THYSSEN SCHACHTBAU GROUP

Report 2004

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IMPRINT

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CONTENT

Thyssen Schachtbau Group

Ladies and Gentlemen, business partners and associates, fellow workers,

Now celebrating its tenth anniversary, the 2004 edition of the Thyssen Schachtbau Report again presents a comprehensive review of the Group's achievements over the past twelve months, with examples of how the company has taken a technological lead over international competition in a number of areas. With more than four thousand employees worldwide the Group recorded an overall turnover of some € 500 million in the business year 2003, thereby successfully consolidating our market position as a highly competitive and innovative player in the mining and construction sectors – a result that has been achieved in a generally difficult economic climate and one that can be attributed to the commitment and skills diversity of all our employees Group-wide, as well as to the ongoing development of our excellent safety and environmental record.

The achievements of 2003 have justified our decision to embark on the selective geographic expansion of our business activities over the last ten years. Rising raw-materials prices, especially in the geographical markets in which we are active, have resulted in a disproportionate increase in investment volume. A long-established direct relationship with our client base, combined with geographic proximity, have proved to be key success factors for us. With the support of our four operating companies

- THYSSEN SCHACHTBAU HOLDING GMBH, GERMANY
- BYRNECUT MINING PTY LTD, AUSTRALIA
- THYSSEN MINING CONSTRUCTION OF CANADA LTD, CANADA
- ÖSTU-STETTIN HOCH- UND TIEFBAU GMBH, AUSTRIA

we are determined to move forward together to ensure the continued growth and prosperity of the Thyssen Schachtbau Group.

With our best wishes!

THYSSEN SCHACHTBAU HOLDING GMBH, DEUTSCHLAND

Thyssen Schachtbau GmbH, through its operating divisions TS Mining and TS Shaftsinking & Drilling, has been providing services to the German mining industry for more than fifty years.

Broad-based expertise supported by many years of experience in conventional and mechanized drivage and shaft sinking – techniques that can be applied to a whole range of strata conditions – has produced a continuous series of internationally-accepted engineering solutions for the coal, ore, potash and rocksalt industries, even including ventilation shafts for Alp tunnels.

The company's other two subsidiaries, Technologie + Service GmbH and Emscher Aufbereitung GmbH, operate in the primary and extractive industry sectors and also undertake special steel fabrication projects, including assembly and repair work, as well as producing pulverised fuel for one of Europe's largest steelmaker.

The company is represented in the building and construction-related sector by its two affiliates TS Bau and DIG Deutsche Innenbau GmbH, who undertake track and pipe laying, road building, structural engineering and interior installation work.

**Dr. Andreas C. Pielczyk,
Chairman of the Management Board (middle)
Dr. Cemal Cetindis,
Member of the Management Board (left)
Werner Lüdtke,
Member of the Management Board (right)**

Management of Östu-Stettin
Peter Jelitzka (left)
Hans-Günther Marchl

ÖSTU-STETTIN HOCH- UND TIEFBAU GMBH

When the long-established Austrian company Stettin Hoch- und Tiefbaugesellschaft merged with the Austria-based contractors Österreichische Schacht- und Tiefbauunternehmen Ges.m.b.H. (a subsidiary of the Thyssen Schachtbau Group) in 1995 to form ÖSTU-STETTIN Hoch- und Tiefbau GmbH the result was a new market player with a broad-ranging spread of technical capabilities.
The amalgamation of specialist know-how and highly-qualified personnel has given the company a solid basis for future success in the competitive environment of the European construction industry.

This has been due in no small part to the breadth and depth of the technical skills available in-house, which range from general contracting (most of which is undertaken by the Vienna office) to structural concrete work, bridge building and industrial construction. One of the company's main focus areas is underground engineering, including tunnelling, shaft sinking and underground rail construction projects, with the fabrication of steel formwork cars for tunnel excavations constituting another specialist activity.
ÖSTU-STETTIN has also been proving itself as a joint venture partner in major project work.
The ÖSTU-STETTIN Group includes the subsidiaries ÖSTU-STETTIN Projektbau GmbH, Leoben, Austria, STETTIN Hungaria Kft, Sopron, Hungary and ÖSTU-STETTIN Tunnelbau GmbH & Co. KG, Ottobrunn, Germany,

BYRNECUT MINING PTY LTD

Byrnecut Mining Pty Ltd, which was formed in 1987, has now established itself as a specialist underground contractor to the Australian mining industry and has grown to become the largest contracting group. The company carries out a wide range of mining activities throughout Australia and is involved in operations in gold, nickel, copper, lead and zinc mines.

Management of Byrnecut Mining
Steve Coughlan, Managing Director, (right)
Bob Evers, Financial Director

The Byrnecut Group, whose head office is in Perth, has undergone an enormous business expansion in the course of the last fifteen years. Although Perth is the capital city of Western Australia, it does not represent the focal point of the company's activities. The highly diversified spread of activities and the developing specialisation in different fields, combined with the Group's reputation as a reliable and highly competitive partner, has meant that contracts have been won in the remotest parts of this vast island continent.
While mining projects like that at Waroonga, which is some 800 to 1,000 km away, are still regarded as a "local operation", this certainly does not apply to the Mount Gordon copper mine some 3,000 km from Perth, which is the most remotely located of all the Group's activities in the region.
Byrnecut also has operations in Tanzania und Ireland. Having achieved a leading market position in Australia the company is now in the process of expanding its overseas activities to include south-east and central Asia, Africa and Eastern Europe.

Byrnecut is noted for its use of high-grade automated development and production technology. Standing contracts with a number of major mining corporations, combined with the availability of the latest mining equipment, has meant that in the course of a single year the company has driven more than 55,000 metres of roadway and extracted some several million tonnes of ore.
A dedicated business policy, which is underpinned by high-level technical and logistical know-how, has established Byrnecut Mining as a reliable contract partner fully equipped to meet the challenges of the future.

THYSSEN MINING CONSTRUCTION OF CANADA LTD (TMCC)

TMCC has been a major underground mining contractor in Canada and the USA since a small team of Thyssen Schachtbau employees was sent to Saskatchewan in 1960. The team introduced the freezing technique to sink shafts for the emerging potash industry, through the glacial till that overlies the giant deposits that have made Saskatchewan the world's biggest producer of potash.

With the potash industry reaching maturity, the focus shifted during the 1980's to the uranium deposits, which were discovered and developed in northern Saskatchewan. TMCC, with First Nations partner Mudjatik Enterprises, has been intimately involved in the development and operation of four uranium mines that produce one third of the world's uranium, whilst providing jobs, training and dividends to the remote communities of the north.

Today, in addition to the potash and uranium mines of the province, TMCC counts numerous companies from around Canada and the western US amongst its regular clients, and since it is highly renowned for its expertise TMCC is also active in places as far as Brazil and Australia. The range of services covers all aspects of underground mining, including shaft sinking, lateral development, ore production and raise drilling, as well as numerous supporting activities such as ground freezing, grouting, underground construction, and electrical and mechanical installations.

Management of TMCC
René Scheepers, President, (left)
Jim Haines, Vice President Finance

Breakthrough-Roadheader AM 85

Nine kilometres from Prosper to Hünxe

Report 2003 contained a detailed description of the roadway drivage project undertaken at Lohberg-Osterfeld colliery.

With this section of the new roadway having broken through to its target point on 5th June 2003, attention can now be focussed on the other end of the connection, which is being driven out from Prosper colliery.
Most of the drivage work has already been carried out, with some 2,004 m of the total length of 2,889 m having now been completed from shaft no. 10.

From the time the first pull was taken on 28th April 2000 to the final moment of break-through the whole project took exactly three years and one month to complete.

The roadway drivage contract also included the excavation of a 650 m-long incline with a slope of 9 degrees. This ventilation road itself has an excavated cross-section of 35 m^2 and features five-piece arch supports with full backfilling.

The main drivage equipment comprises:
- ❏ twin-boom DIG drill jumbo
- ❏ G 211 loader
- ❏ GTA type-2700 working platform
- ❏ Elefantino backfilling rig with 5 m^3 materials bunker.

The roadway drivage debris is cleared using the following items of plant:
- ❏ Ruhrkohle standard PF III. 26 conveyor with hydraulic transfer unit and alignment system
- ❏ WB 1300 crusher
- ❏ chainless ram system with face sprag device.

By the end of the project a total of 104,000 m^3 of debris had been loaded out into mine cars at an integrated loading station via a conveyor system (1000 mm-wide belt installation) and special curving conveyor designed to negotiate the 35 m-long, 102 m-radius curve.

Despite the difficult conditions occasionally encountered, especially in the Franz Haniel and Hünxer fault zones, only one loss time accident was reported over the entire three years required to drive the lateral heading to Hünxe. An impressive achievement by any standard.

A highly-efficient working cycle combined with the very professional approach taken by the heading teams has been reflected in the high standard of the finished roadway, with the project achieving an average quality rating of over 90 %.

Throughout the entire drivage operation the workplace was manned exclusively by personnel from Thyssen Schachtbau. The company provided not only the heading crews but also all the blasters, electricians, fitters, winchmen, loading-station operators, drivers etc.).

Taking the correct decisions at the right time ultimately proved to be the key to the success of the project.

Uwe Reinecke

High-performance dinting systems for gateroad recycling

Financial constraints dictate that gateroads serving long panels have to be re-used, with the old loader gate becoming the tail gate in the new panel. For a number of years now Thyssen has been providing a very successful roadway repair service for the gateroad recycling programme employed at Lippe colliery.

SELECTION CRITERIA

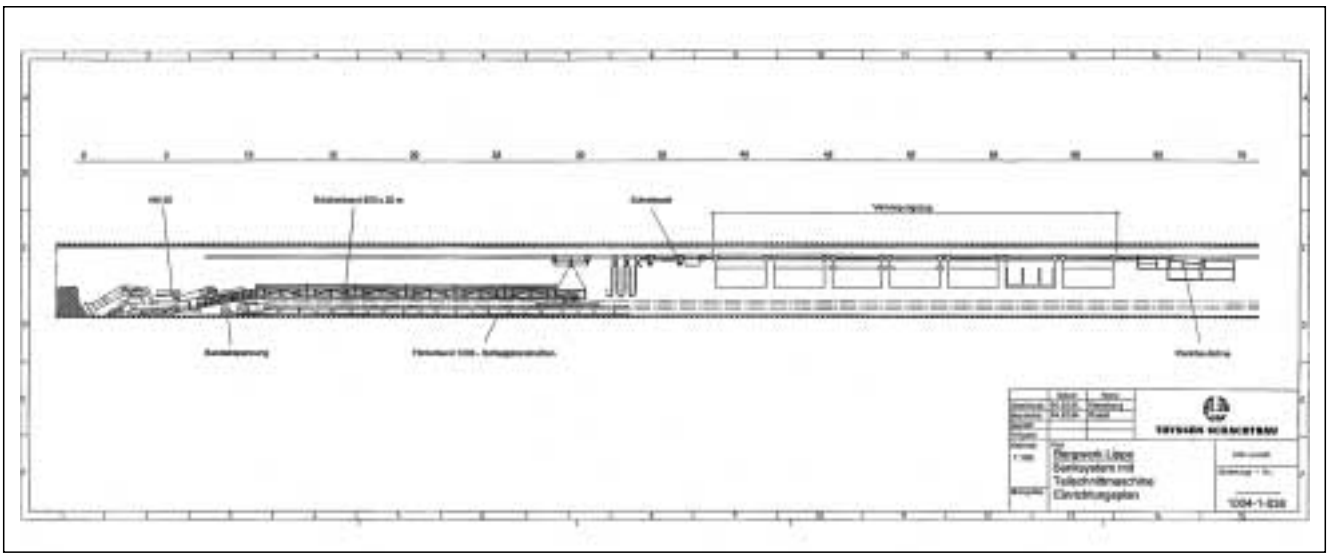
These dinting operations have been carried out using roadheaders like AM 50, AM 75 or AM 85. When choosing a pantechnicon system it is vital to select equipment that is compatible not only with the strata conditions and rock strength characteristics but also with the floor width and available headroom, the deformation rate of the arch supports and the arch-stilt setting.

The main components that go to make up the dinting installation are: the road-header, the bridge conveyor and haulage system, the cable storage unit and the electrical devices.

REQUIREMENTS FOR A DINTING SYSTEM

Dinting operations involve a whole range of different tasks, depending on the condition of the roadway being repaired. Supports that have sunk on the face side, for example, have to be extended, while roadway dinting can also entail peripheral repairs such as the addition of lagging mesh and the replacement of defective arch elements.

Areas where the arches are severely deformed may have to be fully renovated and when the damage extends over a longer stretch of roadway the profile section may even have to be completely reconstructed.



PERFORMANCE REQUIREMENTS FOR THE DINTING SYSTEM

The timetable for the roadway repair operation will depend on the amount of work required to disassemble the old face installation and set up the new face. The roadway repairs have to be concluded by the time the new face is ready to start up, in other words the dinting work must be completed, the supports must be functioning correctly and the conveyor and rail tracks must be fully installed.

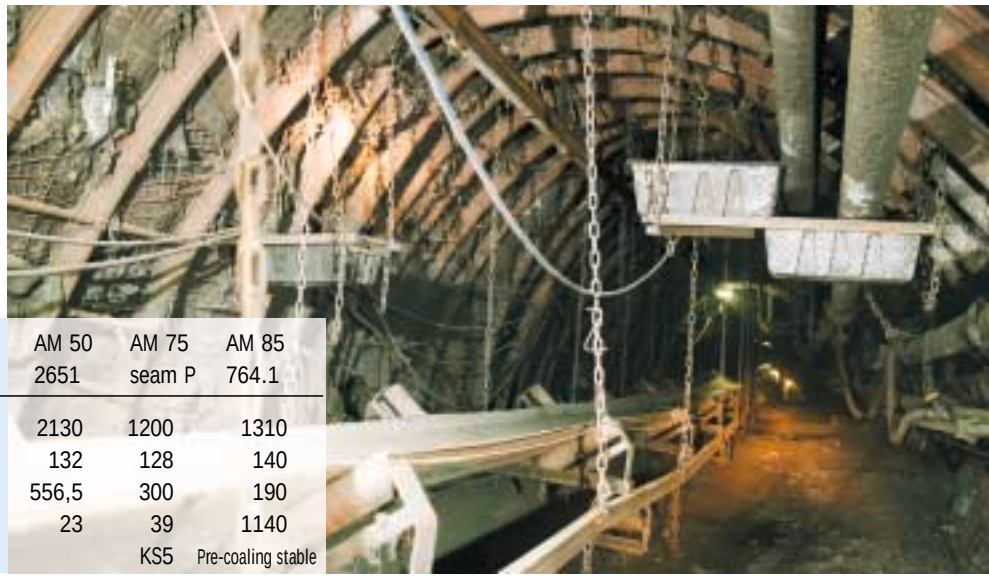
High-performance systems therefore have to be deployed if maximum use is to be made of the time-slot available for the repair work.

The reference projects listed here confirm the high performance levels achieved from current dinting installations.

Deploying equipment of this kind at the earliest possible moment ensures that the new production face will have access to a fully-functional infrastructure. There is no doubt that high-performance dinting installations of this type have made double-use gateroads a very viable proposition.

Dipl.-Ing. Dieter Meiworm

	AM 50 2641	AM 50 2631	AM 50 D2C	AM 50 2651	AM 75 seam P	AM 85 764.1
Dint length (m)	2285	1407	892	2130	1200	1310
Dinting time (days)	127	132	91	132	128	140
max. m / month	503	380	253	556,5	300	190
Part-repairs (m)	84	112	91	23	39	1140
Special features			KS6		KS5	Pre-coaling stable



Underground plant engineering to nuclear-compatible specifications

In recent years TS Shaftsinking and Drilling has carried out numerous projects for the Morsleben radioactive waste disposal site, which is operated by DBE - the German company responsible for the construction and operation of repositories of waste materials.

Regarding execution and safety technology in a nuclear facility most of these projects have involved the construction of underground plant for nuclear-related installations that are bound by stringent nuclear-safety requirements.

BACKGROUND

The Morsleben repository for radioactive waste lies east of Helmstedt in Saxony-Anhalt and is located in the salt dome „Oberes Allertal“. The disposal facility includes the mines of Marie and Bartensleben, which were excavated in the early 20th century for the extraction of potash salt, whereas Bartensleben was later used primarily for the mining of rock salt.

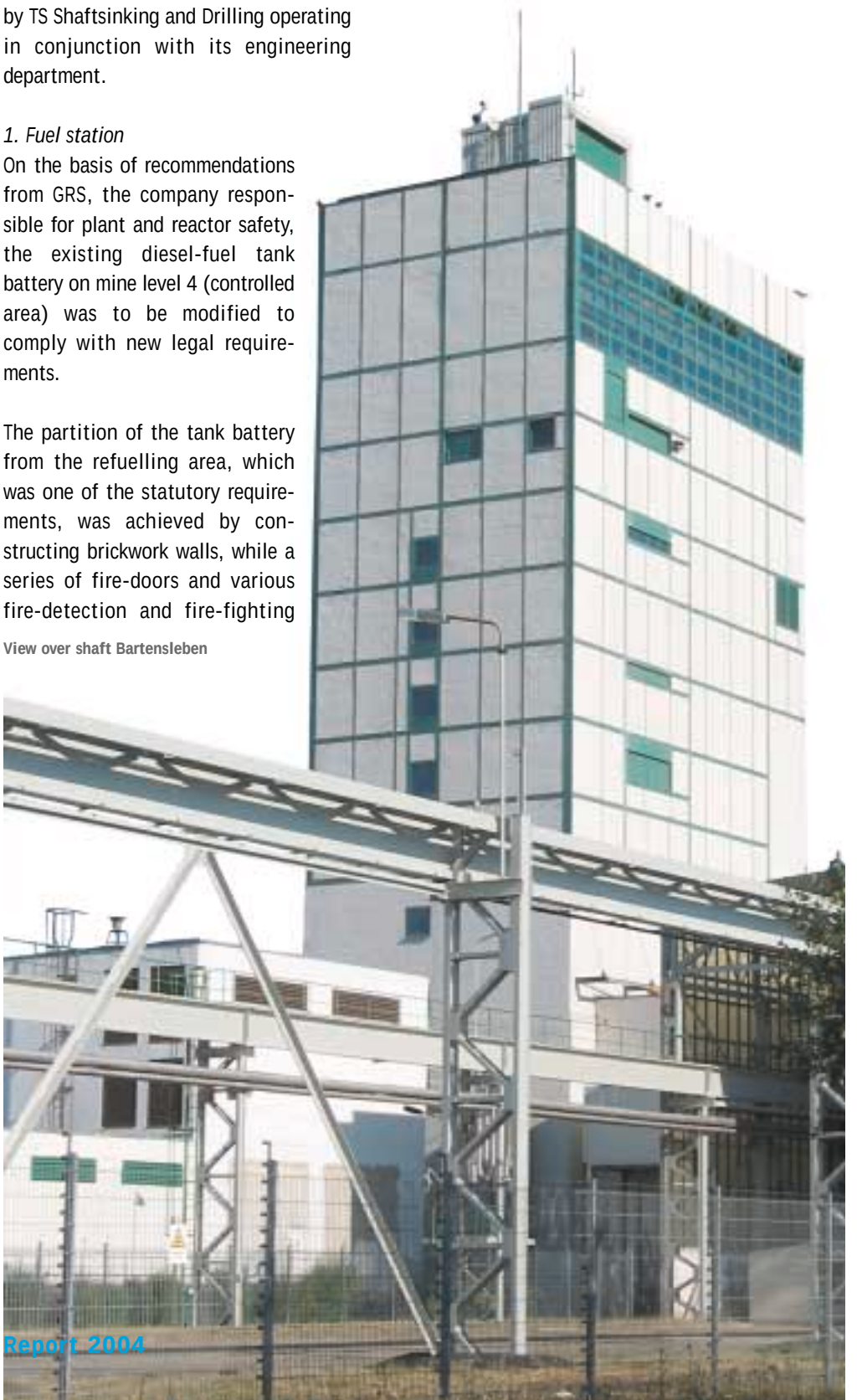
In 1971 approval was given to use the cavities on mine level 4 for the disposal of radioactive waste. The facility's operational phase came to an end in 1998.

The nature of the underground engineering work carried out at Morsleben is illustrated below by way of three projects that have been successfully executed by TS Shaftsinking and Drilling operating in conjunction with its engineering department.

1. Fuel station

On the basis of recommendations from GRS, the company responsible for plant and reactor safety, the existing diesel-fuel tank battery on mine level 4 (controlled area) was to be modified to comply with new legal requirements.

The partition of the tank battery from the refuelling area, which was one of the statutory requirements, was achieved by constructing brickwork walls, while a series of fire-doors and various fire-detection and fire-fighting systems were installed in order to comply with the relevant fire-protection regulations.



View over shaft Bartensleben

Access to tank battery

A total of ten rate-of-rise detectors (six for the refuelling area and four for the tank battery) were installed for fire detection purposes.
The fire fighting equipment comprises two foam extinguishers – one for the refuelling area and one for the tank battery. A special feature of this system is that it uses shaft water fed in under hydrostatic pressure, with the result that the extinguishers can be operated without the need for pumps or an additional water tank.
Thermal fire detectors link these extinguishers to the instrumented monitoring system already installed at the facility. In the unlikely event of a response by the detectors an audible warning sounds in the mine control station as well as being displayed as a clear-text message. The fire extinguishing procedure itself can be initiated by activating the sprinkler-heads from the central fire alarm station located on mine level 2.

After a thorough testing and commissioning phase the tank battery was approved for use and handed over to ERA Morsleben on 26th October 2001.

