THYSSEN SCHACHTBAU GROUP

Report 2003

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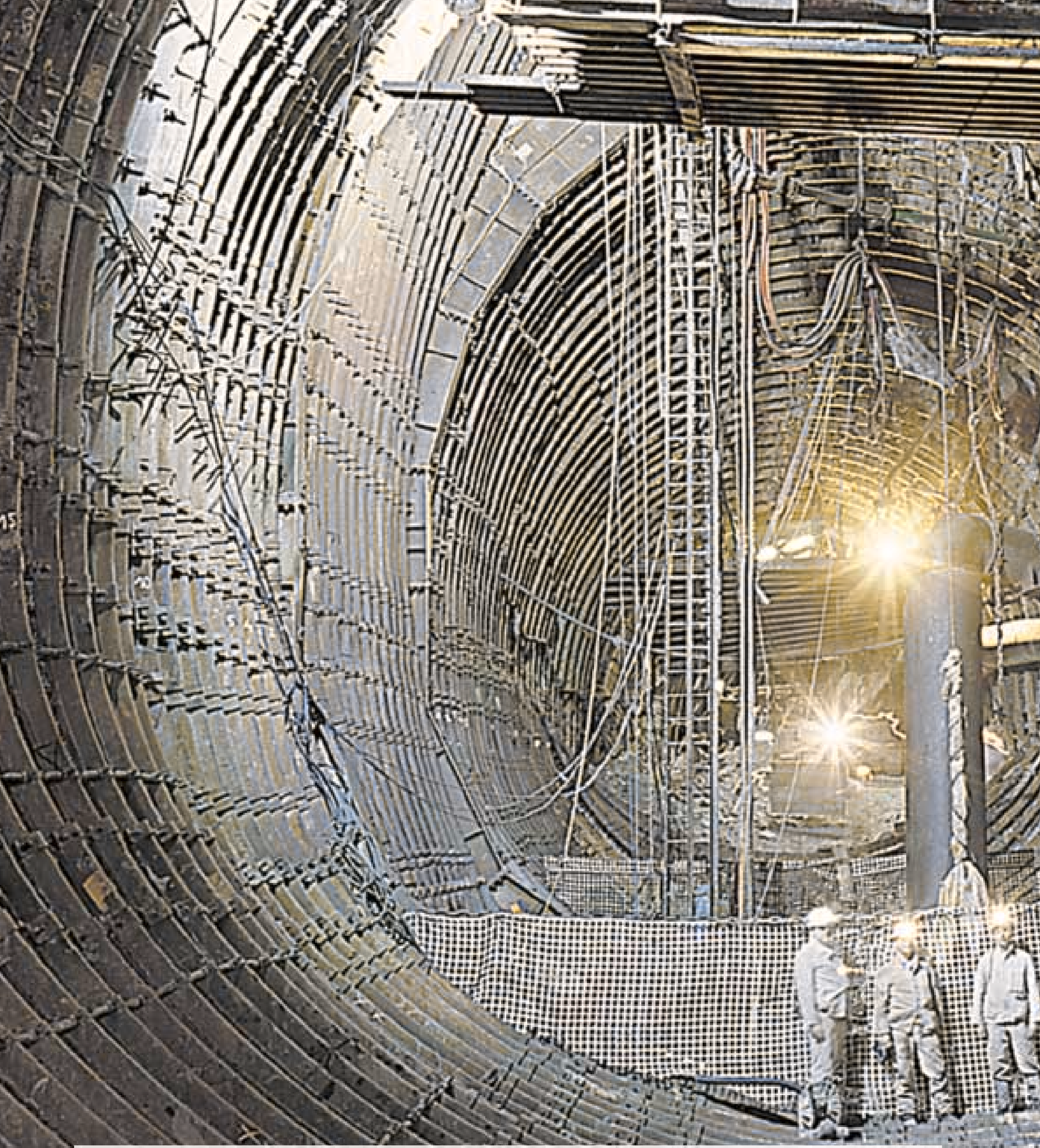

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CONTENT

SITUATION UPDATE

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

the latest issue of the Thyssen Schachtbau "Report" follows the normal practice of presenting some of the most challenging engineering projects on the books of our mining, construction and production divisions – projects that demonstrate the range of talents and problem-solving abilities available to the companies that comprise our international enterprise group.

Let us begin by reviewing last year's activities and looking ahead to the current year's developments to see how they impact on the group as a whole and the individual business units. Both years have seen quite pronounced market and corporate developments.

GROUP PERFORMANCE

With business-sector realignment, the progressive elimination of inherited liabilities and the restructuring of various operating companies and units all now completed, the year gone by has mainly been characterized by a strengthening of the core business and a consolidation of the construction sector.

Our mining/shaft sinking/tunnelling division has shown satisfactory progress at home and abroad, while our domestic and overseas specialist construction business and our technology services have also performed well – and there have been welcome rates of growth in individual markets. However, in a still difficult economic environment (accelerated restructuring of the German coal industry and a change in that market's contract awards procedure, ongoing crisis in the building sector, some weakening of commodity prices combined with sluggish economic activity) a number of our companies have had to suffer a decline in output and, in spite of the countermeasures that have been taken, some have also seen a downturn in profits.

Overall Group performance was € 496.1 million, compared with € 541.7 million last year, with the non-domestic proportion slightly up at 52.3% (as against 51.4% in 2002). The increase in Group

pre-tax profits to € 16.0 million (€ 15.1 million last year) – a result which includes the special effects produced by divestments and property sales and the continued restructuring of the domestic construction sector – has meant a further increase in the Group's equity ratio.

Intra-Group investments rose to € 38.0 million (€ 27.8 million last year), mainly due to overseas mining projects. Despite further consolidation in the domestic construction sector, a similar level of investment is planned for the current year. Ongoing structural and market-related adaptation in the domestic mining industry and the realignment of domestic construction companies have meant that, despite manpower recruitment in the overseas mining sector, the total Group workforce fell to 4,080 by the year's end, compared with a figure of 4,328 the previous year. The proportion of foreign-based workers in the total labour force rose to 45.4% (41.2% in 2002).

Shareholder changes at Thyssen Schachtbau GmbH have helped us create a better investment structure for our domestic and overseas companies. This development has also allowed us to concentrate our domestic property holdings in an investment company and to set up a separate holding company to run the Group's administrative and services functions. The measures needed to accomplish this re-organisation, which is aimed primarily at achieving cost and portfolio improvements and at giving greater profit responsibility to the different business units, will be completed during the current financial year.

BUSINESS SECTORS

In the *Mining Germany* sector the market is still dominated by our major customer of long-standing. Declining demand and increasing pressure on prices have forced TS Mining division to accelerate the process of manpower downsizing and cost adjustment. TS Shaft Sinking and Drilling has continued to perform well and completed projects, such as those at Bulyanhulu and Primsmulde, have been replaced by long-term follow-up orders at Sedrun/Gotthard and Teutschenthal.

The *Mining International* sector has continued to reflect the mixed fortunes of its Canadian and Australian operating companies. TMCC has been affected by market restraint in the placing and continuation of orders, which is the result of falling commodity prices. However, the company is pursuing several promising joint venture projects in western Canada. Byrnecut has again performed remarkably well. This has primarily been due to a series of successful contracting projects in Australia (Jundee, Cosmos and Agnew) and extension contracts in Tanzania and Ireland, which are being managed as joint venture operations with other TS companies as well as with third-party contractors. The company also has plans for further growth based on platinum projects in South Africa.

The same picture is true of the *Construction Germany* sector, where our various companies have been operating against the background of ongoing recession in a construction market that has suffered from a squeeze on profit margins. By further reducing the number of its operating sites, cutting overheads and concentrating on specialized markets (track laying, landfill building and pipeline work), TS Bau has achieved a turn-round in its business fortunes. DIG has once again been affected by the high cost of company restructuring and by the start-up losses associated with the development of the ”cooling panel” market. Further company consolidation will take place in conjunction with TS Bau.

In the *Construction International* sector our companies in the UK and Austria have also suffered mixed fortunes. TGB has experienced a downturn in business from coal mining and from the Irish construction industry, while a number of complex major projects also adversely affected the overall result. Company consolidation under new management is now progressing satisfactorily. ÖSTU's continuing success has been due not only to its tunnel construction activities but also increasingly to general contracting orders from the structural concrete sector and the growing Hungarian market. The company's recent investment in the formwork construction business will lead to further commercial expansion.

The *Production* sector continues to remain stable. Technologie + Service has increased its turnover and is winning further industrial clients for its engineering, steel construction and service activities. Despite technical delays that have affected the start-up of a sixth coal drier-grinder plant, Emscher Aufbereitung was able to achieve its production target.

A WORD OF THANKS TO AUTHORS AND EDITORS

Dedicated managers and staff from every corner of the TS Group have once again provided us with a series of competently-written and informative articles – and our trusty team of editors has again come up with a professional selection of carefully-edited, attractively-presented reports. We would like to thank all the authors and editors for their contribution to this year's publication. Our ”Report 2003” promises to be of great interest to all and comments from readers will be most welcome.

OUR MISSION STATEMENT REMAINS

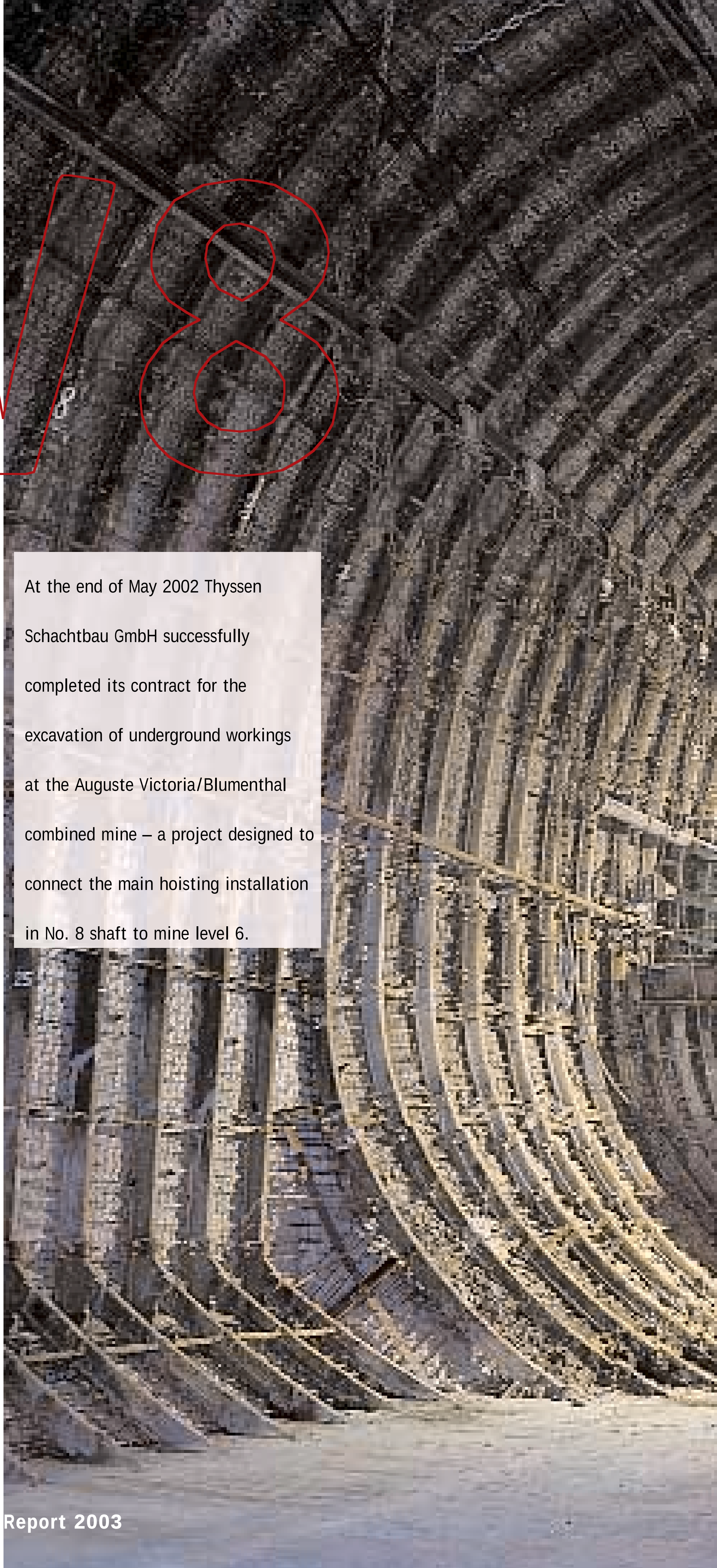
Our stated intention is that domestic and overseas clients interfacing with any of the Thyssen Schachtbau Group activities will be provided with a service of the highest quality based on technically-innovative, forward-looking solutions. Our maxim is reliability and punctuality with in-built cost-effectiveness. Customers and business partners will continue to provide the focal point for our activities for they, together with the TS workforce, represent the future of Thyssen Schachtbau.

With this in mind we wish you all continued success in the year ahead.

Werner Lüdtke | Dr. Peter M. Rudhart | Dr. Cemal Cetindis

AV8

Auguste Victoria No. 8 shaft now hoisting from mine level 6



At the end of May 2002 Thyssen Schachtbau GmbH successfully completed its contract for the excavation of underground workings at the Auguste Victoria/Blumenthal combined mine – a project designed to connect the main hoisting installation in No. 8 shaft to mine level 6.

As this project was covered in great detail in the Report 2002, it now remains to describe only the closing phases of the operation, which were completed right on schedule.

The project began in November 2000 with the careful planning of each stage of the operation.

