THYSSEN MINING
Report 2010

www.thyssen-schachtbau.de

IMPRINT

Publisher:
Thyssen Schachtbau GmbH
Sandstraße 107-135
45473 Mülheim an der Ruhr
Telefon +49 208 3002 - 0
Telefax +49 208 3002 - 327
info@ts-gruppe.com
www.thyssen-schachtbau.de

Editors:
Franz Stangl
Jeanette Meier

Redaktionssekretariat:
Margarete Wehling
Cornelia Kamberg

Translation (english):
KeyCom Konferenzdolmetschen
Christa Gzil
Karin Bettin

Layout:
Iris Huber, denkbetrieb.de, Werl

Photos:
Dietmar Klingenburg
Reiner Lorenz
Michael Seifert
MA Gasser Felstechnik
Airrail Center Frankfurt
Employees TS Group
Archive TS
Archives TS-Subsidiaries

Title:
Ursula Ahlers

Print:
Druckhaus Cramer, Greven
www.cramer.de

IMPRINT

Thyssen Mining Report 2010

CONTENT

The board of directors of the Thyssen Schachtbau GmbH, Dipl.-Kfm. Michael Klein (right) and Werner Lüdtke, in front of the picture of Fritz Thyssen, eldest son of the founder of the company

Ladies and gentlemen,
business partners and associates,
fellow colleagues,

after a break of several years the TS Report is now making a welcome reappearance with news of the current activities of the Thyssen Schachtbau Group and Thyssen Mining Construction of Canada Ltd.

Firstly we are pleased to be able to announce that on 01.01.2009 we moved into our new headquarters building at the Thyssen Schachtbau business park on Sandstrasse. Simultaneously our previous premises on Ruhrstrasse could be rented to the town of Muelheim an der Ruhr.

Brief description of our companies and operating divisions

The Thyssen Schachtbau Group employs 2,200 people and it was due in no small measure to their efforts that 2008 was such a commercial success.
The company can be broken down into the following individual parts:

Thyssen Schachtbau GmbH

Mining division

The mining division is primarily engaged in vertical and horizontal excavation projects at RAG Deutsche Steinkohle AG's German-based collieries.

This mainly comprises roadway drivages and major cavity excavations, along with a wide range of underground mining services. The availability of a technically skilled and highly trained workforce has supported positive commercial developments that have now placed our mining division on a sound financial footing.

Shaftsinking and Drilling division

This division has been operating at national and international level for more than a hundred years and has already completed more than 210 km of shafts for clients all over the world. It is now one of the world's leading providers of shaft sinking and drilling services and as well as conventional shaft construction the division also specialises in cementation work, freeze sinking and mechanised shaft boring.
The division is currently focussed on operations in Russia, Germany and Switzerland. Two extremely challenging major projects are presently under way in Russia, where the latest technologies are being used to sink new surface shafts under the most difficult geological conditions.
The TS Shaftsinking and Drilling workforce has been gradually built up in line with the division's positive business results.

Administration department

The administration department comprises central services as finance, accounts, IT and manpower services, along with staff units dealing with financial control, taxation, legal matters, treasury management and health and safety issues.
The administrative section has responsibility for all Thyssen Schachtbau Group affairs.

Thyssen Mining Construction of Canada Ltd. (TMCC)

TMCC, which is one of Canada's most successful specialist mining companies, primarily serves clients in the Canadian and US potash and uranium mining industries. The company's technical expertise has also led to involvement in international joint venture projects in Brazil and Australia. TMCC's range of services encompasses all aspects of underground mining, including shaft sinking.

TS Bau GmbH

TS Bau, which currently has offices at Jena (Thuringia) and Riesa (Saxony), has been in operation since the mid-1990s.
As well as structural and industrial engineering projects – which can also be delivered as turnkey installations – the TS Bau portfolio of services includes landfill site construction, roadbuilding, track-laying and civil engineering work, demolition and waste recycling, specialist mining operations, pipeline construction, trenchless pipe-laying and high-tech water-pipe and sewer-pipe renovation.
The company has continued to build on the commercial success of recent years.

DIG Deutsche Innenbau GmbH

The company is primarily engaged in the planning and execution of commercial fit-outs to the latest standards and it has special expertise – which extends from initial consultation to site implementation – in standardised drywall installation and in completing challenging fit-outs for major projects, such as the Lufthansa head-office building in Frankfurt.
At present DIG is heading the interior fit-out project under way at the Airrail Center, Frankfurt International Airport, which is currently Europe's largest industrial construction site. The new building is scheduled for completion by mid-2010.

TS Technologie + Service GmbH

T + S is a forward-looking engineering company delivering individual planning and design services through to technical installation assignments on a bespoke basis.
T + S specialises in constructional steelwork, mechanical engineering, installation and assembly, building services engineering, repair work and electrical engineering. With some 7,600 m² of workshop space and an array of high-performance equipment, including a crane capacity for components weighing up to 80 t, the company has what it takes to complete all kinds of large and heavy fabrications.
T + S has now ordered a new large-capacity machining centre that will significantly enhance its range of services. This new installation is due to be commissioned in the second quarter of 2010.

Emscher Aufbereitung GmbH

Emscher Aufbereitung, which is the largest producer of pulverised coal in Europe, has been supplying products to the PCI (pulverised coal injection) market for more than fifty years. The company operates six crusher-drier units at its Duisburg plant and possesses excellent knows about the technical complexities of this type of operation, which involves having to accommodate quality variations in the globally-sourced grades of coal and petroleum coke that pass through the crushing and drying process.
The company has been delivering PCI coal to ThyssenKrupp Steel AG since 1987 and is now the sole supplier to all its German-based blast furnace operations.

Thyssen Schachtbau Immobilien GmbH

The company is responsible for managing the entire property portfolio of the Thyssen Schachtbau Group in Germany. While this mainly comprises office buildings and workshop facilities it also includes houses, rental properties, building plots and industrial sites.

Dear readers,
As this brief presentation shows, the TS Group is well placed to face the future and can provide an interesting and stimulating working environment for its employees, both at home and abroad.
Our customers continue to regard us as a reliable and innovative partner with the expertise it takes to provide solutions to their technical problems.

On the following pages you will find more detailed descriptions of some of the Group's current projects and activities. We hope you enjoy the read.

With all best wishes from

Michael Klein *Werner Lüdtke*

From left: Bernd Grätz, Chair of Works Council
Dipl.-Ing. Michael Haccius, Head of Mining Division
Norbert Handke, Head of Shaft-sinking and Drilling division
Dipl.-Ing. Helmut Ehnes of the BBG

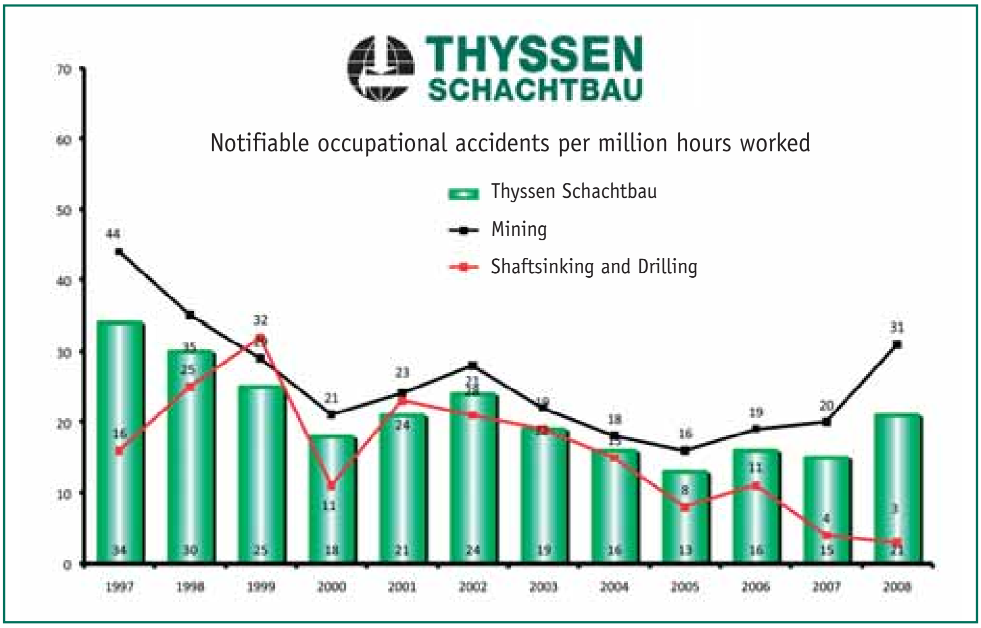
'Safety the systematic way': Thyssen Schachtbau GmbH gets the seal of approval for another three years

As the first corporate member of the BBG (Mining Employers' Liability Association) Thyssen Schachtbau GmbH successfully introduced the workplace safety management system in 2004 for its mining and shaft-sinking and drilling operations and as a result was awarded the quality label for safety. This award, entitled 'Safety the systematic way', was successfully re-audited in 2008 and was therefore bestowed for another three years.

Having a workplace safety management system in place does not automatically guarantee low accident figures. Ensuring long-term success in this area means having to re-focus your efforts every year and drive on with renewed vigour.

The objective for 2009 and 2010 is a 50 % drop in casualty figures by way of a safety concept based on the 'three pillar' approach. This will enable the company to set a new record low for industrial accidents. If this ambitious target is to be realised all operational divisions and branches of Thyssen Schachtbau will have to continue to support their safety managers in delivering the highest possible safety standards and in applying themselves to the task with the utmost vigour. This approach will pay high dividends, for on it depend the health of our workforce and ultimately the economic success of the company.

Guido Barnfeld



Accident trends for the period 1997-2008

View of drivage with loader, drill jumbo, AFC and shotcreting equipment, including three overhead monorails for logistical support

Connecting the Zollverein seams to no. 10 shaft, level 7, at Prosper-Haniel colliery

The Government decision on the withdrawal of subsidies to the German coal industry has also stipulated that Prosper-Haniel colliery, which is based in the western Ruhr town of Bottrop, is to continue in operation beyond 2012.
Developing the mine's Zollverein seams by extending lateral road C 467 to connect into inset no. 7 at Prosper 10 shaft will help secure Prosper-Haniel's long-term future. The mine was created by the merger of four formerly independent collieries as part of a coal-industry rationalisation programme. They mined 300 million t of product at the colliery over its 150-year history.

The establishment of Ruhrkohle AG was accompanied by a re-appraisal of the Ruhr coal deposits, which in turn resulted in the creation of the new Prosper-Haniel combined mine on 1 April 1974. The ultimate objective was to develop the major coal deposits in the northern part of the Haniel take. Accessing these rich deposits not only meant having to drive new roadways but also required the sinking of a new no. 10 shaft at Kirchhellen. This new shaft, which was started in 1977, was to be used for ventilation, transport and manwinding and would serve Prosper V by supplying air and materials to the northern working districts. The shaft came into service in 1981.

The years 1973 and 1974 were marked by energy shortages and an oil crisis – events that raised public awareness of the value of indigenous resources and helped launch a revival of the coal industry. [1]

The excavation work needed to reach mine level 7 commenced in 2004 and was carried out by the 'no. 10 shaft deepening consortium', with Thyssen Schachtbau GmbH acting as technical project leader. This operation was successfully completed at the turn of the year 2008/2009 with the extension of the main manwinding system to level 7. Operations undertaken as part of this project included deepening the shaft by 303 m to a final depth of 1,328 m, the construction of a new inset on level 7 at a depth of 1,230 m and a second at a depth of 1,319 m, the installation of new shaft fittings, the dismantling and removal of the shaft safety platform and the extension of the shaft winding system. [2]

The completion of the shaft 10 deepening project signalled the start of the operation to connect the now-accessible coal panels to the shaft. In January 2008 work began on the excavation of a 350 m section of lateral road C 467 on mine level 7, which was to serve as an extension of the existing roadway that would connect up to the shaft inset on the same level.

The drivage contract called for the excavation of a lateral road with type-B combination supports, i.e. backfilled steel arches at the roadhead with systematic rockbolting installed about 30 m outbye. However this support system suffered problems right from the outset and a serious re-think was deemed necessary. In order to reduce the support lag the colliery decided in collaboration with the technical management of Thyssen Schachtbau GmbH that the drivage should switch over to type-A combination supports, i.e. systematic rockbolting at the roadhead with steel arches and full backfilling installed about 30 m behind the heading face. As it turned out, this decision made a huge contribution to improving the stability of this long-life roadway.

The following types of equipment were used for the conventional drivage operation:

- G 211 loader
- twin-arm drill jumbo with HBM 120 rotary-percussive rock drills and a DBM 1-250 rotary drill for the installation of one-step rockbolts
- GTA AMG 6200 rockbolting platform
- GTA AMG 2700 support setting platform
- 8 m³-capacity Müller concrete bin with an Elefantino pump delivering 15 m³/h.

The roadheading team pose proudly alongside the twin-arm jumbo ...

Key data for Prosper-Haniel colliery/RAG Deutsche Steinkohle AG:

Workforce:
4,400

Annual production:
3.2 million t

Maximum depth:
1,246 m

Roadway network:
125 km

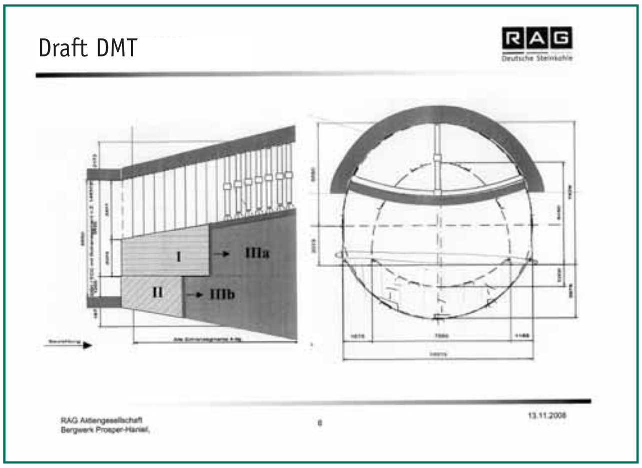
… and just before breakthrough

Right: STOP – no entry without the permission of the heading team

Because of the high levels of tectonic stress present the backfilled supports had to be installed no more than 17 m from the roadhead, instead of the normal 30 m. In fact the steel arches with their concrete backfill frequently had to be set right up to the heading face because of the proximity of the Zollverein 4 seam. The number of rockbolts installed at the roadhead also had to be increased on several occasions and bolts as much as 4 m in length were required in some cases.

In accordance with the recommendations of a DMT survey (Deutsche Montan Technologie) the drivage was halted 10 m before breaking through to the existing shaft inset. A TH 33 m² support system was installed up to the heading face and backfilled, with the final 15 arches being embedded in the floor of the roadway. After a 12-degree ascending ramp had been constructed work was able to begin on the excavation of the pilot drift.

As recommended, the remaining distance was to be completed in three phases. The upper section comprised the pilot drift (5 x 5 m), which was to be supported with rockbolts and shotcrete. Thanks to the accurate measurements taken by the



Prosper-Haniel surveyors the breakthrough point coincided perfectly with the inset on mine level 7.

The pilot drift was then widened to the east and west in stages, also with rockbolt and shotcrete support, followed by the installation and backfilling of the arch crown sections. Before this could be done, however, two layers of weldmesh were fixed in place between the 20 cm-thick shotcrete and the steel arches.

After this operation had been completed work was able to commence on the second phase. Within this step the support recommendations had to be revised again. The support system in the upper section was reinforced by temporary floor fixings and straight TH bars. The floor of the drift was subsequently sealed with a 50 cm-thick layer of concrete. Phase two could then be carried out as planned using the system described in phase one, albeit with the addition of leg extensions to the steel supports and the removal of the temporary floor fixings.

When the third and final phase has been completed the steel supports will be permanently set into the floor, thus concluding the operation.

The completion of the shaft inset and the development of mine level 7 in the direction of the Zollverein seams will help secure the long-term future of Prosper-Haniel colliery.

Michael Döring
Reiner Reese

[1] 150 years of mining in Bottrop – publication commemorating the ongoing history of coal mining in Bottrop
[2] Deepening no. 10 shaft at Prosper-Haniel colliery, Thyssen Mining Report 2010

A conventional approach to developing the last coal panel in the Heinrich Robert workings

Ost colliery, which is located in Hamm in the eastern part of the Ruhr, is to close in September 2010 as a result of the Government's decision to phase-out the subsidised coal industry.

Sonnenschein panel 107 (So 107) in the Heinrich Robert workings will be the last of the production faces to be mined at the colliery, which was created by the merger of four formerly independent mines as part of a programme of coal industry rationalisation. The colliery has a history that dates back 130 years and has during this period mined some 460 million t of product, including much high-quality coking coal.

Panel So 107 has a face life of 580 m. At a planned daily output of 3,500 t this panel is expected to yield a total of 360,000 t of high-grade coking coal. However, much development work is needed before coal winning can commence.

The contract

In May 2008 Thyssen Schachtbau GmbH was awarded the contract to complete the following works:

Extension of roadway S 107.0

Length	300 m
Finished cross-section	29.5 m²
Supports	Type-A combination rockbolt support system
Backfilling	concrete

Construction of a roadway junction from the coal loader gate S 107 leading into rise heading S 107.0

Excavation of rise heading S 107.8

Length	309 m
Finished cross-section	25.4 m²
Supports	Type-A combination rockbolt support system.

The following specifications were laid down for the rise heading, which had to meet special requirements imposed for the subsequent extraction of panel S 107:

- drivage with an excavated cross-section for standard 480 arch supports
- support system comprising RAG standard 480 arches
- the eastern side-wall to have a minimum backfill thickness of 0.30 m
- in the western side-wall full backfilling and roll-out weldmesh lagging to terminate at the roof of the seam
- the pack edge to be secured with two rockbolts per panel
- a further roadway junction to be constructed at the end of the drift.

Geology

The Sonnenschein seam is 1,650 mm thick and rises to the north at a gradient of 9 degrees. The beds to be worked through comprise 39 % coal, 22 % shale and 39 % sandstone.

The geology proved to be almost fault-free and posed very few problems for the drivage team.

Support system (type-A rockbolt combination supports)

Roadways with an excavated cross-section of 25.4 m² were secured at the heading face with 23 fully encapsulated resin bonded steel rockbolts per metre plus rollmesh lagging.
Yielding steel arches with a profile weight of 40 kg/m were installed some 30 m behind the roadhead at setting intervals of 0.8 m. The support resistance of the arch units is transferred into the strata via a concrete backfill.
The lagging system in the drift terminates at the longwall face, while the full backfill ends at the roof of the seam.

Machines and equipment

A type G 211 side-dump loader and type BTR 1 HLK drill jumbo, both supplied by dhms, were used for the heading work. Arch setting and backfilling was carried out by a GTA type 2800 platform, the cavity backfill material being delivered hydraulically by a Putzmeister 'Elefantino' concrete pump. The fill material was supplied pneumatically from the surface via a DN 125 mm pipe.

The heading debris was loaded out on a 130 m-long PF 3.26 twin-chain conveyor with an integral type WB 1300 crusher. The twin-AFC, which was equipped with a hydraulic advancing system and transfer table, discharged its payload on to a 1,400 mm-wide rubber belt installation.

Performance data

The drivage operation required an average of 46 men per working day divided over four working shifts. With this manning level and operating equipment, and allowing for the high support requirements, the S 107.0 drivage achieved an average heading performance of 4.5 m per working day.
Some sections of the heading were at a gradient of 13.5 degrees and this posed such problems that in these areas the drivage team was only able to average 4.00 m per working day.

For ventilation reasons the bridging zone had to be set up as a counter-heading running from coal loader gate S 108. The cut-through was made on non-production days at the turn of the year and then sealed up again immediately afterwards.

After the winning equipment has been installed face So 107 started up as scheduled in August 2009.

Dirk Wagener
Peter Hien

P. 8 left: The heading crew pose proudly after completing the tunnel breakthrough
P. 8 right: The first eye contact through the new rise heading into tailgate 108
Right: Before the final round of shots in heading 107.8

Key data for Ost colliery/RAG Deutsche Steinkohle AG:

Workforce:
2,400

Annual production:
1.5 million t

Maximum depth:
1,470 m

Roadway network:
73 km

Nearly 140 years of shaft building at Thyssen Schachtbau GmbH

Responsibility to the past and commitment to the future

In 1871 August Thyssen renamed his company 'Gewerkschaft Deutscher Kaiser' and in doing so laid the foundations of a business that was destined to serve the coal industry – and was to be the forerunner of today's Thyssen Schachtbau GmbH. In those early days most of the company's business centred on shaft sinking and exploration drilling, with roadway drivage being added to the remit some time later. The first shaft construction project was also taken on in 1871 with the sinking of Friedrich Thyssen 1 shaft.

As well as conventional sinking methods the company also began to use freeze sinking and shaft boring techniques. A notable achievement of the time comprised the Lohberg I and II freeze shaft projects that commenced in 1907. These two shafts required a freeze depth of some 415 m and both operations were a great success. Schachtbau Thyssen GmbH, whose head office was in Mülheim an der Ruhr, was set up as a separate undertaking on 07.05.1919 following the reorganisation of the August Thyssen group of companies.

Shaft sinking, roadheading and underground drilling still make up the core business of Thyssen Schachtbau GmbH, just as they did 140 years ago. TS Shaftsinking and Drilling has its own operating facilities at various locations, including the RAG Deutsche Steinkohle AG collieries, K + S Kali GmbH and the esco-european salt company GmbH & Co. KG.

Another important area of operation has been the specialist mining projects undertaken for Germany's permanent nuclear-waste disposal programme, which is managed by the DBE (German Association for the Construction and Operation of Waste Repositories).

Branching out

Against the background of a dwindling mining market in Germany, which has seen a drop in demand for services from specialist mining companies, even greater focus is now being placed on overseas operations. In fact Schachtbau Thyssen's international activities have gradually been expanded over the years to include projects in the USA, Russia and Switzerland.

The company has a long tradition of operating in Russia: as far back as the early 1920s Schachtbau Thyssen GmbH carried out a number of shaft sinking projects as part of a major programme to develop coal deposits in the Donets Basin.
National and international activities, both then and now, include planning, the supply of machinery and equipment and the provision of modern, innovative construction and installation services. The strategic approach is to employ an ongoing process of prudent adaptation and improvement so that the company's activities can be developed in a controlled manner for the greatest benefit of our clients. Here it is vital that we retain and continue to develop all the expertise and knowledge acquired over many decades. This process is supported

P. 10 left: Shaft sinking project for an ore mine in the extreme north of Russia

P. 10 right: Site preparation works for the water power plant Schattenhalb 3 raisebore project in Meiringen, Switzerland

Decline project at a coal mine in Illinois, USA

Muelheim an der Ruhr, head office of Thyssen Schachtbau's Shaft-sinking and Drilling division

by intensive know-how transfer on a regular basis with Thyssen Mining Construction of Canada Ltd. (TMCC). Technological expertise and a highly motivated, well-trained and flexible workforce will be crucial for the company's long-term future. Operational activities are complemented and supported by Thyssen Schachtbau's highly efficient Technical Department.

All current overseas projects have to follow a set of in-house guidelines that have been drawn up for the adoption and implementation of measures for minimising and managing the risks associated with project planning, design and construction. These guidelines detail the procedures to be used for identifying risks and describe the mechanisms to be employed for risk management and monitoring as based on risk schedules and risk assessment routines. Their scope of application covers operational phases such as project development, planning and execution.

