.

2004 Development and introduction of Shaft Sinking equipment to bore vertical shafts mechanically with diameters of up to 12 m in groundwater.

2005 Development of vertical drilling rigs for use in geothermal projects at depths up to 5000 m.



Small, fine and very successful.

The name Herrenknecht is very well known among tunnel builders all over the world. In the wider public domain, people generally connect the name Herrenknecht with huge tunnel boring machines which produce the biggest, deepest and longest tunnels for infrastructure projects around the globe. But for the last 20 years or so, Herrenknecht has pursued an equally successful business with small tunnel boring machines, for diameters up to 4.20 m. Since 1986, the company has sold more than 1,000 high-tech small tunnel boring machines from its "Utility Tunnelling" Business Unit, as well as the corresponding equipment for the construction of pipelines and tunnels for sewage, and water, oil, gas and electricity supply.

The era of the "Utility Tunnelling" Business Unit began 20 years ago. Following the motto, "Best to begin small and end great than the other way around", Herrenknecht began its market launch of "Microtunnelling" technology for non-accessible diameters in 1986. Working together with the Federal Ministry of Education and Research, and supported by funding of DM 500,000, Herrenknecht developed a hydro machine system for pipe jacking, which can drive DN 500 pipes in water bearing European soils. The first slurry machine prototype had its debut as part of an urban sewage project in Hamburg.

The practical experience gathered led to a simplified machine concept which continued to convince more and more projects, construction companies and clients every year. The range of diameters has consistently increased – according to market demands – and the so-called AVN machines (German abbreviation for "Automatic Tunnelling Wet") have become top sellers throughout Europe. So far, more than 500 machines of this type have been sold on the market.

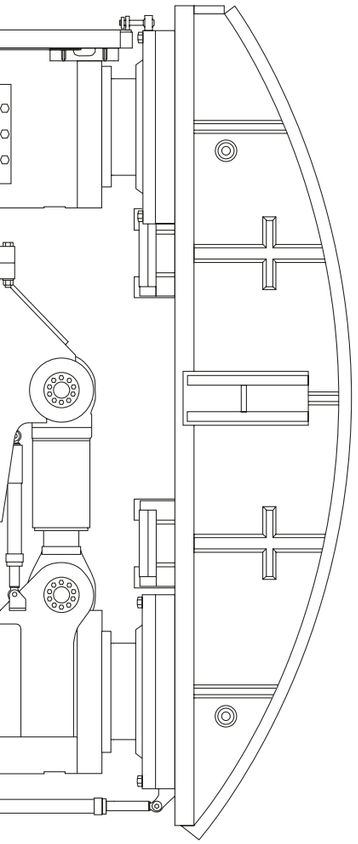
At the beginning of the 1990s, as many as 70 machines in Germany alone were on an underground mission to construct sewage and water projects. The "Europipe Project" is legendary and remains unique to this day. In only 100 days, a 2.5 km pipeline was laid under the Wattenmeer with an AVND 3000 without intermediate shafts and without disturbing the important ecosystems. This record remains unbroken to this day.

Herrenknecht has gradually increased and internationalized its business and applications of mechanical Utility Tunnelling with continuous process innovations and consistent knowledge transfer to local markets.

Today, Herrenknecht Utility Tunnelling Systems are used in almost every region of the globe. Trenchless tunnelling technology is still on the rise and its advantages over conventional construction methods are becoming ever clearer. For Herrenknecht, Europe remains the core market. The establishment of a world-wide service and sales network has enabled the company to gain a long-term hold in the markets of the Middle East, the USA, Eastern Europe and the Asia-Pacific region over recent years.

Herrenknecht Utility Tunnelling aims to secure its strong market position in the future with the highest possible availability of after-sales services around the world and around the clock. This Business Unit, which began 20 years ago with a few employees, has developed into an important pillar of Herrenknecht AG under the guiding hand of the Management Board Member Werner Suhm.

"In the past 20 years we have given impetus for impressive technological developments together with our customers, clients, construction planners and scientific institutions," Werner Suhm recalls. "With this foundation we can now concentrate fully on providing our customers with an even more comprehensive range of services and the best possible project-specific solutions. If we can offer our customers the best concepts for safety, economic feasibility and service they can be sure of being ahead of the competition."