The shaft bell inset and the north and south landings were completed within 10 months. The scale of this performance can be measured by looking at some of the figures involved:

- Shaft bell inset: approx. 478 m^3 of material excavated
- Shaft inset structure: approx. 143.5 t in weight
- North landing: approx. 2,500 m^3 of material excavated
- South landing: approx. 3,550 m^3 of material excavated
- Special fixtures and fittings: approx. 170 t in weight.

The final phase involved the dismantling of the working platforms, connecting up pipework between the landings and the shaft and the placement of floor seals in the north landing, followed by the laying of a sub-base and the installation of various consoles and brackets. This operation marked the conclusion of a substantial and technically interesting mining project.

The scheduled completion of the shaft project meant that by New Year 2003 the main hoisting operations were able to begin from mine level 6.

Official opening ceremony

The new level-6 hoisting operation in shaft No. 8 was officially inaugurated below ground on 14th February 2003 in the presence of invited guests and representatives of the main project contractors.

The successful completion of this major project will play a vital role in providing Auguste Victoria/Blumenthal mine with a secure future.

In recognition of the skill and resolve displayed by the excavation teams, Mine Director Dipl.-Ing. Horst Sablotny presented ceremonial deputy's sticks to departmental head Dipl.-Ing. Witold Krawiecz and district deputy Andreas Boy, who represented Thyssen Schachtbau GmbH on site.

Helmut Fust

Drivage team

SHAFT RECONSTRUCTION WORK at Borth rock-salt mine

Borth rock-salt mine is situated to the north of Rheinberg on the Lower Rhine district and is part of the ESCO European Salt Company, a joint venture operation set up on 1st January 2002. The ESCO grouping combines the salt mining operations of Kassel-based K+S Aktiengesellschaft and the Brussels company Solvay S.A.

The mine's 200 m-thick salt deposits, which dip at about 5 degrees to the north west, are accessed by two vertical shafts and the product is extracted at a depth of about 740 to 900 m. Production currently totals about 1.5 million tonnes a year.

DOUBLE TUBBING SUPPORT FOR RUNNING SAND ZONES

Borth salt mine commenced operation in 1926 after the sinking operation had taken some 20 years. This work proved to be extremely difficult and the sinking was delayed by water inrush, lightning strikes, explosions, material shortages and problems caused by the aquiferous overburden. No other German mine had ever tackled such difficult geology or ever required such a long period of time for shaft sinking operations.

At the time of their construction the Borth shafts were the world's deepest freeze sinkings. The presence of running sand meant that both shafts had to be supported with double tubbing columns: number 1 shaft to a depth of 555 m and number 2 shaft to 520 m.

ROOM AND PILLAR WORKING

The salt is extracted by the room and pillar method. The chambers are blocked out using Marietta-Miner full-section cutting machines and the workings are then extended by drilling and blasting to as much as 20 m in width and 20 m in height either by stoping or by blasting down the roof. The debris is loaded by electric shovel on to swop-body Kiruna trucks, which transport the salt to the crusher installation. From here the product is transferred via a system of belt conveyors and bunkers to the skip winding plant in Borth No. 1 shaft.

SHAFT REFURBISHMENT AND REPAIR

Over the years Thyssen Schachtbau GmbH has performed numerous contracting activities at Borth salt mine. This has mainly focused on the refurbishment of the two shafts (Borth 1 and Borth 2), though maintenance and repairs have also been carried out on infrastructure facilities and other operating areas around the shaft zone. The approval and implementation plans for the reconstruction of the Borth 1 shaft skip loading system and the refitting of the guides in Borth 2 shaft were drawn up by the Engineering Section of Thyssen's Shaft Sinking and Drilling division.

RECONSTRUCTION OF THE SKIP LOADING INSTALLATION AND PIT BOTTOM AREA (740 M LEVEL) IN BORTH NO. 1 SHAFT

Reconstruction work has been carried out over a number of years on the skip loading installation and adjacent shaft zone below the 740 m level. This was always done during the summer period, when the mine works a two-shift or one-shift system.

Convergence and floor lifts had resulted in serious deformation to the steelwork, loading installation and adjoining mine cavities, with the result that major reconstruction work had become necessary in order to ensure the safe charging of the skips.

The first phase of this operation involved rock-face stabilization using TH 44 support rings with lagging, sealing mesh and concrete backfill. The damaged mounting frame, buntons and shuttle platforms could then be dismantled without interrupting the production cycle and the entire system replaced by a completely new supporting structure.

ADJUSTABLE SHAFT DECKING FRAME

In order to be able to compensate for future strata movements the entire shaft decking plant was housed in a special carrier frame that could be re-aligned as and when necessary. The confined space conditions and the mine's insistence that skip winding should not be impeded during the conversion phase complicated the refurbishment work, which had to be carried out in sections.

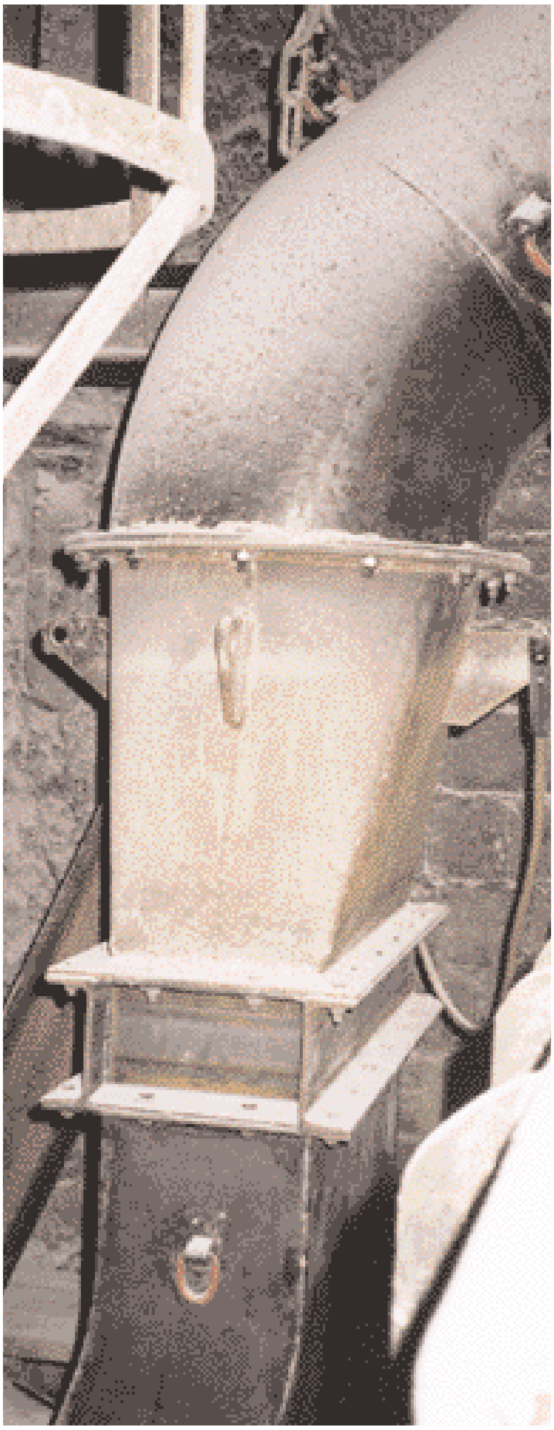
Manwinding shaft and alighting platform beneath Borth No. 1 shaft decking level

The reconstruction project is to continue in the spring of this year beginning in the area above the skip loading system.

The shaft inset equipment and inset frame at the 740 m level are also affected by the convergence and reconstruction work are required here too. The plan is to extend the east and west shaft face of the landing and to secure this area by installing TH 44 support rings with backfilling. The support rings are to be connected to the restored upper section of the shaft, while the badly damaged brickwork around the landing will be removed. The timber-prop arch construction, which currently plays an important statical role, could then be dismantled.

The plan is to erect a free-standing framework of uprights and cross-beams around the deformed inset frame so that regular shaft winding will be disrupted as little as possible. This framework structure will then serve as the mounting point for the new inset frame and existing inset crane track. The new inset frame is designed in such a way that it can be assembled around the old unit.

Dust-extractor casing for skip decking system in Borth No. 1 shaft



Steel support rings in Borth No. 2 shaft

REFURBISHMENT OF BORTH NO. 2 SHAFT GUIDES

The wooden buntons installed above the 740 m inset up to the 560 m level had already been replaced by steel items. This work, which took place in 1998 and 1999, had been carried out during the reserve shifts and there was little disruption to the shaft winding cycle. In the course of this operation the shaft face was secured with ring supports, lagging, sealing mesh and backfilling.

The timber buntons in the tubbing-lined section were replaced with steel items in 2001 and 2002. While the new buntons installed below the tubbing section had been bolted on to pipe brackets, those being installed along the tubbing column had to be mounted on angle brackets that were bolted to the tubbing ribs using pre-drilled holes. When carrying out this work provision had to be made for the two double-compartment cage winding systems that were operating in the shaft at that time.

Two specially designed triple-deck working stages were used for the installation and dismantling of the buntons and brackets. The stages were operated by two 3/6 tonne compressed-air chain hoists with extension chains, which were mounted on heavy-duty brackets some 100 m above.

REFURBISHMENT OF NUMBER 2 SALT BUNKER

Severe convergence and general wear and tear had seriously deformed and damaged the bunker discharge chute and connecting plates leading to the rock face. This meant that it was no longer possible to guarantee a controlled and unrestricted flow of product from the bunker.

A working platform was used for the renovation work on the bunker, which measured approximately 40 m in depth by 6 m in diameter. The first step was to dismantle the defective plates and strip the discharge chute.

To ensure that the new connecting plates were a perfect and seamless fit the salt face above the plates was channelled out with a milling tool and profiled down to the discharge chute. The new junction plates for the chute were then fitted into place, welded up and anchor-bolted to the rock face.

Hubert Ludwig
Udo Stracke
Rainer Lietz

Number 2 bunker showing reconstructed discharge chute

The Lerche Shaft is the strategic hub for Ost colliery

Prior to 1998 the Lerche shaft served as the upcast shaft for the underground workings of Heinrich-Robert colliery in Hamm.

Since the merging of the Haus Aden/Monopol mine with Heinrich Robert colliery on 1st April 1998 to create the combined Ost mine the Lerche shaft has played a key role in the development of new coal reserves in the Monopol production panels.

Between 1998 and 2001 the shaft was deepened by 366 m to a depth of 1,300 m in order to prepare it for its new works. Since this work was completed the Lerche shaft has supplied not only fresh air but also cooling water and electricity to the Monopol production districts. It has also served as a manwinding and materials supply shaft.

Thyssen Schachtbau GmbH was subsequently awarded the contract to drive northern and southern connections to the 1,300 m level at Lerche shaft and to excavate a materials haulage road to the Monopol panels.

AIR COOLING FACILITY

The completion of the northern connecting road will ensure a supply of fresh air to the planned production fields. The new link-road also houses a triple-chamber tubular air feed along with electrical supply equipment. This triple-chamber air feed, which will provide air cooling for the proposed production faces and development drivages, delivers a cooling performance equivalent to that of 26,000 standard refrigerators.

To facilitate the installation of the air-cooling system the roadway was driven with a special support system that comprised steel arch supports with additional leg extensions (finished cross-section approx. 44 m^2).

The 9.3 m floor width and 7.85 m roof height meant that the connection to the Lerche shaft had to be excavated in two levels so that the supports could be installed as quickly as possible and with minimum strata break-up.

Triple-chamber tubular air feed

As the roadway interface with the shaft was already in place, this consisting of a 5.8 m-long connection with floor-embedded arches, great care was required when cutting through into this area. For this reason a wall of conveyor belting was erected in the shaft zone in order to protect the 9.3 m-wide floor and 10.5 m-high roof of the chamber from the blasting operations. The cavity between this wall and the adjoining rock was also filled with foam so as to prevent damage to the shaft lining even when firing the final round of shots. These careful preparations meant that the cut-through operation was a complete success. The final shots were fired at a residual pillar some 2.8 m in width. This left a rock face 0.8 m in thickness, which was easily removed by jackhammers. The first airway into the new panels was complete. After the last two floor-embedded arches had been set, and the lower winding pulley installed, work immediately began on the transfer to the southern link road.

STRATA INJECTION AND ROCKBOLTING FOR ENHANCED SAFETY

The south connecting road also acts as an intake airway for the Monopol production fields, as well as serving as a transport route for men and materials. A separate level 3 m above the normal entry point allows mineworkers to transfer from the shaft to the workings and back again without running the risk of injury from the free-steered vehicles and diesel trolley trains transporting materials around the main shaft pass-by.

A 60 m-long section of connecting road first had to be driven to a bridging point, after which the main drivage could begin towards the shaft. An interesting feature of this work was that the sliding cribs for

the supporting structure required for the subsequent manriding system had to be installed at an exact height, and at precise intervals, as the drivage advanced. This meant that the roadway arches had to be set very precisely to the nearest centimetre. A special assembly rig was developed for the installation of the sliding cribs and this device performed extremely well.

As it was known in advance that the drivage zone would encounter geological disturbances in the Flierich fault zone, the following strata consolidation measures were also put in place:

- ❑ Concrete rockbolts 3 m in length at 0.8 m spacings in rows set 0.8 m apart
- ❑ Type-A injection bolts 2.5 m in length at 0.8 m spacings in rows set 0.8 m apart
- ❑ Type-B injection bolts 3.5 m in length at 0.8 m spacings in rows set 0.8 m apart.

The strata consolidation work had to be carried out in a specific time sequence, so it was not possible to synchronize the working cycles. Full backfilling of the roadway arches was required for the rockbolting operation. This meant that after each round of shots two or more standpipes had to be set into the roof to the highest cavitation point for use as backfilling pipes after the completion of the following two pulls, so that any remnant cavities could be completely filled. Steel fibres were admixed to the backfill material to increase the strength of the concrete.