2011 Sicher mit System BG geprüft

Die Bergbau-Berufsgenossenschaft
berechtigt das Unternehmen

Thyssen Schachtbau GmbH
- Geschäftsbereich Bergbau -
D-45468 Mülheim an der Ruhr

das Gütesiegel „Sicher mit System",
die branchenspezifische Umsetzung des NLF/ILO-OSH 2001,
zu führen.

Durch ein erneutes Audit wurde der Nachweis erbracht, dass die Anforderungen der Bergbau-Berufsgenossenschaft an einen systematischen Arbeits- und Gesundheitsschutz in dem Unternehmen wieder erfüllt sind.

Die Anforderungen gemäß den Inhalten von OHSAS 18001 werden durch die Begutachtung ebenfalls wieder nachgewiesen.

Diese Bescheinigung ist gültig bis zum 26.06.2011.

Präventionsleiter

Begutachter

Certificate "safety the systematic way" (SMS), re-audited until 2011

Huge efforts have been made in the area of training and upskilling ongoing over the last two years, with the main emphasis being placed on shaft winding, explosives, hydraulic systems and control technology. This proficiency upgrading process will be continued in 2010 so as to promote the individual and technical skills of the shaftsinking and drilling workforce.

The efficiency-improvement and streamlining measures introduced in 2004 were also continued through 2008 and 2009. Substantial changes have already been made to the company's organisational procedures and structure and this process is now nearing completion, with the company remaining fully resolved to the development and promotion of new talent.

Training high on the agenda

Workplace safety has been steadily improving year on year and TS Shaftsinking and Drilling ended 2008 with an accident rate of 3, in other words the division recorded three notifiable accidents per million hours worked. And this trend is continuing – improved safety is an ongoing process and occupational health and safety standards are now at a very high level. There is no doubt that the reduction in accidents has been due in no small measure to the safety drive initiated by the BBG (Mining Employers' Liability Association) under the motto 'safety the systematic way' (SMS), which Thyssen Schachtbau GmbH introduced in 2004. The SMS certificate, which certifies that all systematic safety provisions have been put in place, was again awarded to the division after a further safety audit in 2008.

'Fully committed'

Further lucrative contracts are also in the offing, both within Germany and elsewhere. The objective is to remain a 'fully committed' and successful market player, in spite of the adverse circumstances created by the global economic crisis. Having to deal with a changing environment and take on fresh challenges is something that mineworkers are well used to. The underground geology puts these attributes to the test day in and day out and has profoundly shaped the way in which we operate. We are used to tackling difficult situations and finding new solutions. It has been this way for the last 139 years and will continue to be so.

Norbert Handke

Shaft sinking north of the Arctic Circle

Planning, construction and installation of the WS 10 mine project for MMC Norilsk Nickel, Moscow

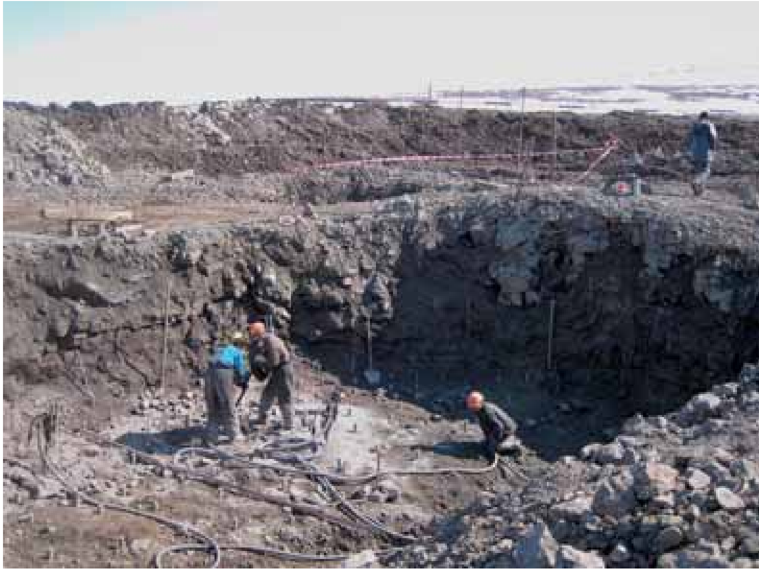
Three years of tendering and negotiations came to an end in September 2007 when THYSSEN SCHACHTBAU GMBH was commissioned by OJSC MMC NORILSK NICKEL (MMC Norilsk Nickel) to undertake the 'planning, construction and installation of the WS 10 ventilation shaft site for the Skalisti Mine', which is part of the ore mining complex at Norilsk on the Taimyr Peninsula, a mining region of Siberia north of the Arctic Circle. The contract effectively involves the planning and construction of an ore mine and its integration and link-up with the existing ore production facility.

Sometimes a shaft will be established here, some 8 km away from the next living area deep in the tundra

MMC Norilsk Nickel – company profile and history

MMC Norilsk Nickel is a Moscow-based mining and metallurgical company. The operational side of the business is centred in the northern Russian mining region of Norilsk-Talnach.
MMC Norilsk Nickel is the world's leading producer of nickel and palladium. It also ranks among the largest international suppliers of platinum and is in the top-ten list of copper producers. In addition to this the company is involved in the mining of cobalt, rhodium, silver, gold, tellurium, selenium, iridium and ruthenium.
Though it was known as far back as the 17th century that there was copper and nickel on the Taimyr Peninsula mining did not in fact commence in and around Norilsk until the 1920s. The USSR Government set up the Norilsk Combine on 23.06.1935, thereby laying the foundations for the world's largest mining and metallurgical company for non-ferrous metals. The mine officially started production on 10.03.1939.

Combines for the production of copper and nickel were also established in the Murmansk mining region on the Kola Peninsula. The Severonikel Combine was founded at Monchegorsk in 1935 and the Petchenganikel Combine, which was based at the towns of Zapolyarny and Nikel, followed in 1940.
On 04.11.1989 a Government resolution merged the three combines with another two companies and the Gipronickel Planning Institute to form Norilsk Nickel. A further resolution of 30.06.1993 set up the joint-stock company RAO Norilsk Nickel. The company was then restructured in 2000 and renamed the Norilsk Mining Company. Further reorganisation took place the following year and as a result the group adopted its current name of 'Mining and Metallurgical Company' (MMC Norilsk Nickel).



Top: Every shaft project starts with a small step, here already 4 months after contract awarding

Below: Some meters ready sunk which was easier than to overcome all that administrativ barriers

Shaft sinking north of the Arctic Circle

The Norilsk mining area is located in the Arctic Circle region of central Siberia to the east of the Yenisei River. At these latitudes the freezing temperatures that constantly prevail mean that the permafrost soil only thaws down to a maximum of 6 m for a short period during the two summer months. The Norilsk mining region contains rich ore bodies, with nickel, copper and platinum the main focus of mining activities.

The WS 10 ventilation shaft is also to be constructed above an extremely rich body of ore and will form part of the new Skalisti mining development whose deposits will secure ore production from the Norilsk mining area from the end of 2015 well into the future. In addition, work will soon be commencing on the SKS 1 production shaft, which is to be located about 1,500 m from the WS 10 site.

WS-10

Norilsk Nickel

17th century:	
	Existence of copper and nickel deposits known
1920:	Mining commences
1935:	Norilsk Combine set up
1935:	Severonickel Combine established in Monchegorsk
1940:	Petchenganikel Combine set up in Zapolyarny
1989:	The three Combines are merged with three other companies to create Norilsk Nickel
1993:	RAO Norilsk Nickel
2000:	Norilsk Nickel Company
2001:	Mining and Metallurgical Company OJSC MMC Norilsk Nickel

Below: Connection of the waterproof fan drift is a first time used new concept for Norilsk

Some 2,800 m³ concrete installation preparation work for the shaft cellar in parallel to the final headframe installation

The two WS 10 and SKS 1 shafts for the future Skalisti Mine are about 35 km to the north-east of Norilsk and close to the urban district of Talnakh in the middle of the tundra. A 3 km-long paved road connects the WS 10 site to Skalisti's WSS 7 main shaft, which has already been completed. Before the shaft construction work started Norilsk Nickel laid pipelines to supply the site with compressed air and fresh water and also installed an overhead power line for the supply of electricity.

Installation of the shaft building from which the highest head-frame of Norilsk will be built

The extreme climate conditions prevailing within the northern Arctic Circle posed a huge challenge for the construction crews. In winter temperatures in the Norilsk mining area are generally between -20°C and -35°C. However they can also plunge to below -40°C and stay there for several days on end, making it impossible to operate load-lifting cranes, transport vehicles and other types of machinery. However the biggest problem is posed by the snowstorms that prevent any kind of outdoor work from being undertaken, and in some cases even make it impossible for heavy machinery to reach the worksite.

A logistic challenge

Supplying the construction site with machines and equipment is a huge logistic challenge. Deliveries from Germany have to take the sea route from Rotterdam to Murmansk and then be transported onwards to Dudinka. As the ports of Murmansk and Dudinka are closed from the end of April to mid-July because of adverse weather conditions all supplies have to be carefully planned several months before they are shipped to the site and must also be registered well in advance with the customs authorities and shipping companies.

Materials supplied from within Russia, such as pipework, vehicles, items of equipment and concrete reinforcement, can be transported on the Trans-Siberian Railway to Krasnoyarsk and from there shipped down the Yenisei River to Dudinka. These internal shipments also have to be planned in advance in great detail, as the Yenisei is only navigable during the ice-free months of July to September.

Scope of the contract

The volume of work assigned to Thyssen Schachtbau GmbH as the general contractor essentially involves the construction of a complete mining facility:

- Above ground the project includes the preparation of the shaft site, the erection of all temporary and permanent surface buildings and mine facilities and the installation of the shaft surface infrastructure.
- Work to be carried out underground comprises the sinking of the 2,055 m-deep ventilation shaft, the construction of the fan drift and the excavation of shaft landings, pump rooms, roadway entries and a shaft undercut.

The preparatory work at the shaft site, which is located in a river valley in the foothills of a range of mountains, required

Surface structures:

The surface work mainly comprised:
- construction of an accommodation block for some 150 workers,
- erection of the permanent 66 m-high shaft headframe,
- construction of the winder house and installation of two SIEMAG M-TEC² twin-drum winding machines,
- installation of two HOWDEN mine ventilation fans delivering approx. 750 m³ of air per second, along with fan housings and diffusers,
- 110 kV and 6 kV AREVA transformer station for permanent power supply to the shaft,
- workshops and stores buildings,
- temporary concrete mixing plant and temporary fan building for the shaft sinking,
- permanent belt installation to serve the waste tip.

The shaft facility in September 2009; left to right: Basestructure of the 110 kV power station, 45 m of final 66 m of permanent headframe, 6 kV station, temporary ventilation building, temporary social building

extensive earth-moving operations to be carried out under strict environmental conditions in the natural landscape of the tundra, the aim being to create an average gradient of 1.5° over the 40,000 m² site. The shaft surface was covered with a 1.5 m-thick layer of aggregate and surrounded by a drainage trench.

Because of the permafrost the foundations for the buildings had to stand on drilled piles 700 mm in diameter and set on compact rock. The piles were between 7 m and 20 m in depth, depending on the local ground conditions at the shaft site.

The shaft, which is to be sunk by conventional drilling and blasting, has a specified finished diameter of 9.0 m and an end-depth of about 2,055 m. The 135 m-deep section of foreshaft has a concrete-backfilled cast-iron tubbing lining, while the main shaft section is to be constructed in steel concrete from the 135 m level to shaft bottom.

The blasting holes, which have a maximum depth of 4.5 m, are drilled with a pneumatic, six-arm shaft drilling machine. This rig can also be employed for large-profile holing work and for drilling exploration boreholes to a maximum length of 60 m.

WS-10

Surveying on difficult conditions with equipment up to date

This construction panel will provide project information to future visitors

The foreshaft is excavated using a portal crane and kibble system, with a hydraulic excavator loading out the debris on the sinking floor. The main shaft section will be constructed using a 7 m³-capacity dirt bucket and a grab with a payload of some 1.2 m³.

An innovative six-deck working platform system is used for installing the permanent shaft lining and shaft fittings, some of which are to be fitted in parallel with the sinking work. This six-deck platform moves on a walking mechanism without the need for the normal scaffold winches and is a very effective piece of equipment for the sinking of 'ultradeep' shafts.

Clearing from snow in Norilsk official called „snowfighting"

The two permanent SIEMAG M-TEC² twin-drum winding machines are available for the sinking operation. The kibble winch is essentially used for manwinding and debris clearance and for supplying materials to the sinking crew.

The SIEMAG M-TEC² twin-drum winder, which will operate the skip conveyance when the mine comes into permanent production, is to be equipped with two manwinding cages during the sinking phase so as to keep the platform team supplied with materials such as pipework, shaft guides and buntons.

The concrete for the shaft lining is mixed above ground and then transported by a pump and drop-pipe system to the placement point behind the formwork at the level of the shaft platform, where it is compacted. A combination of rockbolts, wire mesh and, where required, shotcrete is used to provide temporary cavity support at the sinking floor. The shaft insets, pump rooms and roadway entries, along with the shaft bottom road, are all to be excavated conventionally by drilling and blasting with shotcrete spraying.

The entire shaft complex is to be handed over as a turnkey facility at the end of 2015. The TS programme of work has so far not deviated from the project schedule.

Progress to date

Earthmoving and ballast laying work commenced at the shaft site on 28.11.2007, which was just two months after the contract was awarded. In spite of the adverse weather conditions – the site was covered with up to 4 m of snow during the winter 2007/2008 – the earthmoving and excavation work progressed speedily. Some 150,000 m³ of tundra and loose soil were moved and about 60,000 m³ of crushed stone ballast laid in place. Preparation work at the shaft site was therefore practically completed by the autumn of 2008. A tipping point was also set up to accommodate the sinking debris.

After the local authorities had issued the regulatory blasting permit the first round of blasting for the shaft profile commenced in July 2008. The shaft collar section was constructed to a depth of about 18 m and lined with cast-iron tubbing. The shaft cellar and four sets of headgear foundations were also completed during 2008.

The excavation for the fan drift, which in some places was 16 m below ground level, was also constructed by drilling and firing. The drift broke through into the shaft in August 2008. The connection between the shaft and the fan drift was formed using an adapter frame, which was bolted up to the tubbing segments to create a watertight, flexible junction. The shaft cellar and entire length of the fan drift were lined with a waterproof welded membrane.

Work on the drilled piles for the accommodation block began in early May 2008. After the foundations had been completed and a lattice of steel beams erected the actual building work was able to commence at the end of August. The accommodation block with its adjacent wastewater treatment plant will provide washroom facilities for about 150 workers. The unit also contains offices and conference rooms, along with lounge areas. The accommodation block was ready for occupation in February 2009.

Good humor some adverse conditions notwithstanding

The 6 kV power supply station temporarily required for the shaft sinking operation was fully installed and commissioned. The temporary fan building, a storehouse and the permanent 110 kV and 6 kV transformer units are all currently under construction. The bottom 45 m section of headgear has been erected and is now being covered with steel sheet cladding. The complete headframe structure, which will stand 66 m in height, is to be ready by early 2010.

Outlook

Developments on the international financial markets, and the fall in the world market price for nickel, have forced MMC NORILSK NICKEL to reschedule the WS 10 shaft complex project by gearing down the construction work for a year or so. In other respects the operation has been taken to a point where the foreshaft sinking from the 18 m level to a depth of about 150 m can be resumed at short notice and by mid-2010 at the latest.
The installation of the permanent SIEMAG M-TEC² twin-drum winding machines, which will be used to sink the WS 10 shaft from the 150 m level to its final depth of about 2,055 m, has now been postponed until 2011.

Summary

In spite of the extremely exposed location of the shaft site good progress has been made on the extensive surface facilities, including the construction of the accommodation block, the shaft cellar, the 18 m-deep shaft collar, the fan drift and the permanent headframe structure.

The extreme climate has affected not only the planning of the project but also every aspect of the construction work and has required the planning engineers and site managers in particular to be able to adapt to events as they arise and to have the flexibility needed to acquaint themselves with local building methods. Because of the limited transport options and restricted payload capacity the procurement and transport of equipment and materials, which have to be shipped via the Polar Sea or down the Yenisei River, has to be organised many months in advance and well before the items in question are required at the construction site.

The planning, construction and assembly work required for the WS 10 shaft complex has posed a number of exceptional problems. However, thanks to the commitment and technical skills of the construction crews and the excellent working relationship established with the personnel from MMC Norilsk Nickel, all these difficulties have been successfully resolved and the various construction phases have been delivered on schedule.

Dr. Oleg Kaledin
Andreas Neff
Dietmar Schilling
Andre Marais

Sinking the 'Gremjatschinskij' freeze shaft for EuroChem

On 29.05.2008 the Moscow-based Russian minerals and chemicals company MCC EuroChem OJSC (EuroChem) awarded Thyssen Schachtbau GmbH the contract to sink the 1,180 m-deep production shaft for the "Gremjatschinskij" potash deposits. In addition to the actual sinking work the contract includes the drafting of building permit applications and project execution plans in accordance with Russian standards and regulations.

The potash mine at the "Gremjatschinskij deposit" is located in the Kotelnikovo district of Russia's Volgograd region, about 170 km south-west of Volgograd and some 20 km to the north-east of the town of Kotelnikovo.
The potash shaft is scheduled for completion in early 2013 and the mine is to be equipped for a future production capacity of 2.3 million tonnes of potassium chloride a year. The facility is to be operated by the Volgograd-based company EuroChem-VolgaKaly, which is a 100 %-owned subsidiary of MCC EuroChem OJSC.
Potash is an extremely important strategic raw material. The world of tomorrow will require ever-increasing agricultural productivity if it is to meet the growth in demand for agricultural products – and potash fertilisers will play a key role in this area.

EuroChem

EuroChem is one of Europe's three major suppliers of mineral fertilisers and is ranked in the top ten of world producers. The company reported a turnover of some three billion US dollars in 2007. As Russia's only chemicals corporation EuroChem is involved in a number of areas, including mining, manufacturing and logistics, and also operates a distribution network in various parts of the world. EuroChem has a total workforce of 25,000.

At the end of October 2008 EuroChem took out a credit facility of 1.5 billion dollars for a period of four years. Half of this investment is intended for developing the company's potash production operations, a sector in which EuroChem has not previously been involved. EuroChem's aim is to become Russia's leading producer on the potash market.

The potash mine at the "Gremjatschinskij deposit" is operated by EuroChem-VolgaKaly. With its rich deposits of potassium salt, which geological investigations have assessed at over 1.2 billion tonnes, and raw potash of outstanding quality, with a potassium chloride content of over 41 %, the mine clearly has a unique potential.

In April 2008 EuroChem was also given an operating licence to set up a mine in the Palashersky and Balakhontsevsky districts of Verkhnekamskoye deposit, in the Perm region.

The Volgograd and Perm resources will in all probability enable EuroChem to achieve an annual potash production of between six and seven million tonnes of potassium chloride by the year 2016.

RB 50 rig being assembled prior to drilling the freeze holes in February 2009

Mine project planning by Belgorchimprom, Minsk

For help with the planning of potash mine at the "Gremjatschinskij deposit" EuroChem turned to Belarus's leading scientific research institute for the mining and chemicals industry, OJSC Belgorchimprom. Since 2006 this institute has been providing technical and scientific support for a geological report on the Gremyachinskoye mine.

P. 18: RB 50 drill rig with mud circulation system preparing the freeze holes

Right: Complete drilling installation showing RB 50 drill, mud circuit with pumps, mudtanks, settling pit and mud control system, fire extinguishing equipment, borehole controls, pipe rack and freeze circuit

Below: Quality control – measuring the drill mud with a marsh funnel

RB 50 drilling rig during freeze-pipe installation

RB 50 drilling rig with freeze plant, pump house and Thyssen flag against the Russian sky

Volgograd airport, still three hours by road from the construction site

Sinking the production shaft

The geological and hydrological findings obtained from the exploration drilling programme indicated that the freeze method would be required for sinking the 1,180 m-deep shaft. Much of the overburden in the target area was described as 'weak' to 'moderately stable' and rated as 'water bearing'.

The freeze pipe was inserted to an end-depth of about 520 m. The freeze-hole operation commenced in February 2009 and was completed at the end of August that year. This involved drilling 44 individual freeze holes and four temperature measurement holes. It is scheduled to switch on the freeze plant by the end of 2009.

In order to hold back the subsurface water on a permanent basis and relieve the petrostatic and hydrostatic pressure the shaft was lined with cast-iron tubbings to a depth of about 870 m. The shaft had a finished diameter of 7.0 m.

The shaft diameter was extended to 8.0 m in a number of areas, namely in the saliniferous section beneath the 1,003 m level, which mainly consists of anhydrite and dolomite, in the zones comprising sylvinite and the actual potash deposits, and in the shaft sump. The three shaft insets are located between the 1,083 m level and the skip winding station at the 1,133 m level.

Summary

The project was officially handed over to the contractors by EuroChem at a formal ceremony held in Kotelnikovo on 17.07.2008. Thyssen Schachtbau GmbH is to be partnered in the sinking project by the South African company Shaft Sinkers (Pty) Ltd, who are to complete the adjacent service shaft. Another agreement has been concluded between EuroChem and Hatch of Canada, who will be responsible for the base work on the potash enrichment plant. This installation is to be designed for a production volume of 2.3 million tonnes a year. The technical operations required for the potash mining project will be handled by Belgorchimprom, the leading Belarusian scientific research institute for the mining and chemicals industry.

The Regional Governor called on the contracting companies to plant a tree for every worker who will be engaged in the

Shaft data:

Finished diameter:
7.0 m

Saliniferous section:
8.0 m

Final depth:
1,180 m

Depth of freeze shaft:
520 m

Depth of tubbing supports:
870 m

Depth of saliniferous:
1,003 m

3 shaft landings between:
1,083 m and 1,133 m

Planned production:
2.3 mill. t/a

Left: Electrical connection for the freeze plant

Top: View of freeze plant and administrative building

project. This gesture will symbolize the bonds of solidarity between all those involved and will also help counteract the impact of environmental erosion. The area around Volgograd has a very continental climate and rainfall levels are low. Summer temperatures are around 40°C, while the winters are short and relatively mild.

The completion of the project will make EuroChem Russia's leading producer, and the world's fourth largest manufacturer, of nitrogenous, phosphorous and phosphate fertilisers.

Erhard Berger
Ibragim Rizvanov
Dmitri Kononov
Hubertus Kahl

[1] FAZ edition dated 29.12.2008
[2] Wirtschaftsnews dated 22.10.2008

Planning shaft sinking projects in the Russian Federation (RF)

Certain procedures have to be followed when drafting and agreeing project documentation and when receiving approval documents for machinery and equipment to be used in the Russian Federation – and these regulations currently apply to Thyssen Schachtbau GmbH in its role as contractor for the Norilsk Nickel and Gremjatschinskij projects that are currently at the planning and execution stage. Much of the approval and design work is being carried out by the technical office of TS Shaftsinking and Drilling based in Mülheim an der Ruhr.
A clear distinction generally has to be made between the planning and the construction phases.