Shirley Franklin (center) mayor of the city of Atlanta, City Council Member Anne Fauver (right), together with Gebhard Lehmann, Vice-Chairman of the Board of Management of Herrenknecht AG underground in Atlanta.

The city of Atlanta in the US State of Georgia must act: in order to meet US environmental protection law, the city must increase considerably the efficiency of its sewage system. Atlanta's sewers are made up of a so-called combined sewer system. When it rains, stormwater enters the wastewater system.

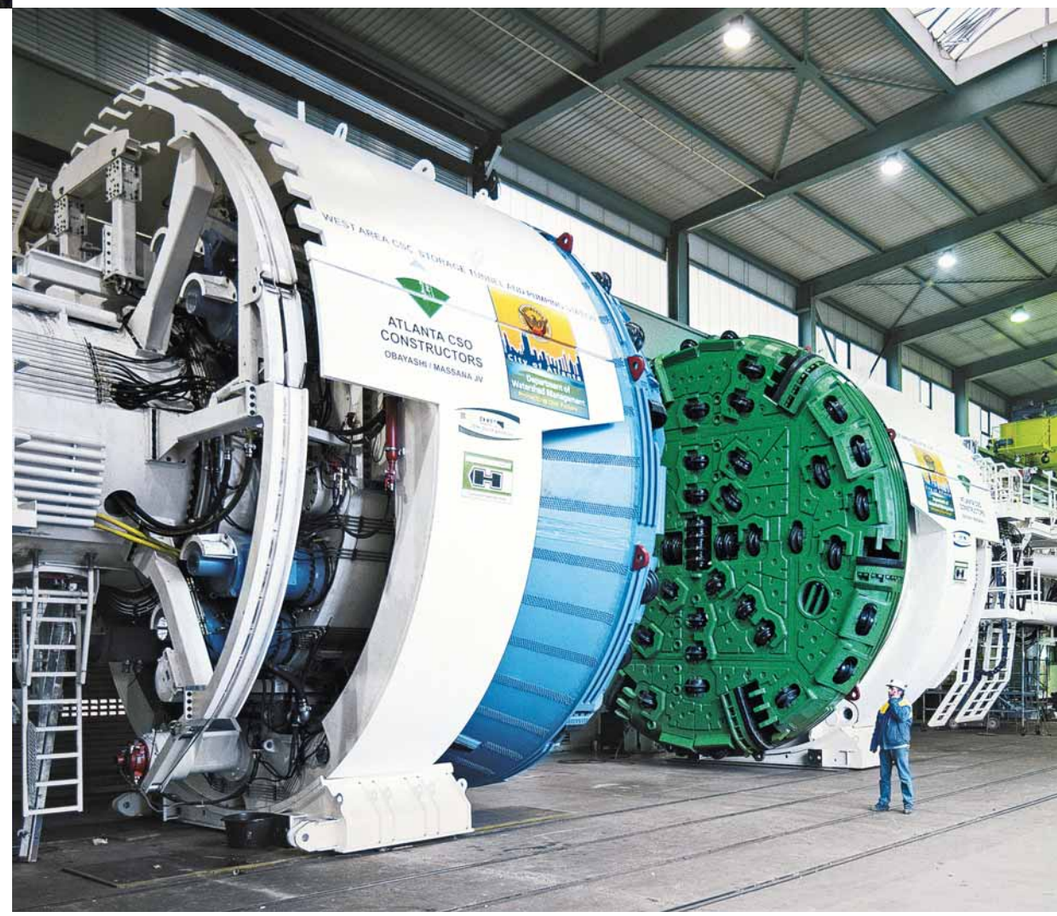
In order to protect the sewage treatment plants from flooding, superfluous water is fed through so-called CSOs (combined sewer overflows). In times of very high rainfall, untreated sewage can also find its way into the Chattahoochee River. This happens about 80 times per year. The number of such discharges of untreated sewage must in future be reduced to a maximum of four per year.

To achieve this target the city is having the West and East Area CSO Tunnel built. After completion, the 13.4 km tube of the West Area CSO Tunnel, with an impressive diameter of 7.92 m, will first of all collect and then store stormwater in western Atlanta and then carry it to a new treatment plant.