In spite the presence of finely comminuted rock around the fault zone, the use of strata injection – in conjunction with short pulls and closely-set arches – meant that no problems were encountered during the entire excavation project.

As in the northern connection, the remaining 20 m of roadway leading to the shaft was excavated in two levels. This operation again involved a series of precautionary measures and was undertaken with a high level of precision – with break-through finally being achieved on 29.08.2002.

RESIDUAL WORK

Even as the residual operations were being carried out in the roadway cut-through zone work had already begun on moving out the machinery and equipment required for the subsequent excavation of the materials supply road to the south; a stone drift will then connect up with the panels in the Wilhelm seam.

SAFETY FOR THE FUTURE

The Lerche shaft and adjoining workings will help secure the future of Ost colliery by:

- ❑ supplying sufficient quantities of cooled fresh air
- ❑ providing a safe and separate transport route for mineworkers in the shaft and haulage-road zones while at the same time
- ❑ allowing materials to be moved unimpeded
- ❑ providing an uninterrupted twin-strand belt system to transport men and materials to the workings
- ❑ allowing the deployment of free-steered vehicles in the shaft zone along with twin-rail diesel trolley transport for materials haulage duties.

If these requirements are to be met it is essential that the pass-by routes at the 1,300 m level remain stable throughout their operating life. The motivated and highly-skilled heading teams involved in the project have met this challenge head-on and remain fully committed to the job in hand.

Reinhold Neukart

Drivage team

Roadheader drivages meet up

New ventilation drift for the Primsmulde deposits

Ensdorf colliery, which is one of the Saar's last two remaining coal mines, produces some 3.4 million tonnes of power-station coal a year and is one of Deutsche Steinkohle's most productive pits.

Coal is transported from the production faces along a network of 38 km of conveyor roads before being taken to the surface via the Barbara inclined drift. The development of the new Primsmulde production field is now essential if Ensdorf is to safeguard its future beyond 2005.

The development programme, which has seen the deepening of the North Shaft to the 1,711 m level (see Report 1997) and the sinking of the Primsmulde shaft (see Reports 2001 and 2002), is now continuing with the excavation of the new ventilation drift 64.30 as the spine road for gate-roads Prims 1 to 3. The contract to drive the new road was awarded to the Ensdorf-Horizontal Joint Venture, comprising Thyssen Schachtbau GmbH (technical leadership) and Deilmann-Haniel GmbH (commercial leadership).

Drivage team

As well as the drivage operation itself, the contract included the maintenance and overhaul of four belt conveyors, two floor-rail haulage installations, the materials transport system between the shaft and drivage face and the entire electrical system.

The colliery's existing roadheading equipment consisted of the following items:

- ❑ Paurat E 200 roadheader with telescopic arm
- ❑ 600 m³-capacity Hölter dust extractor
- ❑ EKF II drag conveyor
- ❑ 1200 mm belt conveyor
- ❑ hydromechanical backfilling system
- ❑ Müller bunker and Elefantino
- ❑ 1000 V pantechnicon.

This was supplemented by the contractor's equipment, comprising:

- ❑ GTA type AMG 2700 support setting platform
- ❑ GTA/Deilmann rockbolting gondola.

The ventilation drift followed the line of the Schwalbach seam at an average rising gradient of 13 degrees.

The roadway was supported by TH 27 (long) arches measuring 7.0 m in width by 4.85 m in height. These were set at 0.8 m intervals and were supplemented by systematic rockbolting and a 0.4 m layer of grout backfill. Bolting density was 21 units per m of roadway.

Because of planning modifications the roadway cross-section had to be increased and the ventilation system changed-over after a drivage distance of approximately 500 m. For this reason the dust extraction system was upgraded from 600 to 800 m³ and the ventilation ducting, along with the Coanda vortex duct at the roadhead, increased from 800 to 1,000 mm diameter.

The new TH 31.6 arch supports had a finished floor width of 7.5 m and a finished roadway height of 5.15 m. Rockbolting density was increased to 22 bolts per metre of roadway to suit the new roadway cross-section.

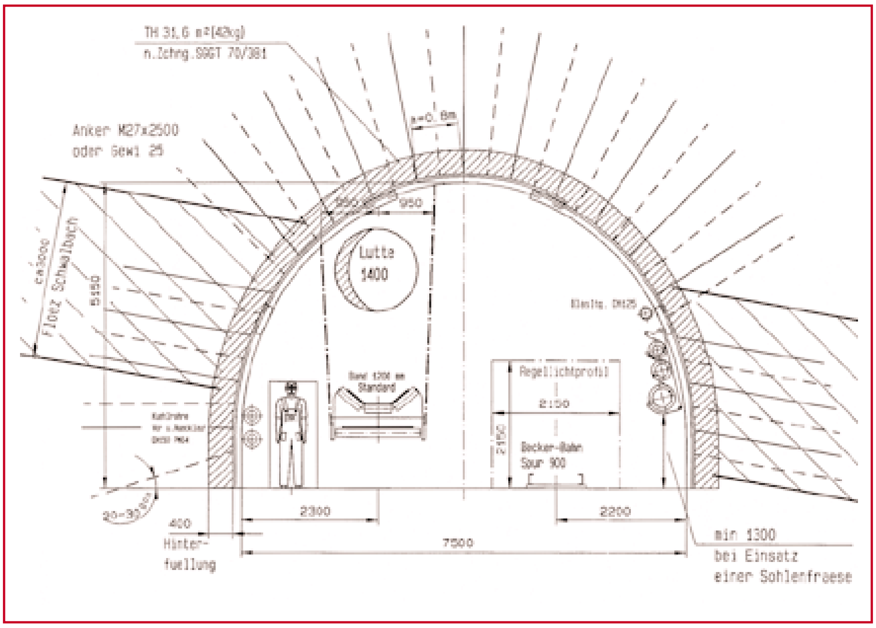
After 350 m of drivage the rockbolting gondola had to be converted to rotary-percussive drilling because of the increasing hardness of the surrounding rock. The drivage also encountered numerous geological faults, which meant that the arch setting distance had to be reduced to as little as 0.5 m in these areas. Continuous floor-lift, which set in immediately after the passage of the pantechnicon, meant that the roadway had to be dinted throughout the entire drivage operation. The average dint taken measured 0.8 m in depth.

After a drivage distance of 1,460 m the roadheader broke through on target to the counter-heading, which had also been driven by one of the colliery's roadheading machines. The accuracy of this achievement was testimony to the professional skills of the Ensdorf surveying team.

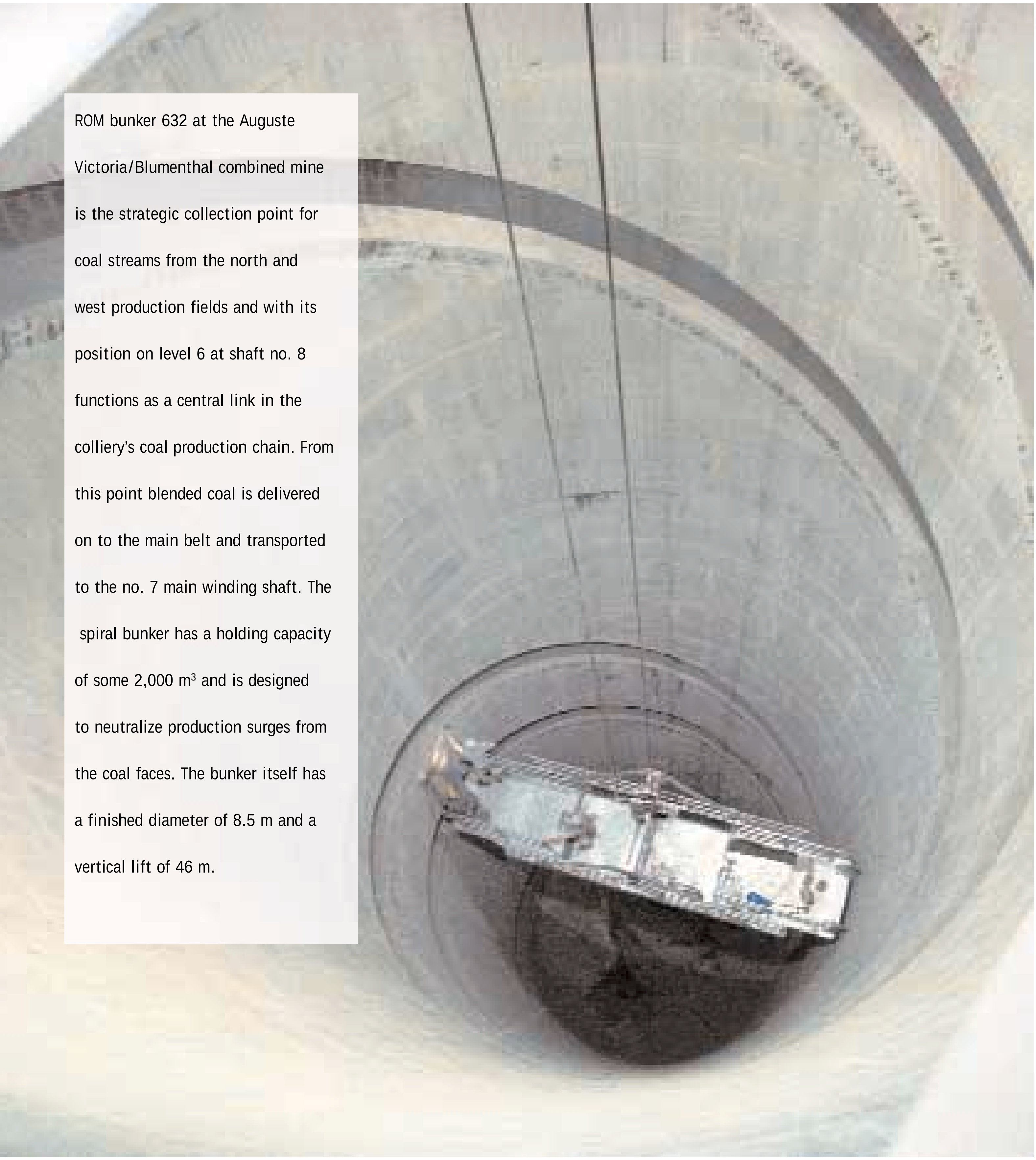
The future of Ensdorf colliery now seems secure, thanks in no small part to the commitment and motivation of two German specialist mining contractors working in partnership.

Michael Döring

Bolting pattern for air drift 64.30 during the drivage commencing on level 24 from Primsmulde cross-cut 641



SPIRAL-CHUTE BUNKER
reduces product degradation and helps cut costs



ROM bunker 632 at the Auguste Victoria/Blumenthal combined mine is the strategic collection point for coal streams from the north and west production fields and with its position on level 6 at shaft no. 8 functions as a central link in the colliery's coal production chain. From this point blended coal is delivered on to the main belt and transported to the no. 7 main winding shaft. The spiral bunker has a holding capacity of some 2,000 m^3 and is designed to neutralize production surges from the coal faces. The bunker itself has a finished diameter of 8.5 m and a vertical lift of 46 m.

COAL FINES AS A COST FACTOR

Investigations have confirmed that reducing size degradation results in a considerable decrease in the make of coal fines in the production stream. Simply by focusing on the bunker installation it is possible, by introducing a spiral-based design, to reduce the amount of fines below 10 mm to between 2 and 3% and in this way to achieve significant savings in the coal preparation costs. Investment in spiral flow technology can therefore pay off in a fairly short period of time.

With this in mind the colliery management decided to fit spiral chutes to bunker no. 632. Two spirals were needed to ensure that coal streams entering from two different directions could be fed into the bunker with minimum size degradation.

The northern connection to the coal transport route is via crosscut SO 60. Here a 1600 mm-wide belt connects centrally with the bunker installation. The bunker feed system at this point consists of a "snail-shell" intake whose space-saving design is suitable for installation in the existing bunker chamber.

The western connection is via lateral roadway DB SW 61, where a 1400 mm-wide belt feeds the bunker by way of a tangential intake.

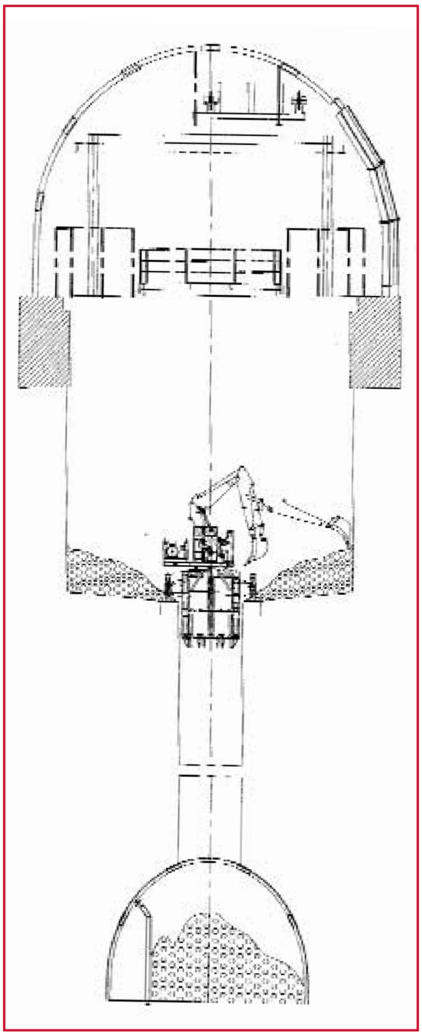
Both spiral intakes are constructed in such a way that the bunker head assembly requires little additional excavation and is arranged centrally above the bunker unit itself. Computer-aided simulation of the coal streams, coupled with a realistic calculation system, resulted in an optimal geometric design of the spiral units. High-precision construction work meant that the spiral chutes were able to perform to maximum effect and ensured that the coal was safely delivered into the bunker with minimum degradation as it traversed the chutes.