Planning phase

The planning phase includes preparing the documentation for the project as a whole along with all material required for the individual construction phases and sub-projects.
The project documentation is built up on the basis of the job description presented by the client (project owner).
These documents consist of a text section and a graphic section.
The scope, composition and content of this document file is to be determined and itemised by the client as a function of the degree of detail required for the development of the architectonic, technical and technological solutions being presented in the project documentation and in accordance with the various rules and regulations laid down by the Government of the RF.
The project documentation is subject to a client acceptance process, which means that an 'expert's report on industrial safety' has to be drawn up in advance by a state-accredited company. This expert's report will highlight any deviations from Russian standards and issue a health and safety clearance in respect of the methods being proposed for the construction and operational phases of the project. An expert assessment will then list any shortcomings in the proposals and specify the remedial actions that are to be taken.
When this procedure has been concluded and the contractor and client have reached an agreement on the course of the project the second stage of the process begins with the client then submitting the entire project to a 'state expert assessment'. This is carried out by a state authority with responsibility for the region in which the project is to be carried out. In the case of the above shaft sinking projects

GOST R, the certificate of conformity

P. 22: The Thyssen Schachtbau project planning team taking responsibility for the basis of success

Right: From project planning to equipment mobilisation – platform winches for shaft sinking in Russia

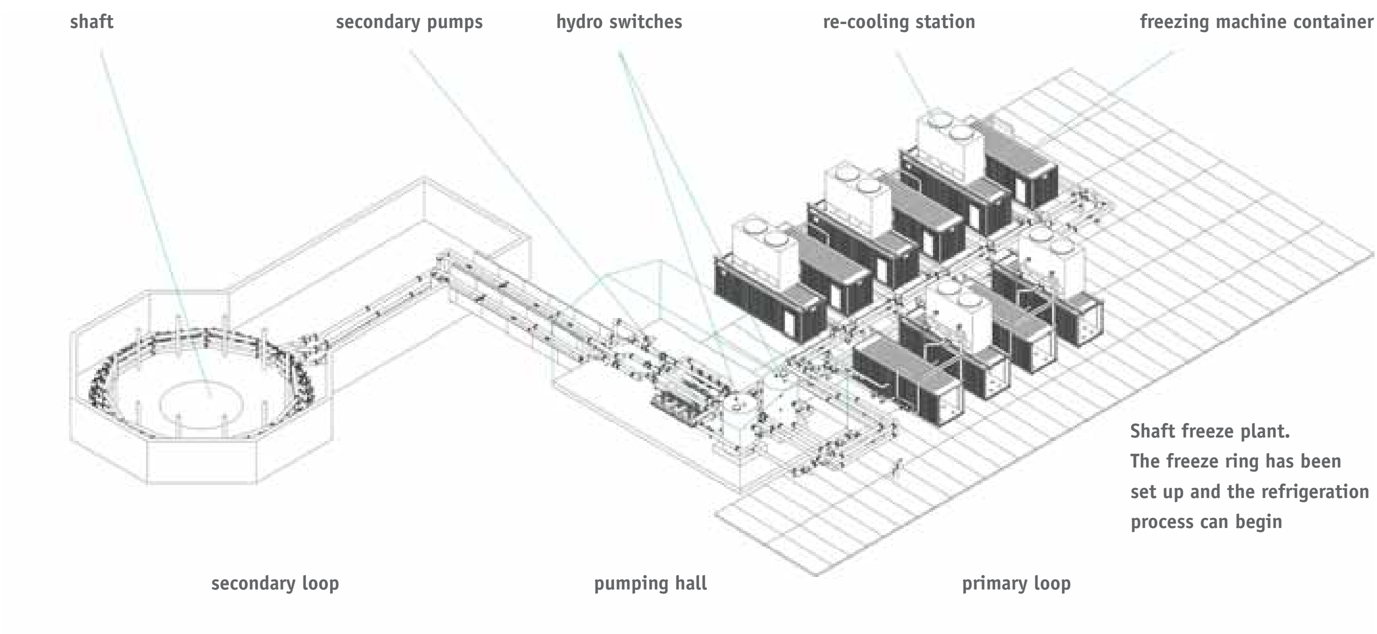
the 'state expert assessment' examines not only the 'shaft construction' aspects but also all the other details of the project, including the mineral preparation plant, the surface complex, the shafts and the underground facilities. This fastidious examination includes the safety measures to be taken during the construction and operational phase, the ecological aspects associated with the project and the degree of compliance with certain declared (state) objectives. The project is then either given the go-ahead or, as the case may be, a request is put for various aspects of the plans to be amended. There is no facility for issuing a conditional approval.

Construction phase

A detailed set of documents has to be drawn up for the project construction phase.

This includes the submission of blueprints for the individual structures (e.g. headgear, winding machines, winder room, workshops, electrical equipment, etc.). The sequence of operations and technical equipment required (crane, working platforms, auxiliary winches, drilling machines, etc.) also have to be described and listed.

Some members of the team at their desk



Shaft freeze plant. The freeze ring has been set up and the refrigeration process can begin

Like the general project documents, these construction and work-sequence plans also undergo scrutiny in order to ensure that they comply with and take account of the technical rules, provisions and standards in force in the RF.
All listed items of equipment that are to be imported into the RF must first obtain a certificate of conformity (GOST R).
This involves submitting technical data, descriptions and operating instructions for each item of plant.
No distinction is drawn between temporary plant and equipment (auxiliary winches, working platforms, drilling machines, etc.) and permanent installations (winding machines, electrical equipment, etc.).
As well as a GOST R certificate some items of plant also require a health and safety permit confirming that they comply with the hygiene regulations applying in the RF. In the case of the Gremjatschinskij project this requirement applies to the freeze plant (type of coolant medium to be used) needed for sinking the shaft at the "Gremjatschinskij deposit".
These certificates have to be presented to the customs authorities along with the customs declaration that is part of the transit clearance process and they therefore constitute an essential part of the documentation that is needed to obtain approval for importing the products in question into the territory of the Russian Federation.

Winch being overhauled at the company's own workshops

The GOST R certificate only authorises importation into the RF and a separate operating licence, for which an application has to be made to the State Technical Monitoring Authority 'Rostechnadzor', is required for the commissioning of the plant and equipment in question.
Companies wishing to obtain this operating licence first have to register with the Monitoring Authority.
The equipment can only be operated in the territory of the Russian Federation after all the aforementioned certificates, expert's reports, approvals and registrations have been obtained.
In the course of the various approval and planning procedures required for the first stages of the Norilsk Nickel and Gremjatschinskij projects it became increasingly apparent that that progress depended on close cooperation between everyone involved – not only the technical and commercial sections of TS Shaftsinking and Drilling here in Germany but also the various engineering consultants, customs brokers, expert bodies and authorities working with us in the Russian Federation. All played their part and in spite of some initial difficulties the permits and licences for the first project stages were eventually obtained and work was able to commence on site.

Rainer Lietz-Nagel
Till Kaufmann

Operations in Switzerland – from drilling Sedrun 2 shaft to operate with TIMDRILLING

The development of the Thyssen Schachtbau GmbH (TS) Sedrun branch (TS-ZNL Sedrun), which led directly to the setting-up of the Swiss-based TIMDRILLING Joint Venture, has once again demonstrated that full commitment and dedication at individual and team level can drive a successful marketing venture in a new country.

Thyssen Schachtbau's activities in Switzerland commenced in 2002 and since then the company has been successfully involved in raise-boring and preventer-supported core drilling work and other specialist mining projects. There is no doubt that the high point of these operations was the sinking of the 800 m-deep Sedrun 2 shaft, which was completed within 12 months using a shaft boring machine. Some of the planning, transport and installation work required for the permanent shaft winding system was undertaken in parallel with the shaft sinking and was then completed after the shaft touched bottom.

In order to provide real hands-on support for the tunnelling operations and to carry out specialist civil engineering and shaft construction work in the Alpine regions, most notably in Switzerland and its neighbouring countries, three project partners – namely Implenia BAU AG (created by the merger of the two Swiss construction companies Zschokke and Batigroup), Thyssen Schachtbau GmbH and ICOS of Italy – got together to set up the TIMDRILLING project group on 06.12.2006.

The common strategic objective is to develop the TIMDRILLING Joint Venture into a stand-alone company by 2010.

Market entry with the sinking of the Sedrun 2 shaft and installation of the permanent heavy-duty winder

After lengthy preparations and negotiations the contract to sink the 800 m-deep Sedrun 2 shaft was awarded to the Sedrun II Shaft Boring Consortium in March 2002. This contracting group comprised RUC (South Africa), TS (Germany) and OESTU-STETTIN (Austria). A pilot hole first had to be drilled with an HG 330 raise-boring machine before the VSB VI shaft borer could be brought in to excavate the shaft to a diameter of 7.0 m. The sinking broke through to the level of the new Gotthard tunnel in June 2003, an achievement that was due in no small measure to the excellent support and

cooperation provided by the client, namely the TRANSCO tunnelling consortium, which was responsible for the dust extraction, drainage, debris clearance and materials supply services.
TS had already supplied and installed the heavy-duty winder that was to be used for the sinking operation. The work subsequently needed to fit out this system as a heavy-duty shaft winding installation, and the first follow-on contract for the servicing and commissioning of this machine, provided the basis for long-term operations in Switzerland.

Commercial conditions for contracting companies working in Switzerland

Companies wishing to engage in business activities in Switzerland first have to meet the following conditions:

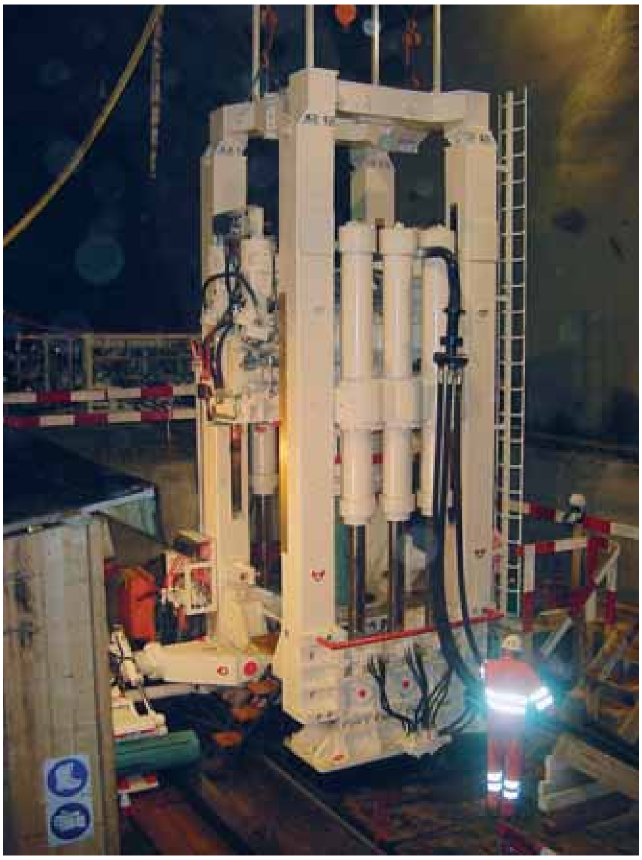
- Set up a branch office
- Arrange for entry in the commercial register
- Register with the taxation authorities (for capital gains tax and VAT)
- Apply for residence and work permits for company workers.

The branch office, which was first based in Zollikon, was entered in the commercial register of Zurich Canton in April 2004. The office subsequently moved to Sedrun (Graubünden Canton).

Another requirement for commencing operations in Switzerland is that all deployed workers must be paid in accordance with the collective bargaining agreement for the Swiss construction industry (LMV). While employees' wages and salaries are taxed locally from the moment they start working in Switzerland, existing social security arrangements between Switzerland and the Federal Republic of Germany allow any pension insurance established in Germany to be retained for a period of six years.

Once the first of the Thyssen Schachtbau employees had exceeded this time limit at the end of 2008 those concerned switched over to the Swiss pension insurance scheme on 01.01.2009. This also ended all BBG responsibility (German Mining Employers' Industrial Liability Association) for these workers, this role then being taken over by the SUVA (Swiss Accident Insurance Fund), a company under public law that is responsible for statutory accident insurance in Switzerland. These changes, which were a legal requirement, also indicate that the TS branch office in Switzerland is gradually developing into 'real' Swiss company.

The conversion to an independent subsidiary is planned for the end of 2010.



Left: The first phase of drilling at Sedrun, June 2002, 800 m of directional drilling with the hole then taken out to 1.8 m by an HG 330 boring machine.
The VSB VI grits its teeth to open the shaft out to 7.0 m

Below: The success of the Sedrun II project was followed-up by a number of drilling contracts for the tunnel and hydropower-plant construction sectors

Mining expertise in big demand in the 'land of the tunnel builders'

A large number of tunneling and specialist civil engineering projects, most of which involved work for Alptransit Gotthard AG, have been carried out since operations commenced in Switzerland in 2002. The initiative first developed by TS has in turn been taken over by the Sedrun office and TIMDRILLING. In addition to exploration drilling in the Faido and Sedrun sections of the Gotthard base tunnels the current scope of operations includes:

- Preventer-supported rotary percussive and core drilling work for preliminary exploration of the tunnel drivage
- Rotary percussive and core drilling without a pressure closing system
- Conventional and mechanised shaft sinkings, mainly for tunnel and hydro electric works
- Materials and heavy-load transport tasks, installation and operation of vertical and inclined conveying installations
- Installation of infrastructure and supply systems for tunnel construction projects
- Injection work for strata sealing and reinforcement.

In addition to the above activities the permanent Joint Venture TIMDRILLING will be providing the following specialist civil-engineering services as part of its long-term remit:

- Raise-boring
- Micro-tunnelling
- Ground freezing.

The TIMDRILLING head office is at Sedrun in Switzerland.

TIMDRILLING project portfolio and future prospects

TIMDRILLING is able to draw on TS' expertise in shaft-sinking and drilling along with the specialist civil-engineering know-how of Implenia Bau AG, with the Italian-based ICOS company bringing valuable experience in micro-tunnelling and ground-freezing to the overall group portfolio.

TIMDRILLING's current activities are mainly focused on core drilling and percussive drilling work for the excavation of the Gotthard base tunnel. The geology, hydrology and geological make-up of these sections of tunnel are extremely complex and heterogeneous in nature. Sophisticated tunneling techniques were needed to drive through the fault zones, steep and inclined stratification and extreme strata overlap encountered along the tunnel route, an operation that posed a real challenge for the tunnel construction engineers.

Raise-boring heads on their way up to start work …

… and the tunnel boring machine frequently had to stop to give the small Diamec 282 the right of way

Preliminary drilling was carried out during the drivage phase for better geological reconnaissance and in order to verify, confirm and/or modify the existing prognoses. Thanks to recent advances in drilling and strata-injection technologies tunnelling engineers now have access to preliminary exploration and strata reinforcement tools that can be employed effectively as the drivage advances.

TIMDRILLING's future not only lies in drilling and injection work in the challenging environment of the Gotthard base tunnel but will also focus on raise-boring and shaft construction projects for the Alpine hydro electric industry.

Heinz-Wilhelm Kirchhelle
Michael Müller

The preventer system in the tunnel crown above the TBM is mounted on the standpipe and secured by steelwork and chain blocks

Pioneer work explorating the Piora-Trough with core drilling

Success for AlpTransit Gotthard AG, the principal constructor for the New European-Alpine Transit project (NEAT), and for the TAT consortium (Tunnel AlpTransit Ticino), which is responsible for constructing the Bodio-Faido section of the Gotthard base tunnel in Switzerland:

Core drilling work carried out in August and September 2008 by TIMDRILLING in collaboration with the TAT consortium, which focussed on the now notorious Piora trough between Faido and Sedrun, yielded excellent results and provided the evidence needed for the mechanised drivage of the Gotthard base tunnel. The survey findings and the manner in which the core drilling was carried out through the highly challenging geology of the Piora trough section of the Gotthard base tunnel proved to be an overall success and met with highest recognition from Swiss colleagues.

TIMDRILLING was set up as a partnership between Swiss-based construction company IMPLENIA and Thyssen Schachtbau GmbH and its workforce has expertise in drilling and specialist civil engineering.

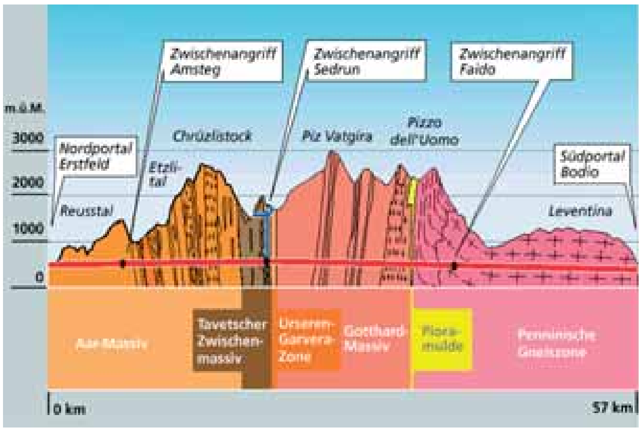
Core drilling to a diameter of about 10 cm established that the Piora trough consisted of stable, non-aquiferous rock. The 57 km-long rail tunnel passes through three different geological formations as it advances from north to south: the Aar massif, the Gotthard massif and the Pennine gneiss zone.
There are special risks involved in cutting through the Piora trough, which is part of the Gotthard massif. Lithologically speaking the trough consists of dolomite and anhydrite rock that was metamorphically altered during the formation of the Alps. The trough itself extends horizontally for some 150 m at the tunnel drivage level.

Some sections of the 12 km-long section of the Gotthard base tunnel between Sedrun and Faido are overlain with up to 1,800 m of cover rock. The strata temperatures at this depth can reach 50°C.

The geological profile at the drivage level was drawn up before the tunnelling operation commenced. Surface outcrops with beds dipping at a gradient between steeply inclined and nearly vertical formed the basis of the geological profile. Geological exploration holes drilled from the surface provided additional information on the structural make-up of the tunnel strata.

During the 1990s the Piora trough zone was surveyed via a 5 km-long exploratory drift (5 m in diameter) that was

Faido surface site

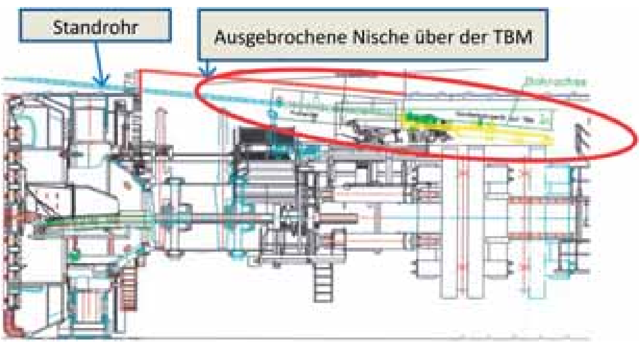


Geological profile along the Gotthard base tunnel

excavated with a tunnel boring machine (TBM) working from the Faido sub-section. From this point a number of additional holes were drilled, some reaching down to the tunnel alignment, which showed that the rock in this zone was stable and, more importantly, dry. When drilling into the upper part of the Piora trough, however, an uncontrolled water inrush was encountered and within a few hours several thousand cubic metres of water, mud and scree were flushed at high pressure into the tunnel. This resulted in the complete burial of the tunnelling equipment and the filling of some sections of the drift. The drivage was therefore stopped in its tracks even before the Piora trough was reached and the TBM had to be dismantled below ground. This whole event served to underline the high risk potential that would be present for the rest of the tunnelling operation.

Until the exploratory drift was completed it had been assumed that in the Piora trough the sugar-grain dolomite encountered at the surface would also be present at tunnel level. According to predictions the dolomite rock should be under hydrostatic pressure from some 1,800 m of overburden. One article that appeared in the Zürcher Tages-Anzeiger referred to these predicted running sands with a sense of foreboding as the 'geologist's nightmare'. Sugar-grain dolomite, with its tendency to crumble into sand, exhibits a very low compressive strength. When under water pressure this strength factor drops to practically zero and causes huge problems for tunnelling engineers.

Technical view of core drilling rig and preventer above the TBM (marked)



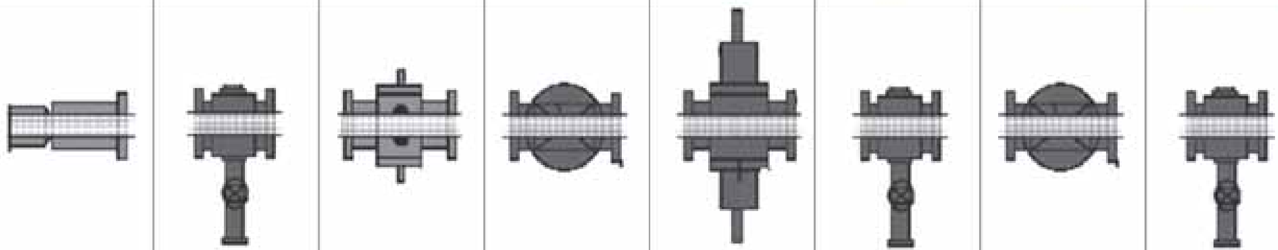
The data supplied by the core drilling work were sufficient to give the go-ahead for the two tunnel boring machines. The Piora trough was then tunnelled through successfully to a diameter of 9.5 m – firstly by the lead machine working in the advancing 'east' drift and then, a few months later, by the second TBM.

Only the core drilling work carried out by TIMDRILLING and TAT as part of the tunnel drifting operation could provide the ultimate assurance and yielded an accurate geological picture of the tunnel alignment.

The tunnelling engineers were extremely satisfied with the outcome of the 280 m-long core drilling in the east pipe of the Faido section, which had been a particularly challenging drilling operation.

Core drilling from the TBM drift

The TBM in the east drift was halted some 100 m before the predicted entry into the Piora trough in order to start the preventer-supported core drilling. Exploratory holes drilled from TBM headings suffer from the enormous disadvantage of having to be completed under very cramped and confined conditions and under severe deadline pressure. At the Faido site the fact that the tunnelling machine was parked-up close to the heading face presented the additional problem of



Rotation preventer	Kill- and Choke Line N° 3	Jaw preventer	Gate valve N° 2	Shear preventer	Kill- and Choke Line N° 2	Gate valve N° 1	Kill- and Choke Line N° 1
Length 63 cm	Length 54 cm	Length 26 cm	Length 51 cm	Length 34 cm	Length 54 cm	Length 51 cm	Length 54 cm

Preventer stack with explanations

having to drill the core holes from the machine deck above the TBM drillhead.

TIMDRILLING and the TAT consortium are party to a framework agreement for the execution of preventer-supported core drilling and rotary-percussive drilling work for the Faido-Sedrun tunnel section.
On this basis the exploration programme could be planned out in great detail by both contract partners ahead of the actual drilling operation.

Preventer-supported core drilling

The core drilling work was carried out by a modified Diamec 282 core drilling machine supplied by Atlas Copco. The relatively short drill feed fitted to this machine made it the ideal choice for the confined working conditions. The Diamec has a relatively powerful hydraulic torque motor and can deliver a maximum thrust of 130 kN.

As the core drilling operation in the Piora zone could not completely exclude the possibility of encountering high water pressures, despite the findings of the exploratory holes drilled in the 1990s, the decision was taken to use a blowout preventer. These devices are fitted in order to seal off any sudden releases of water pressure and to allow the pressure build-up to be released in a controlled manner. As the maximum water pressure expected in the Piora trough was between 180 and 200 bar the blowout preventer was set to this pressure stage.

The complete borehole sealing system comprised the following items:
The rotation preventer is a rubber seal that is in permanent contact with the drill rod and is able to rotate on a set of ball bearings. This allows the system to rotate while at the same time applying thrust to the drill rod.
The jaw preventer is fitted with rubber-edged metal pistons that match the diameter of the drill rod. In the event of a sudden water build-up a set of handwheels can be turned to force these pistons mechanically against the drill pipe, thereby sealing the annulus.
The ball valve is able to seal-off the borehole completely after the drill rods have been withdrawn.
The shear preventer is a hydraulically actuated impact ram that is able to shear through the drill rod and so completely seal-off the borehole in the event of an accident.