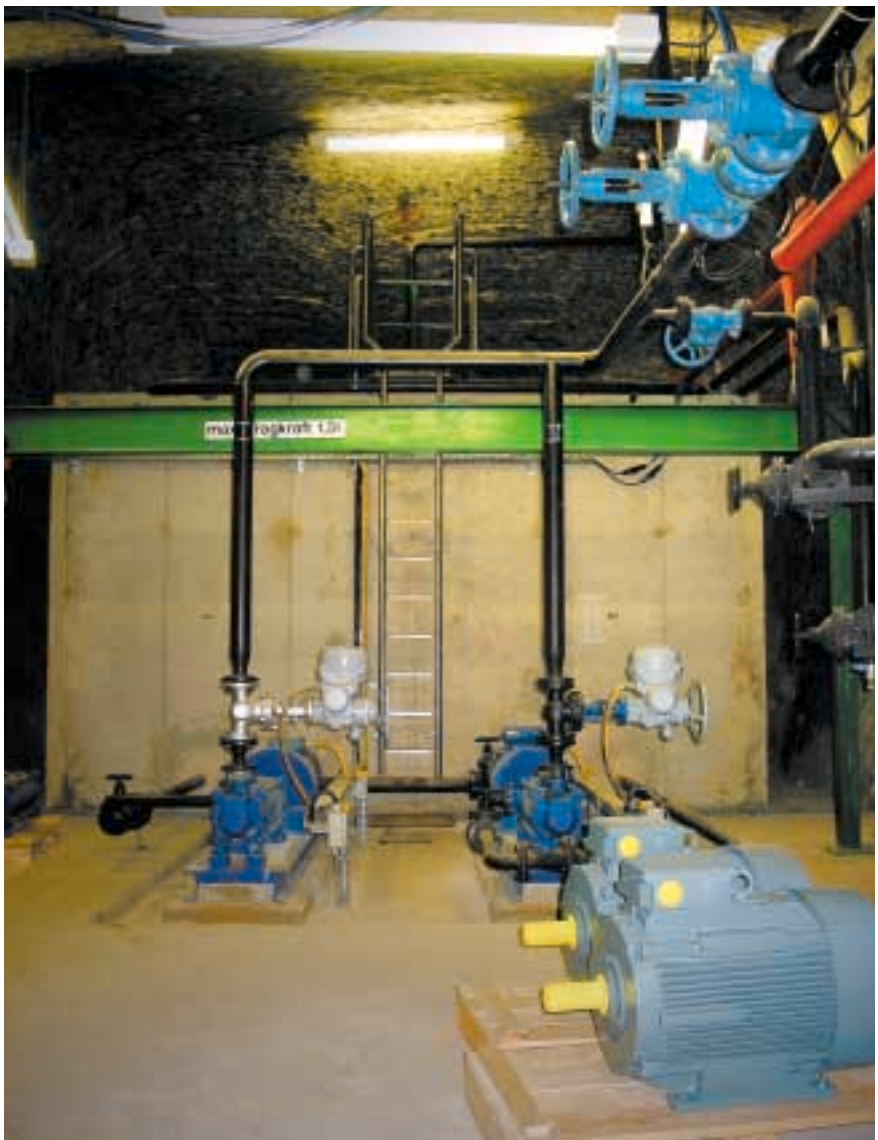
2. Bartensleben water pumping system
The Bartensleben water pumping system was during the development of the project initially set up on mine level 1 and was subsequently transferred to mine level 3. Then in the mid-70s it was moved back to level 1.

In early 2000, during scheduled inspections, an overall became necessary. As a full overhaul would have been very expensive, and would have had a relatively limited technical chance of success, the only alternative was to construct a completely new system. This was to be modelled on the mine dewatering system recently installed by Thyssen Schachtbau GmbH in the Marie shaft. However, in view of the low inflow rate in the Bartensleben shaft (about 8.4 m^3/day has been recorded over a period of years) its water collector tank was a smaller one.

The new dewatering system is located on mine level 2 at a point north of the main shaft and outside the shaft safety pillar. The excavation work required for the chamber itself, which measures 18 m in length by 6.8 m in width by 5.3 m in height, was carried out by the mine.

The drainage system primarily consists of two water collectors with a total capacity of approximately 76 m^3, which both stand on a concrete base. To achieve complete water tightness the collectors are constructed as welded sheet-steel

Dewatering system with pumping station



Conditioning plant

tanks, which are supported by an outer ring of reinforced steel concrete designed to withstand the water pressure. The inner surface of the tanks is completely lined with cement clinker as corrosion protection against the slightly mineralised mine water.

Two 12-stage centrifugal pumps, each delivering 12 m^3/h, were required in order to pump the mine water to the surface from a depth of about 424 m.

As mentioned in the description of the tank battery (see above), the underground fire extinguishers were incorporated into the pipeline system. This particularly suitable arrangement means that fresh water can be fed in from the surface to supply both the main-shaft extinguishers and the tank battery extinguishing system.

After a four-week trial period the new Bartensleben water pumping system went into service in November 2003.

3. Stabilisation plant

In the spring of 2000 a call to tender was issued for the planning and construction of a stabilisation system for the conditioning of liquid radioactive waste. This plant was required in order to treat liquid waste in temporary storage since 1990 and was to comprise an agitator device that would allow the material to be mixed with cement and then set hard into drums for subsequent final storage using tried and tested waste deposition techniques.

Conditioning plant: cold test run

After the contract was awarded in September 2001 the planning documents then had to be prepared for a first inspection by ERAM. These documents then had to go through an approval process by the BfS (Federal Office for Radiation Protection) and other relevant authorities. Once the plans had been released in November 2002 Thyssen Schachtbau GmbH was awarded the contract to execute the work.

The stabilisation plant is partly located in one of the facility's restricted areas, which means that it comes under a higher security rating. The installation therefore has to comply with all relevant statutory provisions pertaining to controlled activities involving external plant and equipment (Clause 15 of the Radiation Protection Order).

The complexity of the system meant that the extensive assembly stage could not be completed until early April 2003. Progress was not helped by the fact that the new installation had to incorporate an existing and non-modifiable unit that was designed for the reception of liquid waste.
During the subsequent "cold test run" a number of regulation and process-control adjustments had to be made to the system; further fine-tuning was also needed in the course of the phased commissioning period.

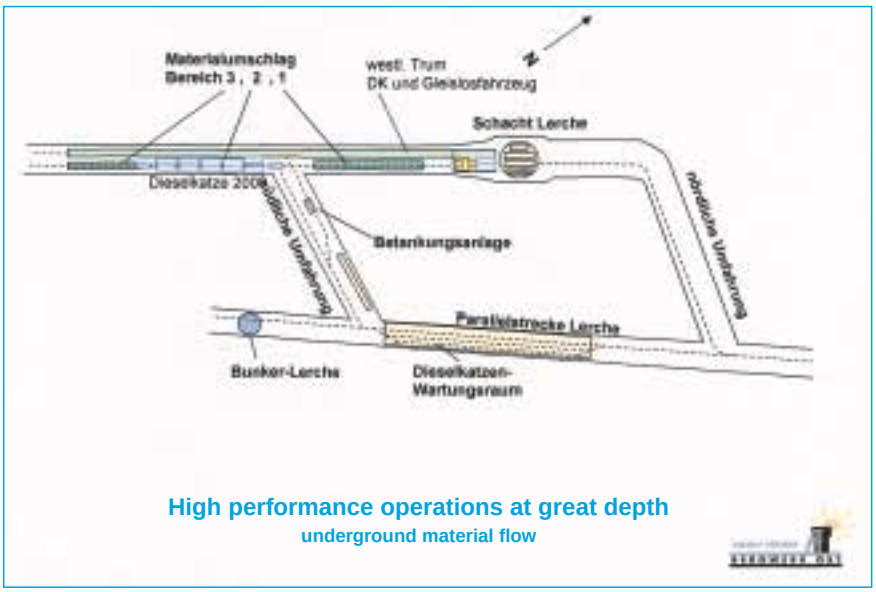
As this was the first time such a stabilisation system had ever been used, the installation can justifiably be described as a "pilot plant".

Once the "inactive trials" (with water as the operating medium) have been successfully concluded the installation will be handed over to ERAM and the existing plant incorporated into the new system in the course of 2004.

Dipl.-Ing. Tilo Jautze
Dipl.-Ing. Ulrich Berghaus
Dipl.-Ing. Andreas Koch

New supply road for Wilhelm seam

The Wilhelm seam at Deutsche Steinkohle's OST COLLIERY has been the focus of development work since late 2002. A number of panels have been planned and several have already been equipped for high-performance coal winning. If the production targets are to be met, the existing infrastructure will have to be adapted accordingly – and this requires driving a new materials haulage road from Lerche shaft to the seam horizon.



High performance operations at great depth
underground material flow

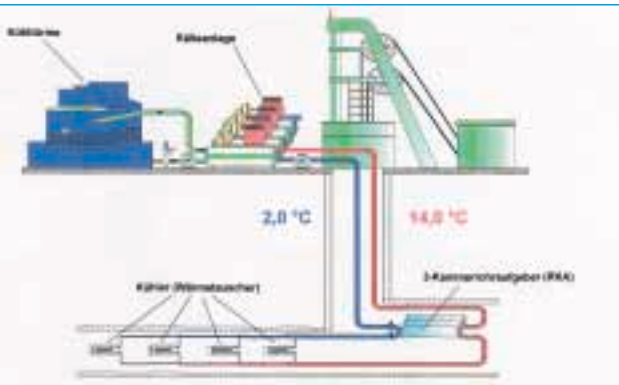
The materials haulage road has to perform the following functions:

- ❏ It must provide sufficient transport capacity to meet the needs of roadway drivages and production faces, as well as for face equipping and general operations. The decline therefore has to be equipped with a twin-track system to provide a two-way haulage service.

- ❏ It must ensure uninterrupted man-riding from Lerche shaft, via a separate platform, as far as the decline, from where a twin-strand belt conveyor (manriding on top and bottom belt) takes the men to the Wilhelm seam without impeding the normal transport arrangements.

- ❏ It must provide sufficient fresh air not only for the workforce but also to allow a reduction in the air velocity in the coal loader gate. The increased airflow will also give better CH_4 dilution.

- ❏ It must have sufficient space to accommodate large-diameter pipes for the supply of compressed air, water



High performance operations at great depth
central cooling plant of Lerche Shaft

Band conveyor-transfer point

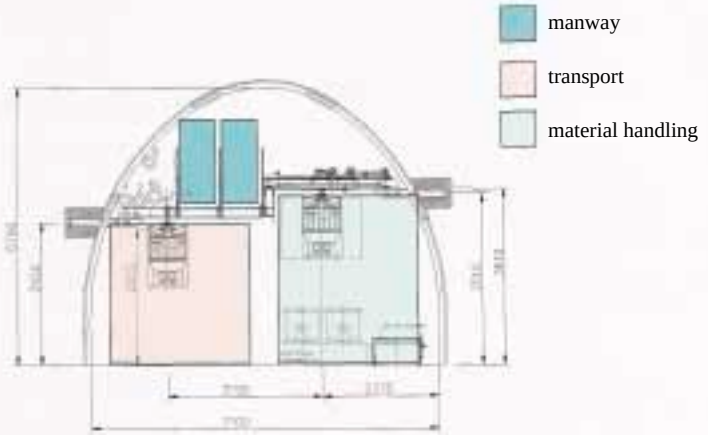
Material transport

Picture right: Transport drift

NEW SUPP

and cooling medium. With local rock temperatures exceeding 60° C an efficient cooling system is required to maintain an acceptable working environment. The new haulage road will provide a low-loss airway by which all the production panels can be supplied from the surface-mounted central cooling plant, which has a rated output of 20 MW.

❑ It must be suitable for the transport of backfill material and for energy and data transmission. The surface installation delivers the backfill material to the workplace batchplant via a series of underground transit stations. Between 600 and 800 Nm³ of compressed air is required for each tonne of material used, i.e. for both transport and processing operations. To manage the complex cycle of operations without interruptions a permanent display, analysis and control is necessary.



High performance operations at great depth
functional sections of the Material Level Lerche

SPECIAL EQUIPMENT DESIGNED FOR HIGH PERFORMANCE

The tough requirements being imposed on the drivage project meant that a lot of thought had to be given to the selection of the road drivage equipment. The choice finally fell on the following items of plant and machinery:

1. G 210 side-discharge loader with high transmission ratio gearbox. Because of the need for uphill runs with a full scoop-load the vehicle's power transmission system had to be designed for high-performance rapid loading operations.

2. Single-boom drill jumbo for fast and reliable blasthole drilling. The very compact sandstone strata encountered in the heading was the determining factor for equipment selection.

3. The Elefantino backfilling system is capable of delivering approximately 21 m³ of material an hour. The installation is supplied from a 6 m³ integrated bunker.

Pictures above:
Differnt scenes of drift construction

PLY CHANNEL

4. The Adam conveyor installation, which features a 26 x 32 twin outboard chain assembly, and the WB 1300 crusher, with its chainless advancing system, are both extremely rugged and heavy items of equipment that could not possibly be moved forward using conventional means. Although this plant is very costly to assemble and to transport, once it has been commissioned the system is very easy to maintain and service. Although built for the toughest conditions, the chain assembly along with its drive and return shafts had to be replaced after about three months of service. This severe wear and tear can certainly be attributed to the very hard and abrasive sandstone debris.

5. The air-driven working platform, a well-proven design of the type employed at Heinrich-Robert colliery, is equipped with four climbing trolleys. This extremely reliable, service-friendly unit requires no electric power supply.

By carefully selecting and matching the different items of operating equipment a high-performance drivage installation was created that in the hands of a highly-trained workforce was capable of achieving average advance rates of 4 m/d.

CONCLUSIONS AND FUTURE OUTLOOK

In spite of the difficult geological conditions excellent performance rates were achieved and the work was brought to a successful conclusion. The completion of the new materials road will provide Ost colliery with an extra supply route that is large enough to meet the needs of the coal production at the Wilhelm panels.

Dipl.-Ing. Reinhold Neukart

Drift construction

Gorleben No. 2 shaft refurbishment

Mini manwinding cage after refurbishment

In July 2003 the Gorleben shaft project joint venture was contracted by the DBE (the company responsible for the construction and operation of toxic-waste disposal facilities) to replace the existing 3-deck conveyance in Gorleben no. 2 shaft with a single-deck working platform and to refurbish or replace the existing shaft and shaft-bottom covers.

SCOPE OF WORK

No. 2 shaft at Gorleben mine, which serves as an access route for the exploration of the Gorleben salt stock, is equipped with a lightweight manwinding system (mini manwinder) and a working platform.

The 3-deck non-guided conveyance, which was controlled by four scaffold winches, operated between the 820 m level and the shaft bottom area.

When "parked" at the 820 m level the platform also served as a limit stop for the manwinding system.

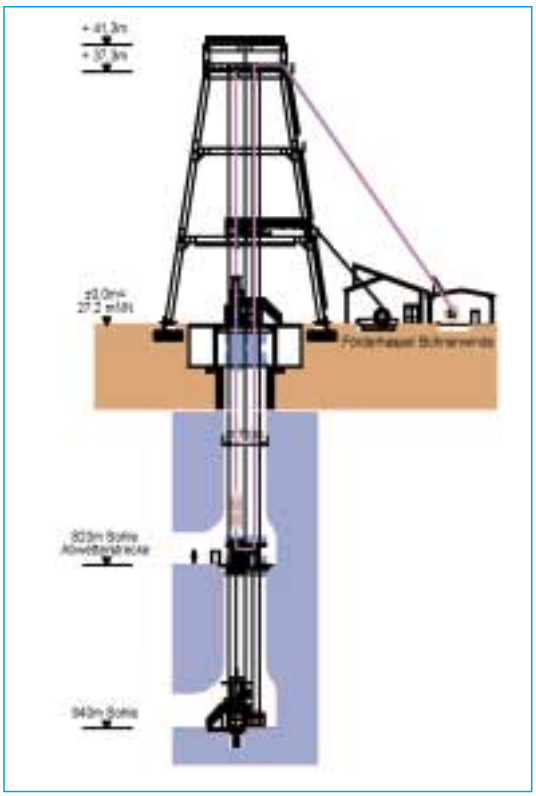
As the platform was very costly to operate in terms of time and manpower, the DBE commissioned the shaft consortium to design, construct and install a new single-deck, rope-guided installation.

The new platform, which measures 7 m in diameter and weighs a total of 17.5 t, is carried on three ropes and operated by a single winch.

The mini-manwinding cage, which before had been free to rotate on its rider, was now to be positively guided by two ropes using a system of guide-shoes fitted to the top and bottom frame; this meant that it would be free to travel through the platform.

For cost reasons it was decided to re-use the old platform winch ropes to make up the five guide ropes required for the new installation (three for the platform and two for the cage). This meant that the ropes had to be shortened in length before being fixed securely into the shaft head frame and attached with counterweights to their bracing points at the 840 m level.

Guide-rope tension weight with guide frame at the 840 m level



Overview of mini manwinder and platform installation

During the shaft and headgear renovation phase the existing shaft and shaft-bottom covers, which measured about 350 m² and weighed 98 t, had to be completely dismantled and replaced.

FABRICATION, DELIVERY AND ASSEMBLY

After the planning preliminaries had been completed and all necessary factory documents and approval permits prepared by the TS Shaftsinking and Drilling drawing office, TS Technologie + Service GmbH (T + S) and its joint-venture partner Deilmann-Haniel were able to proceed with the fabrication of the individual components (working platform, counterweights, shaft cover, etc.).

After the first of the new components had been delivered, the site work commenced in early September 2003 with the dismantling of all existing equipment no longer required, followed by the installation of the new parts.

First, the manwinding cage was removed and sent to T + S for modification.

After the shaft inset at pit bank had been dismantled the shaft cover in the vicinity of the working platform was opened and the existing 3-deck conveyance removed section by section. The bottom deck was subsequently set on supports at the mouth of the shaft to act as an overhead screen during the headgear rebuilding phase.

As part of the headgear conversion work the existing scaffold ropes had to be manoeuvred into their new position as guide ropes and then relocated in the headframe.

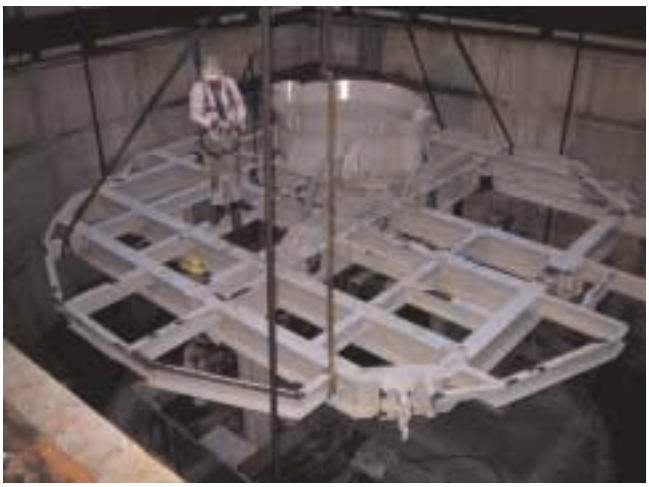
After the part-assembled replacement platform had been delivered to the site the lower deck of the old conveyance was removed and the new unit with its four retractable keps was then installed at the mouth of the shaft.

Once the new platform had been fully assembled at the top of the shaft the modified shaft cover was installed along with the refurbished manwinding cage.

One of the four existing platform winches was given a general service and overhaul, fitted with a Lebus rope reel device and installed on a new set of mountings.

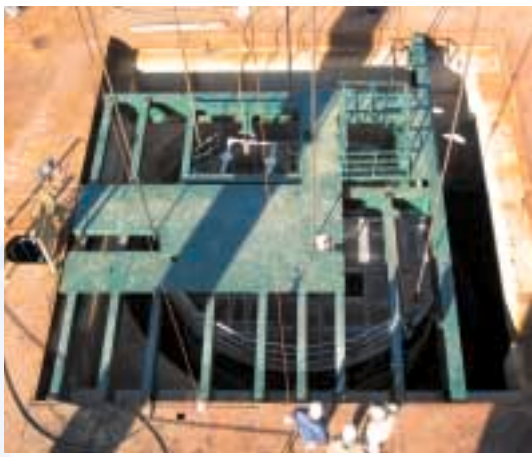
As the surface reconstruction work was being carried out the counterweights and guide frame had to be installed at the 840 m level and the guide ropes pre-tensioned so that the buffer brackets could be fitted once the work had been concluded at the bottom landing, which was in fact the platform parking position at the 820 m level.

The last of the operations to be carried out above ground comprised the assembly of the new shaft bottom cover and the renovation of all the electrical components.



Picture left: Assembling the overhead protection with intake gate for the mini man-winder on the single-deck working platform at the mouth of the shaft

Bottom picture: Overhead protection being assembled on the single-deck platform at shaft mouth



Installing the new shaft cover from the protective roof of the single-deck platform

All the mechanical and electrical equipment was then examined and approved by the Mines Inspectorate and the TÜV Nord (Technical Control Board) and the refurbished winding installation subsequently went back into service in mid December.

Rainer Lietz
Peter Nowack

REPORT – HOT TOPICS

New bunkers for Ensdorf colliery

Over the next two years Deutsche Steinkohle's Ensdorf colliery plans to construct four coal bunkers in the Primsmulde production field so that the existing cost-intensive and uneffective coal conveyance circuit can be improved by a new product transport system. This coal bunker project will in conjunction with the Primsmulde ventilation shaft help safeguard the medium and long-term future of Ensdorf colliery.

Bunker no. 10 will be 65 m deep and will have a finished diameter of 9 m, while bunker no. 12 will have a depth of 14 m and a finished diameter of 7 m. Both bunkers are to be excavated conventionally using the pilot-hole method and will be supported by a single-shell shotcrete lining in B 25 grade concrete with systematic rockbolting.

The 125 m-deep coal bunker no. 11 is to be constructed by the mechanized shaft boring technique. This technique was considered to be less expensive and less time consuming than the conventional sinking on advance borehole.
The bunker projects mean that the Ensdorf bunker joint venture (under the technical leadership of Thyssen Schachtbau GmbH) will be actively engaged at Ensdorf colliery until the second quarter of 2005.
A detailed account of this work will be given in REPORT 2005.