UNIVERSAL CAGE EXCAVATOR GETS DOWN TO WORK

Preparatory work included the drilling of a 2100 mm-diameter pilot hole and a 40 m-long ventilation borehole alongside the bunker. This borehole, which measures 2400 mm across and is cased to a diameter of 2100 mm, ensures the supply of fresh air to the bunker underside.

The sinking work was undertaken as part of a joint venture with Deilmann-Haniel and commenced with the installation of the sinking gear and the setting up of the bunker collar. The latter was scaffolded using an industrial formwork system and built with B25-grade cast in-situ reinforced concrete.

The bunker shaft was excavated by drilling and blasting using an open-trench method following standard foreshaft construction guidelines. Temporary support was provided by systematic rockbolting with wire-mesh lagging.



Sinking with the cage excavator

A special cage excavator designed by Thyssen Schachtbau was employed for drilling the shotholes and bolting holes and for loading out the blasting debris into the pilot hole.

The excavator was mounted on the borehole cage by means of a rotating ring. The excavator jib could also be fitted with a drill boom for the boring operation; after blasting this was replaced by an excavator shovel so that the debris could be slushed into the borehole. This mechanised system resulted in a further increase in sinking performance.

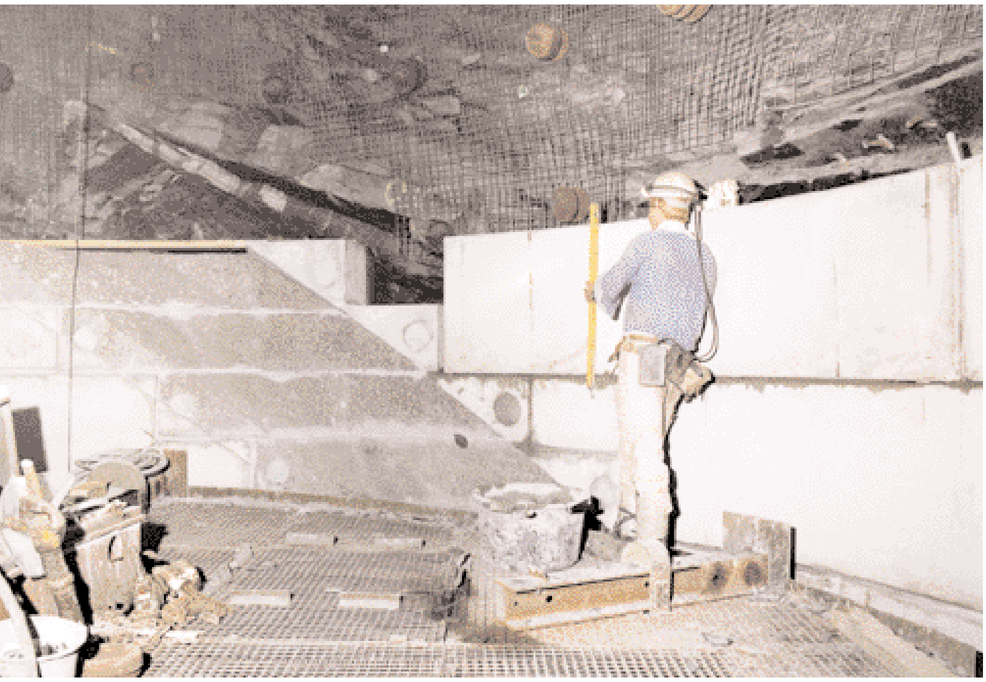
The sinking debris was then delivered via the borehole into the bottom level, where it was transferred by slusher on to a chain scraper conveyor.

MODULAR CONSTRUCTION MEANS QUALITY ASSURANCE

As the roadway below the bunker had been driven with a cross-section of 27 m^2 using a temporary support system the bunker installation had to be sunk down to the floor of the undercut. This meant extending the roadway cross-section in the bunker discharge zone to some 70 m^2 in order to accommodate the future discharge system. The load-bearing discharge structure was then constructed as a steel-concrete arched framework spanning the extended bottom roadway area.

After the bunker discharge system had been completed a working platform was brought in to help install the precast steel-concrete segments that would comprise the bunker lining.

These precast sections were carefully designed and manufactured to create a self-contained modular system. The advantage of this technique is that a lot of time is saved during the lining installation work and, what is more, quality control is built in at the concrete casting stage. There is no need for formwork or reinforcing bars to be installed, which can impede the working cycle. Concrete



Installing the precast segments

quality is of a uniformly high standard and can be matched more flexibly to the site requirements. Fitting tolerances can be more accurately maintained and there is less need for expensive surveying work. The sinking and lining equipment allows the bunker lining elements and spiral segments to be lifted from the roadway transport system and transferred into the bunker shaft zone. A manipulation circuit on the working platform collects the segments and delivers them to the point of use, where they are accurately installed in their final position.

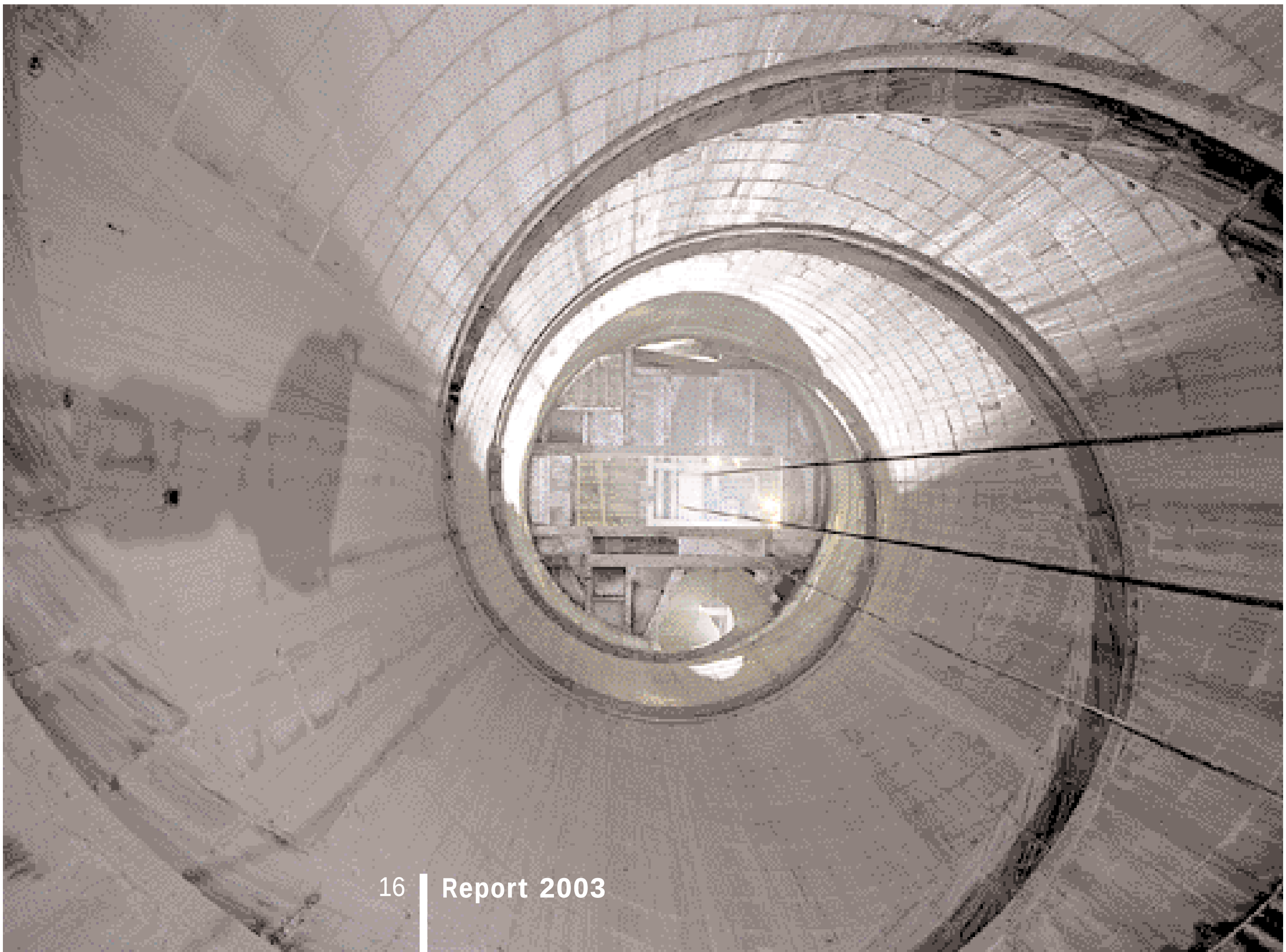
PROJECT COMPLETED ON SCHEDULE

After the basic construction work had been completed the working platform was again used to fit special anti-wear linings to the spiral chutes and bunker-discharge zone. The anti-wear lining for the bunker discharge comprised cast-basalt plates, while the spiral chutes were fitted with a combination of metallic and ceramic plates. The bunker intake was covered with a metallic lining material to protect it from the additional impact wear occurring in this area.

In spite of the very tight deadline, the project was completed on schedule with the fitting of the bunker cover and inspection conveyance and the installation of the draw-off conveyor beneath the bunker discharge point.

Dr.-Ing. Helmut Otto
Dipl.-Ing. Veit Passmann
Dipl.-Ing. Siegfried Temming

Spiral bunker after completion



Nine-kilometre link-up

between Prosper and Hünxe shafts

Plans for a new airway to connect Prosper No. 10 shaft with Lohberg-Osterfeld colliery's Hünxe shaft were drawn up back in the 1990s in order to meet the increased ventilation requirement of the Haniel-West production field at Prosper-Haniel colliery.

The 9.2 km-long drivage was initially begun using a full-face roadheading machine, but was temporarily suspended before achieving completion. The operation to complete the remaining 2.5 km of roadway was then resumed in April 2001 by a team from Thyssen Schachtbau using conventional drivage equipment. The engineers in charge decided that driving a counter-heading from the Hünxe shaft end was the quickest way of ensuring that the airway would be operational as soon as possible.

PREPARATORY WORK

Work commenced in August 2001. As well as creating a roadway junction in number 2 district east on mine level 4, this operation included various activities designed to upgrade this part of the Lohberg-Osterfeld infrastructure, which the colliery had designated as low-priority. This included roadway dinting, the laying of new tracks and the erection of an intermediate bunker station for building material. This was followed later by the construction of a high-performance loading point.

Twin-boom drill jumbo in action

ROADHEADING EQUIPMENT

- G 210 side dump loader with 2,000 l scoop capacity
- Twin-boom BTR 2-254KK drill jumbo equipped with HBM 120 SLS rock drills
- GTA AMG 2.700 working platform with integral roadhead support
- backfilling system consisting of:
  - Putzmeister BSM pump with associated hydraulics
  - material receiving bunker with 5 m^3 capacity
  - 33 m^2 filter bag
- DMKF 3 drag conveyor approx. 76 m in length
- two overhead track-mounted support setting platforms
- 1,000 mm belt conveyor with loop take-up
- loading point with pneumatically-powered loading cage and hydraulic decking ram
- intermediate bunker station for "Big Bag"-contained material.

DRIVAGE OPERATION

The drivage work commenced in September 2001 with the first few metres being excavated using a twin-section platform and hand-held percussive drills. By the end of the year, when the drivage had reached a suitable length, the operating equipment was supplemented by a GTA 2,700 support setting platform with integral roadhead support and a twin-boom drill jumbo.

The drivage had a specified supported cross-section of 28.6 m^2. The five-piece support units were set at 80 cm intervals (reduced to 60 cm in problem areas) and backfilled. Type B systematic rockbolting was installed to a density of 1.11 bolts/m^2 and comprised fully grout-embedded, 2.5 m-long type-25 GEWI rockbolts.

The drivage had to cross the fault zones of the Tester Berge ridge (thrust faults 1 and 2). The difficult geology encountered in some areas meant that strata injection had to be employed for ground stabilization. As a result the heading performance deteriorated to 2.2 m a day.

The heading was supplied with materials brought in by rail from number 4 shaft. The high strata pressures encountered along the drivage meant that the roadway had to be dinted immediately behind the heading face and even before new tracks could be laid.

After about 600 m the drivage has to be directed around a 94 m-long bend with a 100 m radius. This means setting up a belt-curve system and the curving conveyor will then have to be extended as the drivage advances.

View of completed roadway

INFRASTRUCTURE

As the infrastructure requirements were considered subordinate to the overall investment project for Lohberg-Osterfeld colliery, certain logistic and organisational arrangements had to be put in place that could generally be described as "non-integrated solutions":

- The building material was supplied in Big Bags that were delivered to an intermediate bunker located at number 4 shaft level 4. It was then transported pneumatically by conventional means to the road head bunker.
- Debris was transported out in 3,000-l mine cars, which were taken to the surface via shaft number 4 and then tipped. The potential heading performance was restricted by the shaft capacity.
- The drivage crew had to be transported to and from number 4 shaft by bus.
- A roadway cooling machine has been installed at the roadhead, since the area is out of reach of the central air-conditioning plant.

This situation posed a challenge for the project team. However, by using highly flexible working regimes it had been possible to reduce the number of stoppages caused by the deficient infrastructure. All individual operations, such as the heading, dinting, systematic rock-bolting, stocking the intermediate bunker station, backfilling and conveyor conversion work, were carried out independently – which means that everyone involved had to operate in close collaboration. The efficiency of this system had significantly reduced the effect of technical shortcomings and geological problems and their impact on the daily performance of the heading.