Drilling spools with lateral ball valves are arranged between the shear preventer and the rotary preventer in order to allow the drilling mud to circulate.

Drilling supervisors in the cross chamber at the Faido multi-function station – an underground escape route – before making the descent to the north drilling site

Steering the drill hole

The core hole was started above the TBM drillhead so that the tunnelling machine would not be obstructed by the drill rod sticking out into the heading face in the event of a drilling accident. High directional accuracy was another important requirement. The drill rod had to be kept out of the planned TBM alignment, which meant drilling at a slightly rising gradient (and at a precise directional accuracy of 5.5°). Single-shot borehole surveys were carried out at regular intervals in order to check the alignment. This involved taking photographs of a special in-hole survey tool fitted with a direction display and an inclination display system.

Summary

The core drilling survey undertaken by TIMDRILLING and the TAT consortium clearly confirmed the stability of the tunnel drivage line through the Piora section. Evidence was also provided that the strata within this zone were not prone to water inflow. On the basis of these findings the mechanised heading operation through the Piora trough was able to continue without any major problems and without having to alter the plan of attack.

Drilling recess above the tunnelling machine

This technically challenging, preventer-supported core drilling project was carried out to high professional standards and with excellent results. The success of the undertaking can be attributed to the modern drilling machine and technically sophisticated drilling equipment used for the operation, as well as to the skills displayed by the highly trained and experienced drilling team.

The successful completion of the drilling work was also due in no small measure to the close co-operation built-up between the TAT consortium (which comprised IMPLENIA AG, Hochtief AG, Alpine Bau GmbH, CSC Impresa Costruzioni SA and Impregilo S.p.A.), the client AlpTransit Gotthard AG and TIMDRILLING as contractor.

Michael Müller
Raimund Bartl
Christian Bremer

Raise-boring in Switzerland

Thyssen Schachtbau has been involved in raise-boring projects in Switzerland for some seven years now. The company's entry into this sector began in 2002 with the sinking of Sedrun II shaft for the Gotthard base tunnel. After Sedrun I had been completed using conventional techniques it was decided that Sedrun II shaft should be sunk by a shaft boring machine. This operation required a pilot hole to be drilled to provide a route through which the boring debris could be cleared away under gravity. The pilot drilling was carried out by an HG 330 raise-boring machine and the operation proved so successful for everyone involved that similar contracts were subsequently awarded. Three of the most recent of these projects are described in more detail below.

Developing the 'Rüti' quarry

The Rüti quarry development is located near Rotzloch quarry in the canton of Nidwalden and as at Rotzloch the new Rüti facility will be mining siliceous limestone. The stone is blasted in-situ and passed through a pre-crusher unit that reduces it in size to a maximum edge length of 350 mm. The material is then tipped into a vertical shaft for intermediate storage. The vertical shaft is filled to the top so that the material is not degraded by the impact. The shaft terminates in an 'installation chamber' where the stone is automatically diverted on to a belt conveyor that carries it through the Rüti tunnel, across the Rotzloch gorge and down the short Rotzloch tunnel before arriving at the new transfer station in the current Rotzloch quarry. A second belt conveyor then transports the product to the ballast works, where it is further processed into crushed stone and chippings.

The Shaftsinking and Drilling division was contacted about undertaking the vertical shaft project and was subsequently commissioned to carry out the work. The shaft was 130 m in depth by 3.0 m in diameter and was to be sunk using the raise-boring method.

Working sequence

After the tunnel undercut had been completed and the 'dirt box' chamber constructed, along with its concrete lining, the Wirth HG 250 raise-boring machine set to work.

The machine was set-up above ground on a pre-prepared drilling baseplate.

P. 32: Rotzloch – a construction site with an unbeatable view

Top: Drilling round the clock overnight too

Drilling accuracy was a critical factor – the pilot hole had to come out 'dead centre' in the chamber roof. In order to meet this tough requirement Thyssen Schachtbau GmbH opted to use a rotary-vertical drilling system (RVDS).
Because of the length of the steering tool a vertical section some 6 m in length first had to be drilled out using a stabilised drill set before the RVDS could start work.
With the RVDS fitted into the drill string the pilot hole was promptly drilled downwards to the 12¼" (311 mm) diameter needed for the subsequent raise-boring phase.
After breakthrough the pilot drill bit was removed and the raise-boring head set-up in the chamber. The widening operation then commenced with the drill string and its reaming head drilling upwards to take the hole out to its final diameter of 3.00 m.
After breaking through to the surface the raise-boring machine was removed from the hole and the reaming head dismantled.
An excellent working relationship was maintained with the client company Gasser Felstechnik AG for the entire duration of the contract. This enabled the project to progress swiftly and a drilling advance of 20 m a day was achieved during the hole widening phase. All work was completed within schedule.
The location of the drilling site some 630 m above sea-level, along with the existing infrastructure and very narrow mountain roads, posed a particular challenge for transport and supply operations and for the assembly and dismantling of the drilling machine.
Local support was always on hand to help solve any difficulties encountered, including mud loss during the drilling operation. When this problem arose the local farmers sprang to our assistance by arriving with their water-wagons, while the fire brigade helped out by supplying a pump. Where else could we have obtained so quickly the water that we desperately needed for drilling, 630 m up a remote hillside at the foot of the Alps.
But of course the marvellous view and the nearby Lake Vierwaldstätter helped make up for the tough demands imposed by this most unusual of drilling sites.

Schattenhalb 3 penstock consortium

Construction work on the CHF 31 million Schattenhalb 3 hydroelectric station began on 18.06.2008 and is expected to take

Top left: Raise-boring machine Robbins 73 with control console

Top and below: Pilot bore with drill mud and settling tank 1

two and a half years to complete. The contract to undertake the excavation work and build the penstock was awarded to the Schattenhalb consortium, comprising project partners Gasser Felstechnik AG, Frutiger AG and Montagen AG. The project also requires a 280 m inclined shaft to be raise-bored at an angle of 37° from the vertical, to give a height difference of about 218 m. The contract for this raise-bore-hole operation was awarded to the Swiss branch of Thyssen Schachtbau GmbH, who assigned as subcontractor the Swiss branch of the Italian-based company Edilmac.

Project execution

The pilot drilling commenced on 10.03.2009 and was completed by 23.03.2009. The local rock was mostly stable and exhibited a high uniaxial compressive strength of between 120 and 200 MPa with a slightly inclined stratification. Given the proposed position of the new inclined shaft the local rock beds were not expected to generate a high overburden pressure. The drilling equipment comprised a Robbins 73 machine from Atlas Copco.

The 283 m-long pilot hole, which was to have a 37° deviation from the vertical, was first drilled with a TCI roller cone bit to a diameter of 12¼″. The drill cuttings were flushed away using up to 1,200 l/min of clean water at a pressure of about 5 bar. A discharge channel was created on the bedplate in front of the drilling machine and the drilling mud with the drill cuttings was directed into the first of three settling tanks.

The drilling stack comprised the aforementioned roller cone bit, the roller stabiliser, the main stabilisers and drill rods 11¼″ and 10″ in diameter.

When planning the raise-boring operation the Schattenhalb penstock consortium decided for economic reasons not to use directional drilling technology. The work in the access drift leading to the bottom of the shaft was halted about 40 m before the planned drilling target point so that conventional drilling and firing could be used for the final few pulls in order to adjust the course of the drift to the line of the pilot hole. The borehole alignment and the coordinates at the bottom of the hole were first surveyed specifically for this purpose.

The pilot hole was reamed out to its final diameter of 3.05 m by a Sandvik raise-boring head working upwards from the underground installation chamber at the end of the access drift. The operation to widen the inclined shaft required less drilling mud than the pilot hole and only about 30 l/min was needed for flushing the debris and keeping the drill tool clean. The material excavated by the raise-boring head was removed from the shaft bottom by wheel-loader.

In spite of the technical problems, which included the failure of a drill-rod joint after 142 m of hole, the raise-boring head

arrived at the top of the shaft on 24.06.2009. The rock being drilled through to create the final shaft diameter of 3.05 m was found to be extremely stable, in line with the geological prognosis, and the completed raise-bore shaft presented an extremely clean rock profile with no overbreaks.
After completing the raise-bore shaft to a length of 258.50 m the boring head was anchored into place and secured and the Robbins 73 removed. The upper section of the shaft head was excavated using hydraulic rock hammer on a hydraulic excavator and the 12 t raise-boring head was lifted out of the shaft by mobile crane and loaded-up for transport off site.

In summing-up the success of the Schattenhalb 3 penstock shaft drilling operation, which was completed between 9 March and 29 June 2009, Thyssen Schachtbau GmbH would like to acknowledge the excellent support and cooperation provided by the client and subcontractors alike.

Looking ahead, the inclined shaft will subsequently be allocated a strata reinforcement category, according to the local geological situation, and will then be secured by rockbolts and shotcrete. This will be followed by the installation of a corrosion-proof DN 1000 compression steel pipe, an inspection ladderway and various cable ducts.

Raise-boring for the Taschinasbach hydroelectric station

When planning the pressure-compensating shaft, or surge chamber, for the Taschinas hydroelectric power station the client, Rätia Energie AG, chose the raise-boring method as the preferred option. In April 2009 the project consortium 'GrischaTaschinas' awarded Timdrilling the contract to undertake the raise-boring work.
The drilling site was about 1,000 m above sea-level on the slopes of the Plileisch disposal area north of the village of Seewis-Dorf in the Prättgau district Access was via a steep, narrow road with a number of hairpin bends that posed real problems when transporting equipment up to the site.

The disposal area was to be used for storing the material from the underground excavations (pressure shafts, surge chamber and so on).
The hillside location and the composition of the overlying rock immediately presented a challenge for the preparation and setting-up of the drilling site. The top 9 m of overburden comprised Quaternary loose rock material interspersed with cohesive clay.
In order to stabilise the overburden zone a circular bored pile wall was constructed down to the solid rock. The inside of this pile ring was also reinforced by cementation

Top: The drift reaches the pilot hole and the drill bit can now be swapped over for the cutterhead

Middle: The raise-boring head disappears from view as it heads for the installation chamber . . .

Below: . . . and sees daylight after work was done

Top: Drilling site for the surge chamber north of Seewis-Dorf, foundations and bored pile positions for strata consolidation

Below: Installation of the HG 160/2 drilling machine

The set-up area for the drilling machine comprised layers of compacted excavation material topped by a bedplate. This baseplate was specifically designed to be able to absorb both the tractive forces generated by the anchored raise-boring machine when drilling the pilot hole and the compressive forces produced during the main reaming operation. The concrete foundations were required not only to serve as an abutment for the drilling equipment but also to distribute the loading forces of the machine in such a way as to effectively prevent the latter from sinking in and tipping over.

Project execution

In order to construct the surge chamber a 48.8 m-deep vertical hole first had to be precision-drilled through to the roof of the underground installation chamber. By referring to local geological data Timdrilling was able to undertake this operation without resorting to a directional drilling system. When drilling the 12¼"-diameter pilot hole the drill string was reinforced with five stabilisers each 1.5 m in length. The homogeneous cementation of the bored piles also helped keep the drill string on line for the first 9 m of drilling.
The drilling mud, which consisted of clean water without any additives, was pump-circulated through a 30 m^3-capacity settling tank.
The pilot bore was completed in 1.5 working days.
The reaming head, a Sandvik CRH3 unit with a cutting diameter of 1.05 m, was then set up in the underground installation chamber and the hole was reamed out from bottom to top. This operation was also completed in 1.5 working days.

Looking back on the project it can now be said that the borehole was drilled with accuracy and precision, according to specifications, and to the complete satisfaction of the client. No unexpected geological conditions were encountered during drilling.
For the next phase of the project the client will be fitting the surge chamber with a DN 800 centred steel pipe, after which the annulus will be filled with a concrete suspension.

We should at this point like to express our thanks to the client for all the preparatory work and for providing back-up throughout the project.

Left: Rotary drilling head of the HG 160/2 with rod feeder

Right: Breakthrough for the pilot hole, reaming head fitted

Summary

The projects described above have helped enhance Thyssen Schachtbau's reputation in the Alpine region as a highly efficient and reliable raise-boring contractor.
Further contracts for mining and hydroelectric construction projects are currently at the tendering phase.

Thyssen Schachtbau GmbH are always on hand when it comes to delivering high-quality construction work.

Tilo Jautze
Joachim Gerbig

Drift entry leading to the installation chamber

Sinking equipment at the head of the bunker with pulley frame, kibble winch and fall protection

Planning and construction of a spiral-chute coal bunker for Ibbenbüren anthracite mine

Even though collieries are being closed down in the Saar, Rhine and Ruhr coalfields the German mining industry will continue to need new vertical coal transport and storage facilities.

Ibbenbüren mine, which is operated by RAG Anthrazit Ibbenbüren GmbH, is located in the most north-easterly corner of North Rhine-Westphalia. Along with collieries such as Prosper-Haniel and Auguste Victoria, Ibbenbüren is one of the production sites that according to the current coal policy planning is scheduled to remain in operation after 2012. These installations will therefore continue to require excavation work for new mine infrastructure.

In 2006 Thyssen Schachtbau GmbH was commissioned by Ruhrkohle AG (RAG) to undertake a pilot-hole sinking for a 60 m-deep coal bunker and then to install the permanent lining in the form of concrete-backfilled precast reinforced concrete sections. The work was to be carried out in collaboration with a team of RAG engineers. When completed the bunker would have a finished diameter of 9 m and a total capacity of some 3,800 m³. Because of the need to maintain the quality of the anthracite product it was decided that a spiral chute be incorporated into the ring of precast segments forming the lining so that the anthracite nuts could be delivered into the bunker with minimum degradation.

Profile of Ibbenbüren colliery, RAG Anthrazit Ibbenbüren GmbH

The underground workings at Ibbenbüren colliery are accessed by five surface shafts. The 1,545 m-deep North Shaft, which provides ventilation and serves as a manwinding and materials shaft, is one of the deepest in Europe.

Ibbenbüren produces about 1.7 mill. t of high-grade anthracite nuts a year. This product is an important source of supply for the heat market. In order to preserve the quality of the nuts and minimize the percentage of fines it is essential to reduce the freefall distance as the coal is being transported to transfer points and placed in intermediate storage. A spiral-chute bunker is one way in which the anthracite nuts can be held in interim storage without any deterioration in quality. The construction of a new central bunker close to the hoisting shaft was also needed to break the link between the coal winning process, which comprises two or three longwalls in constant operation, and the shaft winding cycle. The district bunkers were no longer able to meet this requirement.

Sinking work

Before the sinking work proper commenced teams from the colliery had already completed the upper and lower bunker roads and the pilot hole.

In order to prevent delays that might affect the transport and installation of the 900 or so concrete segments needed for the bunker lining a large number of precast sections had also

Ibbenbüren anthracite mine

been stored in the top road prior to the start of the sinking operation.

Sinking equipment

The sinking equipment for the excavation of the coal bunker essentially comprised a scaffold winch, a windlass and an emergency travel and supporting cable hoist. A conventional kibble was used for manriding and materials transport operations. A horizontal sliding stage was set up at the head of the bunker to serve as a kibble loading and discharge point.
In order to meet the particular requirements of the sinking project the pulley frame with its inspection platform had been specially designed to assist the sinking and bunker lining operation and to serve subsequently as a permanent fixture.
Before the sinking work commenced a circular runway system was also set up for the installation of the concrete segments. This could also be used, in a modified form, as a bunker cover and overhead protection screen during the sinking phase. Signalling was provided by an electrical system backed up by a mechanical knocker line. An in-shaft telephone was also available if required.
A slusher system, which transferred the material via a chain conveyor to the existing belt installation, was set up in the bottom road in order to clear the debris from the sinking operation. A safety tunnel was also excavated in the critical area of the pilot hole in order to provide a continuous ventilation route and permit inspection of the bunker bottom section. A baffle screen was erected to contain the impact of the slusher operations in the rear part of the bunker bottom road.

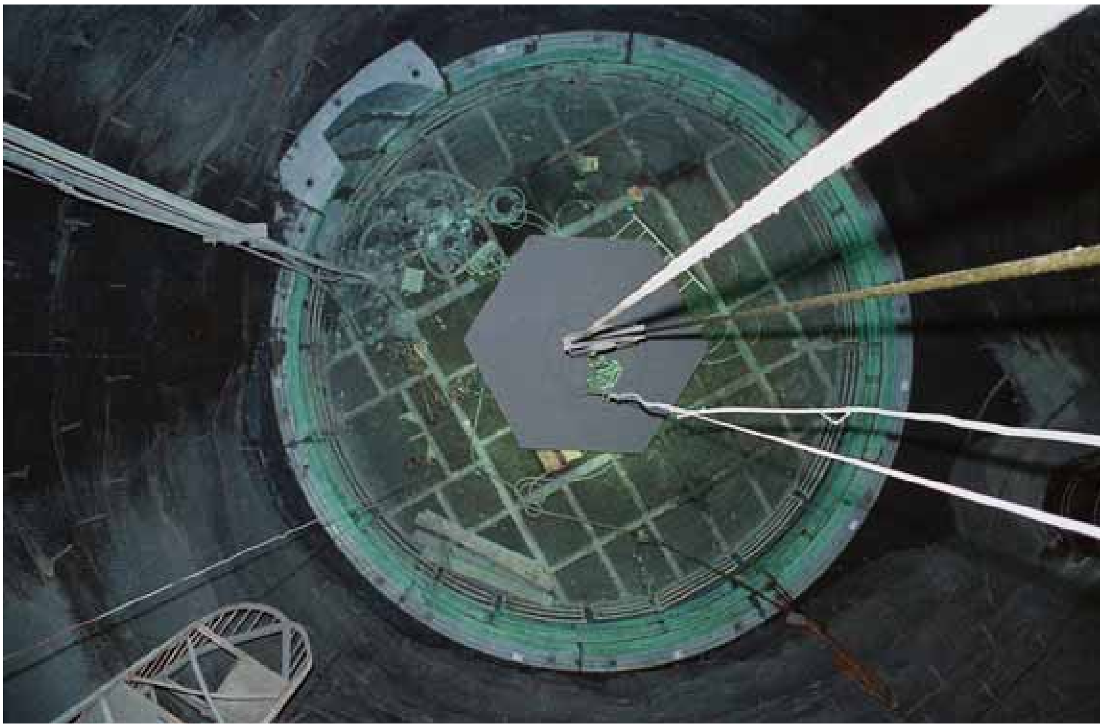
Sinking equipment with borehole fence and slusher system

Top: Sinking operation with borehole fence, slusher system and transport kibble

Below: View to the working area during installation of the concrete segments

Foreshaft

After a 3 m-deep section had been excavated for the foreshaft industrial formwork was set up for the construction of the bunker collar, 8 t of reinforcing bars were laid out and finally some 200 m³ of structural concrete was poured into place. The concrete was dry-pumped to an on-site concrete bin via the colliery's own pneumatic transport system. After mixing it was delivered to the placement point by means of a concrete pump and feed line.



Rebars and formwork of the bunker discharge system

The discharge system is constructed as a steel-concrete arch framework that can effectively transfer any forces generated into the surrounding strata.

Sinking operation

The actual sinking work was undertaken by conventional drilling and blasting, the blasting holes being bored using handheld drills and drill feeds. Blasting was carried out using W I safety explosive (of type 'Permit B') and electric low-sensitivity millisecond detonators in delay stages 1 to 18. About 220 blastholes were drilled and some 250 kg of safety explosive consumed per pull. After firing each round the debris was transferred from the sinking floor into the pilot hole by means of a slusher system operating from the borehole fence.

The local strata mostly consisted of firm sandstone with two thin beds of coal. The sinking was at times also affected by water inflows of as much as 180 l/min. The excavated sandstone beds did not exhibit any signs of convergence, though were prone to sudden eruption and collapse due to the high levels of stress present in the rock. The rock face was therefore systematically secured with rockbolts and steel mesh.

After the excavation broke through into the bunker bottom road the crown section of the standing supports in this area was opened up and a square steel frame set up to support the two bunker discharge hoppers. Concrete formwork, 20 t of reinforcement and the suspension gear for the coal discharge system were then put in place before pouring the 400 m³ of concrete required. The bunker outlet consisted of two openings each 1,600 mm in width by 2,800 mm in length.

Lining

After the sinking work had been completed and the bunker discharge system built a single-strut mobile working stage was set up for the installation of the precast concrete segments with their concrete backfilling.

The precast segments were installed in a circular sequence working upwards from the bottom, with the first ring resting on the bunker outlet. Each completed ring comprised nine ring segments and two spiral chute profiles. The ring segments, and therefore each complete lining ring, including the horizontal joint, are 840 mm in height. Each ring also includes two 420 mm-high spiral chute profiles set one on top of the other.

In order to construct the lining the precast segments were first attached to the hoisting system at the top of the bunker and then lowered to the working level where they were collected by the circular runway system at a point 1 m above the working stage. The circular track system could then be used to manoeuvre the precast segments horizontally to their placement point. Each segment was set in a bed of grout and aligned for position and height. The butt joints with the adjacent segments were then sealed with grout.

The dimensional accuracy of the lining column was controlled by means of six shaft lasers positioned around the circumference of the bunker along with two plumb lines. Once the bottom ring of precast concrete segments had been constructed in this manner the team was able to move on to the next ring above.

After each group of three lining rings had been completed the annular space between the lining and the strata was backfilled with concrete, which was also delivered via the colliery's materials transport system and concrete feed line.

In this way the bunker was lined up to the collar level. The chute intake above this point was built out of solid structural steelwork.

After the lining had been completed special ceramic tiles were applied to the surface of the spiral chute to create an anti-wear surface.
The sinking and lining work ended with the dismantling of the sinking equipment and the installation of the permanent mechanical systems and special structures.
The permanent bunker equipment essentially comprised two offtake conveyors in the bunker bottom road and, at the top of the installation, the bunker cover and bunker inspection system, consisting of a scaffold winch, pulley frame and square-section inspection platform with extensible arms.

Spiral chute

The planning and design of the spiral chute called for a preliminary study to be carried out in collaboration with RAG to define the relevant requirements and constraints for the permanent bunker operations. Thyssen Schachtbau GmbH then used simulation tools, supported by computer assisted calculation processes, to determine the gradient and geometry of the chute, which was followed by the planning of the construction phase. The entire bunker lining was reproduced as a 3D model in a CAD program and then further developed and refined.

View into the final spiral-chute bunker

Summary

In spite of the decline in German coal production collieries will still require vertical excavation work to be carried out below ground. It is therefore important to have available the technical know-how required for the planning and construction of this type of mine infrastructure.
The special construction methods used in the coal industry, which often differ fundamentally from the procedures employed in the iron ore and potash mining sectors, therefore need to be preserved and maintained. The experience acquired over many years of shaft sinking and bunker construction work proves invaluable when engineers are called on to undertake challenging projects and deal with technically demanding situations.
Thyssen Schachtbau GmbH will continue to provide contractor services to its customers for shaft and bunker construction work and for special infrastructure projects for the deep mining industry.

Veit Passmann
Tim van Heyden
Axel Weißenborn

[1] RAG Anthrazit Ibbenbüren GmbH; http://www.dsk-anthrazit-ibbenbueren.de; 2002

Transport of a concrete segment with the circular runway system

Positioning and installation of a spiral-chute concrete segment

The last stone is in position

The high-wear-resistent coating of the spiral-chute

Underground storage tunnel

Konrad iron-ore mine to become a permanent repository for nuclear waste

Mining specialists Thyssen Schachtbau GmbH and Deilmann-Haniel Shaft Sinking GmbH, working in a joint venture partnership, have been commissioned by the Peine-based DBE (German Service Company for the Construction and Operation of Waste Repositories) to retrofit the Konrad 1 shaft at the former Konrad iron-ore mine in order to prepare it for its future role as a manwinding and materials transport shaft.