Erhard Berger

Deepening Prosper 10 shaft

In August 2003 TS Shaftsinking and Drilling, as technical leaders of the joint venture, was contracted by DSK to deepen Prosper no. 10 shaft in the Haniel West field of Prosper Haniel colliery. The plan is to deepen the riding and material shaft currently used down to mine level 6 by some 296.5 m using the technique of conventional full face sinking.

A protective temporary shaft plug is to be set up in the shaft sump so that by April 2004 work can begin below it on sinking through the 9 m-thick shaft pillar to create a connection to the newly-excavated shaft undercut. The sinking equipment will then be installed at this point.
The 50 m-deep foreshaft will be excavated in two sections. The sinking equipment will then be fully assembled so that the final concrete lining can be installed using a formwork system.
The new section of the shaft will eventually feature two insets, though these are not yet included within the scope of the contract. The entire project is expected to take to early or mid 2007 to complete.
A detailed account of this work will be given in REPORT 2005.

Erhard Berger

New connecting roadway for Teutschenthal mine

In 1996 the former potash mine of Teutschenthal suffered a serious rockburst incident which completely destroyed some 2.5 km^2 of mine workings within the space of a few seconds. The facility, which is operated by Teutschenthal Sicherungsgesellschaft mbH & Co.KG, now requires a new emergency escape route and airway between the Angersdorf and Teutschenthal takes in order to meet the statutory obligations for underground maintenance.

Before the new roadway could be excavated the existing Halle shaft, which was not fully functional, had to be refurbished and retrofitted in order to upgrade its winding system and in-shaft fixtures.

In March 2003 the Angersdorf consortium, consisting of partners Thyssen Schachtbau GmbH and Schachtbau Nordhausen GmbH, was awarded the contract to carry out this challenging major project.

The renovation and retrofitting work in the Halle shaft can be summarised as follows:

- Shaft safety measures, namely reconditioning the shaft lining and renewing seals to prevent water ingress.
- Installation of fittings for a heavy-duty winch to allow the in-shaft transport of machinery and equipment for roadway drivage operations.
- Installation of a new central man-winding system with a rope-guided cage conveyance. Converting the existing shaft winder to serve as an auxiliary winding installation. Modification of the headgear and alteration of the shaft insets; installation of new a signalling system.
- Fitting of new shaft cables and installation of an auxiliary ventilation system comprising two sets of shaft ducting each 1200 mm in diameter.

As part of the planned mechanised drivage operation a number of mine-infrastructure chambers in and around the shaft pillar zone first had to be excavated by drilling and shotfiring and then fitted out. This included widening and equipping the shaft inset for the subsequent assembly of the heavy-duty heading machines and constructing a transformer station, a fuelling and oil-storage area and a materials depot.

The connection between the Angersdorf and Teutschenthal districts is being driven out from the Angersdorf end as a single rectangular-profile roadway 5.2 m wide and 3.5 m in height and the new tunnel will mainly lie in the floor section of the rock-salt horizon. As the drivage connects up with the Teutschenthal district it will pass through a 240 m section comprising main anhydrite and grey salt pelite strata.

The drivage will be routinely monitored by drilling a series of geophysical survey holes in order to ensure that the specified safety interval of 5 m is maintained between the tunnel and the base line of the rock-salt horizon.

The first cut for the new tunnel was officially celebrated on 5th December 2003 in the presence of project patron Petra Wernicke, the Agriculture and Environment Minister of Saxony-Anhalt.

The 3,840 m-long connection is being driven by a Voest-Alpine AM 75 road-heading machine delivering 200 kW at the cutting head.

Safety measures include the provision of a mobile emergency chamber, which offers protection for up to ten persons.

Two dump trucks each with a payload capacity of 10 m^3 will transport the heading debris to the old stowing cavities. New access roads with a gradient of 1 in 6 will first have to be driven to facilitate this transfer.

A scaling vehicle will be deployed to remove the loose material from the roof and side-walls in order to increase the stability of the working chambers, some of which have been in existence for many years.

As the new connection is required as a matter of some urgency, the contractors have been set a very tight completion deadline of 30th April 2005.

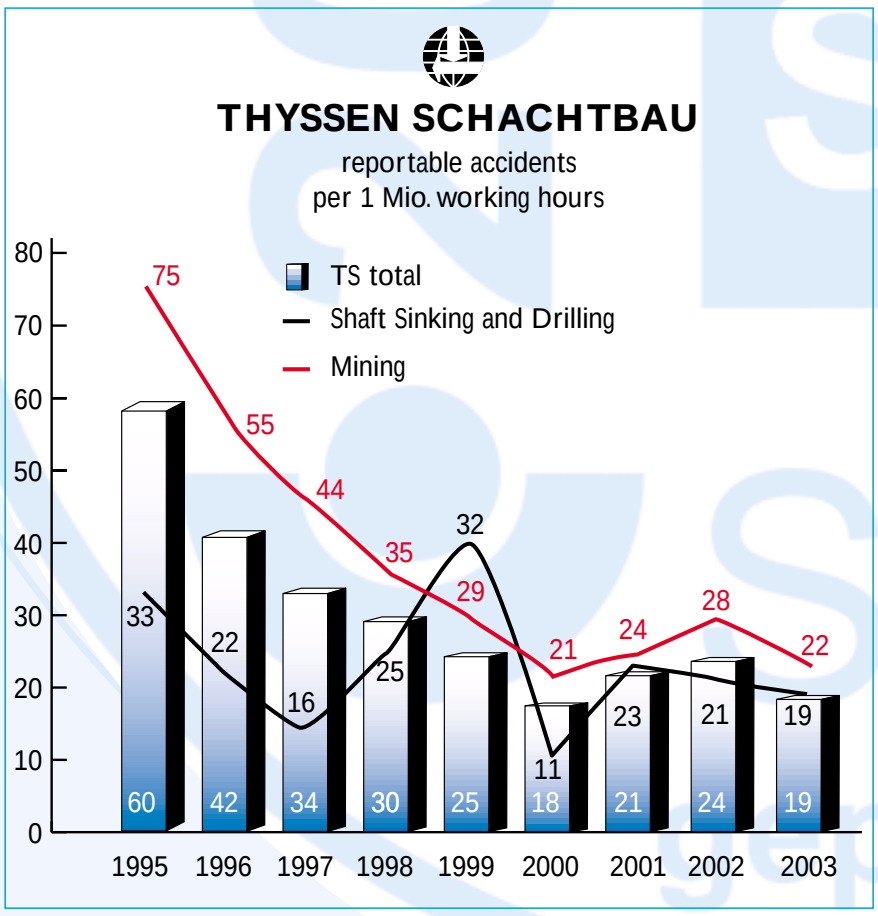
The project will be described in detail in REPORT 2005.

Dr Helmut Otto

So close to the record

With just 19 notifiable incidents recorded per million hours worked, the accident figures for 2003 just failed by a single point to beat the company's best ever performance of three years before. We were that close to setting a new all-time record.

A number of projects being carried out by Thyssen Schachtbau's two operational divisions, namely Mining Division and Shaftsinking and Drilling Division, were accident-free for months on end – and in fact neither the drilling nor the shaft-construction departments of TS Shaftsinking and Drilling recorded a single notifiable accident during 2003, making them the best-performing of all the Group's operational branches. While none of the mining division's operations could match this impeccable performance, the accident figures for four of the branch's six projects were below the division's target of 19 notifiable accidents per million hours worked.



ACHIEVEMENTS REWARDED

The successful implementation of our work safety programme has also been acknowledged in other places. At a ceremony organised by the BBG (the Mining Industry Employers' Association) to celebrate outstanding achievements in industrial safety the relevant section heads and the safety coordinators of our operating stations at OST, LOHBERG and LIPPE collieries accepted special safety certificates and financial rewards from the BBG Board of Trustees – honours that will be passed on to their respective workforces. Since 1999 TS operations divisions have therefore been winners of the 11th, 12th and 13th awards for outstanding achievements in industrial safety.

NEW OBJECTIVES

The Safety Planning Team, which is Thyssen Schachtbau's senior safety body, has drawn up an ambitious set of new goals for 2004 based on the previous year's performance. The accident target for 2004 has been set at a figure of 17 for the mining department and 10 for the shaft sinking and drilling section. On the basis of these thresholds Thyssen Schachtbau has laid down an annual target quota of 15 notifiable accidents per million hours worked.
The objective of the safety programme, namely to meet the target for notifiable accidents and at the same time to reduce by at least the same amount the number of shifts lost through injury and the resulting costs, was achieved in spectacular fashion in 2003 by a set of results that were 30% better than the previous year's total. This was a major success in

WORK SAFETY

sector cost-management terms and a clear indication of the economic importance of having an accident-free workplace.

THE SMS PROJECT

In order to promote safe working practices and to ensure that by clearly identifying the starting-line performance further improvements can be made through 2004 the Management Board and the divisional managers have decided to take part in the **SmS (system-based safety)** project that has been developed by the BBG. The performance of the different operating units will now be audited until the end of the second quarter of 2004 – and those sectors that pass the test will receive the Seal of Quality of the Mining and Quarrying Employers' Association, which will be awarded in the summer of 2004.

This process will mark the high point in Thyssen Schachtbau's programme for the consolidation of safety standards and will represent the successful culmination of all the industrial safety work put in over the years.

Implementing the Thyssen Schachtbau Safety Standard at all workplaces operated by the Mining and Shaft-sinking/Drilling divisions will always mean having to confront new challenges – and this applies not just to managers and employees but also to the staff of the company's health and safety department.

Dipl.-Ing. Thomas Sievers

Tubbings

„Safety first“ policy reduces LTI Frequency to 4.6!

Thyssen Mining Construction of Canada Ltd works hard on continually improving its safety record and exceeding the current industry trends. TMCC has long been aware of the importance of a good safety program morally and economically, and has developed a program that creates a focus on having ”Zero“ incidents in the workplace.
The Thyssen Safety Management Plan has been in place since 2000, and provides the tools and framework to, over time, turn a good safety program into great safety results. We can only accomplish this by ensuring that our employees are well trained in tried and true mining methods as well as the latest technology. As illustrated below, our statistics have shown a trend toward a reduced accident frequency, as well as less severe injuries.

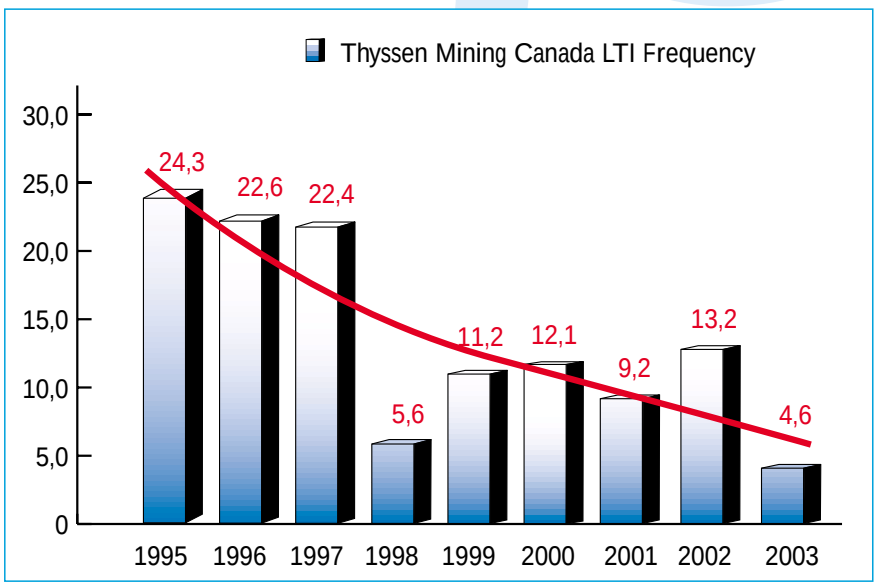
SAFETY POLICY

Our Safety Policy has been our guide to ensure we remain attentive to our most important natural resource – our employees.
Thyssen Mining Construction of Canada Ltd. is committed to a strong safety program that protects its staff, its property and the public from accidents. ***There is no task that cannot be done safely and TMCC is committed to ensuring that this philosophy is implemented across all of our operations.***
Employees at every level are responsible and accountable for TMCC's overall safety initiatives. Complete and active participation by everyone, every day, in every job is necessary for the safety excellence the company expects. Management supports coordination of safety among all workers at the job sites.
Management supports participation in the program by all employees and provides proper equipment, training and procedures. Employees are responsible for following all procedures, working safely, and wherever possible, improving safety measures.

An injury and accident free workplace is our goal. Through the implementation of the ”Thyssen Safety Management Plan“ we can accomplish this.

Safety is NOT a thing we do; Safety is the way we do a thing!!

Dave Speerbrecker
Safety Manager



Hunting for Diamonds in Saskatchewan

At present, there is both excitability and sparkling interest in the exploration ventures by several companies and the possibility of eventual diamond mines in east-central Saskatchewan, Canada.

INTRODUCTION

The Saskatchewan diamond play began back in 1988 beginning near Sturgeon Lake where blocks of kimberlite were discovered in a gravel pit. This find resulted in a staking rush that included nearly 2 million acres close to Prince Albert.

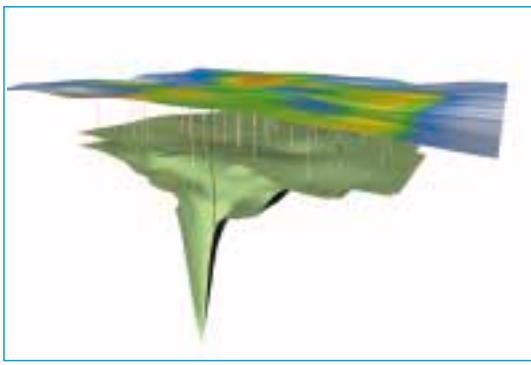
Located approximately 65 miles east of Prince Albert, hidden in the Fort a la Corne forest, lie some of the biggest kimberlite bodies in the world. Early exploration and delineation drilling was performed by a number of different companies who have staked property in the area.

Shore Gold Inc., a Canadian-based corporation engaged in the acquisition, exploration and development of mineral properties, is one such company whose work has led to a much better understanding of the potential of these diamond bearing kimberlite bodies.

THE STAR KIMBERLITE PROJECT

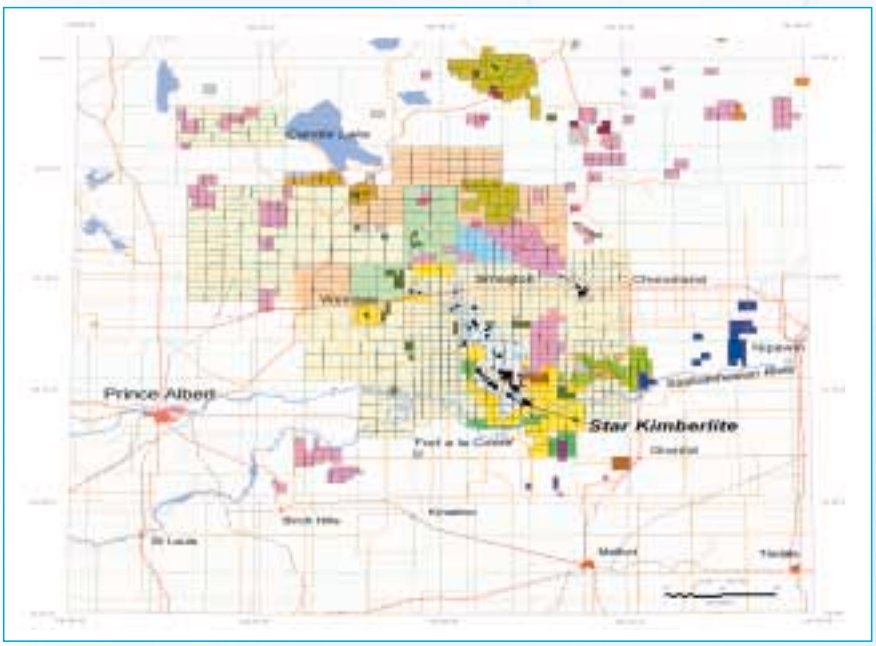
Shore Gold owns 100 % of the Star kimberlite project, located at the southern end of the Fort a la Corne belt. Shore Gold acquired the 46 square kilometer area in 1995 and holds other mineral claims covering some 226 square kilometers in the immediate area.

Further exploration and delineation drilling proved favorable results leading to the discovery of the first-ever feeder zone in Fort a la Corne. One of their drill holes intersected 539 meters of vertically continuous kimberlite. Preliminary estimates have the Star kimberlite covering almost 4 square kilometers with an average thickness of 88 meters (excluding the deep intersection of 539 meters) and exceeding 500 million tons of micro-diamond bearing and macro-diamond bearing kimberlite. The Star kimberlite property consists of 15 contiguous mineral dispositions totaling 4,608 hectares. All holes drilled within the Star kimberlite have returned micro and macro diamonds, the majority being clear with no inclusions and exhibiting good crystal form.



3D image of the Star Kimberlite showing exploration drill holes

Claim map as of March 2002, by Robertshaw Geophysics



Moving forward to valuation of the Star body meant obtaining a diamond parcel of at least 3,000 carats. Shore Gold had two options to choose from to obtain this parcel. One method was to continue sampling with the 24-inch large diameter drill holes. The other method consisted of sinking a 4.5-meter shaft into the Star kimberlite and to develop laterally on one or more levels to obtain the necessary tonnage to produce the required parcel. After careful consideration and geotechnical and hydrogeological evaluation of the proposed site, Shore

Picture showing freeze headers at collar

opted for the second method; to sink a shaft into the heart of the Star kimberlite to a depth of 250 meters and recover a total of 25,000 to 30,000 tons of kimberlite.

SHAFT FREEZING

Thyssen Mining Construction of Canada Ltd. (Thyssen Mining) was selected as the contractor to sink the shaft. With the information gathered on the ground conditions and the water bearing nature of the 120 meters thick glacial till overburden, it was decided that a frozen shaft to 130 meters was required to sink to the kimberlite bedrock.

After the freeze holes were drilled and installed on a 7.3-meter diameter circle around the center of the shaft, Thyssen Mining mobilized to site. We hooked up the freeze system, excavated and poured the concrete collar to support the sinking system and performed all other site set-up activities.
Thyssen Mining has a history of successfully sinking frozen shafts in Canada and we were excited to take on the challenge of being the first ever to sink one into kimberlite. We employed two 80-ton refrigeration plants to circulate super-cooled brine water into the freeze pipes to extract the heat from the ground in the shaft area. Thermo-couple temperature sensors were installed in two observation wells outside of the freeze circle to monitor the freezing. After 27 days of "shaft freezing", the measured temperatures of the thermo-couples indicated that an ice-wall had formed in the shaft sufficient for excavation to commence.

SHAFT SINKING

With the concrete collar in place, Thyssen Mining started excavation using a cryderman clam mucker supported by a clam frame. Access to the shaft bottom was provided using a muck bucket and crane. With the crane as means of egress in and out of the shaft, we continued sinking in 1.8-meter intervals using hand-held plugger drills and poured the concrete lining on 4.5-meter intervals. Thyssen Mining decided to work one 10-hour shift at this stage for safety reasons.

At a depth of 30 meters, it was time to switch from crane and bucket to headframe and hoist means of sinking. Thyssen Mining designed and built a portable headframe specifically for shafts of this nature (small diameter and shallow) and it required approximately 2 weeks to complete the changeover. The shaft forms were placed on the shaft bottom, the Galloway was lowered into the shaft and anchored, and the headframe, hoist, Galloway winches, clam winch, form winches and sideline winches were secured in place. After commissioning was completed and all safety checks performed, we re-commenced sinking activities ramping up to working three 8 hour shifts per day.

Through the first 110 meters of shaft, we encountered many clay and mud seams, which proved difficult to drill and excavate. Even though the shaft was frozen, we were drilling with brine water to flush the holes and consequently they turned to mud. We resorted to drilling with auger steel and taking shallower benches to sink through these zones. Altered kimberlite was encountered at approximately 110 meters and bad ground conditions caused us to keep the shaft forms uncommonly close to the shaft bottom.

View of collar and concrete pouring

View from 130 meters looking upwards

At a depth of 130 meters (depth of the frozen section of shaft) Thyssen Mining crews started to encounter water on the bench. With every blast we picked up more and more water and eventually, a pumping system was put in place to pump water to the surface holding pond. The severely fractured nature of the kimberlite allowed for water to migrate around the ice wall and into the shaft. A 140 horsepower pump was installed to pump from a wall tank at 138 meters to surface.

LATERAL DEVELOPMENT

Shaft sinking continued into the unfrozen kimberlite. Again the highly fractured nature of the rock resulted in using safety bolts to keep the walls intact until they could be supported with concrete lining.

Sinking continued to an elevation of 175 meters where Shore Gold decided to develop laterally to extract the first 10-thousand tons of the bulk sample. A 3.6-meter by 3.6-meter by 13-meter long station was excavated using jackleg drills. We used a slusher for moving the muck from the station back to the shaft where it was loaded into buckets for hoisting to surface. After each blast, the fresh rock was sprayed lightly with shotcrete to seal it from the air. As a means of a more permanent ground support, we installed bolts, screen and another 100 mm to 150 mm of shotcrete. Resin bolts were used in the back and split-set bolts in the ribs and we bolted to the face after each round. Seams of mud and altered kimberlite were encountered which caused us to change our drilling and blasting pattern in an effort to reduce overbreak.

The initial station excavation was funneled down to 2.4-meter by 2.4-meter at the end. Other development on the station included a scoop turn-around and electrical cutout. After the station was fully excavated, we returned to the shaft once again and are currently sinking to bury the Galloway below and set up a chute system for loading buckets.