ACHIEVEMENTS TO DATE

Deploying a well thought-out organisational plan has compensated to a large extent for the various problems posed by the local infrastructure and difficult geological conditions. The project has also seen other positive effects, including an improvement in drivage quality, a better remuneration package and a very low accident rate. In fact, up to the end of October 2002 no reportable accidents had occurred in the workplace.

Dr. Stanislav Kopiec

Drivage team

Sinking frame and surface installations

Once again – a report on: the world's deepest raise boring and deepest bored shaft

The Primsmulde ventilation shaft project has already been presented in detail in Report 2002. The following account describes the performance of the individual components that go to make up the sinking equipment.

SHAFT BORING MACHINE

The Wirth SB VII shaft boring machine fulfilled every expectation, achieving average results of 8.5 m/d with peak performances of around 15 m/d. The decision to set aside 6 hours a day for machine maintenance paid off in that the final sinking phase experienced very few mechanical stoppages and required no major repair work whatsoever.

The drilling tools consisted of single-ring discs 350 mm in diameter. The less than favourable drilling conditions in the upper section of the shaft resulted in an extremely high level of tool wear. The subsequent experimental introduction of reamer disc bits fitted with carbide studs produced the desired result and this solution is now recommended for drilling projects in similar conditions.

The loading point set up for the clearance of the drilling debris had to be modified several times to suit the changing conditions in the shaft sinking. The rush of material through the pilot hole generated pressures of up to 10,000 Pa, as measured at the air brattice erected on mine level 20. This ventilation problem could only be controlled by reducing the airflow and installing two dry de-dusters at this level (shaft bottom road).

ROCKBOLT DRILLING AND SETTING SYSTEM

Hole-drilling and bolt setting was carried out using Deilmann-Haniel rockbolting equipment mounted on top of the shaft boring installation. A total of 31,000 resin-bonded rockbolts were installed with the DH system. The dry-drilling equipment with drillings extractor performed well and its much lower drill-water consumption rate proved beneficial in significantly reducing the problem of pilot-hole destabilization.

"Touch-down"

SHOTCRETE LINING

The bored shaft was lined with 20 cm-thick shotcrete in B 25-grade concrete with a single layer of Q 188 steel-mesh reinforcement. The Meico MBT Robojet shotcreting robot mounted on the working platform was supplied by an electrohydraulic concrete pump and fulfilled the required performance of spraying one metre of shaft an hour. The concrete quality and surface characteristics were up to standard and the rebound rate of between 3 and 5% was extremely low.

The concrete supply system, which consisted of a surface-mounted automatic dry-delivery unit feeding the intermediate bunker on the middle platform deck, performed extremely well and no problems were experienced in respect of abrasive wear and equipment malfunction.

PROGRESS TO DATE

The boring machine "touched down" at mine level 20 in October 2002 – an event that was celebrated in a fitting manner. The SB VII has now been dismantled and is currently in storage awaiting its next assignment.

An air connection was put in place some 70 m above mine level 20. This opening was excavated by conventional drilling and blasting and will serve as an access to No. 10 ROM bunker, which has still to be constructed. Construction work on the shaft inset began in February.

The sinking installation of the JV-contractors will then be dismantled in the summer of 2003 so that the new upcast shaft can start operating as planned in 2004. This will mark the successful completion of the Primsmulde project – the deepest bored shaft in the world.

Erhard Berger

API pipework systems
demonstrate deep down reliability

The Lerche API pipework joint venture was contracted to install nine API pipes having a total length of 12.5 km and ranging from 2 7/8" to 18 5/8" in diameter, in the Lerche shaft at Ost colliery. This shaft had been deepened in order to develop the coking-coal deposits in the Monopol take.

1,200-t-crane in action

The first task for the joint venture, which comprised Deilmann-Haniel (technical leadership) and Thyssen Schachtbau (commercial leadership), was to draw up an operating and approval plan. Much of this work focused on the pipe mountings, which had to be designed to suit the available clearance in the shaft and the installation procedure. To ensure better static equilibrium the mountings were not located in the pit bank area, as is normal practice, but at a depth of some 100 m.

API

RAPID INSTALLATION

The installation phase first involved the construction of a temporary mounting point in the shaft sump where the individual pipe sections could be held and bolted together.

API pipes, which are self-supporting and connected by tapered-thread couplings, have been widely used by the deep drilling industry for many years. Their special design eliminates the need for the time-consuming installation of in-shaft mountings, with the result that the pipes can be laid many times faster than the conventional flanged-coupled type.

The two cooling pipes (feed and return) for the 20 megawatt refrigeration plant have a diameter of 18 5/8" (450 mm) and each weigh about 300 t unladen.

Special technology – in the form of a 1,200-t crane - was needed to ensure that these heavy pipe strings could be manipulated safely into position. The crane installation, which itself weighed 850 t, was transported by truck to the site and then assembled. Equipped with the latest electronic systems, and operated by experienced personnel, this crane was able to manipulate the heavy components with great precision.

PIPE STRINGS A KILOMETRE LONG

While meticulously accurate planning of the installation phase was essential for the success of the project, it was also vital to have logistical coordination. The kilometre-long pipe strings, each consisting of 9 m-long sections, were first stored at a temporary depot before being transported to the shaft-site holding point immediately prior to installation. Before being installed each pipe had to be inspected and measured. The individual pipe sections were bolted together with the aid of a wedge pipe coupler equipped with hydraulic tongs. The tightening torque was electronically monitored and each bolting operation was logged.

The assembly crew required about 70 hours on site for the installation of a 1,350 m-long pipe string 18 5/8" in diameter – a clear indication of the advantages of using API pipes in mine shafts. The project demonstrated that the API system often provides a quicker and more cost-effective alternative to conventional pipe fittings.

To reduce refrigeration loss the chilled-water feed pipes in the Lerche shaft were provided with special insulation, which was applied after installation. The remaining pipework was installed within seven days using a much reduced level of equipment – but with the same care and precision.

Throughout the entire installation phase the assembly team demonstrated an impressive capacity for precision and reliability.

TS Shaft Sinking and Drilling Division has already tendered for an equally interesting follow-up project, involving the installation of six API pipes in Sedrun 1 shaft at the Gotthard Base Tunnel. This operation will be covered in the next edition of Report.

Erhard Berger

PIPEWORK SYSTEMS

Gold in Tanzania – the "Buly shaft" marks a new future

2002 was another successful year for the Thyssen-RUC-Byrnecut joint venture to develop the Bulyanhulu gold deposits (see Report 2001 and 2002).

The Bulyanhulu project is divided into separate actions, with Thyssen Schachtbau and RUC being responsible for the shaft sinking work while Byrnecut and RUC are contracted to excavate the ore ramps and levels.

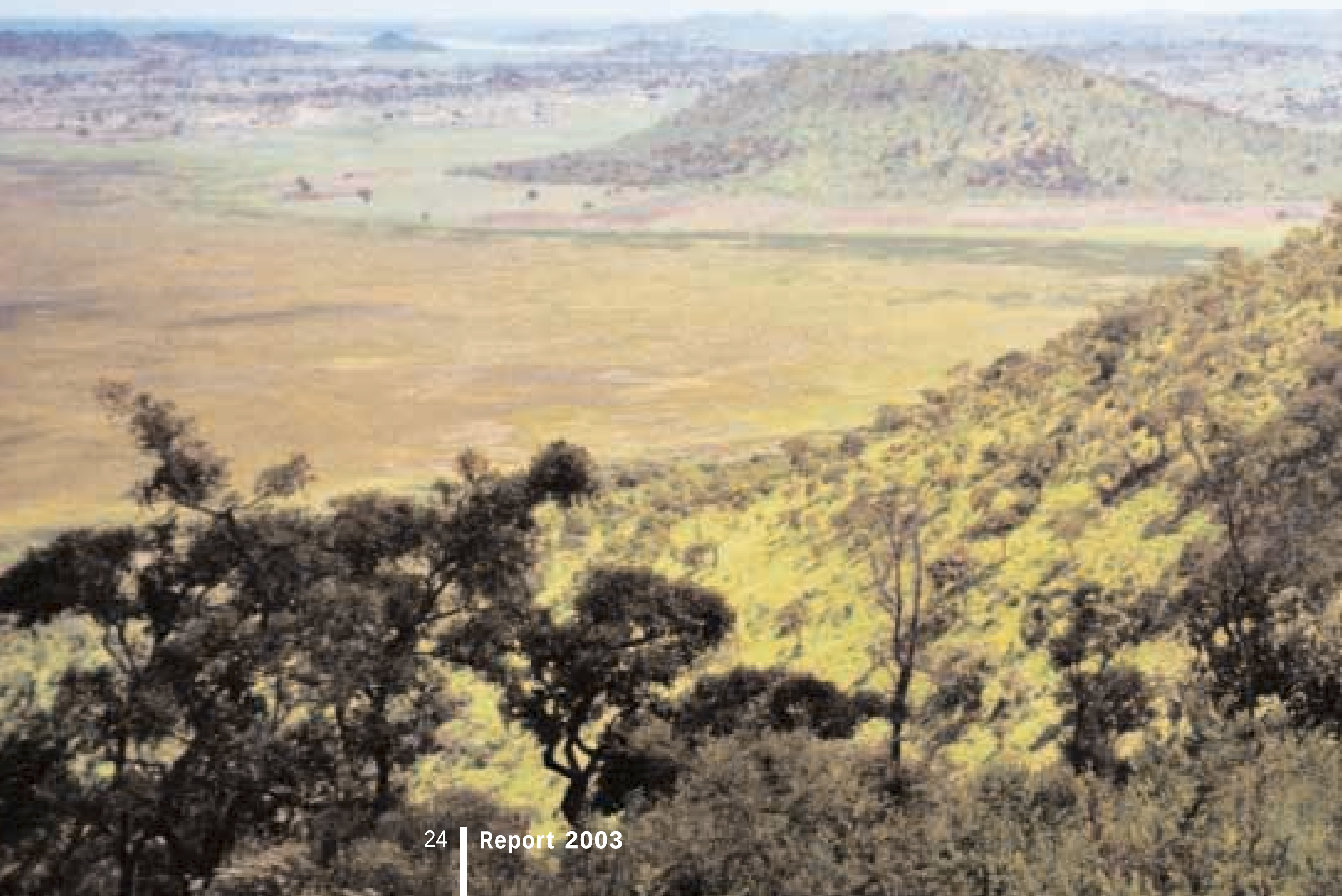
3 YEARS TO SHAFT COMPLETION

The shaft was completed on schedule in September 2002 and handed over to the client – the Kahama Gold Mining Corporation Ltd – as a turnkey facility. Gold ore is now being hoisted from the 460 m level, where the mid-shaft loading system went into operation one month after shaft completion.

While the shaft has now been completed and handed over by the two shaft construction companies (RUC and Thyssen Schachtbau) exactly three years after sinking commenced, work on the development drivages is proceeding at full speed. With Byrnecut and RUC averaging 1,000 m of drivage a month, the original contract performance had to be extended to keep pace with the excellent heading results.

SHAFT TOUCHES BOTTOM AT 1,103 M

After the shaft had reached its final depth of 1,103 m in March 2002 the shaft fittings were installed and the winding gear made operational. This work in-



volved fitting 220 buntons each with six sets of steel and timber guides, installing a shaft compartment to separate the skip and cage winding systems, laying shaft pipes and cables and constructing six shaft insets. All this was done at an average installation rate of about 50 m a day.

After the removal of the surface sinking equipment and the modification of the headgear, the winding conveyances were installed in the shaft and the entire installation was handed over as a turnkey operation on 12th September 2002.