In accordance with the nuclear planning assessment procedure, and in line with Government policy, it has been decided that the former Konrad iron-ore mine is to be converted into a permanent repository for low to medium-level radioactive waste. This work is to be carried out from 2009 to 2014.

According to the Atomic Energy Act of the German Republic, as represented by the Salzgitter-based BfS (Federal Office for Radiation Protection), the DBE is responsible for the nationwide planning and construction of permanent disposal facilities for radioactive waste.

Konrad mine

The Konrad iron-ore deposits were developed with the sinking of the two Konrad I and II shafts during the years 1957 to 1962. Ore winning commenced in 1965 and was then halted in 1976 for economic reasons. More than 6.7 million t of iron ore – representing just 0.5 % of the total in-situ deposits – were extracted from Konrad mine during this period.

After ore mining had ceased the Radiation Research Company (GSF) was commissioned by the Federal Authorities to carry out a scientific exploration and investigation programme to determine Konrad mine's suitability as a final repository for radioactive waste. When selecting sites to serve as permanent nuclear waste repositories preference is generally given to geological formations carrying little or no water. These requirements are met, for example, by salt and clay beds. The former Konrad iron-ore mine with its thick, water-impermeable beds of clay above the ore horizon therefore presented the ideal conditions.

Right: Konrad shaft 2 headframe

Outside: Konrad shaft 1 facility

On the basis of the survey findings, on 31 August 1982, the Government instigated the nuclear planning assessment procedure in accordance with §96 of the Atomic Energy Act. This process was to be implemented by the PTB (the then Federal Institute of Physics and Metrology) in liaison with the Federal State Authority of Lower Saxony. The draft of the relevant planning assessment decision was prepared during the period 1993 to 1998 under the supervision of the licensing body, in this case the Environment Ministry of Lower Saxony (NMU).

Planning assessment procedure

On 22 May 2002, at the end of a process that had lasted almost twenty years, the planning assessment decision was finally granted for the Konrad mine to be converted and operated as a permanent repository for nuclear waste. This legally binding and non-appealable planning decision has been in effect since 26 March 2007 and on the basis of its legal validity the Federal Government has decided to take the necessary steps to prepare Konrad mine as a final repository for radioactive waste. That same year the BfS (Federal Office for Radiation Protection) commissioned the DBE to undertake all work necessary to prepare and retrofit the mine as a permanent waste repository.

Retrofitting the Konrad shafts

Converting the former iron-ore mine required extensive structural measures to be carried out in Konrad I shaft and at the shaft insets. Following a call for bids the contract to renovate Konrad I shaft and fit-out the shaft insets, in order to provide a manwinding and materials transport route for the permanent waste repository, was finally awarded on 24.04.2009 to the winning consortium comprising Thyssen Schachtbau GmbH and Deilmann-Haniel Shaft Sinking GmbH. The first stage of the procedure involved drawing up planning approval documents and contractor's documentation for the various items of plant and equipment, along with the planning control documents required for the execution of the construction work. The contract also included the planning, delivery and erection of the site facilities and all equipment needed for carrying out the work, such as temporary winding gear.

The actual shaft work included the removal of the old guide fittings, various power and signaling cables and pipework. The shaft lining was also renovated, which essentially meant cleaning and re-pointing the brickwork. The contract further required various other operations to be carried out, including the fitting of new shaft guides and pipes and the installation of a new bottom frame, sump fittings, safety platform and set of fire doors. Finally, all equipment and fittings no longer required are to be dismantled and removed from the site.

According to the proposed sequence of operations the work is due to be completed on schedule in 2013.

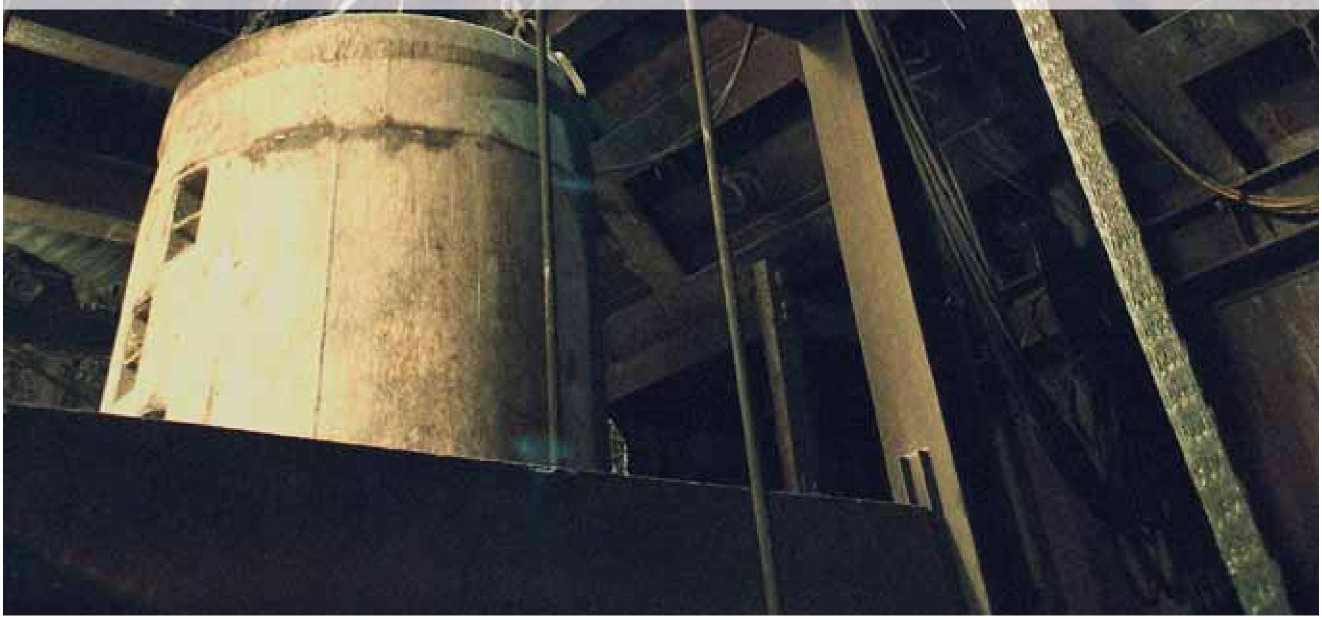
Dr. Helmut Otto
Natascha Groll
Christian Bremer

References

[1] German Service Company for the Construction and Operation of Waste Repositories (DBE); http://www.dbe.de/de/betriebe/konrad/2/index.php Februar 2009

[2] Bundesanzeiger (Federal Gazette) 19.07.2008 and 27.02.2009: 'Public works and mining facilities'

Deepening no. 10 shaft at Prosper-Haniel colliery



P.44: Looking from the inset of the undercut into the sinking tower with its tipper and rope pulley platform“

Right: Looking into the shaft with kibble and concrete lining

The decision to extend the much-used materials and manwinding shaft no. 10 at RAG's Prosper-Haniel colliery posed a particular challenge to the sinking team, especially as there was to be no interruption to the normal winding operations. The deeper shaft will play a crucial role in developing new panels containing some 120 mill. t of high-quality steam coal.

Prosper-Haniel colliery in Bottrop produces about 3.8 mill. t of steam coal a year. No. 10 downcast shaft, which is located in the Kirchhellen district of the town, has been in service since 1981 and is Prosper-Haniel's most important man-winding and materials shaft. Given the important role that the shaft plays as part of the mine's infrastructure it was vital to maintain uninterrupted winding operations during the sinking phase and to ensure that the sinking work went 'unnoticed', as it were, as far as the other colliery activities were concerned.

The aim of the shaft deepening project was to access the coal seams lying below mine level 6. This operation, which involved 300 m of sinking as part of the programme to develop the new mine level 7, was undertaken by the 'no. 10 shaft deepening consortium' ('ARGE TT' for short), comprising Thyssen Schachtbau GmbH as technical leader and Deilmann-Haniel GmbH as commercial manager.

Project phases for the deepening of Prosper V/10 shaft:

- Excavation of the shaft bottom road
- Installation of the safety platform
- Penetration of the barren pillar and excavation of cavity space for the sinking equipment in the shaft bottom road
- Assembly of the sinking equipment and installation of an API materials supply pipe
- Sinking of the foreshaft and main shaft with shaft inset points
- Installation of shaft guide fittings
- Dismantling of the safety platform and connecting in to the existing winding system.

Sinking with full face

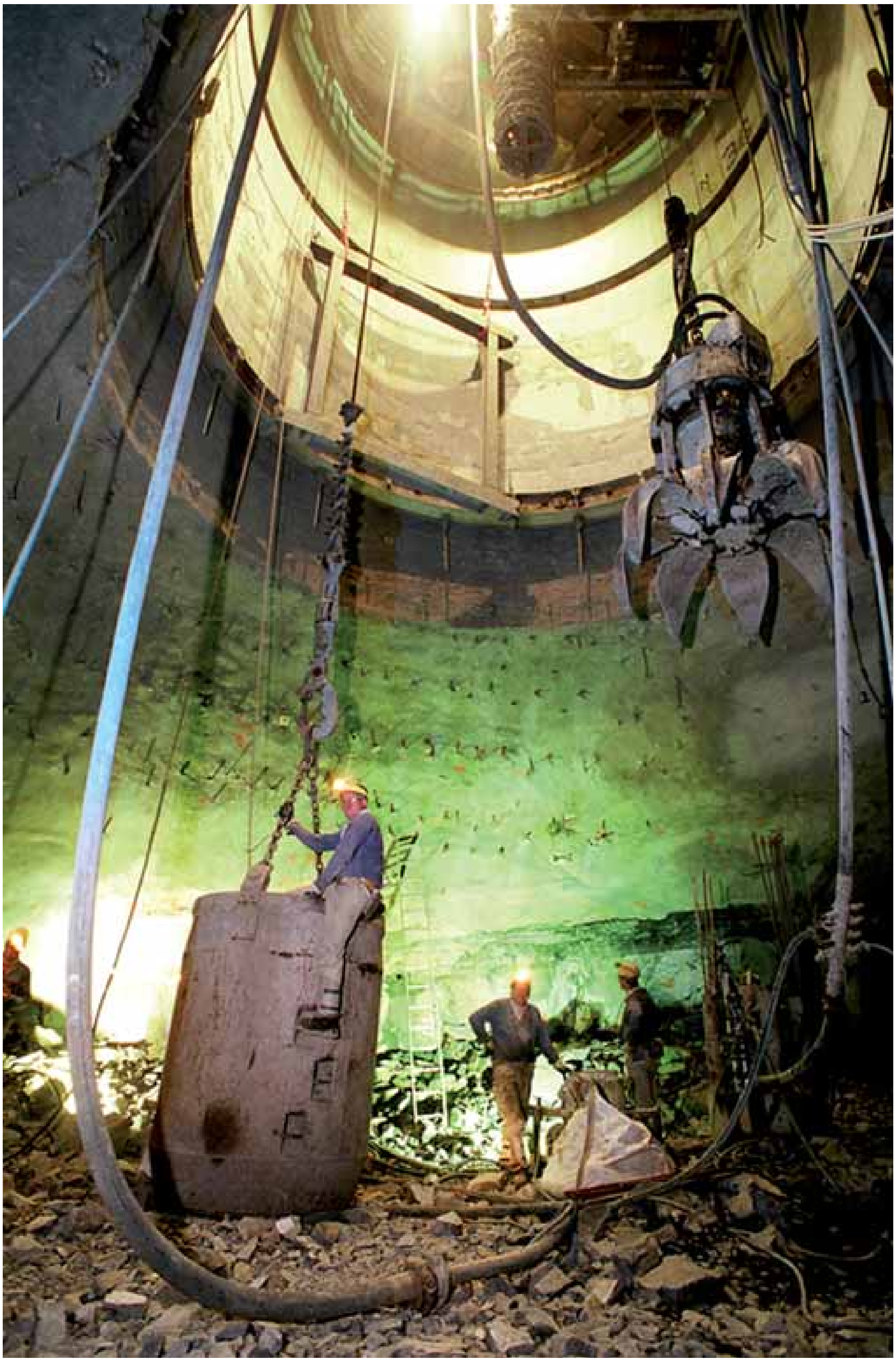
Arge TT used the shaft idle periods to install a shaft safety platform in the shaft sump below the timber deck. Before the sinking operation began a shaft bottom road was also driven some 60 m beneath level 6 in order to create the cavity space needed to accommodate the future sinking equipment. These measures meant that the sinking operation in no. 10 shaft could be kept relatively detached from the colliery's ongoing winding operations. As the existing shaft sump was not deep enough to accommodate either the shaft safety platform or the future rope pulley frame the sump cavity was undercut a sufficient distance below.

Excavation work began in early 2004 with teams working beneath the protection of the shaft safety platform. This involved drilling and blasting through the remaining pillar using a pilot hole. A grab system was used for loading and debris clearance in the pilot shaft. The permanent pulley frame had already been set up in the former pillar zone specifically for this purpose and the grab operating deck of the sinking platform was then temporarily relocated in turn.

A tilting frame with a hydraulically operated chute was temporarily set up on the shaft collar. This system delivered the sinking debris on to a transverse chain scraper conveyor. A downstream conveyor system with a crusher unit then transferred the material to large-capacity mine cars for transport to the tipping site.

While the sinking equipment was gradually being set up in the machine chamber the sinking work was able to progress in the foreshaft. After about 20 m of shaft excavation the sinking performance was then improved by the introduction of what was initially a single-compartment double drum winding system, as a 3 m³ kibble could then be loaded directly on the sinking floor. The grab operating cycles were now a thing of the past and when the excavation reached a foreshaft depth of 50 m the full sinking installation was able to come into operation. A four-deck travelling scaffold system operating with two platform winches and fitted with concreting equipment and grab apparatus was installed in the foreshaft. In its final form the sinking installation also included a twin-drum winding system along with an emergency travel and shot-firing-cable winch. A tipping frame with two extensible chutes was set up on the shaft cover, while a laser platform was mounted below the inset.

The rest of the sinking operation from mine level 7 to the Zollverein inset and the deepest-point at 1,328 m proved to be relatively straightforward. The circular-track grab system that had been used in the foreshaft sinking, together with a



Overhead view of mine level 7 with temporary supports and entry to shaft

Shaft data:

Internal diameter:
8.0 m

Depth of extension:
303 m
from shaft station:
1,025 m
to shaft station:
1,328 m

Depth of foreshaft:
50 m

Concrete inner lining:
0.30 m

Depth of mine level 7:
1,230 m

Depth of shaft landing:
1,319 m

Support lining for the shaft inset on mine level 7 with systematic rockbolts, triple-flange rails and steel-fibre shotcrete

pneumatic shaft boring machine equipped with three drill feeds, were both deployed for this phase of the operation, which achieved pulls of as much as 4.50 m in length. Each round of shots required in the region of 150 blastholes. Class 1 permitted explosive was used at a blasting density of around 1.5 kg/m³. The strata support system, which consisted of systematic rockbolting with a layer of shotcrete, was installed directly from the sinking floor. The final concrete lining of 8.0 m in diameter then followed behind at a distance of 25 m from the sinking floor and was poured into place from the suspended platform using a formwork system. Each section of concrete was poured to a height of 4.30 m and a minimum thickness of 0.30 m. The C 20/25-strength concrete was delivered to the colliery by ready-mix truck and was then gravity fed to the sinking platform via a dedicated concrete downpipe before being placed behind the formwork by means of a concrete distribution hose.

The shaft support system was designed on the basis of a support survey carried out by Deutsche Montan Technologie (DMT) that established strata subdivisions from the geology of the carboniferous strata identified during preliminary exploration work and then produced specific rock categories on the basis of strata pressure levels. The resulting recommendation proposed a twin-shell construction consisting of systematic rockbolting and a concrete inner lining that for geomechanical reasons was to be installed 25 m above the sinking floor.

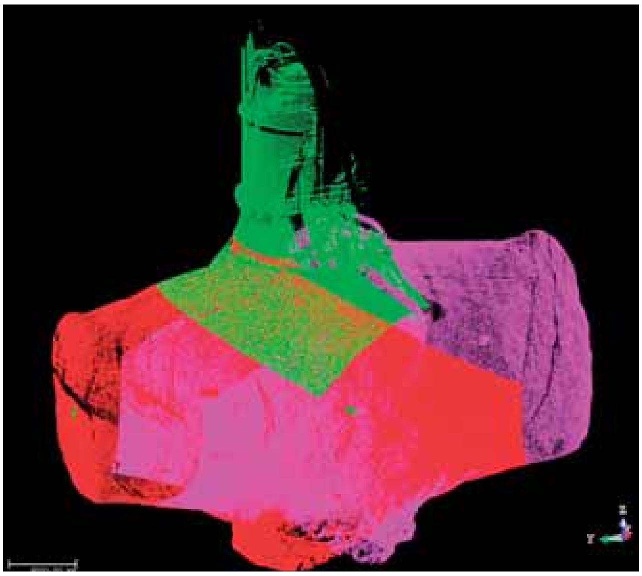
Composite rockbolt and steel-fibre shotcrete support system at 1,230 m depth

In January 2006 the excavation work reached the roof of the shaft inset on the new mine level 7. Owing to the inset development work required at this point all sinking work then had to be interrupted for 10 months. It was decided that the landing on level 7 would be excavated on three sublevels using a crown heading system. This would avoid the need for large excavation cross-sections and at the same time benefit the long-term stability of the structure. Starting from the centre of the drivage this first involved the drilling and firing of 5.5 m-wide chambers with a pull length of 2.4 m. This cavity was supported at the roof by immediate-bearing dry shotcrete in combination with M 27 x 3000 rockbolts. The excavation was then extended outwards working one pull behind, while a further pull back the excavation was taken to the height of the first sublevel. Space availability at this point meant that the permanent M 33 x 5000 systematic rockbolts could now be installed, with the result that any break-up in the surrounding rock could be kept to a minimum. Sublevels two and three could then be driven to the full width of the inset using maximum pulls of 2.4 m. These were subsequently shotcreted and immediately supported with 5.0 m of systematic rockbolting. The debris was loaded out using a slusher operating in conjunction with the kibble. In the porch area the inset dimensions were 17.0 m in height by 14.5 m in width, with the excavation extending for a distance of 15.0 m in both directions.

The inner support consisted of a steel-fibre shotcrete lining up to 0.6 m in thickness. This was applied in three layers, each about 0.2 m thick, using a shotcrete manipulator. The entire support lining on level 7 required more than 1,600 fully-grouted M 33 x 5000 rockbolts and 1,300 m³ of grade C 30/37 steel-fibre shotcrete.

A second inset with a maximum excavated cross-section of 50.0 m² was created on one side of the shaft 9.0 m above the sump at a depth of 1,319 m. Because of the restricted space available in this area the support system was constructed from systematic rockbolts in conjunction with backfilled arches.

Shaft inset on mine level 7, steel-fibre shotcrete lining with systematic rockbolting



Laser scan taken of the inset on mine level 7

The design and planning of the inset geometry, and the on-site geomechanical supervision, was undertaken in close collaboration between the client and DMT. In order to ensure optimum use of materials technology the entire project, and especially the inset excavation work, was monitored and supported by specialists from DMT and personnel from the RAG department for technology and logistics services.

Shaft fittings

Work on the installation of the shaft guides and fittings commenced in May 2007 after the sinking operation had been completed. The sinking platform was run up the shaft so that all the holes required for the fixing brackets in the concrete lining could be drilled using a special template. The horizontal shaft fittings were then fitted with precision on the subsequent down run. The rigid guides and shaft pipes, along with the shaft inset framework for mine level 7, were installed on the final ascent. The shaft guide clamps for the 'middle' manwinding system and main manwinding system, and the fixtures for the inspection platforms, were for the most part anchored in the joints between the concrete segments. The setting-up work carried out in the new section of shaft also comprised modifications to the platform installation, which included adding a further two suspended decks.

Before work could commence on joining up the two winding systems in the old and new sections of shaft beneath mine level 6 all the sinking equipment in the shaft first had to be dismantled. Two hoist-operated scaffolds were installed beneath the safety platform so that the latter could be dismantled and the various shaft guides fixed into place. All work required after this time could only be undertaken when the shaft was closed off. In order not to disrupt the normal colliery routine these operations were carried out exclusively on Sundays and holidays.

Salvage work on the shaft safety platform commenced at Easter 2008 with the lowering of the 6 m-thick ash bed into the shaft bottom road and the removal of the ventilation cribs. By Whitsun holiday the entire safety platform together with the enclosed tier of beams, the main support structure and the bracing frame had all been dismantled. The remaining guide brackets and buntons for the 'middle' and main manwinding systems were installed in stages as the safety platform was removed. During Whitsun 2008 the guide fittings for the 'middle' manwinding system, which had previously terminated beneath the former shaft platform, were connected up and the preparations completed for extending the main winding system to level 7, this work being scheduled for the end of the year. The working scaffold in the 'middle' manwinding compartment was then dismantled and removed, while the hoist-operated working platform in the main manwinding compartment was parked in place beneath the anchor timber mounting on level 6.

Work to connect up the guide fittings for the main cage and counterweight began on 20.12.2008 with the relocation of the working scaffold to a carrier frame on level 6. The anchor timber mounting, guide clamps and arrestor wedges were then all dismantled in succession and removed from the shaft via the bottom road. All remaining brackets and buntons could then be fitted into place.

Once the four rows of guides for the main winding system had been installed the shaft was handed over to the colliery on midday 24.12.2008 so that work could continue on extending the winding installation down to mine level 7.

Concluding remarks

The entire project was marked by co-ordination and cooperation of the highest level between the client, the relevant authorities, consultants, specialists and engineers from the two 'no. 10 shaft consortium' companies. This factor was to play a key role in the operation, which saw the main winding system in no. 10 shaft successfully extended to mine level 7 at the turn of the year 2008/2009.

Hubertus Kahl
Peter Runkler

The Gorleben exploratory mine

Shafts – underground infrastructure – freeze-hole sealing

The DBE (German Company for the Construction and Operation of Waste Repositories), acting as a third party in accordance with § 9a, paragraph 3, of the Atomic Energy Act of the Federal Republic of Germany, as represented by the Federal Office for Radiation Protection (BfS) in Salzgitter, has been entrusted with the planning, construction and operation of facilities intended for the final storage of radioactive waste. Since 1979 the DBE has been engaged in a geoscientific exploration programme aimed at investigating the Gorleben saltstock with a view to determining its suitability as a final repository for radioactive waste of all kinds.

After an intensive period of surface exploration work the underground exploration phase commenced with two shafts – Gorleben 1 and Gorleben 2 – which were sunk some 400 m apart during the periods 1986 to 1997 and 1989 to 1995 respectively. This was followed by the excavation of underground roadways.

As a consequence of the consensus reached in June 2000 between the Federal Government and the energy supply industry it was agreed that the Gorleben facility should be put on hold (i.e. all exploration work suspended) for a period of not less than three and not more than ten years. This agreement is set to expire on 30.09.2010.

Having been involved in both shaft sinkings, the excavation of the underground infrastructure, the first underground exploration zone and the long-term freeze-hole seals, which were completed in October 2008, it is Thyssen Schachtbau's intention – in the event of a call for bids – to tender as a major contractor for the remainder of the underground exploration work.