FUTURE DEVELOPMENT AND SHAFT SINKING

The plans for continued lateral development on the 175-meter level are to drive a 2.4-meter by 2.4-meter drift in the back of the station and break off into several headings in a herringbone type pattern. Utilizing this type of development pattern will facilitate having different sequences of mining activity occurring at the same time in different headings, which in turn will help produce higher production rate.

Shaft sinking will eventually re-commence and Thyssen Mining will sink to the elevation of the second lateral drift planned at the 250-meter elevation. Drifting on this level will be much the

Picture of station drift on 175 meter level

same as the first level but we will implement tactics learned through drifting on the 175-meter level resulting in a higher rate of production.
It is Shore Gold's objective to place diamond drills on each of the two levels, after mining activities are completed, to further define the ore zones and enhance the valuation of the Star ore body.

DMS RECOVERY PLANT

While Thyssen Mining was busy sinking the shaft, Shore Gold was busy installing a Dense Media Separation Plant (DMS Plant) beside the shaft. The huge plant has recently been enclosed in a Cover-all building to keep out the elements of -50 degree Celsius conditions. Shore Gold has commissioned the plant and soon will begin processing approximately 300 tons per day of kimberlite through the plant. Thyssen Mining will excavate on the 175-meter level to keep the plant running at that capacity. Presently, there is approximately 5,000 tons of material stockpiled on surface.

CONCLUSION

Thyssen Mining takes pride in being the first to sink a shaft in kimberlite and we have learned much throughout the mining activity on the Star site. Based on our experience on this Fort a la Corne Star project Thyssen Mining is confident we can to provide others with an effective means of kimberlite bulk sampling in the future.

J.D. Smith

Picture showing the erection of the cover-all building over the DMS plant

Shaft boring in the heart of the Alps:

Successful sinking of new Sedrun II shaft – with application of an innovative fire-proof lining

When the Sedrun II shaft boring machine broke through to the tunnel floor level on 23 June 2003 it marked another important milestone in the construction of the Gotthard base tunnel.

The 800 m-deep and 7 m-wide shaft, which is part of the Sedrun section of the Gotthard base tunnel, was completed in a record time of only 12 months. This remarkable achievement, which was accomplished under extremely difficult geological conditions, was highly acclaimed by Swiss mining specialists and other engineers working on the Gotthard and Lötschberg sections.

SEDRUN II SHAFT SINKING

The contract to sink the 800 m-deep Sedrun II shaft was awarded to the ABS II – joint venture comprising Thyssen Schachtbau GmbH (technical leadership), the Austrian affiliate Östu-Stettin and the South African partner RUC. Work commenced in mid-May 2002 with the installation of the plant and equipment on site (see Report 2003).

The above mentioned JV's innovative special proposal to use the rodless shaft boring technique, based on a directional drilling, proved best while the offers were technically evaluated. This mechanical sinking operation, which is carried out in three phases, offers significant advantages over conventional methods:

- creating a directional drilling from the shaft head to the shaft bottom chamber
- reaming the hole from the bottom upwards to a diameter of 1.8 metres using the raiseboring method and
- widening the shaft to its final diameter by means of a shaft boring machine working downwards from shaft top, with concurrent installation of the shaft lining.

Thyssen Schachtbau GmbH has been in the shaft boring business for more than 25 years. The company has already successfully completed more than 50 bored shafts, representing an accumulative length of more than 25 km.

THE SEDRUN TUNNEL SECTION

The contract to build section 360 (the Sedrun tunnel) was awarded by Alp Transit Gotthard AG on 14th December 2001 to the Transco-Sedrun joint venture, as contractors for the shaft boring work. The consortium, comprising Batigroup AG Tunnelbau (Zurich), Frutiger AG (Thun), Bilfinger + Berger AG (Munich) and Pizzarotti S.p.A. (Parma), is led by the Swiss company Batigroup AG.

The biggest challenge facing the engineers responsible for the Sedrun section, with its 6.2 km-long tunnel pipes, was to drive the galleries through a number of extremely difficult geological zones while all the time keeping the drivages supplied via a 1,000 m-long access drift with its connecting mine shaft, namely the 800 m-deep Sedrun I shaft.

Touch-down and sinking crew

For logistical and safety reasons it was agreed that a second vertical shaft was required at the Sedrun site (see following report). The shaft collaring points were some 1,340 m above sea level, which meant that the tunnel itself was at an altitude of about 550 m.

Sedrun II shaft (shaft head)

Three-deck working-stage Sedrun II Shaft

The access drift and Sedrun I shaft, along with part of the shaft bottom chambers, had already been completed by a predecessor joint venture. Once Sedrun I shaft had been equipped with a high-performance Siemag shaft winding system, everything was in place for Transco-Sedrun to begin work; this included excavating the safety areas and technical facilities, constructing branch tunnels and connections and preparing a series of longitudinal and transverse chambers, as well as starting on the 6.2 km-long Sedrun tunnel pipes. All these operations commenced in April 2002.

SINKING SEDRUN II SHAFT WITH THE WIRTH VSB VI SHAFT BORING MACHINE

While the Sedrun I shaft had been sunk conventionally using drilling and blasting, the rodless shaft drilling technique was applied for the Sedrun II project. The mechanized shaft sinking requires firstly the drilling of a 1.8 m-diameter pilot hole, which was completed in two stages. The reaming out of the pilot hole (phase 2, see above) was performed by the Wirth VSB VI shaft boring machine, which produced a final diameter of 7.0 m.

The rock face is supported by systematic rockbolting with lagging mesh, which was installed from a fully-rotatable platform stage mounted on top of the boring machine, enabling support work and boring to be carried out concurrently.

The final shaft lining with its steel-fibre concrete was set in place above the machine by a team working from a three-deck, rope-suspended mobile stage. An MBT Meyco Robojet spray manipulator was used for the application of the 22 cm-thick steel-fibre shotcrete shell, which was constructed using a single-skin shotcreting process.

TWIN OBSTACLES OF HYDROLOGY AND GEOLOGY

For the first 250 metres of shaft the sinking operation was hampered by an extremely high inflow of water that in some cases exceeded 5 litres/sec. The water was canalized using drainage pipes and gunite seals and then diverted away via a system of pumping basins, drip channels and a single drainage fall-pipe.

The sections between the depth of 190 m and 250 m and between those of 400 m and 480 m contained two fault zones, which included heavily fractured and locally loamified rock. In these areas the rock-face support system was adapted to suit local requirements by employing long-reach rockbolts, systematic rockbolt sealing and reinforced lagging mesh.

"TOUCH-DOWN" RIGHT ON SCHEDULE

The shaft boring machine "touched down" at the 800 m-level on 23 June 2003. The sinking performance had averaged 5.5 m per day, including all

stoppages, with peak sinking rates of 7.2 m per day.
Two of the project months recorded performances of more than 200 m of bored, shotcreted and lined shaft.
The mechanised system used at Sedrun for the shaft sinking and lining work proved more than a match for the difficult geological conditions and the shaft construction project achieved high sinking rates as a result.

Shaft head with heavy load transport kibble

FIREPROOF SHOTCRETE IS A NOVEL SOLUTION

Sedrun II shaft was lined with a highly fire-resistant type of shotcrete, the first time that such a material had ever been used in a shaft sinking. The shotcrete was also delivered via a fall-pipe and then applied using the shotcrete manipulator. This special type of lining was needed because the shaft is also to serve as a ventilation shaft. In the unlikely event of a fire breaking out at tunnel floor level the hot air – which might well reach temperatures of up to 900° C – can be drawn out through the shaft. Usual shotcrete could not withstand such temperatures and would begin to break up. Under such circumstances the resulting fragments would come crashing down and the shaft would almost be immediately blocked.

After an intensive programme of tests Sika Schweiz AG, together with Transco-Sedrun, came up with a special fireproof material with the necessary shotcrete specifications. Sika and Thyssen Schachtbau GmbH then collaborated successfully to develop a method to apply the shotcrete mixture under the specific conditions for shaft sinking.

Hauling of the shotcrete manipulator

A SUMMING-UP

Having decided to use the rodless shaft boring system for sinking Sedrun II shaft ultimately proved to be correct, given the steeply dipping schistosity of the Alpine strata that crossed the line of the shaft at an acute angle. Rock hardness varied enormously and strengths of between 40 and 140 MPa were encountered. The chosen shaft boring technology provided the operating flexibility needed to cope with such geological conditions and moreover offered another important advantage in that the support measures could be implemented with minimum delay.

Although the work outside the tunnel itself was frequently hampered by the extreme winter weather, which included scree avalanches and rockslides, the shaft was completed on schedule exactly 12 months after the directional drilling work had started on 17th June 2002.

Dipl.-Ing. Norbert Handke
Erhard Berger
Michael Müller

Sedrun II shaft hoisting plant means better logistics and a safer working environment

The tunnel heading operation in the Sedrun section of the Gotthard Base tunnel, which is still under construction, has to cope not only with difficult geological conditions but also with exceptional site logistics – with the Sedrun assembly area being located about 800 m above the actual tunnel level. This exposed circumstance was to mark a new chapter in the history of tunnel construction: the sinking of two vertical shafts as opening and as supply and return system for the tunnel headings – with as many as seven individual workplaces having to be served at any one time.

Inside the heavy-duty cage

SEDRUN II DOUBLES AS AVENTILATION AND HOISTING SHAFT

The original plan was to have just one shaft (Sedrun I) to haul/transport men and hoist material and debris of the tunnel site. The scheduled material capacity – equivalent to that handled by an average-sized coal or potash mine – should have been transported by a single-shaft hoisting installation equipped with a Siemag fully-automatic four-rope drum winder.

Even during the tendering phase it was apparent that this single-shaft hoisting installation would create problems regarding operating safety and would clog-up the transport flow. In order to relieve the bottleneck created by the situation at the access drift and the single-shaft hoisting engineers from the responsible Transco-Sedrun consortium took the decision early on that the Sedrun II shaft, which was originally designed as a mere air shaft, should also be fitted with a shaft hoisting plant as soon as it was completed. With the shaft diameter widened from 4.0 to 7.0 m by the same decision the new hoisting installation now makes a major contribution in terms of improved safety and better site logistics and this will benefit

not just the current tunnel construction project but also its future operating phase.

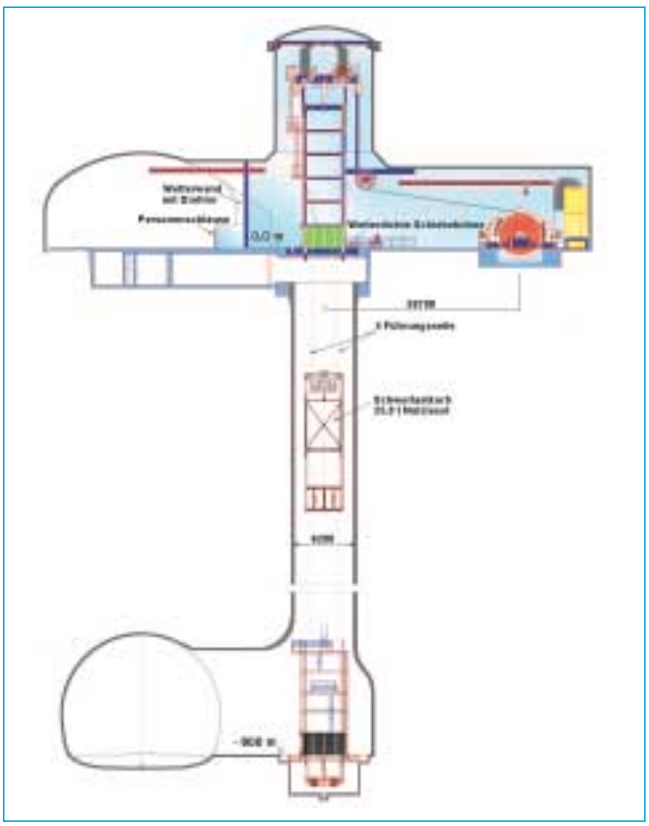
DESIGNED, DELIVERED AND ASSEMBLED BY THYSSEN SCHACHTBAU GMBH

In June 2002 Thyssen Schachtbau GmbH was contracted to design, supply and install the Sedrun II heavy-duty hoisting plant in accordance with German mining regulations (TAS).
After the sinking equipment had been dismantled work commenced on the assembly of the mechanical and electrical installations for the rope-guided hoisting plant at the end of November 2003.
By late January 2004 the TRANSCO-Sedrun consortium was able to take delivery of the shaft in full working order.

Single-drum hoisting machine

HOISTING SYSTEM

The hoisting system is a single-compartment cage winding installation, which is operated by a single-drum floor-mounted hoisting machine and a single-reeved winding rope. The single-drum hoisting machine is driven through a set of gears and couplings by two 380 kW d.c. motors, which deliver a tractive force of 254 kN at a torque of 470 kNm.
The safety braking system consists of a hydraulically-operated disc brake that acts on the rope drum. The latter has a reeling width of 680 mm and a maximum reeling diameter of 4,500 mm.



General view

The single-deck cage is supported on four ropes and is capable of transporting large-sized components weighing up to 25 tonnes and measuring 11,500 x 3,500 x 3,500 mm. The cage roof is fitted with two electric chain hoists so that heavy items can be easily lifted and placed inside the cage.
The cage is also equipped with retractable roof sections and side-wall inserts with a manriding door, so that it can also serve as a passenger conveyance.
The upcast shaft with its shaft cellar mounted ventilation has its own air lock system.
An electromechanically-operated swing gate set in the cavern profile towards the shaft, which operates in conjunction with an airtight shaft cover door that is mounted across the top of the shaft and activated via a rack mechanism driven from a electric geared motor, ensures the partition to the downcast shaft (no. I shaft).
An interlocking system between the swing gate and the shaft cover door prevents any short circuiting of the airflow as it enters no. II shaft.

Guide frame in cavern

LOGISTICAL ARRANGEMENTS FOR NO. II SHAFT

The shaft hoisting system at Sedrun II shaft separates the transport of heavy tunnelling equipment and bulky building materials from the manriding operations and the evacuation of heading debris in Sedrun I shaft while the two base tunnels are constructed.
This provides much better site transport logistics and a safer working environment.

Ram protection gate

For the tunnel heading operations to run smoothly it is strategically important to be supplied with materials and equipment as and when these are required, including steel-arch supports, rockbolts for the tunnel-face and side-wall zones, shotcrete, concrete, concrete additives and piping. The machines, construction containers, building materials and – last but not least – the tunnelling personnel themselves can now all be transported to the workplace using either Sedrun I or Sedrun II shaft.

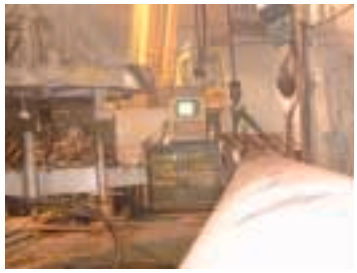
Using Sedrun II shaft not just for ventilation but also for material hoisting has provided much-needed relief for the overused hoisting installation in Sedrun I shaft. Increasing the diameter of Sedrun II shaft to 7 m has also been beneficial from a ventilation point of view in that the reduced airflow resistance means that less energy is required to operate the ventilation system.

Following the tunnel heading operations – probably in 2009 to 2010, when most of the tunnelling work will be completed – the hoisting plant in Sedrun II will be mainly used for transporting personnel. This ensures that the tunnel access can be completely isolated from Sedrun I shaft, as operationally needed where the hoisting machine can then be dismantled and the permanent concrete lining installed using a sliding formwork system.

Future special transports and intermediate manriding can be handled through shaft II, which will significantly reduce the problem of shaft obstructions and so improve operational safety. By the year 2015, when passenger trains will be using the tunnel, the existence of a second shaft will constitute a very useful permanent safety feature for emergency rescue purposes, as well as providing a separate access point for maintenance and repair teams.

Putting safety first!

Ulrich Kaufmann
Gerd Winkler
Dietmar Schilling



Convincing technology:

Self-supporting API shaft pipes for the supply and return system of the Sedrun tunnel headings

The economic and technical advantages of free hanging and self-supporting API pipework connected joints by tapered-thread couplings convinced the Sedrun I shaft design team that such a system would also be the ideal solution for the tunnel heading project.

API pipe systems offer the following advantages over placed on supports, flange-coupled pipes that have to be installed section by section:

1. much shorter installation times,
2. smaller space requirement in the shaft with no loss of nominal diameter,
3. no intermediate shifting points.

In January 2003 the "API Sedrun I shaft pipelines" joint venture, comprising Thyssen Schachtbau GmbH and PPS Pipeline Systems GmbH, was contracted to install six API shaft pipework systems with diameters ranging from 100 to 400 mm. The new pipes were each to be fitted in runs of about 800 m and were to be installed in the shaft bottom chamber using a series of expansion units and pipe compensators to connect up with the existing groundwater pumping systems, the cement silo for concrete production and the heat exchanger for the cooling-water supply.

4,800 M OF SHAFT PIPEWORK INSTALLED IN TEN DAYS

After the pipe shiftings had been set up at the top of the shaft and temporary modifications made to the headgear, the 200-t installation crane was brought into position and the pipeline assembly work then commenced on 2nd June 2003.

Hydraulic pipe tongs were used to connect the individual pipe sections, which measured up to 8 m in length. Instead of working from the bottom of the shaft upwards and fitting one pipe section on top of the next, which is the normal procedure for flange-coupled pipes, API pipework can be installed in the reverse direction from a fixed position at the top of the shaft. By 12th June 2003, a mere ten days after the assembly operation began, the shaft was cleared for use and the tunnelling teams could continue work.

PROVEN TECHNOLOGY

High-grade steel pipes that were first developed for the oil and gas drilling sectors have been tried and tested for more than twenty years in the German potash and coal mining industries (see also Thyssen Schachtbau Report 1999, pp. 23). The system's inherent advantages are now being put to good use for the first time in a tunnel drivage project – concrete proof that innovative mining technology also has a role to play in today's state-of-the-art tunnel construction business.

Dipl.-Ing. Dietmar Schilling
Rainer Lietz

Lake Waggaboonya at Mt. Gordon, Mt. Gordon Aerial, Mt. Gordon Camp

Copper Mining in Australia at Mount Gordon Mine

Mount Gordon copper mine is located in the prospective north-west area of Queensland – a region that is thought to contain vast ore deposits – and lies some 150 km north of Mount Isa and about 1,000 km west of Townsville.

The State of Queensland, with its Cape York Peninsula jutting far out into the Pacific Ocean, occupies the north-east corner of Australia and with a surface area of 1.73 million km^2 is almost five times larger than Germany. Yet only three million people live there. The capital city, Brisbane, is located in the south of the State and like the more northerly towns of Rockhampten, Mackay, Townsville and Cairns it also lies on the east coast of the continent. The region is rich in natural resources, including bauxite, coal, uranium, copper, zinc, lead, silver, natural gas and oil. The climate is bordering on summer monsoonal, being susceptible to seasonal flooding and isolation from major roads and suppliers.

"GUNPOWDER"

The site traditionally named "Gunpowder" has been operated in both an underground and open cut capacity for over 25 years. Various mining techniques have been used at Mt. Gordon historically with varying success. The Mammoth (underground) and Esperensa (open cut) deposits both exploit copper oxide minerals, with the processing plant producing 99.99 % copper from electro-winning. The new found life to the underground mine exploits sub-level caving methods in a recently proven orebody lens.
Byrnecut commenced work in August 2003, stripping and rehabilitating the old decline to allow access for Elphinstone AD55 Trucks (55 t capacity).

THE CHALLENGE ...

... Byrnecut's role at this site is to move in excess of 150,000 t of material per month from underground, making use of an old and very narrow decline.
This goal becomes increasingly difficult as the depth of mining increases. This means further expansion of the truck fleet will be required, and increased efficiencies sought through constant diligence in the areas of road maintenance, matching truck performance, optimal loading and minimal cycle disruption. Automatic data logging weighbridge technology is also used to determine true net loads carried by each truck. This keeps the focus on tonnes trucked and optimizes the loading performance of the trucks. This also allows us to quote with confidence tonnes extracted from the mine in any time period.

Byrnecut's work has expanded from an equipment fleet of 1 jumbo, 2 trucks, 2 boggers, and a workforce of 52 operators, to current levels of 3 jumbos, 6 trucks, 4 boggers, 2 Solo drilling rigs, with a total workforce of 113. The table below summarizes some of the operating physicals for the contract to date.

Physical Parameter	Contract to Date
Development (m)	8,792
Trucking tonnes (total movement)	1,256,895
Trucking tkm (tonnes-km)	4,713,171
Production Drilling (m)	140,440

SAFETY AND WELL BEING ...

... of the workforce is of paramount priority, and a large emphasis of management and supervision time is dedicated to achieving our target of zero accidents and incidents in the workplace. The results of this show in our safety statistics to date with only 1 lost time and 12 medically treated injuries in 518 days of operations. A new initiative we have implemented on site to further emphasize the importance of 'safety first' is quarterly safety workshops. Half a shift of production is forgone to conduct a series of nominated safety sessions relating to different aspects of the operation. These sessions use the advice from external experts, and the experience of management and operators to collectively increase awareness and understanding of issues within the workplace.

Truck exiting portal

WORKING AND ENVIRONMENTAL CONDITIONS ...

The site works in a fly in fly out roster from Townsville and Cairns. The teams work in very tough environmental conditions, with wet bulb temperatures in working areas in the range of 30-34°C. This has forced us to adopt strict working in heat procedures and led to an extensive education process of the workforce on how to stay hydrated both at home and in the work place. The client is

Underground Jumbo

currently in the process of installing two new ventilation rises that will be large enough to accommodate the future ventilation requirements for the mine. The ventilation works will be completed by the end of winter, allowing Byrnecut to sustain full production rates over the summer period of 2004/5.