This imposing construction can carry 670 million liters of water. Two Herrenknecht Gripper TBM are driving these tunnels through gneiss and granite. The S-288 Gripper TBM began work on its 6.8 km tunnel section at the end of July 2005. Its identical sister machine, the S-289 began its underground work in mid-August 2005. The completion date for this construction project is the end of 2007.

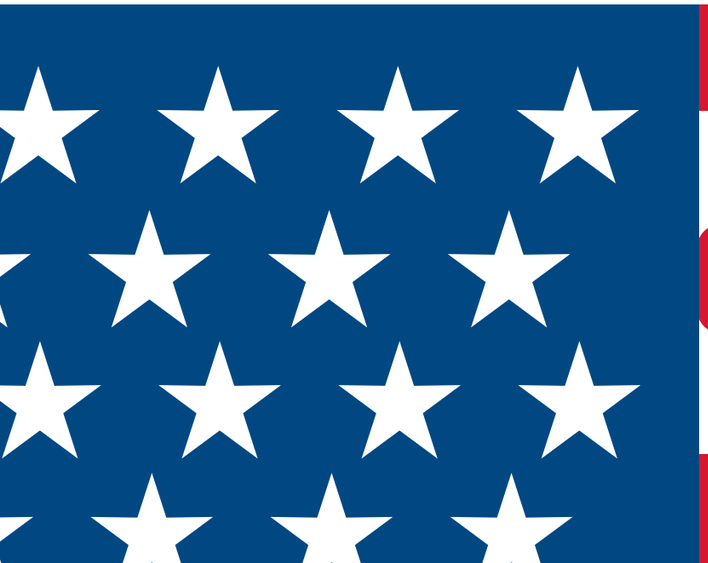
ATLANTA | USA

TUNNEL PROJECT	MACHINE DATA	CONTRACTOR
Atlanta: sewage "West Area CSO Tunnel" S-288: Clear Creak Tunnel S-289: North Ave. Tunnel Tunnel lengths: S-288: 6,800 m S-289: 6,600 m Geology: gneiss, granite	**S-288, S-289** **2 x Gripper TBM** Diameter: 8,230 mm each Cutterhead power: 3,150 kW each	Obayashi Massana JV



Pioneers for the USA: Herrenknecht Gripper Technology is taking hold in the USA, too.

For further information on the Atlanta project, visit www.cleanwateratlanta.org



670 MILLIO N LITER STORAGE TUNNEL

PORTLAND

TABLE ROCK

Water protection in Portland. The US city of Portland is improving its preparedness for future floods caused by rain. Two Herrenknecht Mixshields have therefore been working their way through the underground of the city since February 2004. There they have driven two "combined sewer overflow (CSO)" tunnels with a total length 5.7 km. The route runs below the River Willamette, with an overburden of only 8 m, through heterogeneous geological conditions. It also runs below the foundations of three bridges. In these critical sections, subsidences cannot exceed 13 mm.

The Herrenknecht S-232 Mixshield was already able to complete successfully its 1,350 m-long underground mission in November 2004. The second S-231 Mixshield completed its mission on July 29, 2005. At the moment, the combined sewage systems of the city still flood when it rains. Wastewater then enters the River Willamette untreated. In the future this water will be fed into the new West Side Tunnel, which will lead it to the Swan Island Pump Station. From there it will continue on to the treatment plant. The construction is due to go into operation in fall 2006.

Well-connected in Portland. A Utility Tunnelling Machine of the type AVND1800AB was also used in Portland. As part of the "Combined Sewer Overflow (CSO)" project, it constructed a sewer tunnel which feeds into the West Side Tunnel. The best daily performance of this now-completed project was 58 m in 24 hours, which may be a record. The Micromachine was not only good for rapid tunnelling, it was also particularly flexible. As the tunnel was driven with varying diameters, the machine could be extended quickly and easily.