Sinking of Gorleben 1 and Gorleben 2 shafts

The freeze technique with deep refrigeration was used when sinking, supporting and lining the shafts in the unstable, water-bearing section of overburden and capping rock. Based on results obtained from prospect wells a freeze depth of

268 m was established for shaft no. 1 and 264 m for shaft no. 2. Preliminary exploration data were used to determine the construction concept for Gorleben 1 and Gorleben 2, which was laid down as follows:

- shaft inner diameter = 7.5 m
- shaft excavated diameter greater than 10 m in some areas
- floating, watertight steel-concrete shaft lining with an asphalt joint extending to as much as 90 m beneath the salt dome.

Shaft sinking

The freeze-holes and temperature measurement holes were completed during 1984 and 1985, after a series of pilot holes had been successfully drilled and the findings geoscientifically analysed as preparation for the main sinking phase. Most of these holes were executed using conventional drill bits, though core drilling was also employed in areas where additional exploration data were needed.

After the pre-shaft had been completed and the sinking equipment assembled the sinking work was able to commence under the protection of the solid ice wall. Sinking in Gorleben 1 commenced on 11.09.1986 and in Gorleben 2 on 08.05.1989.

The sinking work was accompanied by the installation of a shaft support column consisting for the most part of block walling with a limited yielding capacity. Because of the geological conditions in shaft no. 1 a rigid outer lining of bolted steel-section ring segments was used between the 216 m and 260 m levels. Rigid steel-profile ring supports were also used in shaft no. 2 between the 46 m and 131 m levels and the 172 m and 258 m levels. The steel rings were installed working downwards ring by ring as the sinking advanced and were then backfilled with grout to achieve a frictional connection with the strata.

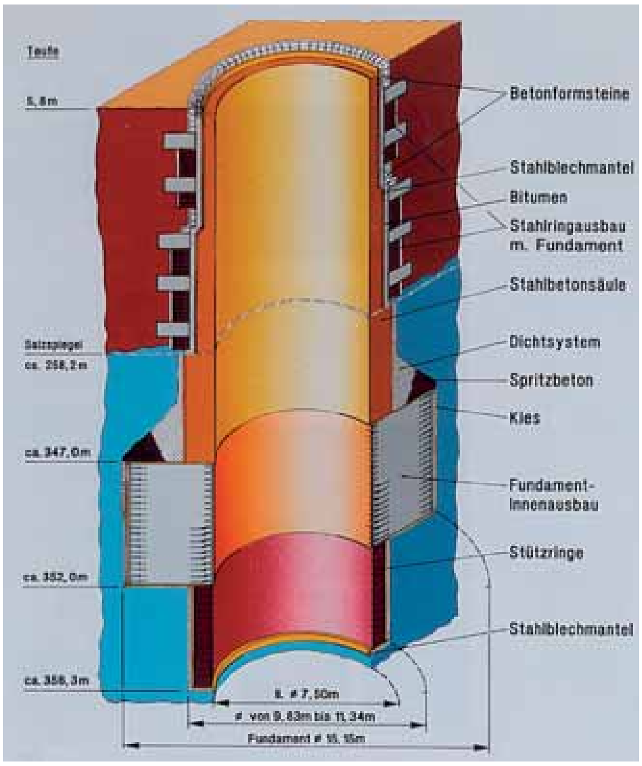
Inset for the exploration level, excavated by drilling and firing, profiling with cutting head

In the unstable overburden zone both shafts were fitted with a final lining consisting of a steel-concrete cylinder enclosed in a fully-welded steel plate casing. An asphalt joint was used to separate the inner support system from the outer.

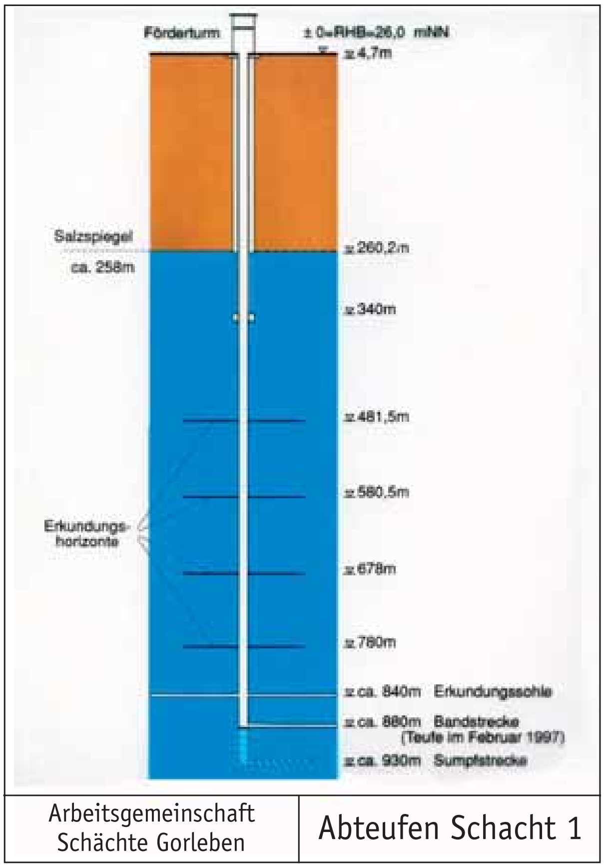
The inner support column was installed to a depth some 90 m below the top of salt dome in the stable salt strata. No further support system or shaft lining was required in the salt

Left: Developing the freeze cellar, 1984

Right: Paurat Helix shaft miner



Top: Schematic diagram of the inner support system in the freeze zone



Right: Schematic diagram of shaft no. 1

rock until the shaft final depth was reached. Sinking was carried out by conventional drilling and firing. A specially developed shaft miner – the Paurat Helix – was successfully used in certain areas of the cap rock.

Shaft no. 1 reached its final depth of 933 m on 10.11.1997. An exploration horizon was started at a depth of 840 m and a conveyor road inset was constructed at the 880 m level.

The shaft bottom road, which runs from the 840 m level to the deepest part of the shaft at the 933 m level, is suitable for large vehicles.

Shaft no. 2 reached its final depth of 840 m on 18.11.1995. Two mine horizons were also constructed from the shaft line; a return-air level was set out at the 820 m point and an exploration horizon at the 840 m level.

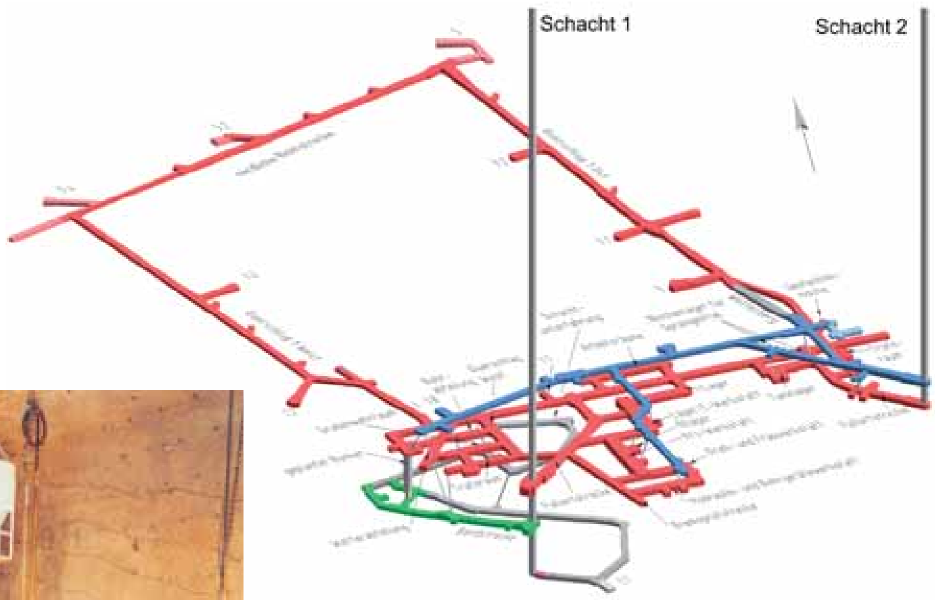
Mine infrastructure and exploration zones

The second project phase, which comprised underground exploration and the excavation of roadways and cavities for the mine infrastructure and reconnaissance zones, commenced in shaft no. 1 on 04.10.1995 with the construction of insets on the 840 m level. Similar work started in shaft no. 2 on 18.11.1995. These insets were then used to create a connection between the two shafts via the main drift. The two connecting drivages joined up on 21.10.1996.

The excavation programme also included the construction of mine infrastructure facilities, including workshops, working areas and storage chambers. Excavation work on the crosscuts '1 west' and '1 east' and the northern lateral road marked the beginning of the envelopment of the Stassfurt salt series in exploration zone 1, which has been designated for the long-term storage of heat-generating nuclear waste.

Long-term sealing of the freeze holes

The long-term security requirements imposed on final repository mines of this kind included the stipulation that all freeze pipes at both shaft sites should be removed and the holes themselves filled with a suitable material to act as a long-term seal. Completely filling the freeze holes would permanently prohibit any exchange of solution between the overburden strata and the salt dome. A total of 43 respectively 45 freeze holes and four temperature measurement holes had to be treated at each shaft site. This operation was successfully completed in October 2008 by personnel from the Thyssen Schachtbau drilling section.



Proposed and partly surveyed exploration zone

System for sinking the shaft cellar

Update on the Gorleben exploration programme

There is general international consensus that the use of deep geological deposits for the permanent storage of high-level radioactive waste (HAW) in specially prepared mine workings is technically safe and feasible and constitutes the best option.
Because of its properties, and the existing body of knowledge in this area, mineral salt is particularly well suited to serve as a host medium for the permanent disposal of HAW material.
The results obtained to date from the first exploration zone confirm the area's potential suitability as a high-level waste repository. Gorleben is the most thoroughly explored potential HAW storage facility in the world. However, a final decision on the suitability of the Gorleben site will only be possible once surveys have been completed in all those parts of the salt dome that are to be used for storage purposes. This is expected to take another five years or so.
Following the declaration of a moratorium the main exploration work was discontinued on 01.10.2000.

Continuation of survey work in the Gorleben salt dome

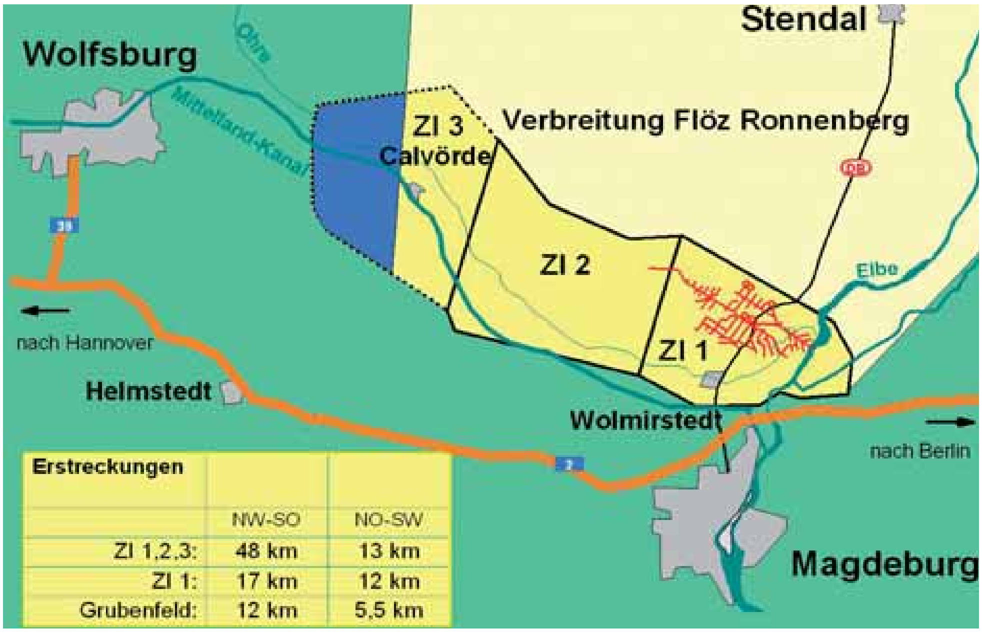
A continuation of the exploration programme in the Gorleben salt dome will essentially consist of the following excavation phases:

- completion of the first survey section and development of further exploration zones to the east by a system of crosscuts and lateral roads
- continuation of the geological-geophysical and geotechnical surveys in the central part of the salt structure and the deeper penetration of these measures beginning from the exploration horizon on the 840 m level.

Thyssen Schachtbau GmbH intends to respond to the call for bids if work is to be resumed when the moratorium reaches its maximum expiry date on 30.09.2010. The experience acquired in the course of operations undertaken between 1984 and 2000, some of which were continued right up until 2009, constitutes a sound premise for success.

Dr. Helmut Otto
Erhard Berger
Peter Nowack

[1] Permanent storage of high-level radioactive waste in Germany – the Gorleben final repository project. Published by BMWi, Berlin, Oct. 2008, pp. 10, 13, 27 and 39



Zielitz potash mine: location map, transport connections and production areas

Targeted exploration of potash deposits meets the highest safety standards

The Shaftsinking and Drilling division had an opportunity to demonstrate its expertise at the K+S KALI GmbH owned Zielitz and Sigmundshall potash mines, where both horizontal and vertical drilling operations were carried out as part of a preventer-assisted exploration drilling project. After the recent boom in the raw materials sector, and especially in the potash production industry, the client lost no time in using the breathing space to explore new areas of deposits and so to be prepared for the next upturn in business.

Safety aspects in exploration drilling

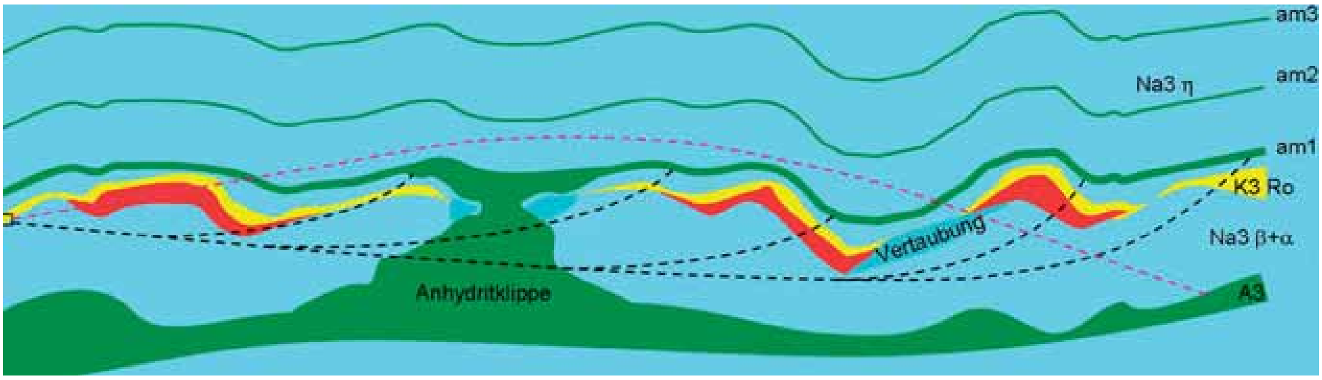
Extensive measures are put in place to protect the drilling team and mine infrastructure from sudden blowouts of gas and fluid during exploration drilling work. The basic technique is to install a standpipe of at least 5 m in length, which forms the connection between the strata and the safety fitting, i.e. the blowout preventer. The safety system comprises the safety valve, the tee connection, the ram preventer and the sealing device. The annular preventer is not part of the safety system.

These various elements perform the following functions: the safety valve is used to seal the hole in order to prevent the ejection of fluids and/or gases, this first requiring the drill-rod to be withdrawn from the hole. The downstream tee connection operates in conjunction with the safety valve to feed the required amount of drill mud into the annulus, while in an emergency it is used to add a suitable densifier, monitor the pressure level and allow fluids to be drained off in controlled doses. In the event of an emergency arising the ram preventer is able to close off the annulus with the drillstring still in the hole. If the drillstring is outside the preventer the open hole can be closed over by means of the sealing device. The annular preventer seals the annulus between the drillstring and the open sealing device while the drilling system is in operation. After the installation of the standpipe and the fitting of the safety devices the system is to all intents and purposes sealed by the injection of the drill mud, whether the drillstring is in place or not. To this effect it is necessary to apply 1.5 times the calculated hydrostatic pressure as a test pressure, as governed by the depth reached at the drilling site.

The relevant personnel are required to attend special training sessions (courses include 'Principles of well control') at the Celle Drilling School in order that the installed safety equipment can be deployed properly and rapidly should an emergency arise.

Exploration drilling programme at K+S KALI's Zielitz potash mine

The Zielitz potash mine is one of six sites in Germany where K+S KALI GmbH extracts potassium and magnesium salts. These are used as feedstock for a large range of potash,



Schematic diagram of borehole curvature

magnesium and sulphur fertilisers and are also processed into products for technical, commercial and pharmaceutical applications. Zielitz started production in 1973 as the most recent addition to the K+S KALI group. The mine employs a workforce of some 1,700, making it one of the largest employers in Saxony-Anhalt.

For 25 years potash mining at this site has focused exclusively on the Zielitz 1 deposits. A roadway system is underway getting established since 1998 to get access to the mining concession Zielitz 2.

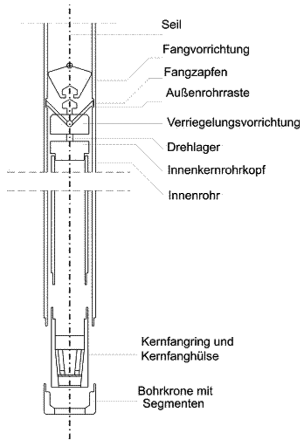
Military activities on the Colbitz-Letzlinger heath have prevented this area of about 36 km² from being surveyed by surface exploration drilling and geophysical measurements. All tunnel developments completed to date have been undertaken on the basis of and under the cover of underground exploration work.

In order to fill this gap in the exploration map and provide back-up for its own survey activities K+S KALI GmbH commissioned Thyssen Schachtbau GmbH in early 2007 to carry out horizontal exploratory drillings in the Zielitz 2 area of the mining concession. Starting out from a number of drilling chambers the team drilled a series of horizontal holes in two to four directions and with a maximum length of 2,500 m. The aim was to identify the location of the Ronnenberg potash seam (K3RO) at predetermined intervals by using a drilling programme comprising undulating holes and deviated holes.

As the survey zone is located in an area of deposits that is prone to salt migration it was also necessary to explore the adjacent salt horizons in the roof and floor (barrier layer identification). The interim results from some 17,200 m of drilling were collated in October 2008 and yielded 28 seam exposures and 26 barrier layer verifications.

The exploration programme is being carried out using a universal drilling machine with an electro-hydraulic drive (type HBR 201, supplied by Hütte) and an electrically powered Triplex mud pump. The company has invested heavily in this new drilling system with its various attachments in order to ensure that the requirements profile is being met to the full.

HBR 201 electro-hydraulic drilling machine



Top: Arrangement of the core-barrel fittings

Left: Diamec 262 drilling system on transport pallet

The drillers use the counterflush coring method with saturated salt flushing. This highly effective and cost efficient core drilling technique has already proved successful in horizontal exploration work where special performance requirements are involved. This system differs from the wireline coring method in that reverse mud flush circulation is used to facilitate uninterrupted core recovery. The annulus between the drillstring and the sides of the hole is sealed by a preventer system that allows reverse flushing (counterflushing) via the annulus. The preventer closing device also acts as a safety system to prevent the ingress of gas and brine. Thyssen Schachtbau GmbH has been carrying out a wide range of drilling projects for the salt mining industry for more than twenty years and the company therefore possesses the know-how needed for special drilling operations of this kind.

The excellent working relationship between client and contractor and the degree of satisfaction recorded by K+S KALI with the quality of the work led to a second drilling project being started at Zielitz in November 2008. In order to obtain more information on an additional potash seam vertical holes of 100 m average length are being drilled from existing workings at the level of the present working horizon. The aim of this operation is to obtain extensive data on the extent, formation, thickness and potash content of the Stassfurt seam (K2).

In order to undertake this exploration programme Thyssen Schachtbau GmbH opted for an Atlas Copco all-hydraulic Diamec 262 drilling machine, which is being employed in conjunction with a special wireline coring system using the dry-drilling technique. The flushing medium, in this case air, is cleaned by being passed through a dust filter unit after exiting from the annulus. The drill rig and its various fittings are mounted on a specially built transport pallet.

With the wireline coring process the core bit is driven by a rotating outer core barrel, while an inner core tube, which is not part of the rotary movement, is located within the outer barrel casing. This arrangement allows the drill core to be pushed up undamaged into the inner core tube, where a core-catcher installed in the inner core tube detaches it from the rock at the end of the drill run.

In order to recover the drill core the inner core tube is released from the outer barrel by means of an overshot tool and is then withdrawn from the hole using a wireline winch. The outer core barrel and drillstring remain in the hole and the complete outer barrel assembly (rotating drillstring) is only withdrawn if and when the drill bit has to be changed over.

Exploration drilling programme at K+S KALI's Sigmundshall potash mine

Sigmundshall mine, which is located to the north-west of Hanover near the town of Wunstorf, began operating in 1896 as the 'Wunstorf Potash Drilling Company' and was connected to the Steinhuder Meer railway in 1906. The three active shafts, namely Sigmundshall, Kohlenfeld and Weser, are all sited to the south-west of the zone.

Thyssen Schachtbau GmbH has been engaged in exploration drilling work at this site since March 2007. This involves both horizontal and vertical drilling with hole deviation using counterflush and wireline coring methods.

Sigmundshall drilling site 31 – drill rig being deployed under very hot conditions

Drilling core

The Weser project – wireline coring with directed deviation

The exploration work carried out at the Weser shaft placed particularly high demands on the operating crew and technical equipment. As at Zielitz this operation used a Hütte type HBR 201 universal drilling machine with electro-hydraulic drive and an electrically powered Triplex mud pump.

Project description

A vertical NQ borehole 700 m in depth was drilled from the starting point, which was the former mine fan workshop at the 440 m below sea level (b.s.l.). After the hole had been surveyed the diameter was taken out to 96 mm. The borehole was then surveyed with a georadar probe (EMR). After the results had been processed the four deviation points were determined according to the geological requirements and technical possibilities. From this vertical drilling deviated holes – each with a down-the-hole motor and a deviation of about 2° over 10 m – were drilled in the predetermined direction at four different levels, namely at 239 m, 117 m, 72 m and 69 m. A 500 m b.s.l. cored section was then drilled from a start channel using the wireline drilling technique. After encountering some initial problems in the vertical section all four deviated holes were completed to the full satisfaction of the client.

Thyssen Schachtbau GmbH is looking forward to further successful collaboration with K+S KALI GmbH on future projects.

Tilo Jautze
Frank Hansper
Michael Mizera

Left: taking face samples at the Gehren barites mine

Below: blast-hole-jumbo underground

Diversification into the non-metallic minerals industry

Shaftsinking and Drilling has for a number of years been diversifying increasingly into three key markets:

- **Geographic expansion into Russia**
- **Technical expansion through increased drilling activities and**
- **Market expansion into the mining sector of the non-metallic minerals industry**

In the past Thyssen Schachtbau GmbH has primarily been involved in national projects for the coal, salt and ore mining industries. For the last six years the Shaftsinking and Drilling division has also been engaged in specialist engineering projects for tunnelling and hydro power plant construction industry in Switzerland.