...AND EQUIPMENT

Additionally, Byrnecut has realised operational efficiencies through the use of a Leaky Feeder PED control system throughout the mine. This system allows simultaneous use of the leaky feeder for radio communications, remote fan telemetry and control, and a computer controlled blast initiation system. This acts as a central firing system on the surface for all blasting activities underground, eliminating the need for exposure of operators to potential hazards associated with underground blast initiation. It has also had the added benefit of reducing the firing times required which subsequently means that re-entry after blasting can occur earlier.

Another first for Byrnecut has been the purchase of a Tamrock Data Solo 1520 production drill rig. This has enabled increased drilling productivity through the use of the Data's automatic drilling capabilities for use during mid-shift firing and end of shift hand over.

Jumbo and operator

CONTRACT ARRANGEMENTS

The existing contract between Byrnecut and Birla Mt. Gordon extends out to August 2005. Production is planned to ramp up to a total trucked material movement in excess of 160,000 t per month. There is potential upside beyond this with development and production planned for a separate orebody, via a new portal access from the bottom of the open pit mine.

Wade Bickley
Project Engineer

Underground Loader

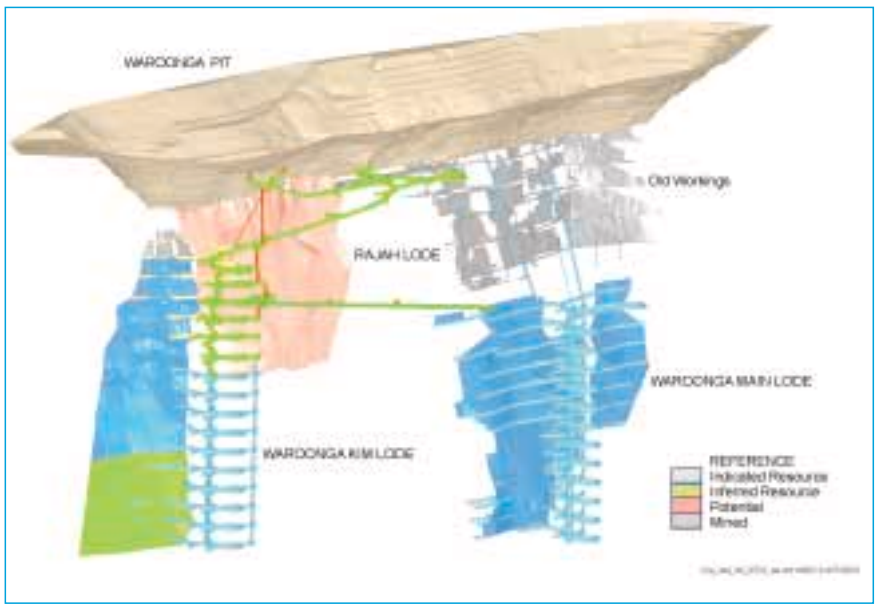
Agnew Gold Operations and the Waroonga Project

Mining in the Agnew Area commenced over 100 years ago and has continued intermittently throughout. In February 2002 the portal was cut for the Waroonga Project, whose target was to exploit the Kim, Rajah and Main lodes that sit below an existing open pit and an array of old workings.

The Agnew gold mine is located approximately 630 km north-east of Perth in Western Australia. Gold was first discovered at Waroonga in 1897 and an underground mine has operated there on and off over the past century. Mining was suspended in 1911 and recommenced in 1936, only to cease again in 1948. Open-pit extraction commenced in 1984, but stopped eight years later when the reserves were apparently exhausted. In March 2000 mining resumed in the open pit and, following a feasibility study, the owners – Goldfields Australia – decided to cut the portal for the Waroonga Underground in early 2002, with open pit operations continuing through to February 2003.

Waroonga is one of a number of deposits that have been mined at Agnew over the years. The others include Redeemer, Crusader, Deliverer and Pilgrim.

Layout of the Waroonga Project



BYRNECUT MINING AT AGNEW

Byrnecut Mining's first contract to mine the Redeemer deposit at Agnew was won in 1989 and in the course of the past 13 years this operation has taken many different forms. In early 2003 Byrnecut again won an open tender for underground mining at the Agnew Gold Operations, this consisting of a three-year contract with an extension option of a further two years.

With the Kim and Main lodes, plus other possible projects such as Vivian, Byrnecut has definitely cemented a position at Agnew.

MINING THE KIM LODE

The upper levels of the Kim lode are currently being mined, while diamond drilling continues to prove the lower Kim levels and the upper section of the Main lode. The old workings, which date back to the original Emu mine, are currently flooded and are being pumped out via the Main decline – which has developed adjacent to the lower levels of the old workings. The pumping system is currently being upgraded to allow the water to be extracted at a higher rate, so that development work can start on the Main lode levels in three months.

The portal for the Kim decline is located on the western wall of the Waroonga pit, which spirals down in the hangingwall side south of the Kim lode. At the 1270 m level the Main decline branches off and heads 650 m south to the Main lode. The Kim decline continues downwards and has recently reached a depth of 400 m.

The Kim lode is a small high-grade deposit that strikes north-south for an approximate distance of 120 m. The lode varies in width, with a maximum of 8 m and an average of 4 m, and is characterized by a 70° plunge to the north and a 58° dip to the west.

The Kim lode is being mined using open stoping on 25 m level intervals down to the 1260 m level, with rib pillars being left to provide support. At this point the mining method is changed over, with cemented aggregate fill (CAF) being used to backfill the primary stopes before the secondary stopes are mined. A cement batching plant was mobilized in October 2003 to prepare the CAF in conjunction with shotcrete for the in-cycle shotcrete trial. The first primary stope was filled in December 2003.

As Byrnecut has the contract for both the Waroonga and Deliverer mines, it was logical to share operating equipment between the two sites, which are approximately 10 kilometres apart. Waroonga normally operates two Elphinstone AD55 underground articulated trucks, which haul some 55,000 tonnes of material to the surface each month. The two development jumbo drill rigs – a Tamrock Powerclass 205D and a Tamrock Superdrill Axera D07 – develop approximately 400 m per month. Two underground loaders – an Elphinstone R1700 and an R2900 - are used to muck out the stopes and development headings, the R1700 being equipped with tele-remotes. Support equipment includes two Integrated Toolcarriers (ITs) and a Normet Charmec charge-up machine.

IN-CYCLE SHOTCRETE RAISES THE PRODUCTION POTENTIAL

In February 2003 an in-cycle shotcrete trial was conducted by Byrnecut in conjunction with the client and Jetcrete Australia. This was carried out in the main decline and lasted approximately two weeks, with 16 cuts being supported using shotcrete as a replacement for 100 mm weld mesh. Following the success of the initial trial a full three-month test was run from November 2003

to January 2004 in order to determine the production advantages of using an in-cycle shotcreting system for all waste development.

Using in-cycle shotcreting and hydroscaling could potentially increase development rates by up to 25%, since it eliminates the need for mesh to be placed with a twin boom jumbo (which can sometimes be a tedious task) and means that rattling can be restricted to the face only, with the backs and walls being excluded. Rattling (detaching loose rock with the jumbo drill rig) generally results in higher maintenance costs and is responsible for most of the downtime on jumbo drill machines.

Another advantage is that the rockbolt spacing can be increased, as this is no longer dictated by the size of the mesh sheet. At present 2.4 m split sets are used on a 1.5 by 1.5 m spacing for shotcrete. This may be increased in the future, following further geotechnical assessment of the rock conditions at Waroonga.

While spraying shotcrete and meshing with a jumbo are comparable in pure time terms, the former does offer an advantage in that before the heading has been fully mucked-out the shotcrete can be sprayed and left to cure while the mucking-out operation is completed.

To date the trial has been hampered by development face availability, which is determined by a number of factors. Historically the Waroonga Mine has been affected by a large number of local water courses and flooding is a common occurrence in both the Kim and Main declines. What is more, a lower proportion of available headings are in fact waste and this impacts on the focus of the in-cycle shotcrete.

However, the shotcrete cycle has proven to be quicker at an average of 55 minutes

to hydroscale and spray the shotcrete and 30 minutes to install the rockbolts as opposed to at least 180 minutes to the mesh and rockbolts. This time saving resulted in approximately 50 m of extra waste development for the two months of the trial so far.

THE FUTURE

With the Main lode and other potential lodes, such as Donegal and Vivian, giving the Agnew area an operating life of at least ten years, and as the client – Goldfields Australia – is keen to pursue an alliance for future development, Byrnecut Mining is now in an excellent position to capitalize on a positive future.

Bryn Jones
Project Mining Engineer

Picture above: Entrance to the mine on a winter day

Picture left:
View of the PC3 conveyor negotiating a 27% slope on its way to the mill

"Just in Time" development
at the Henderson Operations

Since early 2003, Thyssen Mining Construction of Canada Ltd has been involved in the on-going pre-production development of one of the most efficient underground mining operations in the world.

At a rate of approximately 800' per month, a team of only 14 miners and mechanics are completing part of the development requirements for the next production level of this massive block caving complex. At the same time, a team of 4 raisedrillers is completing a series of 7' to 10' diameter ore passes at a rate of 2,000' per year. Both projects require – and maintain – strict adherence to schedule and budgetary targets, as well as one of the highest safety standards in the industry.

INTRODUCTION

The Henderson Mine, located in the Colorado Rocky Mountains is in many ways a unique mining operation. Part of the Phelps Dodge Corporation-owned Climax Molybdenum Company, the mine is the largest primary producer of molybdenum in the world. "Moly" is a metal with many everyday uses and is found in stainless steel, high strength and high temperature alloys, in the wire of light bulbs, and in lubricant-containing products such as grease. Its derivates are often used as catalyst, e.g. in the manufacture of special plastics, for chemical synthesis and in the refinery of petroleum products.

The mine was built between 1971 and 1976 at a cost of half a billion dollars and is located over 9,000 feet high in the Rockies, just east of the Continental Divide. Moly has been mined in Colorado since 1917, when the Climax Mine started production at a rate of 250 tons per day. In 1963, AMAX started development of the URAD property and started producing at a rate of 5,000 tpd in 1967. During this period of development, a diamond drilling program begun under the leadership of Robert Henderson indicated the existence of a much larger ore body below the known reserves. The Henderson Mine has produced over 170 million tons from this source since 1976 and has reserves for at least another 20 years at the current production rate in excess of 20,000 tons per day.

The mill is situated 15 miles west of the mine (60 miles by road), on the other side of the Divide. Originally, ore was transported via a 15 mile long rail road, two-thirds of which was situated in a tunnel below the mountain range. In 1996 the decision was made to embark on an ambitious, $150 million dollar project to replace the rail haulage system with a conveyor system in order to reduce operating costs. The German company MAN TAKRAF was selected to lead the engineering for the two main conveyors, one of which is the longest

Aerial view of the mine with the crescent shape of the cave visible in the background

single flight conveyor in the world at 10.45 miles (16.8 km). Ore is drawn from the block cave by 9 yd LHD's and transferred through a series of ore passes to the transport level, where 80 ton trucks haul the ore to a 54 x 84 gyratory crusher. From there, the ore starts its 15 mile, 1 $^{1}/_{2}$ hour journey by conveyor to the mill stockpile.

SAFETY

A description of the Henderson Operations is unthinkable without an emphasis on safety, which is one of the company's key values. Thyssen Mining is committed to achieving the company's aim of Zero And Beyond, meaning that no reportable injuries will occur at work and that the safety awareness is taken home and into the community by the employees. Continuous improvement is achieved through safety observations involving the complete work force, as well as through training of every employee in active leadership, personal accountability and responsibility for safety.

Final destination of the ore is reached after its 15-mile trip by conveyor

"JUST IN TIME" MINING

To optimize the use of resources and capital, the Henderson Mine has adopted a policy of "Just in Time" mining. No work is done – no money is spent – before it is required. This involves Thyssen Mining directly because every detail of the development and raise drilling has been scheduled and requires completion at the right time and for the scheduled amount. To date, both raisedrilling and development projects have performed exceptionally well, providing the client as well as Thyssen with predictable outcomes. The scope for 2003 was completed by mid-December, 2 weeks ahead of schedule, at the budgeted cost.

DEVELOPMENT

The original contract comprised of a total of approximately 8,000' of tunneling with dimensions varying from 20' wide x 18' high to as small as 7' wide and 9' high. Recently, another 2,500' were added due to the good performance to date. During 2003, the total work force on site

What is molybdenum?

Molybdenum is obtained from the mineral molybdenite, the word coming from the Greek molybdos, meaning lead. It is a relatively rare metal, whose hexagonal crystals are often foliated and grey-blue in colour. The mineral has a hardness of 1 to 1.5, is readily sectile and has a distinctly greasy feel. Having its origins in pegmatites and pneumatolytic dikes, molybdenite is found in granite and diorite cavities, though can also occur in metamorphous contact with limestone. The best-known deposits are in Colorado, Australia, Bolivia, Italy and Norway, though the mineral is also to be found in Germany in the Bergstrasse area north of Heidelberg and in the Riesengebirge and Erzgebirge mountains on the border with the Czech Republic.

consisted of 18 miners, mechanics and supervisors, achieving up to 1,070' of advance in one month. This total was reduced to only 14 employees in December as the monthly requirements started to decline to about 800'.

The crews work 10 days out of each 2 week period, 2 shifts per day. Due to logistics, two sets of equipment are used, each consisting of a two-boom jumbo, a bolter and an 8-yard LHD. Occasionally, a 40 ton truck supplied by the client is used for longer tramming distances. Support vehicles such as tractors for transportation and Triple 4CE charge-up units also used. Ground support consists of 5' and 7' Split Set bolts, sometimes supplemented with mesh and if required shotcrete.

RAISE DRILLING

A contract to raise drill 2,000' of ore passes with diameters ranging from 6' to 10' was awarded in December 2002. This has since been extended by a similar amount to be completed in 2004. The raise drill used is an RBM7 with a 10 $^{1}/_{4}$" drill string. To date, the project has progressed on schedule with very little machine down time and without accidents. Two crews, each consisting of a driller and assistant, work five days a week.

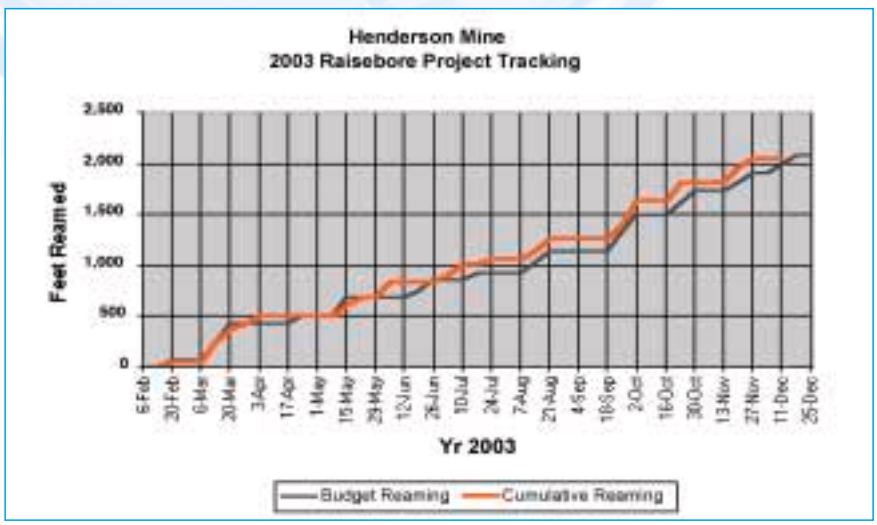
An 80 ton side-dumping Tamrock Supra truck tipping its load into the underground crusher in a matter of seconds

RELATIONSHIP

The success of both projects is to a great deal contributable to the excellent relationship and cooperation that exist between the client's and Thyssen's site as well as off-site personnel. Both parties contribute equally to achieve a level of safety, productivity and quality that is world class. The high standards set and required by the Henderson Operation are considered by Thyssen Mining to be met and exceeded. With that in mind, both parties look forward to a continued relationship for years to come.

René Scheepers
President

Graph tracking actual vs. budgeted meters



A practical and efficient solution:
Sewage, water and gas pipes share common ground

New water regulations now mean that local authorities and municipalities are responsible for laying and renewing their sewage disposal installations.

Stadtwerke Essen AG (the city of Essen municipal services), which originally were only responsible for water and gas supplies, took over this new service in 1998 and are now 99 % connected to the public sewage disposal network – well above the average for the former West Germany.

THE PROJECT SITE

The project is being carried out in Bäuminghausstrasse in Essen North, a residential street that is used mainly by local traffic. In order to minimize the impact on local residents and keep general construction costs low the municipal services have decided to depart from normal practice by laying not only the new sewer but also the new water and gas supply pipes in the same trench. This naturally requires a much higher level of coordination, since stoppages have to be avoided in spite of the different working procedures involved. The project also has to be carried out in close collaboration with the road traffic department and local police authorities so that safe access to garage entrances and doorways can be maintained at all times.

TS BAU GETS THE CONTRACT

TS Bau was awarded the contract to renew the existing sewer over a length of some 1,200 m. The operation involves laying about 400 m of DN 500-700 concrete pipes and some 800 m of HDPE pipes (DN 315-450). The client has shown special interest in using pipes of this type, for while HDPE as a material is already in common use in the gas and water supply sector it has not yet been employed for sewer laying. As sewer pipes in the Essen North area can be subject to stress as a result of mining subsidence, the municipal services hope that the new material will result in a more durable and fracture-resistant sewer system.
Smaller-diameter pipes will then be used to connect up the many households located in this densely-populated part of the city.
The project will also include renewing the district's water and gas supply pipes over a total length of some 800 m and making the necessary connections to local houses and businesses.

Welding operation

WORK BEGINS

Soon after work started it was found that the ground-water level in this area was excessively high. In order to ensure the safety of the site the water table had to be lowered by 6 m using vacuum plant. However, due to the risk of the HDPE pipes being affected by ground shift at some time in the future, the engineers responsible have decided to use specially adapted pipe laying techniques and retention devices in order to inhibit any movement. The slab construction method originally proposed will also have to be replaced by trench sheeting. In the course of the construction work almost 6,000 m^2 of trench wall are to be secured in this way.

CATALOGUE OF WORK

The overall project will involve moving some 5,000 m^3 of earth, making a total of 300 welded joints and re-asphalting about 6,000 m^2 of roadway surface.
At the moment the mechanical excavation work is still under way around the clock. If all goes to plan, the local residents will be given their street back in late summer 2004, secure in the knowledge that the sewers, water pipes and gas pipes beneath their feet have been laid in a way that guarantees strength and stability for decades to come.

Friedhelm Rutkowski
Dipl.-Ing. Andreas Pabst

Capillary barrier sets the seal

The construction of basal, intermediate and surface seals on landfill sites has been an important part of TS Bau Jena's working programme for more than ten years.

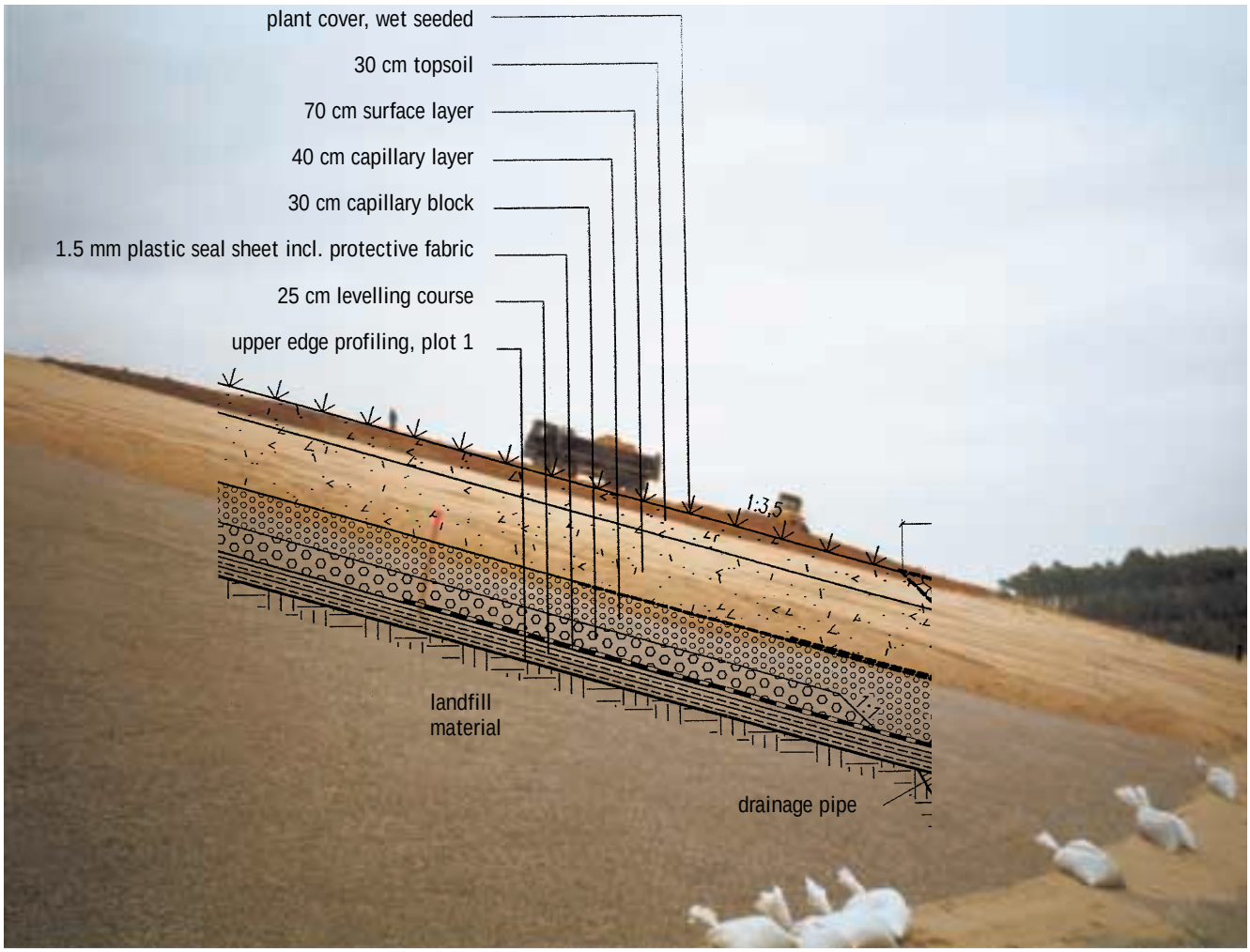
This activity has involved the application of a whole range of different sealing techniques and the company can now boast a team of workers with extensive experience in the construction of waste disposal sites of all different shapes and sizes.