PORTLAND | USA

TUNNEL PROJECT	MACHINE DATA	CONTRACTORS
Portland: sewage "West Side CSO Tunnel" Tunnel lengths: S-231: 4,350 m S-232: 1,350 m Geology: sand, gravel, alluvium	**S-231, S-232** **2 x Mixshield** Diameter: S-231: 5,050 mm S-232: 5,140 mm Cutterhead power: S-231: 500 kW S-232: 330 kW	Impregilo S.p.A., S.A. Healy
Portland: sewage "West Side CSO Tunnel" Tunnel lengths: total 3,238 m Geology: sand, silt, gravel	**M-876M** **AVND1800AB** Diameter: 2,260 mm Max. torque: 520 kNm	Impregilo Healy JV

For further information on the Portland project, visit www.portlandonline.com/cso

Outfall in hard rock. A 150m-long pipeline had to be driven deep below Table Rock Lake in Table Rock Lake National Park in South Carolina. The pipeline was driven from the shore into the lake at a slope of 50 mm per meter. The goal was the target shaft built 30 m below the water level in the lake. The construction of shafts under these conditions in open water is extremely difficult and expensive.

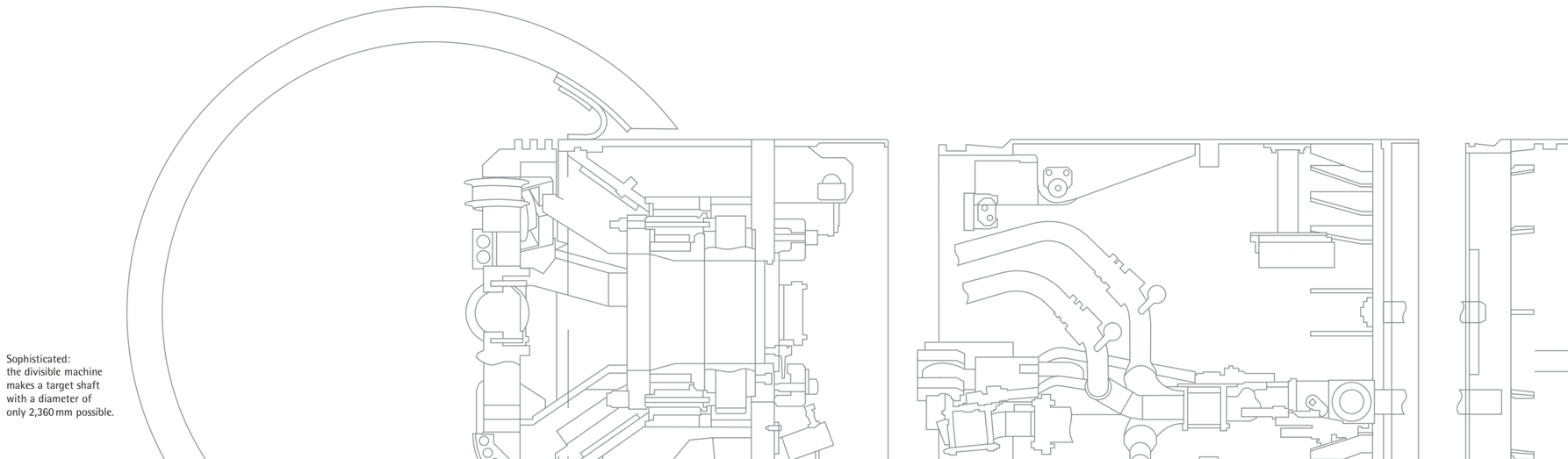
For this reason, the shaft diameter had to be kept as small as possible. To achieve this aim, Herrenknecht development engineers designed an AVN1200TC as a multi-divisible articulation shield and machine can. This made it possible to reduce the longest machine component from 3.22 m to only 1.394 m. This meant that a shaft with an interior diameter of only 2.36 m was necessary to recover the machine components.

The divisible Utility Tunnelling Machine was successfully recovered from Table Rock Lake.

Abrasive rocks with strengths of up to 150MPa meant this was a real test of strength for the machine and the cutting tools. The face access facility on the AVN1200TC which allows the cutter discs to be changed from within the machine was ideal for this project and the cutter discs had to be replaced several times during the tunnel drive. This Microtunnelling machine mastered the tough challenges excellently.

GREENVILLE | USA

TUNNEL PROJECT	MACHINE DATA	CONTRACTOR
Table Rock State National Park: freshwater tunnel Tunnel length: 150 m Geology: rock, groundwater	**M-906M** **AVN1200TC** Diameter: 1,505 mm Max. torque: 260 kNm	Bradshaw Construction



Sophisticated: the divisible machine makes a target shaft with a diameter of only 2,360 mm possible.

The Herrenknecht S-247 Earth Pressure Balance Shield makes breakthrough for the first tunnel.