Projects successfully completed for the non-metallic minerals sector include the reopening of the Gehren barites mine in Thuringia in 2005/2006 and the new development of the Mähringer Berg lime mine in Baden-Wuerttemberg in 2007/2008.

Excavation of a spiral chute and other development work in the Gehren barites mine

The former fluorite and barytes mine at Ilmenau-Gehren had to be closed for economic reasons in 1991. The mine workings were subsequently flooded.

The ever growing demand for raw materials and the resulting increase in the price of imported commodities at the beginning of this century, combined with the unusual purity of the Gehren deposits, led the Fluorchemie Group to consider freeing itself from economic and political uncertainty by procuring raw-materials supplies from own resources.

Between January 2005 and mid-2006 the FSB Gehren joint venture group, comprising Schachtbau Nordhausen GmbH, TS Bau GmbH and Thyssen Schachtbau GmbH, was contracted by the Phönix Fluorite and Barytes Mine in Gehren (a subsidiary of the Fluorchemie Group) to construct an access ramp and spiral chute, and complete some 800 m of underground drivages, with a view to developing the ore body.

Before the work started it had been planned and predicted that about 70 % of the developments could be driven without support. When the heading work commenced, however, it was found that the fracture-tectonic origins of the hydrothermal lode deposits and the influence of former mine workings had combined to create an unexpected set of strata conditions. The FSB joint venture then reacted appropriately by introducing suitable support technology and immediately modifying the drivage concept.

After that the twin-arm drill jumbo with its hole-charging cradle was able to work its way forward pull by pull. The debris was cleared out by loader and dumper – with rockbolts and shotcrete providing overhead protection.

The somewhat complex strata support arrangements consisted of seven different types of system. Systematic rockbolting with shotcrete had to be employed in various forms over practically the entire length of the drivage. Swellex bolts were installed with great success over a wide area, while the project also perfected the manipulator system for wet spraying in confined spaces.

Though exploratory work initially proved disappointing, the predicted deposits were soon proven in all four runs. The load was between 6 and 8 m in thickness and had a fluorspar content of between 30 and 50 %. Planning work was started on a new mineral preparation plant and the first items of equipment have already been delivered. Unfortunately the unexpected slump in prices and the fall in demand to practically zero caused the whole project to be suspended in May 2009. A skeleton crew has been retained to keep the mine open and the project is now awaiting the recovery of the raw-materials market.

Construction of the new lime kiln at Herrlingen quarry in the background

Development work for the undergound lime mine at Mähringer Berg.

Märker Kalk GmbH is part of the Harburg (Bavaria)-based cement maker Märker Zement GmbH, which has a history dating back some hundred years. Märker currently operates ultramodern lime kilns at its Harburg and Herrlingen works where eco-friendly, high-efficiency processes are used to produce lime of the highest quality.
Lime production provides a basis for the manufacture of various processed products. Innovative techniques combined with a forward-looking investment policy have helped make Märker one of the leading producers of lime in southern Germany.

Going underground
Experts have been predicting for years that the non-metallic minerals industry would go underground. A few pits did take this step, usually for environmental reasons, i.e. to reduce the dust and noise nuisance for the local residents. This included our client Märker Kalk GmbH, whose resources at the Herrlingen quarry in Baden-Wuerttemberg were nearing exhaustion. There was no prospect of obtaining yet another approval for surface quarrying close to a residential district. The logical move was to consider using underground mining methods and as a result the Mähringer Berg project was put into action.
Planning considerations were based market conditions and the geology of the deposits

'All is dark ahead of the pick'- this old mining saying had twofold significance when it came to the Märker project:
It applied firstly to the client's general project for developing the underground workings and building a new kiln to process the high-grade white lime. This first required a lengthy planning and clarification process that included financing arrangements, technical equipment, licences and partners. All these procedures were carried out against a background of increasing demand for the end product. But now that everything is ready for 'harvesting' the market appears to be much less favourable. The global economic crisis, which has been accompanied by a fall in demand, has left its traces. Nevertheless, as soon as the markets recover this long-term investment project will be delivering the expected returns.
And secondly to the geology in the strict sense of the word. In 2001 an exploration roadway was driven and a small-scale test extraction undertaken. And the geology, it has to be said, was perfect.
However, after the contract to develop the Mähringer Berg deposits was awarded in June 2007 to the Mähringer Berg joint venture, comprising Schachtbau Nordhausen GmbH and Thyssen Schachtbau GmbH, it was found that the geological conditions encountered along the 1,350 m of drivage differed somewhat from the original predictions and findings.

Rockbolts, weldmesh panels and shotcrete had to be employed on a large scale in the long-term excavations and

Outside left: Entry point to the new drift with the quarry in the background

Left: Mine support measures at the intersection between the parallel heading and the crusher room

roadways. However it is hoped that the poor geology encountered in some of the roadway developments will not be repeated to the same extent in the excavations made to the north of the same extraction zone.

The 'Mähringer Berg deposits' development project

Excavation work on the conveyor road, parallel headings, crosscuts and rooms for the crusher, transformer and mine fan began on 09.09.2007. The highly karstified strata called for the highest safety standards and required a lot more support than had been planned. Roadways with profiles of 32 to 36 m^2 would have to serve as the main production arteries for decades to come. The crusher room, for example, was not spot-bolted but instead supported by a 30 cm-thick coating

The increased safety measures, additional length of drivages required for the parallel heading and crosscuts and the need for additional ripping at the roof and ancillary support work all combined to delay the completion of the project by nearly half a year.

The development work was completed at the end of 2008. A total of 1,350 m of roadways and some 49,000 m^3 of cavities had been excavated at an average pull of 3.14 m and with an explosives consumption rate of about 1.7 kg/m^3. Each complete pull took 18.5 hours to execute, including time for ancillary operations and unscheduled support and reinforcement work.

Drilling blasting holes and bolt-setting holes

ITC and dumper in action

of shotcrete, two layers of weldmesh and rockbolts up to 5 m in length. After each round of shots the heading team had to reassess the condition of the strata and determine in collaboration with client the most appropriate measures to be used for support and reinforcement.

In order not to contaminate the high-quality lime shotcreting was only permitted in the cut-through road. More than 3,000 tonnes of this material were eventually used in all the infrastructure cavities.

The shotfiring pattern, length of pull and choice of explosive all had to be coordinated so as to maximise the heading performance, reduce the degradation rate and keep the proportion of debris less than 20 mm in size below 35 %. Of course this could not always be achieved in those karst joints that were filled with loam and silt. An upper limit had also been placed on the vibration levels due to blasting, with no firing permitted at all between ten in the evening and six in the morning.

This outstanding performance was achieved by a mixed team from both JV partners, whose members were soon working as a close-knit unit.

Available resources and equipment

This outstanding performance was achieved by a mixed team representing both JV partners, whose Members were soon working as a close-knit unit. Some of the drivage work was undertaken using the multiple-entry system with a team of between 13 and 17 men. The heading crew was supported by some very effective equipment, comprising the AC 352 S twin-arm drill jumbo from the Gehren project, which was used for drilling the shotholes and rockbolting holes and installing the weldmesh screens, an ITC 312 H3 Schaeff excavator for loading and salvage work and two Terex TA 30 dumper trucks for haulage duties between the intermediate stores and the tunnel portal. As well as ventilation equipment, a compressor and a shotcrete supply bin the operation was also supported by a Komatsu WA 470 loader

Marbled lime and what it can become to the drill steel

with a payload capacity of 4.2 m^3 and a Merlo P30.13 telescoping forklift.

These performance levels could not have been attained without some terrific support and cooperation from the client. We would therefore like to take this opportunity to express our appreciation for this back-up and for the hospitality served up in the form of pretzels at our regular meetings. As well as providing site supervision the client was also responsible for mine planning approvals, rescue services and project planning.

The client's satisfaction with the quality of the mining activities and support measures was borne out by the fact that the JV was awarded a follow-up contract for the complete electrification of the mine. This work essentially comprised the installation of a transformer room and the electrification of all lighting, underground fans, crusher and conveyors.

The future

All work was successfully completed and the new mine infrastructure was handed over to the client right on time for the start-up of the new lime kiln in April 2009. Output from the surface quarry can now be scaled down – to be replaced by production from the new underground workings.

At this point we would like to wish Märker Kalk GmbH every success in its new venture along with a rapid upsurge in market demand. Schachtbau Nordhausen GmbH and Thyssen Schachtbau GmbH also hope that the Gehren barytes mine will see raw-materials prices stabilising again and that the operators will have the entrepreneurial courage to continue the process that commenced with the underground development work.

Franz Stangl
Heinz-Wilhelm Kirchhelle

The Regina TMCC team

Thyssen Mining Construction of Canada Ltd.

The history of TMCC goes back to 1960, when a small team of ground freezing and shaft sinking experts from Germany travelled to Saskatchewan, Canada, to assist with the sinking of shafts for the emerging potash industry. By 1972, with most of the potash shafts completed, the Thyssen group made the decision to maintain a permanent presence in Canada. Ever since, TMCC has served the Canadian and North American mining industry from its head office in Regina.

During the nineteen seventies and eighties, TMCC grew from a shaft sinking contractor into a full service mining contractor offering every aspect of underground mining and construction, including ramp development and drifting, raise boring, electrical, mechanical and civil construction, grouting, ground freezing and production mining. In 1983, TMCC started the development of Cogema's Cluff Lake uranium mine in northern Saskatchewan, and remained the mining contractor on that site until its depletion and closure in 2002. This heralded the beginning of TMCC's involvement with uranium mining, and was followed by the development of the McArthur River, Cigar Lake and Rabbit Lake mines, all operated by Cameco and to this day important clients of TMCC.

Saskatchewan is fortunate to have the world's largest reserves of potash in the south and the world's richest uranium deposits in the north. This puts TMCC in a great location, especially during the recent recession, as the demand for both minerals is expected to exceed supply in the medium to long term, and producers are expanding capacity at existing operations and starting new ones. However, TMCC's focus goes well beyond Saskatchewan's borders. Being centrally located in North America, TMCC has spread its wings across the continent and has recently completed projects in locations as diverse as Alaska, New Mexico, West Virginia, and Colorado in the U.S.A., and even in Brazil and West Australia, the latter in joint venture with its sister company Byrnecut. TMCC also owns 50 % of CMAC-Thyssen, a company based in Val d'Or, Quebec, specializing in production drilling & blasting and a designer and manufacturer of drilling equipment.

TMCC's enduring catch phrase is Safety, Quality and Cost. We believe that each task can and must be performed without harm to people, property or the environment, and that no job is worth the risk of an injury. We consistently improve our safety performance, but will not be satisfied or rest until the goal of zero harm is achieved. The quality of our work is what keeps clients coming back to us, and we pride ourselves in the large amount of repeat-business we have as a result. We realize that we have to provide value for money and are continuously looking to improve efficiency, though the implementation of new technology, hazard analyses and project controls.

Another word describing the essence of TMCC is partnership. Since 1996, the work performed by Thyssen for the uranium mines in Saskatchewan has been done in Joint Venture with a company called Mudjatik, owned by the English River First Nation and representing a dozen indigenous nations and communities of the north. Mudjatik Thyssen Mining has provided consistent dividends to its shareholders and employment and training to many hundreds of northern residents, and is widely regarded as a model partnership of its kind. TMCC has also successfully partnered with sister companies, clients and even competitors, combining resources, knowledge and experience to get the best overall outcome for projects too big or complex for one single party to handle on its own.

Finally, and most of all, TMCC is defined by its employees. Many of our people have been with us for numerous years or have returned time and time again after projects were completed and subsequently replaced by new ones. They are proud of their achievements and always ready for the next challenge, to be safer, better and more efficient. They are dedicated, motivated, well trained, and they enjoy what they do. Each one of them is essential to who we are.

I kindly thank our clients, partners, employees and their families for choosing and supporting Thyssen Mining and hope that you will enjoy this brief overview of what we do.

Rene Scheepers
President – Thyssen Mining Construction of Canada Ltd.

EJC 220 after complete rebuild

Equipment yard and repair facilities

Located in Regina, Saskatchewan, the storage yard and repair shop facilities are a part of the head office of Thyssen Mining Construction of Canada Ltd. (Thyssen Mining).

The facilities were built on a 10.5 acre site, with a 20,000 ft^2 repair shop, with 4 additional cold storage buildings that allow for the centralized storage location for all of Thyssen Mining's equipment. The main focus is repairing and rebuilding of the Thyssen Mining equipment fleet. With the vast experience and many years of service of the shop's long-term employees, the facility enables Thyssen to provide cost effective and reliable equipment for its job sites. Whether it is a newly purchased drill jumbo or a reconditioned scoop, all of our equipment at some point will spend time in the Regina shop.

Top: Testing Toro 1400 LHD after complete rebuild

Left: Concrete transmixer custom built in Regina shop

Thyssen Mining's equipment is maintained on site by our qualified mechanics. When the equipment is in need of lengthy repairs, reconditioning or a complete rebuild, it is being sent off site to the Regina Shop. Once the unit is back in Regina, an assessment is completed and our management team reviews the data to ensure it is cost effective to proceed. It is imperative that all repairs and updates are completed to meet the ever-challenging changes in the mining industry, as the final outcome has to meet underground mining standards throughout North America. This proves to be challenging at times as Thyssen's rebuilt equipment may not have a final destination until the work is complete, and different jurisdictions across North America often have different rules and requirements. Complete overhauls are also done on a regular basis in the Regina shop.

When Thyssen Mining purchases new equipment, it is delivered to the Regina Shop for inspection and data information, and assigned a unit number for the tracking of equipment location and the maintenance costs while on site. The equipment is then shipped from Regina to the appropriate site. When the equipment is shipped internationally, the shop is also responsible for importing and exporting according to the international laws. It is necessary to make sure all shipments are imported or exported in a timely and cost effective manner. Any delays can cause loss of production on a site level or cause delays in the shop.

As part of Thyssen Mining's Preventive Maintenance Plan, Thyssen has a centralized purchasing department for all of its jobsites, which operates under the supervision of the shop. All sites are responsible for locating and pricing of their purchases. The orders are then entered and tracked through the purchasing department and all costs relating to equipment, parts and labor are assigned to the correct equipment assets. This information is prudent in determining the future of the equipment, maintenance planning and overall equipment costs.

At Thyssen Mining, the focus is on "Safety, Quality and Cost". Safety is a top priority for the Regina shop. In December of 2009, the shop is hoping to achieve 10 years without a Loss Time Incident. The shop's management team's priority is to provide training and pass on knowledge to its newer employees to ensure a safe work place. Quality work is expected and with the combined years of experience and service from all of the shop's employees, the highest possible standards are met. The Regina shop is always striving to meet the challenge of providing the sites with the appropriate combination of new equipment and quality rebuilds, to deliver the most efficient and cost effective options to the projects, and ultimately to our clients.

Dwayne Metz
Shop and Equipment Manager
Volker Ebert
Vice President, Operations

Freeze hole drilling – Rocanville
March 2009

AMC – back to the future ...

In the early 1960's, ground freezing and shaft lining technology from Germany was introduced in Saskatchewan, the Canadian province that boasts the world's largest reserves of potash. This enabled the successful construction of shafts through some of the world's most challenging ground conditions, such as the Blairmore formation, a sequence of water-saturated sandstones and flowing sands occurring at a depth of approximately 450 to 550 m below the surface at all the potash shaft locations. Amalgamated Mining Construction Limited (AMC), which was incorporated in May of 1960, sank 9 of the 14 shafts that are all still in operation today. AMC Ltd. was a joint venture between several companies, in particular Thyssen Schachtbau GmbH and a predecessor of what is now Deilmann-Haniel International. In 1972, Thyssen Schachtbau became the only remaining shareholder and Thyssen Mining Construction of Canada Ltd was born.

AMC – now

AMC re-emerged in May of 2008 in response to the need to sink further shafts in the Saskatchewan potash field. Thyssen Mining formed a joint company with JS Redpath Ltd., another Canadian shaft sinking contractor and part of the Deilman Haniel International group of companies, and called this new entity Associated Mining Construction Inc. Together the two parent companies, with the technical support from their German-based sister companies, are uniquely equipped to design and construct the new wave of potash shafts that are required to meet the world's increasing demand for fertilizer.

AMC's aim is to be the undisputed leader in the design, engineering and construction of shafts for the Saskatchewan potash industry. AMC offers a complete service from concept to commissioning and uses project control systems according to the Project Management Institute standards.

Projects

Scissor's Creek Ventilation Shaft – PCS Rocanville

In March of 2008, AMC began discussions with PotashCorp of Saskatchewan (PCS), the world's largest potash producer, about the planned expansion of one of their operations near Rocanville, Saskatchewan. The expansion requires a new, 1,100 m deep and 6 m finished diameter service shaft, as well as the deepening of the existing service shaft and its conversion into a second production shaft.

Freeze hole drilling to a depth below the Blairmore formation started in February of 2009, and was completed ahead of schedule and meeting stringent tolerances for hole accuracy, thanks to gyro surveys and MWD (Measuring While Drilling) technology. A total of 36 holes were drilled, including freeze holes and temperature monitoring holes, and a casing was installed in each hole. Next on the agenda was the construction of a 84 man construction camp, offices, change rooms, freeze plant building, shop and storage facilities. While these were constructed, work started on the foundations of the concrete head frame. This colossal structure is due for completion before the end of the year 2009 and will be used for sinking the shaft as well as for the permanent service requirements. Sinking will commence early in 2010, once the sinking set-up is completed and the ground sufficiently frozen to ensure safe working conditions.

The shaft will be lined with various lining materials, depending on the depth and the geological and hydrological conditions at each

Headframe formwork and rebar

P. 66: Head frame foundations and freeze pipes

Installing piling for headframe foundation – freeze pipes exposed

horizon. Besides the traditional concrete, these vary in type from cast iron panels to a composite liner made up of a welded steel membrane reinforced with concrete and a steel inner mantle. This will ensure a dry, low-maintenance and durable end product.

Triton project – Agrium

Agrium is a major producer and marketer of agricultural nutrients, and owns and operates the Vanscoy potash mine near Saskatoon.

Agrium has engaged AMC to assist with the shaft construction portion of the feasibility work for a new potash operation, called the Triton Project. If the project goes ahead, AMC will be responsible for the design and construction of the two shafts. Preliminary design work, costing and scheduling has been ongoing since late 2008 and once the required internal and external approvals and permits are secured, AMC's work in the field will start with the drilling of two geotechnical holes to gain the information required for designing the freeze wall and shaft lining systems.

Rebar in piling cap

BHP Billiton – Jansen Project

BHP Billiton is the world's largest diversified natural resources company, and has recognized the fundamental attractiveness of the potash industry. The company is currently focused on developing a new underground potash project near the village of Jansen in Saskatchewan. After Thyssen Mining completed the shaft sinking portions for a scoping study and a subsequent selection study, AMC was awarded the drilling and testing work for the two shaft pilot (geotechnical) holes. This work involves the site preparation, coring of the holes to a depth of approximately 1,100 m and extensive logging and testing of the holes and cores. BHP Billiton hopes to commence with freeze hole drilling some time in 2010.

PCS Cory – Shaft Steel replacement

A second project for Potash Corp completed by AMC was the shaft steel replacement at the bottom of the production shaft of the Cory mine. The work included the removal of 40 year-old shaft sets, loading pockets, crash beams, ladderways and other ancillary steelwork, followed by the installation of the new steel components. This difficult project was completed in a very timely fashion during the summer shut-down and to the client's full satisfaction.

J. D. Smith
General Manager of Operations, AMC
Rene Scheepers
President Thyssen Mining

USA operations

In the last few years, Thyssen Mining has seen a steady increase in business in the United States. The number of contracts, the volume of work and revenue as well as the number of personnel all increased substantially. Unfortunately, in the current recession, the hardest hit geographical business area for Thyssen Mining was the United States and a number of long term contracts came to an end – for the time being.

Our philosophy of building long-term relationships with our clients has paid off. We have seen the results of these long-term relationships in the form of numerous contract extensions at most of the projects. We continue to maintain those relationships in order to be ready when the economy rebounds and the level of activity increases again.

Some of the recent projects completed by Thyssen in the U.S. are:

Greens Creek Mine – Alaska

The scope of work at this silver producer was to develop a new block to be mined within the existing mine. Over a two year period, Thyssen Mining drove a decline, stope accesses and ore drifts, raise bored twin ventilation raises and installed a 300 HP ventilation fan and ventilation doors. The mine is situated on an island within a National Park, which presents unique challenges when it comes to access, logistics as well as environmental constraints.

Henderson Mine – Colorado

In 2003, Thyssen Mining was awarded a contract to excavate 3 km of lateral development and perform 1,000 m of raise boring at this large-scale molybdenum producer. Six years and numerous contract extensions later, Thyssen had completed approximately 24 km of drifting and 6km of raise bored ore and ventilation passes. The mine is situated in the Rocky Mountains at an elevation of 3,150 m. At it's peak, the project employed 67 people and had a total of 30 pieces of mobile equipment.

Questa Mine – New Mexico

Another block cave molybdenum mine, Questa experienced an extreme convergence of the draw points in the only active mining block. The mine was one step from completely shutting down when Thyssen Mining was brought in, initially as consultants to recommend a new ground support regime and supervise its implementation. As lines and draw points were rehabilitated, Thyssen Mining started to bring in its own crews and equipment to assist with rehabilitation work and development. The mine resumed production and Thyssen focused on the development of a new mining block. Our crews numbered 65 people, when the project was suspended due to declining commodity prices.

Left: Raise boring at Henderson Mine, Colorado

Below: Bolter installing screen at Greens Creek, Alaska

Tenmile Tunnel – Colorado

A ten-month contract to rehabilitate a tunnel used to drain and divert water as part of an open pit operation. Part of the tunnel was excavated in the 1950's and additional footage in the 1970's. Situated at 3,450 m elevation in the Rocky Mountains, the altitude and the amount of snowfall were challenging enough. A large amount of old timber and steel sets were replaced with more modern ground support like split sets, cable bolts and, in the most deteriorated areas, concrete.

Greenbrier Smokeless Coal Ventilation Shaft – West Virginia

This project entailed the sinking and concrete lining of a 200 m x 6 m diameter ventilation shaft. A Thyssen-designed mobile head frame was used to rapidly deploy the sinking set-up. Upon completion of the sink, a slip-formed concrete ventilation divider wall was installed in the shaft.

Adrian Bodolan
Area Manager, Western Operations
Volker Ebert
Vice President, Operations

Right: Presink at the Greenbrier shaft, West Virginia

Below: New LHD at Questa Mine, New Mexico

Airrail Center, Frankfurt/Main Airport

In May 2008 DIG Deutsche Innenbau GmbH was awarded the contract to complete the full interior fit-out of the Airrail Center Frankfurt (ACF). In order to carry out this project DIG set up a joint ventureship with materials supplier Becher GmbH – the first time this had been done in the German construction market.

The project

The scale, architecture and design specifications of the ACF project have set new standards for the building industry. The new facility straddles the Frankfurt Airport ICE main-line railway station and therefore occupies one of Europe's most important traffic hubs.

The streamlined building, which is 660 m long and 65 m wide, has been erected as a nine-storey extension on the roof of the existing ICE main-line train station at Frankfurt Airport. When completed the new complex will contain office space, seminar rooms, two Hilton Group hotels, various retail and food outlets and landscaped atriums – all under one roof.
The interior fit-out will be undertaken without any disruption to existing facilities and rail services at the ICE train station.

The ACF has been designed on a huge scale. If set on its end this 'recumbent tower block' would overtop any high-rise building in the world. The nine-storey structure will therefore be far more cost-effective to construct and operate than a tower block.