EMULSION EXPLOSIVE IMPROVES SINKING PERFORMANCE

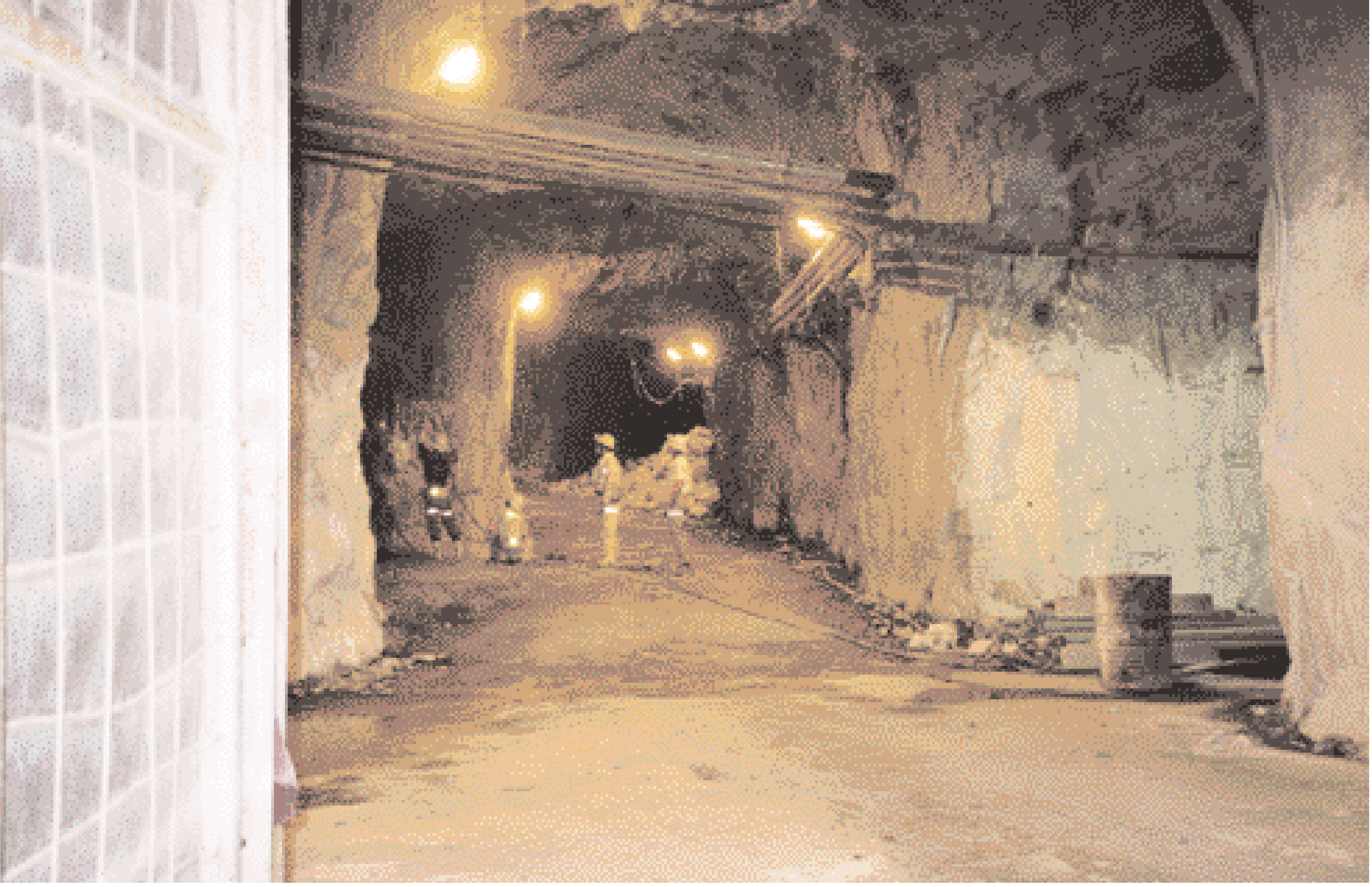
As previously reported, the sinking performance averaged 3.6 m a day. This was due to the deployment of the latest sinking technology, including an Atlas Copco quadruple-arm pneumatic-hydraulic boring machine for drilling out the shotholes. The 5 m-high mobile shutter, which was supplied with ready-mixed concrete through a shaft fall-pipe, proved to be an extremely effective concreting and shaft support system.

The decision to employ a pumpable emulsion explosive for the shotfiring operation had a decisive effect on the sinking rate. As well as its increased blasting performance, emulsion explosive offers safety, logistical and technical advantages for shaft sinking operations of this type, and is ultimately more cost effective.

This user-friendly explosive, which is injected using a system specially designed for the "Buly" shaft, exhibits a high in-hole charging density and excellent blasting power. The time required for the charging of a pull is reduced by 50% compared with cartridge-type explosives, while the effective pull length is increased by about 20 cm. The improved

Vegetation typical to north-west Tanzania

Quadruple-arm shaft boring machine



Inset roadway at the 300 m level

Shaft headframe with ore bunker

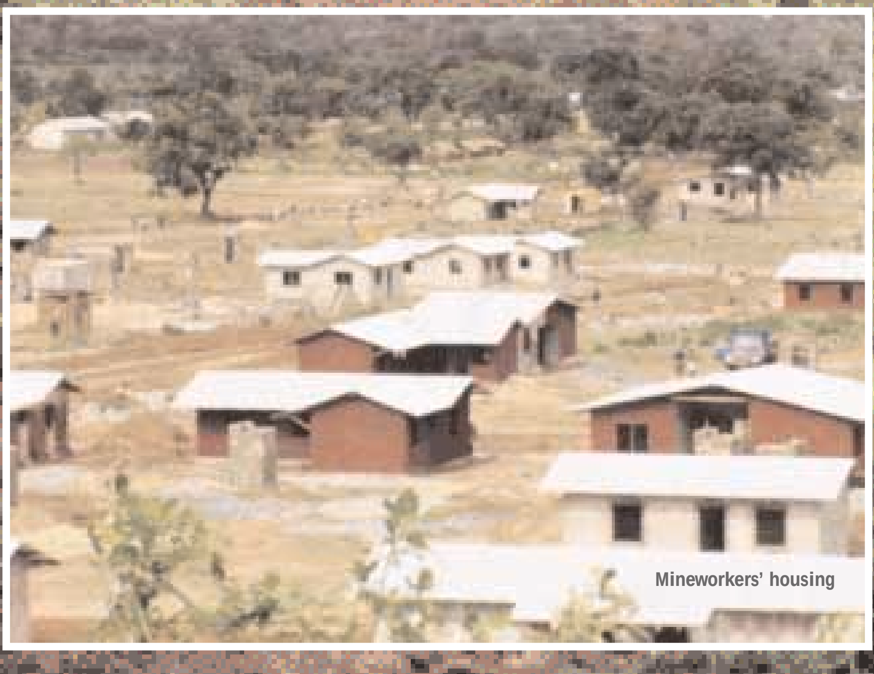
blasting effect of emulsion explosive also means that 15 to 20% fewer shotholes are needed for each pull.

CONSTRUCTION OF THE MID-SHAFT LOADING STATION

As the shaft fittings were being installed, a second mid-shaft loading station was constructed at the 460 m landing. This involved the installation of two large-capacity tipplers at the 420 m level, which were connected to the skip winding system via a series of bunkers and belt conveyors. These tippler units, which are designed for a daily capacity of up to 5,000 t, have given trouble-free service since they came on stream in October 2002.

A NEW FUTURE FOR THE REGION

In spite of the difficult climate prevailing in that part of north-west Tanzania, and the almost complete absence of any basic



Mineworkers' housing

Little Pagi can laugh again

View of the camp

infrastructure, the Bulyanhulu shaft sinking project has been a great success.

Since April 2001 the mine has been producing an average of 3,000 t of gold ore a day and has given employment to some one thousand local workers, who have been trained by Kahama Mining and by Thyssen-RUC-Byrnecut. The construction of the Bulyanhulu mine has also meant a considerable improvement in the living standards of those residing in the surrounding villages – social progress which is reflected in the following accounts:

IMPROVED INFRASTRUCTURE

New roads have been built and power supply lines laid around the mine site. A number of villages have been connected up to the new drinking-water supply pipe, which runs from Lake Victoria to the mine and their inhabitants now have a fresh water supply for the first time.

NEW HOUSING FOR THE MINEWORKERS

Kahama Mining has helped the inhabitants of Bulyanhulu to build modern dwellings (Figure 3). A total of 600 houses have already been completed. The new accommodation has been financed by a 15 to 20% contribution which is retained from the men's monthly salary.

MEDICAL SERVICES

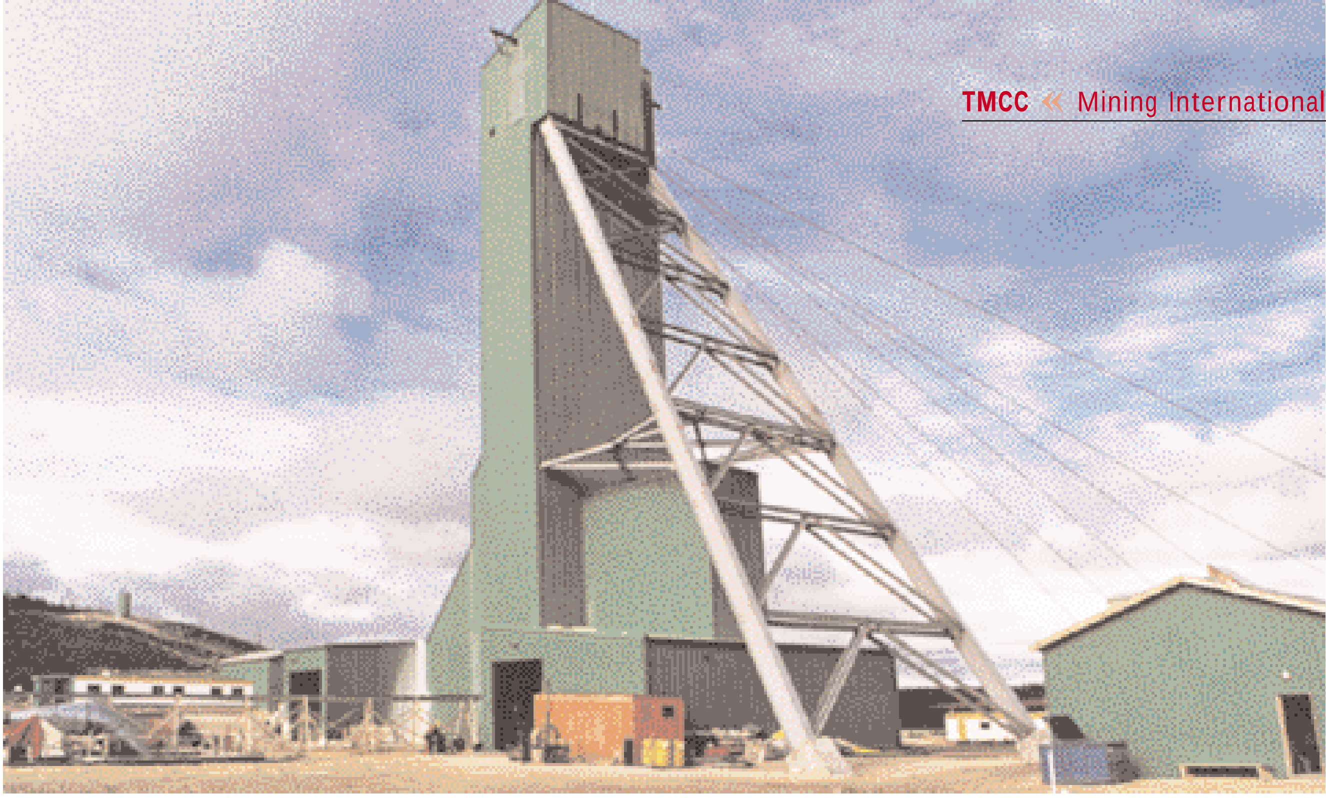
The construction of a clinic within the perimeter of the mine, which can also be used free of charge by the local Tanzanians, has dramatically improved the level of medical care available to the surrounding villages. Pagi Michael, a nine-year old girl from the village of Kasabuya some 10 km from the mine, probably owes her life to the clinic and to the generosity of the Bulyanhulu mineworkers.

Pagi's father brought his sick daughter to the mine clinic, where he told the doctor of the terrible cough that had apparently affected her since the age of two. Despite the administration of countless traditional remedies the father reported that his daughter's state of health had not improved over seven years. As Pagi's condition had deteriorated, with an increase in coughing and lack of appetite, he had decided to bring her to the clinic.

The doctor first suspected a case of tuberculosis. After an X-ray examination the real cause of the cough was identified: two 120 mm-long sewing needles were lodged in Pagi's lung. As the family had no money to pay for the operation that their young daughter needed, the "Buly" miners decided to take action. A total of some 4,000 US$ was collected and the girl was flown by the mine's own airplane to Dar Es Salaam, where she was successfully operated on. Pagi is now back at home in her village – her health fully restored.

The success of the mining project has transformed this corner of Africa – in Bulyanhulu, under the African sun, a new future has begun.

Dipl.-Ing. Norbert Handke
Dipl.-Ing. Dietmar Schilling



Overall view of McArthur River Mine 1993, sinking frame number one shaft

McArthur River

TMCC notches up 10 years on site and is still going strong

TMCC's (Thyssen Mining Construction of Canada) contract work in North Saskatchewan first began on 19th February 1993. The site, which 10 years ago no one had ever heard of, has now become famous as the McArthur River Project – the location of the world's richest uranium deposits.

Ten years later TMCC's 35-man strong workforce continues to support the owner, the Cameco Corporation, in carrying out all the mine's underground development work and in performing other special assignments.

TEN YEARS AGO

Initial accounts of the McArthur River Project and our impressions of this scenic and remote region first appeared in the current TS Report's predecessor publication, the Thyssen Schachtbau Group "Staff News". Follow-up accounts were then published in the 1996, 2000 and 2001 editions of the TS Report.

TMCC is based in Saskatchewan and the area is also home to many of its employees. The Canadian Provinces of Saskatchewan, Alberta and Manitoba are known as the "Prairie Provinces".

Saskatchewan covers an area of some 652,000 km^2 and is about twice the size of the reunified Germany. The Province has a population of 0.9 million, of whom almost one fifth (about 180,000) reside in the capital Regina. Only about 33,000 people live in the northern half of the Province.

About half of the world's potash is deep mined in Saskatchewan. The potash deposits were first developed in the 1960s, when many of the mine shafts were sunk with the help of Thyssen Schachtbau GmbH using the freeze-sinking technique that was at that time new to Canada.

Of course potash is not Saskatchewan's only natural resource. The south of the Province also produces oil, gas and coal, which are used exclusively for energy generation, while uranium and gold are mined in the north.

Though TMCC's range of operations has evolved continuously over the past ten years, the company's fascination for this part of the world remains.

DEVELOPMENT WORK TO DATE

Number 1 shaft, which accesses the main exploratory level at a depth of 530 m, was completed in June 1994. Over the following 30 months some 1,400 m of haulage roads were driven and a series of exploratory boreholes drilled in order to survey the in-situ ore body. The results of this work were so encouraging for the mine owner that TMCC was contracted in July 1997 to carry out the following work:

UNDERGROUND INFRASTRUCTURE

Approximately 6,200 m of roadway were driven to create the mine infrastructure. A further 1,900 m of large-section roadway were excavated to accommodate the ore crushing and grinding circuit and to create space for the installation of thickeners, storage tanks and pumping stations. A workforce of about 240 men was employed at the mine during this period.