There was a time when TS Bau thought it had mastered the entire art of seal design and construction – that is until the company was invited to bid for a surface sealing project to be carried out at the Markendorfer Chaussee landfill site at Jügerbog in Brandenburg.

The project in question specified the laying of a capillary barrier to act as a surface seal. The capillary barrier effect depends on the different physical properties of the soil and uses a combination of coarse-grained materials that are overlaid with a layer of fine-granular material.

In order to ensure that most of the surface seepage water drains away at the boundary between the two layers, the material used has to be properly classified and laid down in accordance with exact specifications.

Overall view of completed surface



Laying the coarse-grained capillary bed

CONSTRUCTION SPECIFICATIONS

A visit to the Ruhr District's central landfill site at Herten, where such a sealing technique is employed, provided the project team with some very useful information.

The 35 cm-thick layer of 2/8-size gravel material, which allows an absolutely flat surface to be maintained right across the sloping contours of the site, has to be carefully laid down if the capillary block is to remain stable and function correctly over a long period.

Any surface irregularities, such as an undulation, edge or cavity, will disturb the capillary action and affect the run-off at the capillary layer, allowing the water to penetrate unimpeded into the body of the tip. In order to obtain an absolutely smooth surface the dozer blade is fitted with a section of rubber conveyor belting and any surface unevenness is corrected by skilfully drawing the rubber strip across the roughly spread gravel.

Dozer blade with rubber strip

When operating on the surface of the tip the dozers must exert a very low contact pressure so as not to compact the gravel material.

Each square metre of laid surface is checked by company inspectors and by the client's surveyors in order to ensure that the material type and grain size complies with the quality assurance plan.

If any surface imperfection is detected the entire layer must be removed and the operation has to begin all over again. As this is a very expensive process, high-quality execution has to be the order of the day. To date some 18,000 m^2 of the total surface area of five hectares have already been completed without a flaw.

Provided weather conditions are favourable the work will continue – and that means more careful laying of the surface seal and more quality workmanship – until the project is completed in August 2004. The aim is simple: to ensure that every single square metre of the complex ground seal is laid correctly first time round.

Manfred Erbrich

Preparing to pull through the liners

Relining project:

Main sewer serving 120,000 people operates as a surface pipe for several months

In 2007 the town of Gera is to play host to the National Garden Show. The programme of preparations for the event includes the construction of a 6 km-long tram line. TS BAU GmbH, NL Jena, has been awarded the contract to construct a 730 m-long section of the new track.

As well as laying the new tram line, the project comprises additional civil engineering work, including the replacement of pipes and cables and the renovation and refurbishment of streets and public areas.

The main 1500 mm-diameter sewer in Leibnitzstrasse is to be renovated using the new "re-lining" technique, which involves pulling a new, smaller-diameter pipe through the existing sewer.

The new system will consist of 1300 mm-diameter pipes and fittings in glass-fibre reinforced unsaturated polyester resin and will terminate in a series of newly-constructed monolithic ferroconcrete shafts.

Leibnitzstrasse comprises four- and five-storey residential homes on both sides, with business premises located at ground level. Access has to be maintained to these homes and shop-fronts for the entire duration of the project.

One of the most challenging and expensive operations undertaken as part of the relining work involves having to divert the flow of sewage, which means handling a throughput of as much as 3300 l/sec.

A 1200-mm welded steel pipeline was laid above ground at street level in order to divert the inflowing sewage, which was delivered through a vacuum siphon pump.

The siphon pump is a low-energy, cost-effective unit that can operate in relative silence and requires little or no maintenance. However, the work has been complicated by the fact that all the house service connections in this district have to be pumped out as a separate operation.

In addition to the work outlined above, the contractors have to re-lay the gas, sewage and drinking-water connections to local households and remake all the other media carriers, which means renewing between 10 and 18 cable ducts beneath each pavement. This operation has been further complicated by the fact that the existing conduits (as many as 12 in number) can only be taken out of

Detail view of the pumping operation

Overall view of sewage pipeline

service after the newly constructed section of line has been completed.
The extremely confined conditions mean that the workmen have to resort to small-sized equipment and in some cases even hand digging.
The team has now completed some 260 m of this very demanding assignment, which is of a complexity never before attempted. The project is expected to end in late 2004.
The operation requires great technical skill, high-quality workmanship and deadline reliability, as well as a tactful approach in dealing with local residents. The contractors have been very satisfied with the progress made to date and building on this experience they expect to achieve similar success over the remaining course of the project.

Heinz Neumann

Household connection work

Future-proof traffic management

Road planners in Heilbronn have come up with a new traffic scheme that should help relieve inner-city congestion and provide better access to an existing industrial estate.

In June 2001 the city highways department awarded the Heilbronn branch of TS Bau GmbH the contract for Section 1 of the road scheme, which involved the extension and reconstruction of the Hafenstrasse and Albertistrasse zones (see Report 2002).

The project comprised a number of individual engineering assignments, including:

- installing 1.3 km of new sewer pipes with nominal diameters of 300 to 1200 mm
- laying 1.3 km of gas and water supply pipes
- construction of a high-water pumping station
- building some 500 m of retaining walls 1.0 to 5.0 m in height
- constructing a new steel-concrete bridge over the dock railway while maintaining normal rail services and
- moving 35,000 m^3 of earth-fill for some 20,000 m^2 of new road surface.

CENTREPIECE PROJECT

The new Wohlgelegen bridge spanning the river Neckar was the main focus for the entire project. This composite steel structure measures 95 m in length and is 16.85 m high and 14 m wide. The bridge was pre-fabricated on dry land and then pushed out into its final resting place across the Neckar in an impressive weekend feat of engineering.

Future-proof traffic management

BRIDGE FIXTURES

During this phase the bridge was also provided with open filigree plates and a lower reinforcing deck to support the future carriageway.
All pipes and cables were pre-fitted during fabrication.
At the time of the “big push” the bridge had a net weight of some 1,150 t.

TS BAU TAKES CHARGE

The entire project, including planning and design, earth moving, specialist civil engineering, solid construction and support work, was carried out under the technical and commercial leadership of TS Bau.

ROAD OPENING

The new road scheme was opened to traffic on 3rd November 2003. The event marked the end of a project that had been a great success from start to finish.

A WORD OF THANKS

The management would like to thank the construction workers and site foremen for their dedication and craftsmanship and also wishes to acknowledge the contribution made by:
the engineering consultants at BUNG in Stuttgart
the planning departments of Prof. Dr. Ing. H. Bechert & Partner in Stuttgart (foundation work) and Dr. Schleicher in Eichwalde (superstructures)
and the testing engineers: Prof. Dr. Ing. Manfred Keuser of Munich (solid structures) and Dipl.-Ing. Ulrike Schömig of Kleinostheim (steelwork).

Dipl.-Ing. Steffen Höfer

The completed embankment is seeded and planted

Track renovation means a faster Inter City Express service between Berlin and Munich

In 2003 the Jena branch of TS Bau carried out a major programme of works for Deutsche Bahn AG, which involved extensive embankment renovation along the Jena to Rudolstadt section of the new high-speed line between Berlin and Munich.

The work was prompted by a landslip in the Zeutsch area in May 1998, which occurred after very heavy rainfall and caused damage to the track over a length of some 600 m. Following the incident trains passing through this section were confined to a maximum speed of 50 km/h.

Embankment renovation work under way

THE RENOVATION PROJECT

The work commenced in October 2002 and as well as renovating the 600 m-long section where the earth slide had occurred, the project involved laying a subsurface drainage course and installing drainage culverts beneath the rail tracks, which would carry surface water to the river Saale, as well as reconditioning both sets of track ballast, renovating the fishplate joints and reconstructing the level crossing at the Zeutsch halt.

The location of the site posed a real challenge for the contractors. The rail tracks, on which trains continued to operate uninterrupted, lay directly at the foot of the slope, while the very busy Highway 88 ran along the top of the embankment.

Before the renovation work could begin the engineers first had to construct an access road along the top of the embankment and another at its base; they also had to erect a temporary wall of Larssen sheet piles up to 7 m in length in order to retain the unstable banks.

CAUTION PAYS OFF

The renovation of the existing cable trough proved to be an extremely time-consuming exercise, as the new sublevel drainage system ran directly beneath the cable ducting. All the cables therefore had to be taken up, and all necessary safety precautions adhered to, before being replaced at the end of the operation. Only after this had been done could repair work begin on the embankment slopes, which also included re-profiling and reinforcing the banking.

As part of this operation the gradient was reduced and the embankment covered with coconut-fibre matting; the area was then wet-seeded and planted with trees and hedging. As the bottom access road was being removed work began around highway 88 on the construction of a new upper embankment ditch with a bentofix mat lining, which would prevent surface water penetrating the body of the embankment. The water is now diverted down a new cascade and then flows through the newly-made culverts beneath the track to the river Saale. This section of track has now been cleared for normal use and trains are again able to travel through at speeds of 110 km/h.

Dipl.-Ing. Ingolf Schilling, René Hähnert

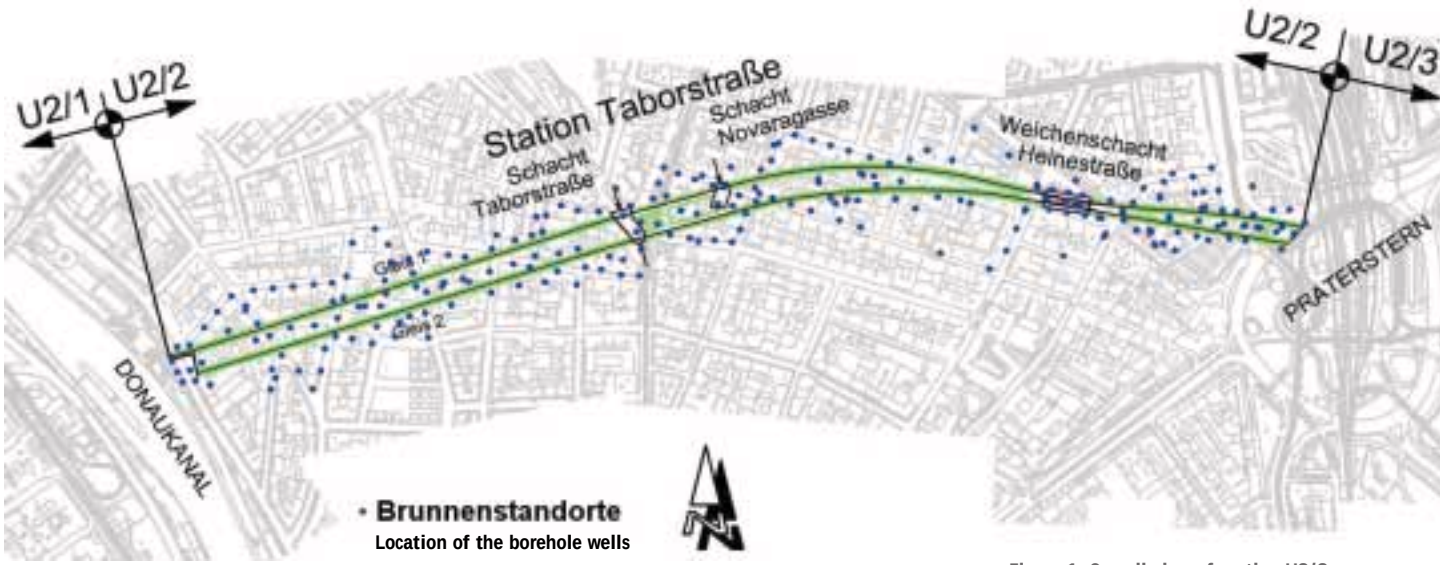


Figure 1: Overall view of section U2/2

Vienna metro system: U2/2 Taborstrasse section

New data transmission system helps in ground-water lowering

Europe's biggest ground-water lowering project is currently under way in Vienna. As part of this operation the water table is being lowered in a controlled manner by about 18 m over a distance of some 1.4 km. The engineers responsible have opted for an all-electronic system with continuous data display and automatic fault messaging logistics – the first time such a technique has been used in an operation of this kind.

The Vienna underground network will benefit considerably from the extension of the U2 line, whose completion will connect the city centre with the new and rapidly-expanding urban development zone in Aspern, which lies on the other side of the Danube. With the European Football Championships due to take place in Austria in 2008, the project contractors are facing a real deadline as this section of the U2 extension is to act as one of the main transport links for the event.

CONSTRUCTION WORK

In June 2003 the U2/2 consortium, comprising Östu-Stettin, Wayss & Freytag and Hinteregger & Söhne (with Östu-Stettin Hoch- und Tiefbau GmbH assuming technical leadership), was contracted by Wiener Linien GmbH to carry out the construction and tunnelling work required for the section of line between Donaukanal and Praterstern – the centrepiece of the new U2 extension.

The new section is located in a heavily built-up district of the city and the line has to pass underneath a total of 97 buildings. For this reason the entire tunnel as far as the station zone is to be driven below ground (the track centre line will be about 20 m below ground level) using the New Austrian Tunnelling Method.

One of the biggest challenges facing the engineers concerned the ground-water

Figure 2: Shaft excavation, Taborstrasse

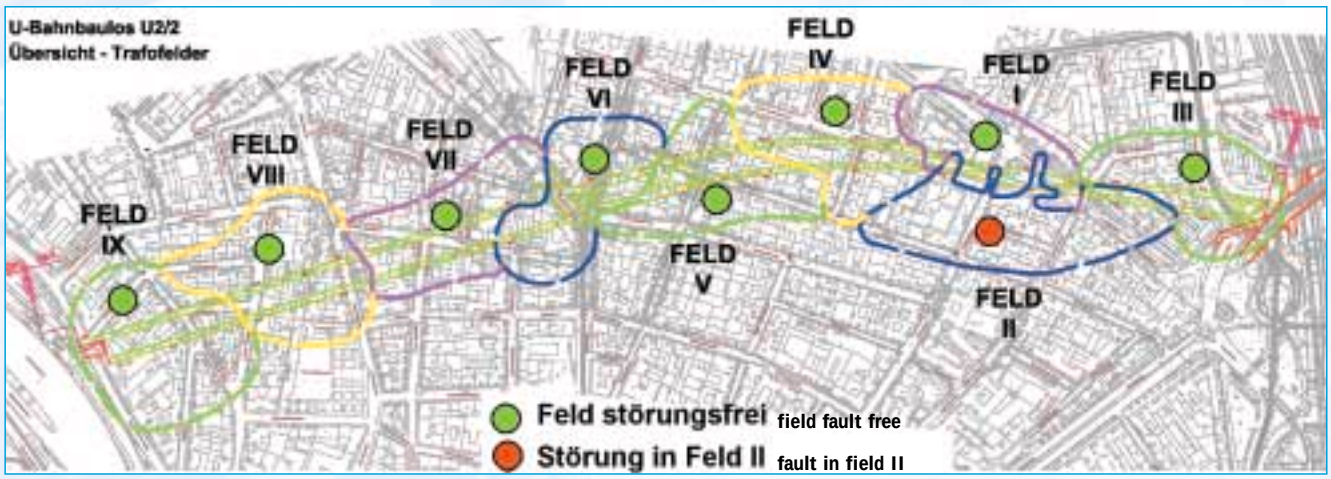


Figure 3: Layout of pumping sectors

conditions in City District 2, which lies between the river Danube and the Donaukanal.

In order to provide the conditions for the tunnel pipes to be driven in dry ground it was clear that a major ground-water lowering operation would have to be carried out for the entire duration of the project.

To this effect some 270 borehole wells up to 40 m in depth were planned and sunk in city-street and courtyard sites as part of an extensive environmental compatibility test.

By rigging the holes with submersible motor-driven pumps, which have an estimated throughput of 800 to 1,000 l/s, the ground water is to be lowered over the entire section of line to a level that will be about 18 m beneath the current water table.

After it is pumped to the surface the water is collected in a horizontal, 5 km-long pipeline system and then discharged into the nearby Danube canal.

GEOLOGICAL RISKS

Preliminary field tests indicated that because of the prevailing soil conditions the water table would rise by 1.5 m in a mere 15 minutes in the event of the failure of any single well, and that the level would rise by a massive 6 m if an entire set of wells (about 30 boreholes) were to fail.

As the tunnel is to be driven under atmospheric conditions such an event would have disastrous consequences, since rapid saturation of the ground would transform the Tertiary sand from a stable body into a fluid mass. This means that if the water were to rise to a level above the floor of the tunnel excavation, the fine sand present at the tunnel face would very quickly run out into the excavated cavity.

In view of the potential risk to drivage crews and surface buildings alike the decision was taken to depart from the traditional method of borehole monitoring, which depended on a pump control station, and develop an innovative electronic system right from the process planning stage.

INNOVATIVE TECHNOLOGY FOR CONTROLLING AND TRANSMITTING DATA FROM GROUND-WATER LOWERING PLANT

The aim of the exercise was to develop a system that would allow the entire groundwater lowering installation to be reliably monitored at all times from a central control station (the consortium site office) and that would be capable of compensating for falls in capacity due to individual well failure by automatically increasing the yield from adjacent boreholes, while at the same time transmitting fault messages to the engineers responsible. Finally, the system also had to be capable of processing and analysing the vast amount of gathered data in a rational and efficient manner.

The Vienna-based company Sonnek Engineering, a reputable supplier of turnkey pump systems, was contracted to supply and commission the entire control system and associated pumps and sensor units.

The pumps chosen for the project were Caprari submersible motorized units rated at 5.5 to 18.0 kW with delivery capacities of 5 to 25 l/s. When completed the entire pumping array has a total rated output of some 2,500 kW.

The wells were drilled to a depth of 40 m and measured 150 to 400 mm in dia-

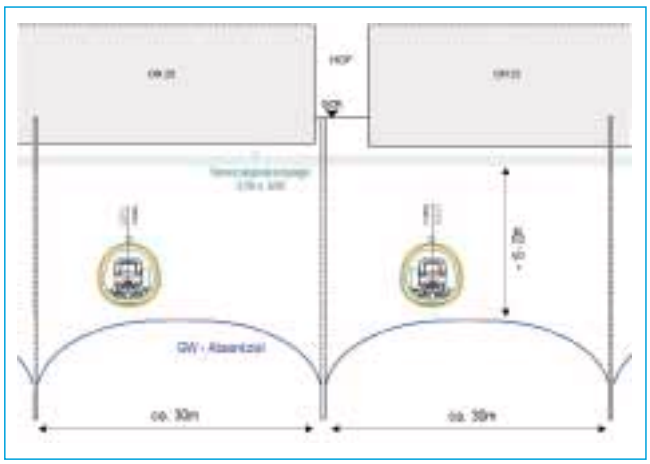


Figure 4: Groundwater Lowering operation

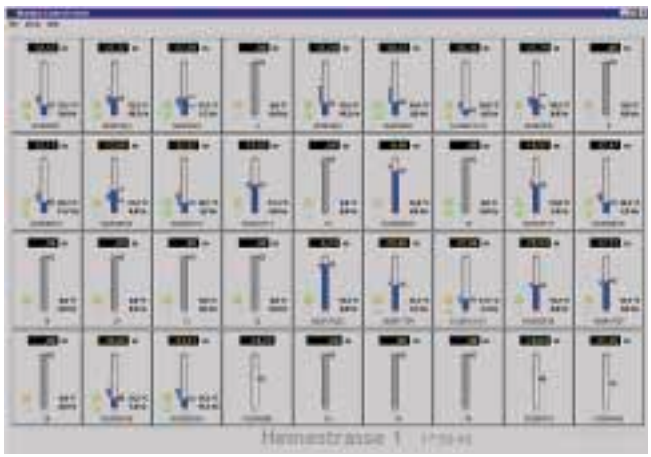


Figure 5:
Display level 3
(overview)

meter. Because of counter-pressure variations over the 5 km-long collector system the pump operating characteristics had to be carefully matched to changes in pressure of 6 to 12 bar. The pumps themselves are subject to severe wear and tear due to the sand content of the medium and the high switching frequency. For this reason each pump motor features a temperature-sensor monitoring system. The wells are also fitted with inductive flowmeters for measuring the volume of water being pumped and pressure sensors for determining the exact height of water in each borehole.

Simple water-level measuring instruments were installed along the pipeline system and these units were also incorporated into the electronic system.

In this way the current groundwater status can be continuously measured and transmitted in parallel to the control room, where the success of the water management operation can be monitored.

When the installation is fully operational in the autumn of 2004 the control system, which is the centrepiece of the entire configuration, will automatically control a total of 270 pumps and manage and display the data collected from some 800 sensors, on the basis of which the control instructions will be issued.

The entire section is divided into nine pumping sectors each containing 30 pumps (see Figure 3).

Each sector is provided with a control cabinet to house the normal power supply, the electronic control system and the data collection system for the attached pumps.

A CAN bus system is used to connect all the pumping wells and gauge wells to the control box via a series of control cables. The maximum distance to the sensors can be as much as 1,000 m. The sensors are simply connected to the bus by pump modules with integrated DAMs (data acquisition modules), which are housed in small boxes fitted into the borehole chambers.

At the centre of each control unit is the "blue box" (see Figure 8) – a data-acquisition and control computer that detects the pump modules immediately after the connection is made and then commences the data recording routine (see Figure 7).