The ACF is located in the heart of the Rhine-Main region and key transport links are all close at hand: the air terminal is immediately opposite, parking space is available nearby in the Airrail car park and trains depart regularly from the ICE railway station beneath the building. The new complex is an office block, hotel facility, conference hub, shopping and gastronomy centre, check-in area for the airport and travel centre for the ICE railway station – a true Airport City with light-filled, glass-topped atriums providing areas of rest and relaxation.

Transport connections from the ACF are really excellent: Düsseldorf and Stuttgart are only 90 minutes away by rail, while Cologne can be reached in less than an hour. The location is also at the heart of the national motorway network, with major routes leading off in every direction.

The Airrail joint venture – retailer and contractor in partnership

The Airrail joint venture constitutes a new approach to handling building projects. While construction JVs usually involve

View of the new Airrail Center, Frankfurt Airport

Total floor space

The complex will have floor space dedicated to the following uses:

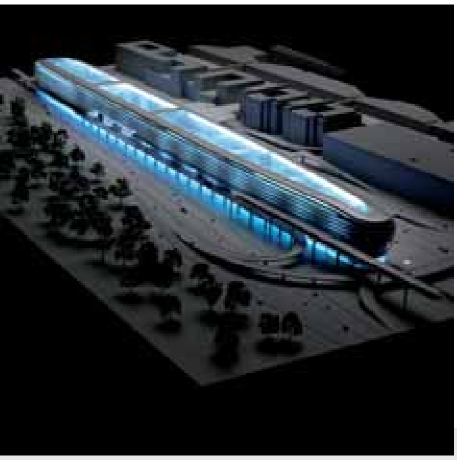
93,000 m²	of office space
34,000 m²	of hotel space (560 rooms)
13,500 m²	of atrium areas
5,700 m²	of retail outlets and restaurants
7,000 m²	of storage and archive space

That's the Atriums invitation to stay and relax

building contractors coming together to turn a profit from their work, the Airrail joint venture is the first time that a building contractor has teamed up with a retail company. Both partners will be generating revenue by a different route. While the building contractor, in this case DIG, will generate income from its construction services as is the case in every joint venture, the retail company, Becher, will essentially be making its profits by delivering material to the JV.

This JV arrangement was also one of the criteria laid down when awarding the contract. During the negotiation stage the client soon came to see that a joint venture organised in this

Evening falls at the Airrail Center



way would help minimise the delays that frequently affect material deliveries in commissions of this kind – and this was an important factor given the ambitious targets that had been set for the completion of the project.

Interior fit-out

The contract is for a full fit-out of the entire ACF building (apart from the technical systems) and the installation work to be carried out by the JV will total more than 60 million euros.

Because of its experience in delivering turnkey interior construction projects DIG was already involved with the client in an advisory capacity during the planning phase and had helped with the design of the internal fittings and fixtures. Various structural details had been agreed with the client before the project started, so that the various interfaces with the other contractor packages, such as shell construction and installation of the technical systems, could be coordinated at an early stage in the operation.

Service package

Our service package comprises all fitting and finishing work to be carried out on the floors, walls and ceilings:

Floors:
Screeding, natural stone, parquet, carpet

Walls:
Drywalls, partitions, glass walls, doors, gates, plasterwork, mouldings, tiling, paintwork and locksmith work

Ceilings:
Suspended ceilings, metal ceilings, cladding for beams and joists, thermal insulation work, plaster and paintwork

The scope of the work places high demands on the skills and working practices of the fitting teams. For this reason our project and site managers only engage builders and foremen with several years experience on major construction sites. Our highly qualified staff ensure that the project is carried out in accordance with the technical, financial and legal requirements that have been laid down in the contract with the client. The site crews also have the flexibility required to react to changes in timing and technical alterations to the construction schedule so that everyone involved is able to work together as a team in order to achieve the best possible result.

DIG may have up to 300 fitters working on site at any one time. As with other full fit-outs carried out in the past (including the Lufthansa head-office building, the Broker Office Dresdner Bank, the RWE office building and the Arcor headquarters) our policy is to employ subcontractors who have worked successfully with us over the years.

We have also adopted a new strategy for our site logistics. Our on-site team is able to plan deliveries in such a way that the materials are not just transported to the site but are delivered by the supplier directly to the predetermined workplace.

Because of the train services operating in the lower part of the building the client has placed particular emphasis on strict compliance with health and safety standards. To ensure that this requirement is met we have a safety officer permanently on site whose job is to work closely with the client's safety coordinator.

View of the new Airrail Center, Frankfurt Airport, with connection to the highway and the Airrail Center on top of the ICE-Station

Build phase

The start of the building work coincided with the laying of the foundation stone on 01.03.2007.

The building is divided up into six lots each fairly equal in size, but with quite different fit-out specifications. The hotels are located in zones 5 and 6, while the restaurants and retail outlets are being set up in zones 3 and 4. The office units are to be housed in zones 1 and 2. The project commenced with the shell construction work for the hotel zones.

After more than one year's work on the structural shell of the building we were able to commence our operations in September 2008 by starting the fit-out in lot 6. In preparation for the technical systems we had already built the drywall partitions and duct casings for the electrical installations. A start has now also been made on other areas. The hotel fit-out is scheduled for completion by the end of 2009.

The ACF complex will be ready by 2010.

Outlook

Projects like the ACF are the key to DIG's future. Adding ambitious new-builds and major refits to our portfolio makes us an attractive partner for site owners and clients. The ACF contract has demonstrated once again that DIG has what it takes to plan and execute turnkey interior fit-outs for major projects.

Horst Berger

Stendal-West gets a modern transformer substation

Electricity from offshore wind power generators will soon be supplied to end-users by a modern new transformer substation – thanks largely to the efforts of TS Bau GmbH.

The contribution that renewables are making to German electricity production has grown considerably in recent years and by 2020 at least 30 percent of the nation's electricity is to be generated from renewable sources. Power from offshore wind turbine generators can and should play a major role in Germany's future energy and climate policy. There is a huge energy potential to be exploited from the high average wind speeds prevailing offshore.
This potential can only be tapped into by extending the grid infrastructure, for ultimately the electricity generated offshore and onshore still has to be transported to the consumers. This will require extensive investment not only in the existing infrastructure but also in new supply networks.

A project that is aimed at harnessing some of this potential is now taking shape on a former greenfield site some 10 km west of the town of Stendal. The new 380/110 kV transformer substation, which is being built jointly by Vattenfall Europe Transmission GmbH and E.ON Avacon AG, will take up an area of 309 m x 235 m.

The new Stendal-West substation will eventually collect the entire output from the wind turbine generators in the Altmark region and convert it via a transformer system so that the surplus power from the 110 kV grid can be fed into the 380 kV supply network.
This new capacity will make Saxony-Anhalt the nation's number-one producer of renewable energy.

The project was awarded to the Riesa office of TS Bau GmbH in the early summer of 2008 and involved a number of construction and installation assignments, comprising preparatory landscaping work, earthmoving operations, traffic routes (including a new access road), 402 foundation pads (for single units, portals, choke coils and transformers), an operations building, firewalls, cable ducts, footings, wiring, water supply and drainage systems, a security fence and out-

P. 74: Floating-in the needle filters for groundwater lowering with steel portals for receiving the transformers

Top: Enclosed vacuum plant for groundwater lowering

door enclosures. The contract has a total value of more than three million euros.

Because of the local hydrological and geological conditions a number of special techniques had to be employed, including the use of vacuum plant to lower the groundwater level, drilled-in caissons beneath the large portal foundations and watertight sheet piling for the construction of a large-scale oil separator. The civil engineering work also included landscaping an area of about 73,000 m², the removal of some 35,000 m³ of topsoil for interim storage, the excavation of 9,000 m of cable trenches for earth conductors and control wires and the laying of 6,300 m² of roads and traffic areas. The civil engineering and track-laying services of the Riesa office were largely involved in this construction project. The operation began in July 2008 with archaeological excavation work and is scheduled for completion in May 2010, when the site will be planted and grassed. The construction work has so far proceeded according to schedule.

What was for so long merely a pipe dream is now becoming a reality. Renewable energy is helping take conventional power stations out of the mix. In the catchment area of the new substation alone wind turbine plant with a total rating of some 600 megawatts of electricity are either up and running or under construction. In fact Saxony-Anhalt only consumes a fraction of the wind power being produced locally and most of this green electricity can therefore be exported to other parts of the country.

The Thyssen Schachtbau Group is therefore not only involved in the winning of conventional fossil fuels such as coal but is also playing a leading role in the provision of future energy resources.

Michael Leposa
Rene Schneider

Top: Sheet piling for the large-scale oil separator

Middle: Foundation for transformer and fire walls

Below: Final construction including transformer

Inspection and stabilisation work at the former Philippshoffnung ore mine

Historical background

Ore mining in the Rosterberg area of Siegen lasted for several hundred years. The main workable ore bodies were of siderite and iron spar with outcropping lodes of brown hematite. Deposits of cobalt, along with copper and zinc ore, were also worked during this period. Recorded mining operations at Rosterberg came to an end in 1926. The existing mine charts and plans date back to the year 1776, though these historical records also contain references to even older workings on this site.

Mine exploration

Underground inspections at the Philippshoffnung site were planned and organised by the DMT department for surveying and abandoned mine workings.

Access to the workings was via the existing vertical shaft (rectangular profile 1.80 m x 0.80 m). During the renovation process the shaft cross-section was widened to 1.80 m x 1.30 m, as dictated by technical constraints. The level drift on mine level 1 was reached after descending some 18.50 m. The section of tunnel leading to the original discovery shaft was cleared of detritus and made secure. Material falls and roof collapses were secured by means of props, lids and lagging. The debris collected from the clearing work was either transported to the surface or deposited in adjacent workings. After the drift had been cleared it was found to have a profile of between 1.80 m and 1.30 m in height and 0.8 m in width. An auxiliary fan was used to blow air through the old workings.

Stabilising the discovery shaft

Once the drift on mine level 1 could be travelled from the vertical shaft to the discovery shaft it was found that the tunnel had no packing over a distance of 11 m or more. There was a material bridge with loose detritus in the shaft column above the cavity. The free cross-section varied between 2 m^2 and 5 m^2. The bottom 5 m of shaft profile had been much widened as a result of mining operations. The actual working cavity could not be accurately surveyed because of the site conditions. The existing cavitations (working faces plus shaft) were initially estimated at some 60 m^3. The shaft was set at an inclined angle of about 60° within the ore body. The distance between the inspected cavity and the ground surface (a school playing field) was between 3 and 4 m.

The condition of the discovery shaft posed a risk for the school playing fields above and immediate action was required to make the area safe. A PE feed pipe was subsequently run down the vertical shaft and along the drift to the discovery shaft to terminate at the highest point of the cavity zone. In order to monitor the progress of the stowing operation a second line was installed in the shaft to serve as a vent pipe. This second pipe was run right up against the roof of the excavation and its bottom end, which terminated in the drift, was fitted with a stop valve. The two drifts connecting with the shaft were sealed off in order to prevent the fill material escaping into those parts of the mine that did not require consolidation. In the first phase of the operation the lower section of shaft was filled to above tunnel-roof level. After a short pause to give the material time to set, and so

P. 59: Vertical shaft with sinking equipment

Bottom: Location and schematic diagram of the consolidation work in the discovery shaft below the Rosterberg school

Vertical shaft after clearance of the shaft top

provide an abutment for the subsequent filling operation, the rest of the cavity was completely filled in. A total of some 150 m^3 of hydraulic setting mixture was pumped by pipeline into the open shaft and old workings leading from it. None of the suspension escaped into others parts of the mine.

Clearing the winze and further reconnaissance

The main-drift staple pit (the 'old winze'), which was sited about half-way between the vertical shaft and the discovery shaft, was for the most part free of debris and in a good condition. The winze had a cross-section of about 1.80 m x 1.10 m. The supports had deteriorated badly over time and were in need of renewal. The ladderway and a materials compartment were assembled in the staple pit . The air ducting installed at the main drift level was extended to provide auxiliary ventilation. The bottom level ('Hinterster Busch') was reached after 20 m. The pumping shaft was found at the bottom of the winze, slightly off to one side. After the shaft had been scaffolded up the inspection team was able to carry out an initial reconnaissance of the Hinterster Busch workings.

After the mine workings had been inspected and surveyed the pumping shaft was examined and stabilised. This shaft measured 2.40 m x 0.90 m and was 35 m in depth. As it was located in the working zone the pumping shaft had undergone extensive support work. These supports, which had stood for many years, were also in a very poor condition and in some areas were completely missing. Large sections of side-wall appeared to be nearing collapse. Supports were installed in order to meet the different stability requirements and a system of square timber work was built up section by section. Any loose material was reinforced with foam filler and pressure cribs were set up as and when required. The existing auxiliary ventilation system was extended accordingly. A ladderway with resting stages and a materials compartment were installed in the shaft. In order to inspect the Christineglück main-drift level the team first had to cut through fallen material and roof collapses. Boreholes were drilled through the larger blockages and roof falls for preliminary exploration purposes. Standing supports and roofbars were set to provide reinforcement.

The debris collected from the clearing work was stowed in the adjoining

Surveying the Hinterster Busch workings

Reinforcement with standing supports

mine workings. This sometimes involved transporting the material over large distances.
As the project then encountered fill material from previous stabilisation measures the operation had to be discontinued before reaching the Rosenbusch workings.

The Rosenbusch drift
The decision was then taken to drive a connecting tunnel between the Hinterster Busch and Rosenbusch workings.
Because of the shallow depth of cover (about 30 m) and the relatively short distance between the proposed connecting tunnel and vulnerable sites above ground (a school and residential buildings) the drivage had to be carried out with minimum rock degradation and ensuring low levels of vibration. Initial attempts were made using RocKracker™ low-powered explosive. As this substance had not previously been used below ground for drivage work this was essentially a trial project. Working in conjunction with the product distributors several rounds of blasting were carried out using different drilling patterns and cartridge types. However this failed to produce the level of performance required and it was decided that because of the hardness of the rock RocKracker™ explosive was unsuitable as a blasting medium for underground drivages. The product could however prove useful for tunnel widening and profiling work. In order to inflict minimal damage on the surrounding strata and to ensure that the operation was almost vibration free a hydraulic rock-splitter was then brought in to continue the project. The tunnel was excavated to a profile of 1.80 m x 0.80 m to match that of the existing roadways. Auxiliary ventilation was provided by means of an air duct system leading from the bottom of the old winze. The debris was transported by hand and stowed in workings some 75 to 100 m away.

A total of 18.50 m of drivage was completed without finding any signs of the Rosenbusch Drift. Exploratory drillings were then carried out into the Rosenbusch from a start-chamber excavated into the side of the tunnel. The target was identified at a distance of 6.50 m away. The tunnel was then deviated in this direction and at the time of going to press was working its way towards the drift.

Surveying, modelling and mapping

In the course of the inspections it was discovered that some of the tunnels and mine workings had not been fully included in the existing mine plans, and in some cases were missing completely. In order to be able to assess the degree of risk all accessible and/or open mine workings in the stabilisation level of the abandoned Philippshoffnung ore mine therefore had to be surveyed and mapped. At the same time the existing mine plans had to be checked and, if necessary, amended.
The surveying work was entrusted to staff from the German Mining Museum (DBM) in Bochum and was mainly undertaken using a mine surveyor's hanging compass.

A three-dimensional model of the workings on the first mine level and on the Hinterster Busch level was then constructed in order to gain a better impression of the layout of the deposits and the underground geometry. This involved using the DBM-developed profile scanner to measure section profiles at more than 300 significant survey points.

Summary of results and future actions

The exploration and consolidation work at the former Philippshoffnung ore mine was the first of such operations in the North Rhine-Westphalia region. The project also discovered a number of workings that had not featured on the original mine plans. The accurate data obtained from the underground survey meant that the fill-material quantities and costs could be assessed and calculated with much greater accuracy, especially in those areas targeted for reinforcement. The increased cost of the inspection and renovation work was recuperated many times over through savings made on the amount of fill material used.
The positive results achieved to date have now inspired the mining authorities to commence similar exploration and reinforcement work in the Feldberg Main Drift workings lying further to the north. TS Bau also successfully tendered for this project.
Work is now being carried out simultaneously at both mine sites.

Olaf Einicke

Right: Oscillating frame

Below: Continuous-casting segments

Repairing and replacing continuous-casting segments and oscillating frames calls for high-quality workmanship

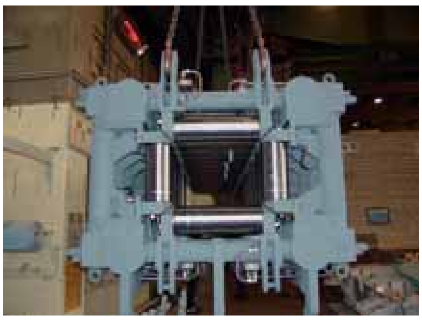
Deutsche Edelstahlwerke GmbH is a leading company in the manufacture and machining of long products in stainless and quality steel and has been a client of Technologie + Service GmbH for many years.

The Mülheim plant, where Technologie + Service GmbH also has its head office, has been carrying out repairs and overhauls on a whole range of components for more than ten years. This also includes work on continuous-casting segments and oscillating frames.

Continuous-casting segments act as guide elements in the casting process as the molten steel is transformed into solid steel ingots. The segments are intensively cooled so that heat energy is drawn from the molten steel and the solidification process is able to take place.

The oscillating frame, which generates a vibrating motion, ensures that the molten steel is transferred into the continuous-casting segments below.

Both items of equipment, namely the continuous-casting segment and the oscillating frame, have to meet the highest quality specifications, as any failure in either component during the casting process would very quickly result in serious damage from the molten steel.



Technologie + Service GmbH has over the years demonstrated its reliability by delivering consistent quality in this area. It was on account of this continuity of service that in 2007 Deutsche Edelstahlwerke GmbH commissioned Technologie + Service GmbH to supply a new oscillating frame along with two new continuous-casting segments.

The new components were manufactured in close consultation with the customer.

The units were delivered to the client on schedule and to the customary quality standards.

Customer satisfaction is often a difficult parameter to measure. Relations between Deutsche Edelstahlwerke GmbH and Technologie + Service GmbH are such, however, that the client's level of satisfaction was very quickly apparent.

It was not long after the first delivery of the new components in early 2008 that an order was received by the summer of that year for another three new oscillating frames and two new continuous-casting segments.

And there was more to come: as well as ordering these new components Deutsche Edelstahlwerke GmbH also commissioned Technologie + Service GmbH to carry out further repair work on oscillating frames and continuous-casting segments – another indication of the high quality standards that have been set.

Quality pays in the end!

Peter Arrachart

A quantum leap for Technologie + Service GmbH

Structural engineering and heavy machining under one roof

Technologie + Service GmbH has been machining steel components of all kinds for many years. This demanding work is carried out by a highly qualified and motivated workforce.

Commissions for machining work have always been limited to the maximum component dimensions of 2,000 mm x 1,250 mm x 1,250 mm. In 2005 an additional milling and boring machine was installed alongside the existing unit. However, the new machine was also restricted to handling components weighing a maximum of 6 t and of the above dimensions.

The structural engineering industry is now faced with a growing number of orders for increasingly heavy components. Generator housings of up to 100 t unit weight and inner casings with unit weights of up to 50 t are now being manufactured by structural steel builders – and the trend is for even larger engineering components of this type.

High transport charges, and the resulting delays, have gradually pushed up the production cost of individual components, with the result that Technologie + Service GmbH found it could no longer supply many items on a competitive basis. The company's aim is to increase its depth of production so that it can compete by manufacturing and selling heavy engineering pieces and specialised components at normal market prices.

After lengthy discussions Technologie + Service GmbH decided to take a bold step into the future.

In the autumn of 2008 the company purchased a new large-capacity machining centre. The operation to install this new machine is due to commence in the second quarter of 2010, as soon as the extensive concreting and foundation work has been completed.

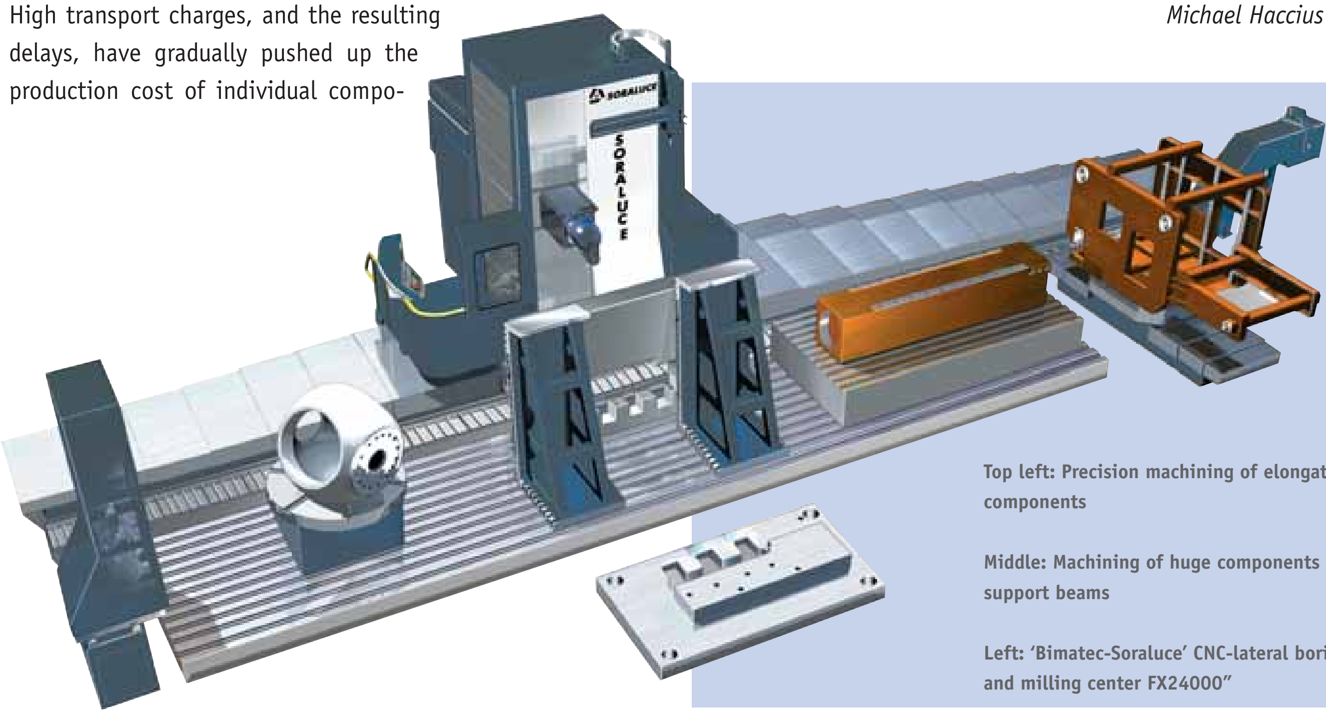
The quantum leap will have been completed by the end of the second quarter.

The new boring and milling centre has a horizontal travel of 24 m and has the mechanical capacity to machine steel and engineering components weighing up to 100 t.

In spite of the fact that order books are currently depressed due to the general economic slump in steel construction and engineering it is hoped that the start-up date for the new machine will coincide to some degree with a growth in demand for steel fabrications and machinery.

We are certain that this investment will help secure the long-term future of Technologie + Service GmbH.

Michael Haccius



Top left: Precision machining of elongated components

Middle: Machining of huge components in support beams

Left: 'Bimatec-Soraluce' CNC-lateral boring- and milling center FX24000"

www.thyssen-schachtbau.de