❑ *Deepening number 1 shaft*

The decision was taken to extend number 1 shaft from a depth of 530 m to the 640 m level. This operation had to be carried out without disrupting the exploration drilling work under way at the 530 m level.

❑ *Sinking number 2 shaft*

Work on the sinking of number 2 shaft was not affected by other mining activities and as a result the connection to the 530 m level was completed by early 1999.

In spite of a very tight deadline, involving extensive structural work, the installation of mechanical equipment and the provision of electrotechnical services, TMCC successfully completed each phase of the operation on schedule and the client was able to commence winding by the end of 1999, with the shaft reaching full performance the following autumn.

Typical haulage road (with full shotcrete lining and concreted floor)

❑ *Sinking number 3 shaft*

Number 3 shaft, whose collar was installed in the autumn of 1999 (see Report 2000), was required in order to increase the ventilation flow needed to maintain the planned annual production figure. The experience that TMCC had already acquired during the first two shaft sinkings was put to good use and the new shaft was completed ahead of schedule in January 2001. The operation was a great success both from a technical and a safety point of view and was completed within the estimated budget.

The McArthur River Mine has now been in full production for some two and a half years. During this period TMCC has deployed an additional drivage team for the underground development work needed to ensure that the mine achieves its planned output of 18 million lbs of U3O8.

In the course of the last ten years TMCC has carried out the following contract work at McArthur River:

- ❑ Full sinking of three shafts with a total depth of 1,750 m
- ❑ Completion of 420 m of raise-bored shafts with diameters of 2.4 and 3.0 m
- ❑ Completion of about 220 m of drop-raise shafts with a diameter of 4.5 m
- ❑ Full drivage of all mine roadways and entries totalling more than 9,100 m in length (approx. 210,000 m^3 of excavated material)
- ❑ Installation of approximately 1.1 million rockbolts
- ❑ Installation of about 150,000 m^2 of wire-mesh lagging (= 12 hectares)
- ❑ Placement of some 18,000 m^3 of concrete underground
- ❑ Spray application of about 8,000 m^3 of shotcrete
- ❑ Erection of underground thickening plant and pumping stations
- ❑ Completion of all electrotechnical work below ground.

Negotiations are currently under way on a follow-up contract for the period 1st April 2003 to 31st March 2004. There is every likelihood that TMCC will be retained by the client as the preferred contractor for the next three to five years.

Volker Ebert

Deployment of a shaft drilling jumbo

Shaft boring in the heart of the Alps

Thyssen Schachtbau GmbH's contract to sink the 800 m-deep Sedrun II bored shaft in Switzerland follows hard on the heels of the Primsmulde shaft project that has just been completed for Deutsche Steinkohle's Ensdorf colliery.

The Wirth VSB VII shaft boring machine touched shaft bottom at Primsmulde at a depth of some 1,260 m on 21st October 2002 and then, only a few days later, assembly work on the VSB VII's "little sister" – the VSB VI – began at the Sedrun site.

Sedrun II shaft, which is part of the Sedrun intermediate section for the Gotthard Base Tunnel, is being sunk by the Sedrun II (ABS II) Shaft Boring Joint Venture, comprising Thyssen Schachtbau GmbH (technical leadership), Thyssen's South African partner RUC International Ltd and the Austrian affiliate Östu-Stettin Hoch- und Tiefbau GmbH (commercial leadership). (see Report 2002).

Thyssen Schachtbau and RUC have now been in partnership for more than 15 years, during which time the two companies have worked together on shaft boring projects in South Africa and Australia that compare with the Sedrun project in terms of shaft size and boring technology.

GOTTHARD BASE TUNNEL: THE CENTREPIECE OF SWITZERLAND'S ALP TRANSIT PROJECT

The 57 km-long Gotthard Base Tunnel and the Lötschberg Base Tunnel are the centrepieces of Switzerland's Alp Transit Project, which will eventually transfer most of the country's trans-Alpine goods traffic from road to rail and connect Switzerland to the main European high-speed passenger rail network.

The two main tunnels are being excavated using the latest tunnel-construction and safety technology and comprise single-track pipes running north to south with link-tunnels and track switching facilities.

When it is completed in 2012 the Gotthard Base Tunnel will probably still be the world's longest tunnel. The new link is designed to accommodate some 300 trains a day with passenger trains travelling through the tunnel at a maximum speed of 250 km per hour.
In order to reduce total excavation time a further three drivage start points (intermediate access points) are planned in addition to the tunnelling work at the north and south portals.

Sedrun village

The two window adits at Amsteg and Faido will each provide lateral access to the main tunnel. At Sedrun the two tunnel pipes are being driven to the north and south from a pair of 800 m-deep vertical shafts. The two shafts are accessed from a 1,000 m-long entrance gallery. Because of the difficult strata conditions, the mountainous location and the demanding nature of the tunnelling work (with conditions resembling those found in the mining industry it would be hard to imagine a more exceptional set of circumstances) the eyes of tunnelling and mining engineers around the world are now focussed on this most scenic corner of the world.

SEDRUN

Like a scene from a painting Sedrun nestles deep in the Alps in the Swiss Canton of Graubünden. This small Alpine town, whose 1,500 inhabitants speak Rhaeto-Romanic, is set at a height of some 1,400 m close to the source of the river Rhine. Sedrun has for many years been a particular favourite of winter-sports enthusiasts, while in summer the village is a popular venue for tourists and holiday-makers. In winter the area boasts excellent snow conditions and ski runs, while in summer it serves as an ideal base for walking and hiking holidays.

As the new link for the north-south Alpine crossing runs right through the Sedrun area, tourist numbers have for some time now been swelled by a new species of visitor – the tunnel mining engineer. By the end of 2003 the village is expecting to have more than 450 of these new residents.

Wirth raiseboring rig drilling the pilot hole

SEDRUN TUNNEL

The contract for the Sedrun tunnel was awarded by Alp-Transit Gotthard AG to the TRANSCO-Sedrun Joint Venture led by BATIGROUP AG, which is Switzerland's largest construction company. The design and planning work for the project was entrusted to the engineering partnership IG-GBTS (Gotthard Base Tunnel South), which was also responsible for the supervision of works.

The engineers responsible for the 6.2 km-long Sedrun tunnel pipes are faced with two main challenges: the first involves working through a number of extremely difficult geological zones and the second is the problem of how to keep the tunnel drivages supplied via the access drifts and their two connecting mine shafts.

The access drifts, Sedrun I shaft and part of the enormous shaft bottom chamber had already been constructed so that TRANSCO-Sedrun could begin work in a number of areas. This included the

”Precision touch-down“: Sedrun II reaches shaft bottom

installation of safety areas and technical facilities, the excavation of various branch tunnels and connections and a series of longitudinal and transverse chambers and, most importantly, the start of the 6.2 km-long Sedrun Tunnel itself.

SEDRUN II SHAFT

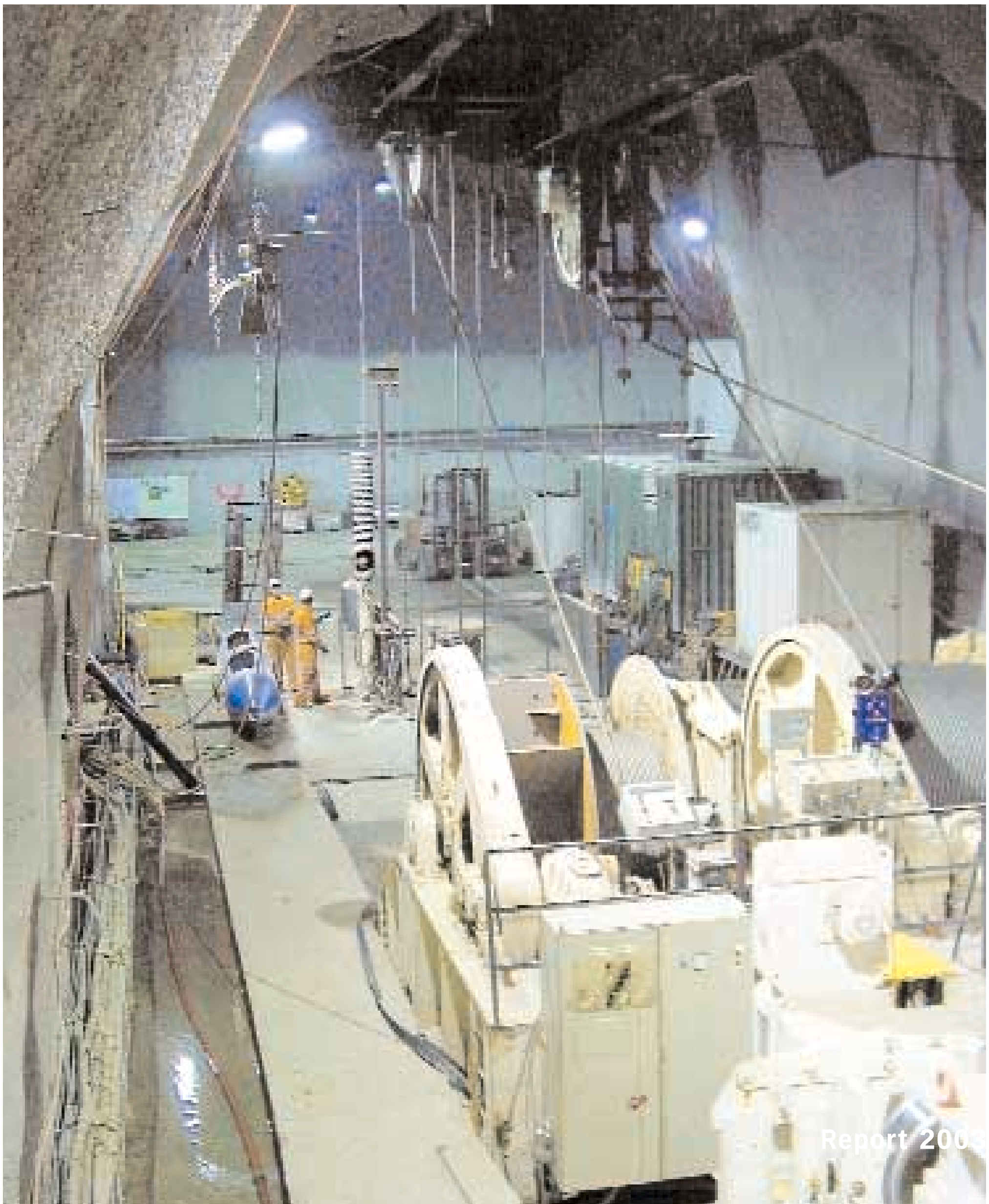
In order to relieve the bottleneck zone created by the 1,000 m-long access drift and the 800 m-deep Sedrun I transport shaft the decision was taken to sink the second shaft – which was initially planned merely as a 4-m ventilation shaft – to a diameter of 7 m and to equip it with a heavy-duty winding installation.

The availability of this new winding facility means that the transport of heavy tunnelling equipment and building materials can now be segregated from the manwinding and dirt haulage operations under way in Sedrun I shaft. As a result the transport logistics are greatly improved and an important contribution has been made to site safety.

SPECIAL BORING TECHNIQUE SECURES THE CONTRACT

After a technical evaluation of the bids, the consortium finally secured the contract on the strength of its proposal to use a special rodless shaft boring system with pilot hole construction. Transco-Sedrun awarded the sinking contract to ABS II on 22nd March 2002 and the ABS II construction site officially opened on 13th May 2002.

Winch chamber with sinking gear



Raiseboring head ready for action

In view of the geological conditions, which consisted of a steeply-inclined sequence of beds comprising both hard and soft strata, the sinking method presented in the tender appeared to be the most suitable and least-risky of all the proposals. The shaft zone consisted mostly of solid layers of slabby or coarsely-bedded biotite-muscovite gneiss, with rock strengths varying from 40 to 140 MPa.

The main Alpine cleavage and joint systems dip steeply and intersect the shaft at a very acute angle. The geological structure of the Alpine schistosity, with its smooth micaceous surfaces, therefore presents the risk of joint-body and rock-wedge failure.

THE RODLESS SHAFT BORING SYSTEM

The shaft boring operation, which was carried out with a rodless shaft boring machine, first involved the construction of a 1.8 m-diameter pilot hole, which was then reamed out to the required shaft diameter in the second boring phase. This reaming operation would give the Sedrun II shaft a final diameter of 7.0 m.

Boring head in the foreshaft

PHASE I: CONSTRUCTION OF THE PILOT HOLE

The pilot hole was drilled with a Wirth HG 330 SP raise-boring machine, which delivered a tractive effort of approximately 8,350 kN and a maximum working torque of around 540 kNm. A 13 1/8"-diameter raise-bore drill-pipe with a 10 1/4" DI screw coupling was needed in order to transmit these drilling forces.

The pilot borehole was required for the removal of the excavated material and to provide shaft ventilation during the main boring operation (Phase II). The directional drilling needed for the pilot hole had to be carried out with great precision and with minimum deviation from the vertical, the client having specified a maximum drift of 90 cm from the target axis.

"PRECISION TOUCH-DOWN"

In spite of the unfavourable geology, frequent alternation between hard and soft rock formations and the extreme strata dip, the directional drilling broke through into the shaft bottom cavity with a hole deviation of a mere 34 cm. This remarkable achievement was a "precision touch-down" in every sense of the word and the feat was widely acknowledged throughout the shaft construction industry.