The system therefore continuously detects all water levels, flow rates, temperature values and switching times from the moment it is switched on. The local 30 GB hard disk in the blue box uses a one-second cycle to record the data from all connected sensors throughout the duration of the project. Each of the nine blue boxes is connected via a fibre-optic cable to the central processor in the U2/2 project control room. From this point the ground-water level of the entire section can be monitored, analysed and controlled using display software that has been specially developed for the project.

"With this solution you can now construct a modular pumping system of enormous complexity and control it from your armchair", explains Dipl.-Ing. Wieseneder, the Managing Director of Sonnek Engineering.

DATA DISPLAY AND SAFETY CONCEPT

The display is divided into several layers, starting from a broad-view picture and increasing in detail as you run through the sequence.

Display level 1 presents an overview of all the sectors and indicates any potential problem areas (see Figure 3).

Display level 2 consists of a graphic depiction of all 30 wells in each sector, including status displays shown against a background plan so that individual wells can be pinpointed quickly.

Display level 3 provides a diagrammatic representation of the wells and water levels in each sector so that all details relating to throughput, water level, temperature, settings and maximum/-minimum values are displayed on the screen in real time (see Figure 5).

Display level 4 allows the user to access the progress curve for each individual well and provides a detailed analysis of the status of the borehole at any point in time during the pumping operation. This information helps users analyse the relationship between the different ground-

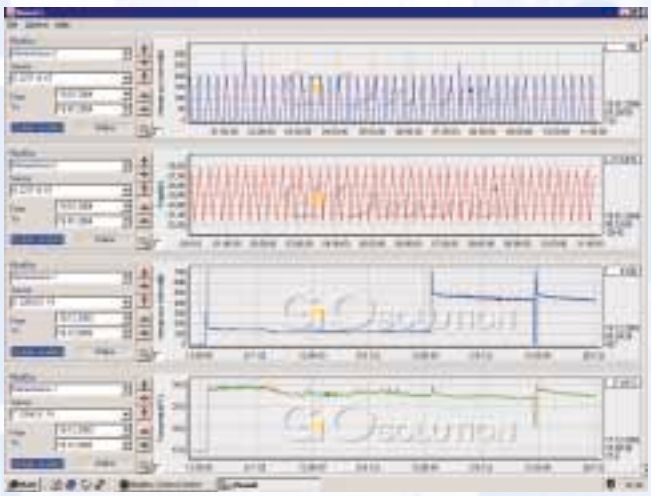


Figure 6:
Display level 4 (water-level isolines)

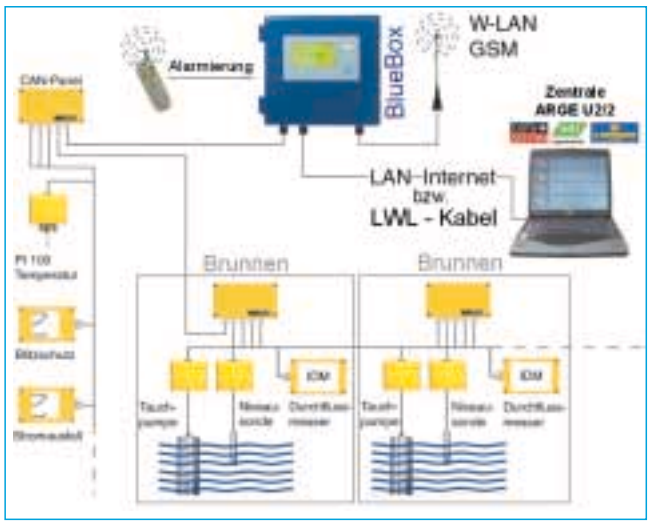


Figure 7:
Connection system

water zones and the interaction between the different pumps (see Figure 6).

An in-house developed report module processes the data from the SQL database on the basis of the contractors' requirements and presents the findings in a series of daily and monthly reports.

All relevant information is therefore automatically analysed for subsequent invoicing to the client. This completely eliminates the laborious work of collecting the data and manually transferring the daily outputs to a set of lists.

The error-message and telecontrol function, on which the entire safety concept is based, plays a vital role in the operation of the system.

Any fault that occurs, such as pump breakdown, sensor failure, line breakdown, unexpected rise in water level and so on, is detected by the blue box and the relevant data relayed to the appropriate operator on the basis of predefined precedence ratings; this information is carried by in-circuit GSM modules in the form of SMS messages. At the same time the data is also transmitted via a glass-fibre line to the main control room, where the fault is immediately transferred to the display software. The arrangement caters for all eventualities, including that of a blue-box failure, which is monitored by a box-to-box surveillance system that immediately transmits a high-priority fault message in the event of a system crash.

Figure 8: Blue box

Failure of the mains electricity supply is one of the contractors' biggest concerns. To deal with such an eventuality a set of emergency generators is kept on standby at the tunnel face and these units are automatically switched-on to provide the necessary electricity in the event of a power cut.

Each blue box has its own low-voltage pack that can operate independently of the mains supply for up to two hours; in the event of a power failure this unit immediately transmits an appropriate fault message.

The equipment also records any activation of the lightning protection system so that the protection device is re-armed for any subsequent lightning strike.

Additional safety is provided by linking the pumps into groups so that the failure of any individual pump can automatically be compensated for. If the pump in a well should fail, or the water level should rise excessively, the switching status of the interlinked pumps is automatically changed and the throughput increased.

All the information can be retrieved on site using a laptop PC connected to the blue box and can also be scanned in the control room or interrogated by telephone (using appropriate software) either directly from the blue box or via the internet. In this way the system can also be monitored, serviced or fitted with new software releases by personnel such as specialists from Sonnek Engineering, without a technician having to be present on site.

MANPOWER SAVINGS FROM A CONTINUOUS MONITORING SYSTEM

The vast quantities of water being produced (as much as 90 million litres per day at full operation), the many pumping points and the large amount of time required for recording and analysing the data would normally call for significant manpower resources.

To operate a conventional system, for example, where each well is equipped with a self-supporting submersible pump, several pump attendants would be required to maintain a constant watch around the clock.

The new system also provides a much better picture of the actual ground-water conditions than any conventional arrangement ever could and system adjustments designed to enhance the pumping performance and improve the energy consumption rate can therefore be planned in a much more accurate way.

Early awareness of the relationship between the different borehole yields, and more especially the prompt detection of pump failures along the 1.4 km-long route, means that response times are cut dramatically and appropriate actions can be initiated very quickly.

The protection afforded to men and equipment operating below ground is very much enhanced and the threat posed by a rise in ground-water levels can be relayed very quickly to the appropriate control station.

The manpower required to monitor the system and to process the operating data, right up to and including the client invoicing documents, is therefore reduced significantly.

Dipl.-Ing. Georg Puntigam

Starting the tunnel portal – inauguration ceremony, 27th August 2003

Nollinger Berg tunnel

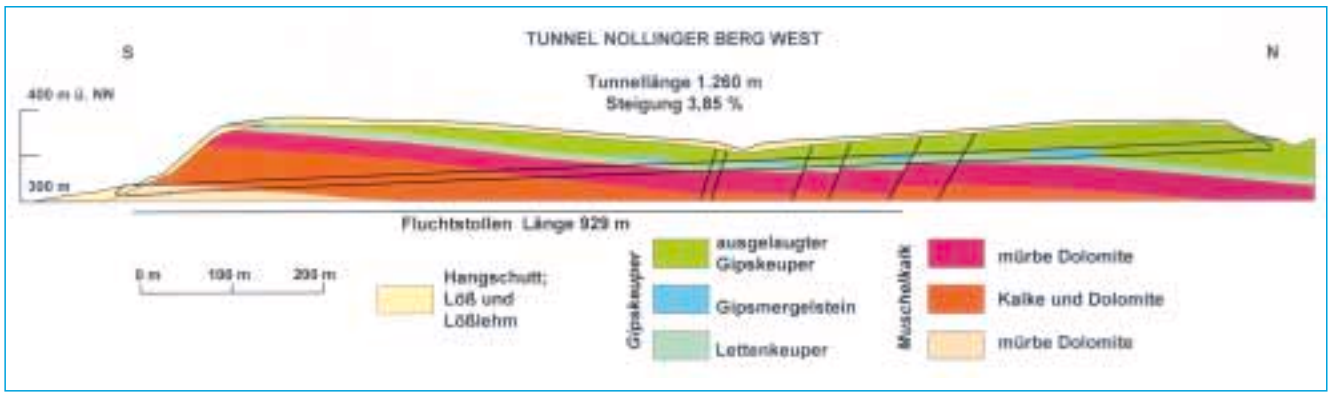
The Nollinger Berg tunnel project is part of the A 98 upper Rhine motorway extension that includes the Weil am Rhein to Schaffhausen section along with the A 861 link between Rheinfelden and Switzerland.

Following the serious fires in the Gotthard, Mont Blanc and Tauern tunnels the project engineers took the decision to abandon the original scheme – which was to have two-way traffic in the existing east pipe that been in operation since mid-December 2002 – and instead opted for the construction of a second tunnel pipe. As well as reducing the risk of accident, such a layout would create additional escape routes by having interconnections between the two tunnel pipes. Before beginning work on the main west pipe an escape tunnel with four connections to the east pipe was excavated along the proposed axis of the new pipe in order to provide safe exit routes in the event of an emergency arising.
As the west pipe is being constructed a new motorway bridge over the river Rhine will also be built at Rheinfelden so that by 2006 a new high-capacity traffic link will be in place to provide a direct connection to the Swiss motorway network.

THE TUNNEL PROJECT

The 1,259.65 m-long west pipe is being driven parallel to and at a centre-to-centre distance from the existing east pipe. The cover depth varies from a maximum of 65 m to a minimum of about 15 m beneath the Wolfsgraben trench. The tunnel pipes run at a slight curve

with a cross dip of 3 % and have a rising gradient of 3.85% from south to north over their entire length. The designers have decided to dispense with a hard shoulder, with the result that the finished tunnel span comprises two carriageways each 3.5 m in width, a marginal strip of 0.25 m on each side and emergency footways each 1.0 m wide. The available headroom is 4.5 m. As stated above, the west pipe is connected to the east pipe by three pedestrian links and one vehicle access route.
The tunnel was driven out from the south portal only using the New Austrian Tunnelling Method.
The south section of tunnel, which is designed as an open-floor drainage zone, has an excavated area of approximately 87 m², while the north section is a pressure-water retention zone and has an excavated area of some 99 m². The interface between the drained and the pressure-water zones features a bulkhead ring that is designed to prohibit the drainage effect of the south tunnel affecting the local water regime. The inner lining in the open-floor section is non-reinforced, while in the floor-arch section a reinforced lining is used.



GEOLOGICAL CONDITIONS

Extensive geological exploration work was undertaken before tunnelling commenced. Back in 1987 a 200 m-long survey drift had been bored out from a vertical shaft along the axis of the west pipe in order to explore those zones where the geological conditions were most challenging. The geological survey required for the west pipe could also be based on records compiled during the construction of the emergency tunnel and on experience acquired from the east-pipe project.

The tunnel gradient and position of the strata meant that the tunnel axis would pass through two bedding sequences from the Triassic period. The south portal starts off in a 40 m-long section of scree deposits and this is followed in turn by friable dolomite beds and layers of solid jointed limestone and marlstone of the Upper Muschelkalk Series, which extend as far as the 550 m mark.

These strata typically contain crevices and karst hollows with boulder-clay infill and are often associated with steeply-inclined faults. The only groundwater problem encountered was water trickling from the joints.

At the 550 m mark the tunnel entered the clay keuper beds (Lower Keuper Series), which corresponded with the 5 to 10° strata dip running north to north-east. This area comprised an alternating sequence of solid limestone and dolomite beds with intercalations of sandstone and argillaceous marlstone. The latter acted as a water retaining horizon.

Anchor-bolts and shotcrete secure the tunnel face in the loose scree section

Driving through the scree section

The second half of the tunnel passes through the gypsum keuper beds of the Middle Keuper Series. The gypsum keuper zone is divided up into solid gypseous marlstone, in the form of irregular lenticular bedding, and lixiviated, low-strength gypsum keuper with a strongly clay-silty or earthy-sandy composition. The keuper beds are frequently displaced upwards by a series of echeloned faults, with the result that as the drivage line rises a longer section of the tunnel crown remains in the boundary zone between

the clay keuper and the gypseous keuper. This has resulted in an inflow of groundwater, which mainly affected the fault lines and the area around the gypsum lenticles.

The south and north tunnel sections therefore displayed completely different geological conditions. While the rocks in the southern part of the tunnel consisted mainly of solid, heavily-jointed limestones and dolomites, the strata in the north section exhibited quite different strength levels and could be liable to softening due to water ingress – a fact which posed real problems for the tunnelling work.

CONSTRUCTION PHASE

After a very competitive tendering process the bidding syndicate of Östu-Stettin Tunnelbau GmbH & Co. KG (technical leadership), Gebr. Hinteregger und Söhne Baugesellschaft m.b.H, Jäger Bau GmbH and Östu-Stettin Hoch- und Tiefbau GmbH was awarded the contract on 19th November 2002. The project subsequently commenced on 15th May 2003 and tunnelling began on 8th August of that year. The contract deadline for the completion of the tunnel construction work was set for June 2005.

TUNNELLING WORK

The tunnel is being constructed using the New Austrian Tunnelling Method and is being driven up-gradient in a single direction from the south to the north portal. The round-the-clock operation is being carried out with an all-Austrian workforce of three 7-man drivage teams. After each 100 m of roof profile has been excavated the corresponding floor section is removed. Where the base of the tunnel has to be immediately tied into the floor, the bottom arch must be constructed simultaneously with the floor excavation.

The tunnelling machinery was chosen on the basis of the geological conditions. The main items of equipment are: one twin-boom AC 352 S drill jumbo, one Liebherr LH 932 T tunnel excavator, one Volvo 150 D free-steered loader and three GHH MKA 32 dumpers for muck clearance. The sulphate-resistant wet-spray shotcrete is applied using a Putzmeister WKM 103 mobile sprayer.

Picture above:
Boring with the pipe screen (scree section)

Picture left:
Excavating the emergency tunnel (extension phase)

About half of the 100,000 m³ of excavated debris is suitable for recycling. There are plans to use some of the material as embankment fill and possibly also as floor infill and for the construction of the frost protection course. The remainder will be deposited at a waste disposal site.

In the lixiviated gypsum keuper sections the drivage work is carried out under the protection of a leading screen of tubular spikes. Even at the beginning of the tunnel excavation a pipe screen had to

be used to protect the crew as they worked through the loose scree. Because of the difficult strata conditions (scree and lixiviated gypsum keuper) the tunnel face in this zone sometimes had to be exposed in sections and stabilised with reinforced shotcrete and anchor bolts up to 18 m in length.
Shotfiring has been employed in the limestone and dolomite sections of tunnel in order to preserve the rock profile. Because of the almost horizontal stratification tubular spikes also have to be used in this area to provide advance protection for the drivage teams. The concave excavation at the heading face is essentially supported using tunnel arches, steel mesh and a layer of shotcrete up to 30 cm thick. A temporary reinforced crown arch of shotcrete is also used in some sections to provide additional support.

DEWATERING

As the gypsum keuper beds can be extremely water-sensitive, special attention has to be paid to the drainage system in this area and in spite of the rising tunnel gradient it has not been possible to employ open water ditches. All groundwater and service water has to be collected and pump-piped out of the tunnel. It is then clarified and neutralised before being discharged into the watercourse.

ESCAPE TUNNEL PROVIDES EMERGENCY EXIT ROUTE

The existing escape tunnel, which runs as far as the 930 m mark, lies in the profile section of the west pipe. During the main drivage operation this route will also provide an emergency exit for travellers using the east pipe as well as for the current tunnelling crews. This means that the work being carried out in the west pipe has to be organised in such a way that the emergency drift remains usable at all times. A special emergency and rescue strategy has therefore been devised and tunnelling teams and tunnel rescue squads are routinely trained in the deployment of the tunnel evacuation procedure.

CONCRETE INNER LINING

The tunnel is basically divided into two sections each with its own distinct inner lining system.
The south tunnel section, which lies in limestone and dolomite rock, uses an open-floor drainage system. This comprises an umbrella seal, which consists of polyester sealing strips 2 mm in thickness, with groundwater drainage ditches running along the tunnel walls. The inner lining, which rests on abutments, is not embedded and no reinforcement is included in this particular section.
The north section of the tunnel in the gypsum keuper strata, which is designed as a pressure-water retention zone, is fully lined with 3 mm-thick polyester sealing strips and features a reinforced floor arch and a reinforced inner lining.

Tunnel excavator clearing the heading face (friable dolomite from the Upper Muschelkalk Series)

Face sealing under way in the loamy gypsum keuper strata

PROGRESS TO DATE

After an amazing performance from the tunnelling crews – who have achieved an average of six and a peak performance of as many as eight roof pulls – some 820 m of tunnel crown section and 750 m of floor had been excavated by the end of January 2004.
Even though the most difficult tunnel sections still lie ahead for the mining crews, the workforce is confident that break-through can be achieved two months earlier than planned.

Manfred Sachs

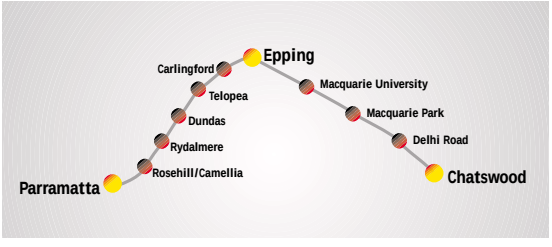
Tunnel formwork for Sydney's new Parramatta Rail Link

The Parramatta Rail Link is currently the largest infrastructure project being undertaken by the Government of New South Wales and is also one of the most important construction projects under way anywhere in Australia.

In order to cope with traffic volumes in the Sydney area the Government has launched its Passenger Transport Initiative with a view to improving rail transport services between the suburbs and the city centre.

The Parramatta Rail Link includes two single-pipe rail tunnels each 12.8 km in length, which will connect the districts of Chatswood and Epping to the Sydney Metropolitan Rail System.

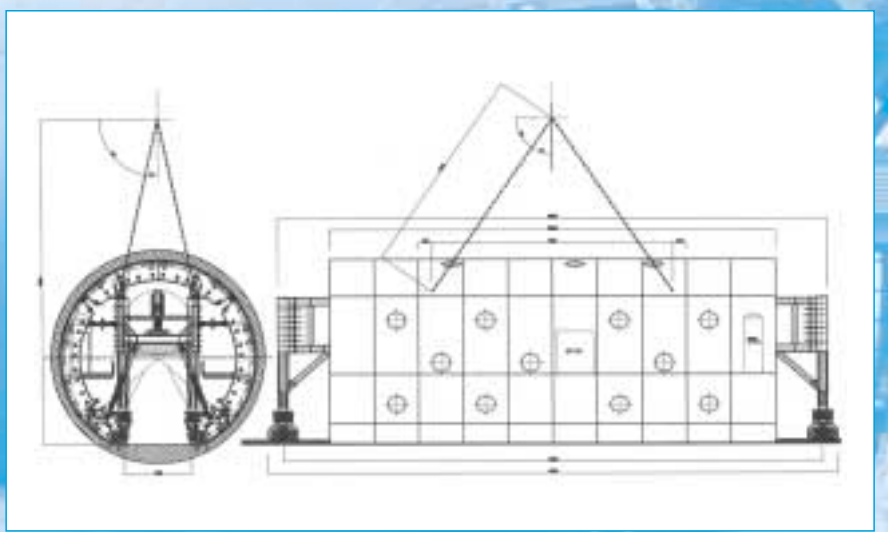
Once the project is completed the network will be capable of transporting more than 12,000 rail passengers a day between these residential areas and the city centre. Trains will operate along this section of the system up to six times an hour.



PROJECT BACKGROUND

The contract for the 485 million project was awarded to a Joint Venture partnership that had been set up by the firms Thiess and Hochtief (THJV). The construction work began in July 2002 and the completion date has been set for December 2006. The 12.8 km-long twin pipes are being excavated by two tunnel boring machines, with the mixed-in-situ concrete lining being installed immediately after the tunnelling phase.
In November 2003 Östu-Stettin Schalungsbau was contracted by THJV to plan, design and fabricate the entire formwork system required for the two tunnel concrete linings.

Front view of tunnel formwork car



Cross- and longitudinal section of the tunnel formwork car

After detailed negotiations, which also included a discussion of the operational procedures, it was agreed that the company would supply:

- six tunnel formwork cars (radius 3325 mm, form length 15 m) and
- six formwork junctions for the connecting tunnels.

The formwork had to be designed to accommodate a variety of local conditions, mainly because of the layout of the tunnel floor.

The 3200 mm-wide precast concrete elements are installed at intervals of 6 m immediately behind the tunnel boring machine. The gap between each element is then filled with concrete and rendered smooth.

The drawing gives some idea of the operational constraints and compromises that have to be accommodated not only because of the floor width but also due to the gauge and available clearance of the self-supporting formwork system.

View of the pre-assembled tunnel formwork car

As neither the prefabricated elements nor the concrete fill were capable of withstanding the peripheral pressures exerted by the formwork, an opportunity presented itself to move the load-bearing points towards the centre of the structure without reducing the clearance width.
In spite of the complexities involved, a satisfactory and practicable solution was found to this problem.

MADE IN EUROPE

In order to guarantee a top-quality and highly-functional end product it was decided that the formwork system would be manufactured exclusively at our own workshops in Leoben (Austria) and Sopron (Hungary).

The formwork cars were then dismantled and shipped to Sydney, where they were re-assembled on site under the watchful eye of one of Östu-Stettin's senior mechanics.

The fully-assembled formwork, weighing some 120 tonnes, was then transported 30 m into the tunnel via an access shaft. Östu-Stettin Schalungsbau – proving that innovation and consultation pays off.

Our international reputation for building high-quality, reliable tunnel formwork systems helps us stay ahead of the competition.