CARACAS | VENEZUELA

TUNNEL PROJECT	MACHINE DATA	CONTRACTOR
Caracas: metro "Line 4" Tunnel length: S-186: 3,853 m S-187: 3,863 m Geology: clay, sand, rock	**S-186, S-187** **2 x EPB Shield** Diameter: 5,850 mm each Cutterhead power: 945 kW each	Constructora Norberto Odebrecht S.A.
Caracas: metro "Line 3" Tunnel lengths: 2 x 2,511 m Geology: clay, sand, rock	**S-247** **Single Shield TBM/ EPB Shield** Diameter: 5,850 mm Cutterhead power: 945 kW	Constructora Norberto Odebrecht S.A.

For further information on Herrenknecht cutting tools, order our Cutter Brochure.

PRECISION WORK IN VENEZUELA.

Constant gridlock plagues the urban highways of the Venezuelan capital Caracas. Drivers can proceed only slowly along the avenidas and side streets of this metropolis. Although Caracas has a modern metro system, its trains are also always over full. Another problem is that the three existing lines serve only downtown, but not the suburbs in the surrounding mountains. For this reason, the existing metro network is being considerably extended.

Three Herrenknecht machines for two metro lines. The first two construction phases serve to extend metro line 3. In addition, line 4 of the metro is being built beneath downtown Caracas. The Brazilian company Odebrecht S.A. chose to use three Herrenknecht tunnel boring machines. Since summer 2004, one machine has been tunnelling its way northward along line 3. By the beginning of October 2005 this S-247 Single Shield TBM, which can be converted to EPB mode, had completed 2,535 m of this new tunnel, which will have a total length of approx. 5 km.

The two S-186 and S-187 Earth Pressure Balance Shields have now completed the two tunnels for the new metro line 4 – with a combined total length of 7,716 m. Breakthrough was achieved in March and April 2005, respectively. The geological conditions beneath downtown Caracas turned out to be unpredictable. The greatest problem was the boulders of more than a meter in diameter, in the loose soil. Areas of old construction debris and waste material also had to be passed through.

In addition, the tunnel ran extremely close to the foundations of the city's highest skyscrapers.

Service made to measure. In order to quickly bring worn cutting tools back to good order in such wear-intensive tunnelling conditions, Herrenknecht installed an extra cutter shop right next to the construction site. This special workshop is equipped with all the tools and spare parts a specialist needs on site to rework worn cutter discs quickly and skillfully. Cutter shops can be set up on any construction site around the world.

A strong partnership for perfect construction site logistics. Dirk Huesmann and Gregor Enneking.

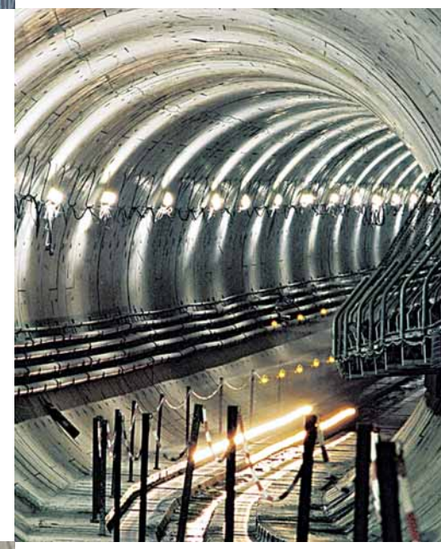
Quick and clever logistics.

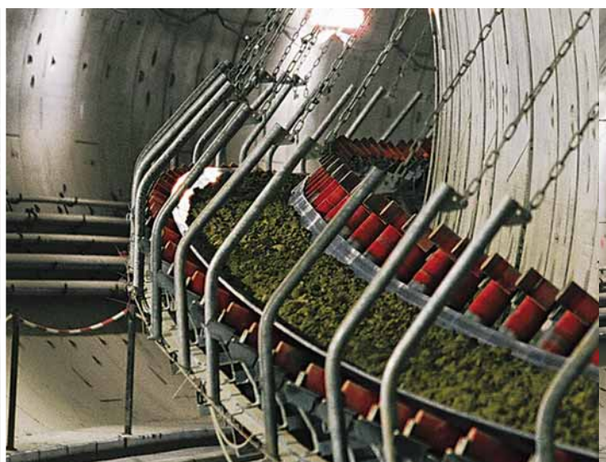
Dirk Huesmann (age 43) and Gregor Enneking (age 49) are two pragmatic and rather uncomplicated guys. Their professional passion is dedicated to a subject which most people would not immediately connect with excitement and thrilling challenges: conveying systems for mechanical and mining tunnelling. Huesmann and Enneking have developed their field into a small, fine niche company, H+E Logistik GmbH in Bochum.