Ing. Harald Pacher

"Living in the Seventh"

Construction has now started on a new residential development in Vienna's Seventh District. The project, which is being promoted under the slogan "Living in the Seventh", is being carried out by Vorsorge Immobilienentwicklung und -verwertung GmbH, a joint venture company set up by Östu-Stettin Hoch- und Tiefbau GmbH and Dr. Jelitzka & Partner.

After the completion and successful marketing of its first property project in 2003 (see Report 2003) the joint-venture company lost no time in acquiring a contract to redevelop a second site – in this case a former schnapps factory building in one of the inner suburbs of Vienna.

The original structure, part of which is to be rebuilt, is located in the heart of the old commercial sector, which is Vienna municipal district no. 7.

The property benefits from a first-class location, being close to the shops and night-spots of the Kaiserstrasse and Mariahilfer Strasse. The area has also attracted many private retailers and is home to numerous arts and crafts shops and design studios.

Transport connections are also excellent. The Burggasse metro station can easily be reached on foot and the new city library is also within walking distance. In a few minutes residents can be at the Spittelberg or museum district, while a number of small parks are also close by.

PROJECT LAYOUT

The new development will contain two impressive pieces of architecture: the main multi-storey building with its pent-house and roof terrace, and the lower-set annex, with its green-planted flat roof, which juts out prominently into the inner courtyard. All will be set off handsomely against the red-tiled roof of the historic, brick-built schnapps factory.

The two buildings complement each other not only in their ambitious architectonic design but also in the functionality and quality of their interior fittings and furnishings.

The new construction and restoration work proposed for the rear of the property, the so-called "lofts", will create a total useful living area of some 4.570 m^2 with 64 separate apartments and a retail outlet, along with a two-storey underground parking lot with space for about 60 cars.

FITTINGS AND FURNISHINGS

The apartments and loft studios come complete with parquet flooring and beautifully-designed bathrooms and each

has been laid out to create a most impressive living space. All units have their own balcony overlooking the inner courtyard and many other details are also included, such as internet connections, security-lock entrance doors and private parking spaces in the underground garage. Most of the apartments also feature top-of-the-range fitted kitchens. The top floor of the main building houses a number of penthouse flats, each benefiting from large dormer windows and a roof terrace that affords a superb view over the city centre. Some of the penthouses also have open fireplaces and air-conditioning systems.

MARKETING

The property is to be marketed by project associates Dr. Jelitzka & Partner. Even before the building work began some 2.130 m³ of apartment space was purchased by a major investment company. This means that 47% of the property has now been sold. Negotiations are also under way for the contract to develop plot number 3, with a commercial developer having expressed an interest. The successful conclusion of this partial sale will leave about 915 m² of residential space still to be marketed, including the terrace and 16 of the parking-lot spaces. With the construction phase not yet started, some 14 apartments, representing about 20% of the total property, are still available for prospective purchasers.

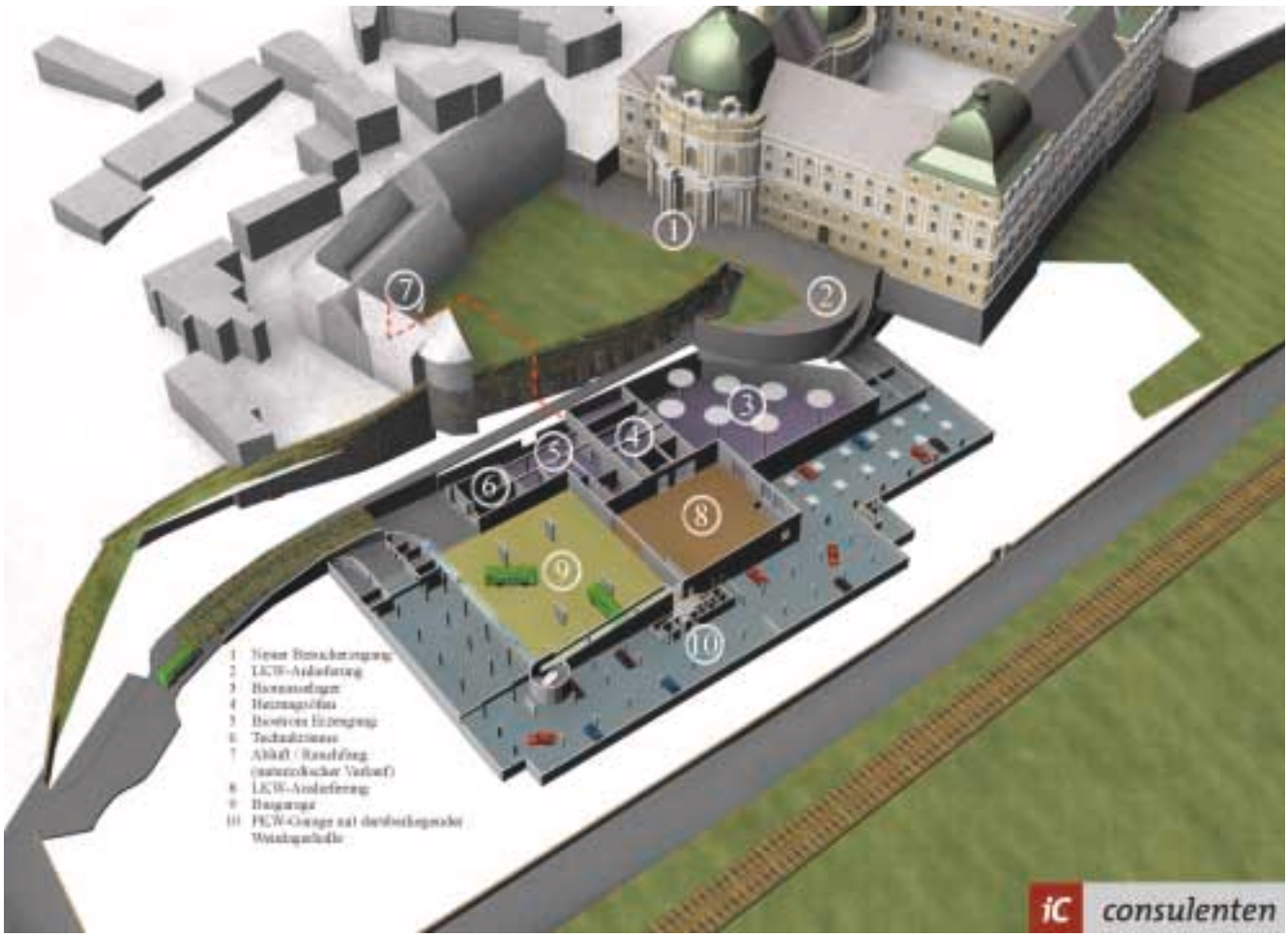
Such efficient marketing speaks volumes for the professional manner in which the project has been arranged and managed.

PROGRESS

The property development project “Living in the Seventh” – site address 1070 Vienna, Kaiserstrasse 63 – has been entrusted to the Vienna branch of the building and contracting firm Östu-Stettin Hoch- und Tiefbau GmbH, who will be acting as general contractors. The demolition work began on schedule in October 2003, with the result that the specialist civil engineering and excavation work was able to commence two months later immediately after planning permission had been granted. The new residential complex has been set a completion date of April 2005.

The project constitutes another interesting addition to Östu-Stettin’s property development portfolio.

BM. Ing. Maximilian Höller



Eco-friendly Heating
for the Cloisters

Klosterneuburg Monastery is now home to the biggest biomass-fired CHP plant east of the Arlberg.

With a wide range of heating systems operated in the monastery buildings, including tile stoves and various oil-fired and gas-fired appliances, the canons at Klosterneuburg Monastery decided in 2001 to “think big” by opting for a completely new type of heating system.

The project team decided, for ecological and economic reasons, not only to construct an eco-friendly biomass combustor, designed to generate energy by burning wood chippings, but also to build an additional and much-needed wine store, an underground parking area big enough to hold 120 cars and 12 buses and a new access for visitors to the famous baroque rooms.

The planning work was entrusted to architects Heinz Tesar, whose design involved “hiding” the combustion plant under a "hill of green” so as not to spoil the view of the historic building. IC consultants ZT GmbH were to be responsible for the constructional design.

Östu-Stettin was awarded the contract for the building work in the summer of 2002 and the project commenced just before Christmas of that year.

CENTREPIECE

At the heart of the new installation is the furnace unit, which stands three stories high in some sections, along with adjoining service facilities and a biomass store – a walled-in space measuring 8.5 m in height and taking up some 12,000 m³ of space. Ceiling support is provided by the surrounding walls and by eight circular columns, a design that allows the biomass material to be easily transported and handled by means of free-steered loaders.

As the heating installation had to be up and running by the following autumn, priority was given to the construction of this storage area.

In spite of adverse winter weather Östu-Stettin completed this part of the contract on schedule and by early April 2003 the firm was able to begin work on assembling the two giant 52-tonne biomass combustors.

Delivery area

The two furnaces convert the eco-friendly biomass into electricity (2.5 and 1.2 megawatts respectively), and also supply some 200 kilowatts of power to the national grid.

AN UNCONVENTIONAL APPROACH

Work then began in the basement area with the construction of the car park and overlying wine store, a number of additional storage rooms and offices and a coach parking area with a span of 38 m, that is supported on four single columns. The project designers opted for a central marshalling area that would be devoid of obstructive pillars. This arrangement was needed in order to facilitate ash removal from the furnaces (using the collector box system) and allow delivery vehicles to supply the new wine store. The 800 m^2 of roof area is therefore designed as an unsupported 1.85 m-high T-beam ceiling with a span width of 26 m.

One of the biggest challenges for the design team concerned the arrangement of the vehicle-exhaust emission ducts. As the exhaust-gas flue could not be erected in front of the monastery building as a free-standing structure, the designers had to install an "invisible" duct system some 80 m in length. Leading out from the service rooms below ground level, a tunnel was constructed using an injection screen and supported with a shotcrete lining; this gallery ends in a vertical shaft, which then runs up to the Jungherrengarten high above

Klosterneuburg Monastery

The town of Klosterneuburg on the Danube lies some 10 km up-river from Vienna and the present-day monastery occupies the site of a Roman fortress that was built in the first century.

In 1095 the margravate passed to Leopold III, who married Agnes, the sister of King Henry V, in 1105. Agnes had previously been married to the Swabian Duke Friedrich, with whom she had a son Konrad – who was later to become the King of Germany. Agnes is therefore the mother of the Hohenstaufen Emperor dynasty.

In 1113 Leopold and Agnes moved their residence to Klosterneuburg, where as well as building a new castle (the current monastery archives) they established a friary, which they turned over to the Augustinians in 1133.

In the Middle Ages Klosterneuburg Mona-

the heating installation. At this point it enters a conventional underground collector, which is an open-trench construction, and this in turn leads into the old Geschirrhof building. The internal structure of the latter had to be completely removed because, firstly, the flue running up through the pre-cast concrete shaft inside the building extended beyond the ridge of the roof and, secondly, a new entry point for fire-fighting teams had to be made in the shell of the building itself.

Another interesting aspect of the project was the way in which the new structure was connected to the main monastery building.

A new goods lift also had to be installed to serve the wine store and delivery area and this facility also connects with existing chambers in the main building. New entry points and passages were made through the outer walls and foundations at a total of four different storey levels, which meant cutting through

The first tunnel at Klosterneuburg

stery was not only a religious venue but also a centre of art and learning. The famous Verduner Altar, a gilded enamel masterpiece erected by Nikolaus von Verdun in 1181, is one of the most important European art treasures of the period.

In 1730 Emperor Karl VI began work on a complete restoration of the monastery, his plan being to make Klosterneuburg an "Austrian Escorial" – an amalgamation of monastery and Emperor's residence in imitation of the famous Spanish edifice. The Emperor's architect Donato Felice d'Allio drew up plans for four courtyards and nine new domes, which were to be the crowning glory of the House of Habsburg.

The sudden death of the emperor put an end to the building project, as Karl's daughter Maria Theresia failed to continue the work. However, by 1836-42 the architect Josef Kornhäusel at least managed to complete one of the courtyards.

The church policy of Emperor Josef II (1780-1790) led to a major extension in the pastoral activities of the monastery – and even today 24 parishes in Vienna and Lower Austria are administered from Klosterneuburg.

By 1920 Canon Pius Parsch had anticipated the reforms of the Second Vatican Council with his popular liturgical movement, introducing the national language into the liturgy and using the public altar. His masses were translated into every language and millions of editions printed.

In 1941 the monastery was shut down by the Nazis and Canon Roman Karl Scholz – the founder of the first resistance movement against the Nazi regime – was executed in 1944. The building was re-occupied again the following year.

Even today the monastery still provides pastoral care, while its art treasures attract tourists from far and wide. The building has in fact become a hub for economic activity – it boasts the area's largest vineyard and its amenities provide a focal point for social gatherings of every kind.

masonry that was as much as 6 m thick in places; these new access routes were constructed partly by installing new supporting joists and partly using ground anchors and shotcrete. The cramped working conditions and ongoing wine production operations in the immediate vicinity meant that the contractors could not use heavy-duty equipment; as a result most of the demolition work had to be carried out manually using stone hammers and pneumatic picks.

The result was a completely new access point for supplies to the monastery. This means that delivery vehicles can now discharge their cargo of wood chippings directly into the biomass store via a hydraulically-operated hatch in the ceiling. The 800 m^3 roof span, which had to be large enough to allow access for fire-fighting vehicles, was constructed from a single ferroconcrete slab. The structure is only supported at a few load-bearing points so that even in this confined area sufficient space is available for the convoy of delivery trucks to come and go and discharge their pay-loads.

T-beam

CONSTRUCTION

In view of the large load that will be imposed by the subsequent overfill, and because of the dimensional bulk of the structure and the prevailing ground conditions (the area lies in the alluvial plane of the river Danube), most of the load-bearing members have been constructed in mixed-in-situ concrete.

The architectonic design required a wide variety of steel-concrete elements. This meant that the different concrete forms had to be deployed very efficiently, since as few of these units as possible were to be used on site. These arrangements were successfully implemented in close collaboration with the project planning team.

During the construction phase the main delivery road to the monastery had to be properly maintained and kept open to traffic at all times, a requirement that was successfully met as a result of some excellent coordination with the client.

With a contract to modify a total building area covering some 9,500 m^2 and a walled-in space taking up approximately 74,000 m^3, the Östu-Stettin team successfully completed the shell of the new structure within 10 months – an operation that involved shuttering some 37,000 m^2 of surface area, pouring a total of 20,000 m^3 of concrete and laying some 1,800 t of reinforcing steel. It was a massive achievement in every sense.

Fuel store with its slab-floor construction

FIRING UP

The installation started up on schedule on 11th September 2003, when the biomass furnaces were lit for the first time as part of an official “firing-up” ceremony performed by the abbot, Provost Bernhard Backovsky.

The commissioning of the new plant, which now also supplies the nearby Happyland theme park, and the replacement of the old fossil fuel-fired generators have made a major contribution to the local environment with a 97% reduction in CO_2 emission levels. Plans are also under way for the new plant to supply electricity to even more consumers in the Klosterneuburg area.

The successful completion of the contract again demonstrated that Östu-Stettin can take on difficult and multi-faceted projects and deliver on schedule.

Bmst. Ing. Andreas Zeininger

A review of recent major projects cannot fail to impress

From engineering to delivery, nothing is left to chance

Generator housing

Press for rail-technique

1.000 t special beam for the shaftsinking and drilling division

Steel transporter vehicle: dimensions 11 x 6 x 7.3m; payload capacity 420t

Customer services at the new Schwelgern coke plant

Backed by the company's in-house workshops, our service team is geared up for fast turnaround and will work round the clock to help our customers with all their breakdown problems and maintenance requirements.

Engineering services for Europe's largest calcareous sandstone producer

Rheinkalk, which is part of the Lhoist Group, extracts up to 64,000 tonnes of lime sandstone a day from the Rhodenhaus quarry in Wülfrath.

After blasting, the sandstone slabs are transported by Caterpillar truck from the quarry to two primary crusher units, each of which has its own 350 tonne-capacity mineral bunker. The maximum edge length of the slabs is 2.5 m.

The quarry owners decided that the steel-plate conveyor that draws the material off from beneath one of the bunkers was in need of a general overhaul – the first time this equipment had been serviced in the six years since its installation.

Despite the difficult working conditions, the T + S assembly team took a mere 17 days to replace and adjust two badly worn and distorted plate conveyor chains together with a 3.5 m-long drive shaft.

After a very short downtime the refurbished conveyor is now delivering the required output of some 2,000 tonnes per hour.

Dipl.-Ing. Heinz-Wilhelm Seramour

Another hydrogen-cooled generator leaves the workshops

Ready to go in a mere 32 weeks from the date the order was received, and using 50% special steels throughout, the new generator required expensive welding techniques that had to be tested to the highest standards, including X-ray analysis. The successful completion of the project was due entirely to the commitment and technical skills of our shop-floor personnel who worked around the clock to ensure that the contract was delivered on time.

TS Technologie + Service GmbH builds its largest ever structural steel component

At the end of May 2003 TS Technologie + Service GmbH was commissioned by Siemens AG Power Generation to construct two low-pressure steel housings that were to form the upper and lower sections of a new steam turbine unit.

Low-pressure internal housings constitute the stationary section of the turbine and it is here that the release of steam pressure over the blade rings causes the rotor to rotate. This rotation is then used to drive a generator, which in turn generates electricity.

WEIGHING IN AT 152,000 KG

When completed the overall structure measured 8000 mm x 5220 mm x 7500 mm and weighed some 152,000 kg, with approximately 200,000 kg of material being required to produce each section.

The engineering drawings and check plans required for the highly-complex components were drawn up in close collaboration with the client.
One of the special inventory control requirements imposed by Siemens AG was that the cobalt content had to be less than 500 ppm, with verification to be provided by material analysis.

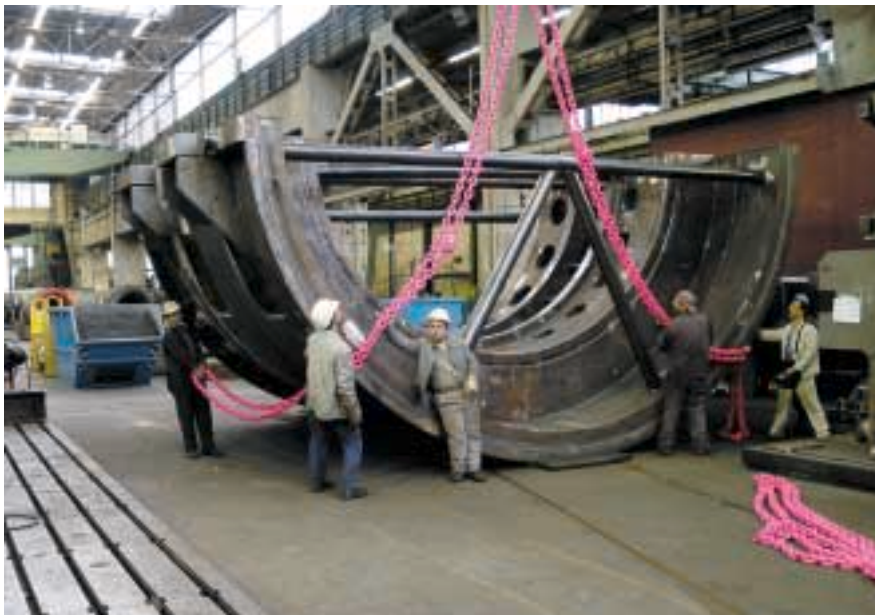
WORK BEGINS

After the engineering data had been compiled and the materials budget completed the fabrication work proper began in July 2003. Initially a two-shift operation, the production cycle was subsequently switched to working round the clock.

Right from day one absolute priority was given to maintaining the high quality specification, with every stage of the process being monitored by the client.

7,000 KW PER BURNER

In order to avoid the need for expensive and difficult transport operations the project management took the decision to install a transportable annealing plant at the TS Technologie + Service GmbH works.
The annealing furnace is heated by five oil burners each rated at 7,000 kW.



DELIVERING THE GOODS

The first of the two housings, fully stress-free annealed, sand-blasted and tested, was delivered to Siemens AG at the end of October, while the second low-pressure unit was dispatched for final machining in late November 2003.
Such was the quality of the engineering that the following month TS Technologie + Service GmbH was awarded a further contract by Siemens AG Power Generation to build another low-pressure housing with a surface area of 13.9 m^2 and a component weight of about 80 t.

OUTLOOK

TS Technologie + Service GmbH will continue to be at the forefront of technological development and will remain a leading supplier of generator core sections, cooling heads, low-pressure internal housings and steam bleeder and steam bypass inlets.

Peter Arrachart
Wolfgang Katritzke

Equipment modernisation at ThyssenKrupp Steel

In mid-May 2003 ThyssenKrupp Stahl AG of Duisburg contracted TS Technologie + Service GmbH to manufacture and install a complete lifting beam for crane no. E 70, which has a span width of 36 m and a rated payload capacity of 80 t.

The overall structure, which measures 3200 mm x 950 mm x 2800 mm, has a finished weight of 3,950 kg and approximately 5,500 kg of materials were employed in its construction. The crane hook alone weighs in at 730 kg.

OLD DESIGN DRAWINGS PROVE THEIR WORTH

The new engineering diagrams and requisite test and welding plans were drawn up on the basis of design drawings and parts lists dating back to 1979, which were supplied by the client. One of the quality standards to be met was the welding approval test to DIN 18800, extended to include DIN 15018, which has been part of the company's credentials for a number of years. After the manufacturing documents had been submitted and the plans agreed with the client, the fabrication work was able to commence in late May 2003. The crane hook had to be incorporated into the design as the assembly work progressed. The assembly department of TS Technologie + Service GmbH completed the installation of the new lifting beam unit at the end of November 2003. The 16-hour operation was carried out to the complete satisfaction of the client.

Peter Arrachart, Dipl.-Ing. Jürgen Michels

www.thyssen-schachtbau.com