Together with 36 employees, they have been developing, constructing and installing clever conveying systems for tunnel and mining construction since 1999. These transport the material excavated by tunnelling and mining machines via conveyor belts over several kilometers in the most direct, rapid and efficient way to an initial intermediate storage facility or to its final destination above ground.

H+E conveying systems now make sure that the transportation of excavated soil or cut rock can keep pace with the excavation speed of the TBM or excavator in many projects in Europe, Asia and Africa. Good coordination is what really brings tunnel production up to speed. H+E conveying systems allow the necessary space for other rolling stock transport systems, avoiding unnecessary truck movements on construction sites or to waste storage sites.

Six years after its foundation, this Bochum-based company has many and varied, highly specialized reference projects to its name. Tricky jobs lead to innovative solutions. For example, belt storage towers which can provide for up to 400 m of conveyor belt. The company developed a conveying system with a length of 5.1 km for a tunnelling project with a Herrenknecht Earth Pressure Balance Machine (∅ 7.75 m) in Toulouse (metro line B/lot 2). A cleverly devised conveyor system ensured that 600 t of earth per hour could be transported safely even along curve radii of less than 200 m.





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In the next edition of Herrenknecht News:

Hasta luego amigos! No European country has as many high-performance TBM boring and burrowing through its underground as Spain. In order to offer the optimum support for customers and projects, Herrenknecht maintains a small but fine subsidiary in Madrid. We spend a day close on the heels of Francisco Avila and Juan Arroyo who run the Spanish subsidiary.

112 trainees with a passion for tunnels. Even at Herrenknecht everybody has to start at the bottom of the ladder. But in Schwanau the next generation is already on its way up. Ten percent of our staff are trainees. The "Herrenknecht Workshop for the Future" offers young people a promising – as well as varied and exciting - start to their professional career. For those who complete their training successfully, the world is their oyster.

Titans in Shanghai. Shanghai and its inhabitants are constantly on the move. This mega-city is growing like no other. Two Herrenknecht TBM titans are due to start work in Shanghai in fall/winter 2006. The Mixshields with a diameter of 15.43 m will build two road tunnels, with a length of almost 8 km, under the Yangtze River. These giants are definitively the biggest borers in the world.

Going down deep! For almost 30 years, Herrenknecht tunnel boring machines have been successfully burrowing horizontally through the earth on all the continents of the globe. Now, Herrenknecht is going down deep vertically. Vertical drilling units made by "Herrenknecht Vertical GmbH" will penetrate to depths of up to 5,000 m to allow access to geothermal energy.

Under extreme pressure. The Hallandsas Tunnel in Sweden is seen as the construction project with the highest level of complexity. Various different attempts to drive this railway tunnel have failed in the past. The Skanska – Vinci Joint Venture began this challenging mission on October 7, 2005 with a convertible Mixshield made by Herrenknecht. In some parts, mountain pressure levels of up to 13 bar have to be mastered.

Teamwork partner MSD. In 1992, shortly after the fall of the Berlin Wall, Martin Herrenknecht bought the East German steel construction company MSD (Maschinen- und Stahlbau Dresden), which merged with Herrenknecht AG in 1997. After initial difficulties, the Herrenknecht subsidiary MSD is now an important teamwork partner. Both as an extension of the workshop of Herrenknecht AG in Schwanau and as a supplier of special steel constructions and innovative conveying systems for tunnelling.

Next issue: summer 2006

44 students of the Max Planck High School in Lahr visiting the mega metropolis Shanghai from September 3 to 18, 2005. Dr. Martin Herrenknecht, himself a former pupil of the Max Planck High School, sponsored the travel costs for ten students. "The earlier young people get to know China, the better. Then they will understand for themselves that we all have to work hard to remain ahead in a globalized world," Dr. Herrenknecht says. The students were all enthusiastic about their visit to China.