The Rotary-Vertical Drilling System (R-VDS) used for the directional drilling was supplied by the Celle-based company Micon. The R-VDS performs continuous inclination monitoring and a set of control ribs ensures that any deviation is corrected back to the vertical. Drilling data are transmitted to the surface via the drill mud using a positive pressure-pulse technique and a sensor system is then used for data display and read-out. The course of the borehole was "redundancy monitored", which means that a number of different measuring systems were used so that parallel sets of intermediate measurements could be taken and compared throughout the drilling operation.
The 380 mm-diameter directional drilling was then raise-bored from the bottom upwards to the pilot-hole diameter of 1.8 m that was required for the shaft boring machine.

PHASE II: FINAL BORING TO 7-METRE DIAMETER

The sinking of Sedrun II shaft is being carried out by a Wirth VSB VI shaft boring machine. This phase of the operation commenced on schedule in mid-January 2003 and the machine is expected to "touch down" at shaft bottom in July.
The temporary support system, which consists of systematic rockbolting with lagging mesh, is installed from a fully-rotating support platform mounted on top of the boring machine, with the support work and boring operation being carried out in parallel.

The final shaft lining is set in place above the machine by a team working from a three-deck rope-suspended mobile stage, which operates independently of the boring operation. The lining itself consists of 22 cm-thick steel-fibre shotcrete. The „wetcrete" is applied by an MBT Meyco Robojet spray manipulator.

LOGISTICS AND INTERFACE PROBLEMS

The altitude of the access point and the location of the tunnel headings some

Installation of shaft boring machine

800 m beneath the level of the access drift pose special problems when it comes to site logistics and the coordination of operations.

Every effort is made to use the available mountain railway system for transporting materials and supplies to the shaft construction site. Advance notice is required before the machinery, equipment and building materials can be transported to the valley station at Landquardt, where they are transloaded on to the High Alpine rack-railway. On its arrival the material is again unloaded and put into interim storage at the Sedrun station assembly yard. The ABS II Joint Venture has already transported a total of some 1,000 tonnes of materials and equipment to the Sedrun assembly site.

WEATHER EXTREMES

The work of assembling and installing the shaft sinking equipment was hampered by the extreme winter weather. Snow-covered machine parts and materials first had to be identified on their arrival at the assembly yard and then cleaned off.

Scree avalanches and rockslides had already blocked some of the supply routes to the site and these areas were impassable on occasions. The transport of the HG 330 machine was delayed by a landslide that occurred the day before the delivery was due, while mud and rock avalanches also held up the transport of the three-deck working stage by more than 5 days.

The unusual nature of the worksite, which features an access tunnel and vertical shaft, and the fact that the main tunnel drivages start out from the shaft bottom, have posed a logistics challenge for all companies involved in the project.

The Sedrun operation requires absolute teamwork and revolves around a succession of individual arrangements with numerous outside firms and sub-contractors. All actions must be closely synchronized on a daily basis with interface coordination – a requirement that calls for the highest level of integration from all managers and supervisors.

SWISS EMPLOYMENT REGULATIONS MEAN EQUAL OPPORTUNITIES FOR ALL

Switzerland's progressive standard earnings system, which is effectively supervised by the authorities, ensures that minimum rates of pay are maintained and workers from low-wage countries are not employed at give-away rates. Every employer in Switzerland is required to observe the current regulations on working conditions and health and safety at the workplace and to apply equality of treatment in respect of wages and social benefits.

SUCCESS IS OUR STRENGTH

The Sedrun II shaft project represents an enormous challenge for those currently working in what is by any standards an unusual environment. The exposed location, difficult geological conditions and complex nature of the construction site have conspired to create a project that is like no other. After all, how many contractors have a client (in this case TRANSCO Sedrun) who is operating as a tunnel construction company and "mine owner" at the same time.

The joint venture is confident that the decision to use a rodless boring machine for Sedrun II shaft will contribute to the success of the Sedrun tunnel drivage project and will demonstrate that this technique can also be used for cutting through the Alpine basement rock complex.

Norbert Handke
Erhard Berger
Michael Müller

Raise boring in the Land of the Midnight Sun

The history of EKATI Diamond Mine

Discovered in 1991, the EKATI Diamond Mine is owned by BHP Billiton (80%) and the two prospectors (20%) who discovered the kimberlite pipes in Canada's frozen north. Only in its fourth year of production, EKATI produces 5% of the world's diamonds by weight and 10% by value. EKATI produces approximately 9,000 carats per day worth U$1.1 Million. At a production rate of 3.3 million carats per year EKATI is expected to operate for a minimum of 25 years.

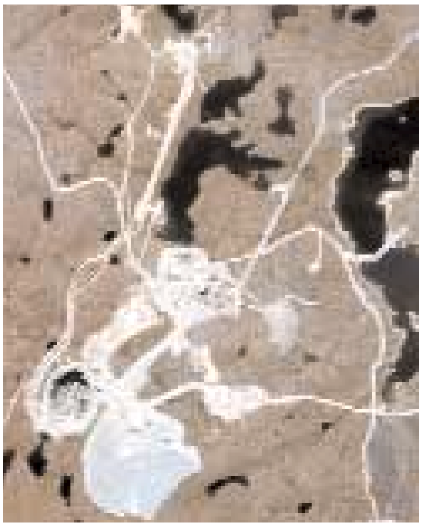
Located at latitude 65 degrees North and only 200 km from the Artic Circle, the mine operates in one of the harshest and most inaccessible locations in Canada's north. During the summer the sun never sets and during the winter there is perpetual darkness – they call it the Land of the Midnight Sun.

KIMBERLITE

Kimberlite is an igneous intrusive rock, which along with other constituents contains milibith, diamond, graphite, calcite and monticellite. The rock has a black or blue colouring, though can also be greenish or yellowish in colour.

The rock owes its origins to an explosive event, in which high pressure and temperature levels were sufficient to transform the existing graphite into diamond.
The rock occurs in dikes and fissures, but can also be present in semicircular pipes that can extend to depths of as much as 200 km.

Kimberlite is therefore the most important parent rock for diamond. The main sources of discovery to date have been in South Africa, Yakutia (Russia) and Arizona (USA), though finds have also been made in Sweden, the Congo and (as in this case) Canada.



Aerial view of Ekati

A SEVEN-WEEK TIME SLOT

TMCC was contracted in January 2002 to supply raise boring services at the Koala North deposit for the first (and smallest) of several kimberlite pipes to be developed underground. The initial scope of work called for the 225 m of 1.8 m and 3.0 m diameter work during the summer months of July to September 2002. The raises are the start of the underground ventilation system to eventually extend from surface to the final economic depth of the pipe at approximately 400 m below surface.

Supplies can only be brought in to the mine site during a seven week window of opportunity each year during the months of late February to early April. At that time the ice on the lakes is more than 2 m thick, allowing thousands of truck loads of supplies to make the trip north over the lakes to the mine. The EKATI mine alone will bring in approximately 3,500 truck loads of fuel and supplies during this period, averaging approximately 42 tonnes per load. Any items forgotten or not available for winter road transport must be flown in.

SUPPLIES BROUGHT IN ON A SNOW AND ICE ROAD

During negotiation of the contract it was agreed that the most economic solution for the client was to mobilize all of TMCC's equipment over the winter road, except for the raise bore rig and one 20' container with the electrical equipment and hydraulic power packs. A contract with Sandvik was quickly negotiated to supply boring tools and reaming bits for the project. In March 2002 over 100 tonnes of reamers, cutters, drill pipe sections, stabilizers, tools, beams and other supplies were transported to the mine over the frozen lakes. There they would stay for one year until the winter road in 2003, when the equipment could be demobilized.

The raise bore rig was another matter. To minimize standby time, the client chose to fly the raise bore rig to the mine site just before the project was to begin. The rig used on the project is an Ingersol Rand / Robbins RBM7SPLH raise borer utilizing a 185 kW DC drive. The rig is rated at 3,500 kN of thrust and 195 kNm of torque. The raise borer has a mass of 20,000 kg and the container has a mass of 12,000 kg.

The raise borer was transported by truck to Yellowknife in July 2002 and a Hercules transport aircraft was then used to fly the rig to the mine site in two loads. Crews were then flown into the remote site and the project was ready to begin.

TMCC crews work eleven hours per day, seven days per week for up to six weeks on end. After six weeks, crews are required to take a minimum three week break. While on site, crews have access to some of the best recreational facilities anywhere – including a swimming pool, Jacuzzi, sauna, gym, weight-lifting room, squash courts, computer golf simulators, internet access, library, theatre, table tennis rooms and running track.

CONTRACTUAL WORK

Over the months of July to September, three raise bore holes – totaling 215 m in length – were completed from surface according to contractual requirements. Work went smoothly and was completed on schedule. Although these operations were being carried out in the (warm) summer months, temperatures as low as -10° C and wind speeds of up to 85 km/hr were common.

The Owner had initially planned to complete future ventilation raises by drilling and blasting. However, after experiencing difficult strata conditions underground, the decision was made to continue with raise boring. TMCC was asked to continue with the first of several underground raises.

After allowing the client opportunity to advance the underground ramp system, TMCC crews were flown back in during October 2002 and moved underground to begin the extension of the surface raises. The new plan requires extending the parallel raise systems underground to the lowest workable depth of the ore body. The first underground raise, which was 3.0 m in diameter, had to be drilled from Number 1 Level through an existing opening on Number 2 Level, through to Number 3 Level. The work was completed without difficulty and the crews were flown out in late October.

Kimberlite

Traveling on a "winter road" across a frozen lake

SEVERE WORKING CONDITIONS

The mine plan at the Koala North underground project calls for large diesel equipment, which requires high air volumes underground. Due to the high heating costs in northern Canada (all fuel must be trucked in up to a year in advance) and the permafrost conditions, mine ventilating air is not heated. With air temperatures falling to -45° C during the winter and averaging below -25° C in January and February, the working conditions underground are severe. In addition, each new raise setup is at the bottom of one of the completed raises – which is being used for ventilation. Air velocities at the workplaces can therefore reach 50 km/hr and the wind chill factor is extreme. A new 500 kW fan installation will further increase the airflow and wind chill factor.

The equipment is extremely susceptible to the conditions. Brine is used for dust suppression, but this is harsh on the operating equipment. Hydraulic oil has the consistency of treacle and will not flow, while the grease tends to freeze. Electric-powered block heaters have to be used on the lubricants to allow the equipment to operate. Steel becomes brittle and drill pipe threaded joints often overtorque as they expand and contract with the temperature changes. The operators must wear heavy insulated clothing and have to take numerous shift breaks to stay warm. In order to make the working conditions more bearable tarpaulins are erected and small electric heaters are used to try and keep the workers and equipment in relatively "warm" temperatures of about –20° C.

FUTURE WORK

As the Koala North underground mine continues to a depth of 400 m the Owner has chosen to complete all future raises by mechanical means. Negotiations on an extension of the contract for the 2003 calendar year are now reaching their conclusion. Contracts for 2003 are expected to total 420 m of work at diameters of 3.0 to 4.0 m.

In order to accommodate the larger diameter raises, TMCC will replace all the current operating equipment by way of the 2003 winter road. The raise borer, drill pipe and reamer heads will be trucked out and a different raise borer, complete with new drill pipe and larger reamers, will be brought in.

RBM7SPLH Raise Borer at EKATI Diamond Mine (August, 2002)

Raise boring in the land of the midnight sun is no picnic.

Colin Wilson, P. Eng.

Dismantling the Sandvik reamer head (diameter 3.0 m) after completion of the raise

Mining in Australia's north-eastern goldfields
800 km NNE of Perth

Following a competitive tendering process Byrnecut Mining was awarded in August 2002 a contract for underground development and production at the Jundee Gold Mine in Western Australia.

The contract which is worth some 75 million Australian dollars, will run for two years. It entails the procurement of personnel and machinery for the development of declines crosscuts and strike drives, as well as the stope production of ore and the haulage of ore and waste to the surface using diesel trucks.
The access declines measure 5.5 m in height by 5.5 m in width at a gradient of 1 in 7. Crosscuts to orebodies are developed from the access declines. The ore bodies are then developed along strike in preparation for stoping of the economic gold bearing lode.
The client at the time of award was Normandy Mining Ltd – one of Australia's biggest gold mining companies. Normandy was subsequently taken over by Newmont, an American gold mining company.
Preparations commenced immediately and deadlines were tight, as a team of 150 workers and a large pool of machinery and equipment had to be mobilised by 1st October.

NORTH-EASTERN GOLDFIELDS, 800 KM NORTH-NORTHEAST OF PERTH IN WESTERN AUSTRALIA

The north-eastern goldfields are located in a remote, semi-arid region where summer temperatures can soar to above 40°C. All materials and supplies have to be trucked in from Perth or from Kalgoorlie some 600 km to the south. The workforce is housed in specially built camps and the men work a two on, one off, fly in, fly out roster. The roster involves seven day shifts and seven night shifts, each shift is 12 hours duration. On completion of the fourteen shifts the crews fly by company charter to Perth for the week off.

The site employs a total workforce of 153, including management and subcontractors' staff. The miners are paid in accordance with a Federal collective workplace agreement.

Mobilisation, training of manpower and procurement of the large fleet of equipment in four weeks was a huge challenge. Final commissioning of equipment on site took place four months after commencement. Despite the rapid mobilisation required target performance was achieved within the first two months and has continued strongly.

55-tonne Caterpillar Elphinstone truck emerging from portal

Picture above: Tamrock Axera D07 development jumbo

Picture left: production drill ...

Equipment:

Production drill:
Tamrock Mercury LC10
Tamrock Solo 720
Development jumbo:
2 x Tamrock 205D Powerclass
2 x Tamrock Axera D07
Tamrock D06
Underground trucks:
4 x Caterpillar Elphinstone AD55
LHD:
Caterpillar Elphinstone R1600
2 x Caterpillar Elphinstone R1700
2 x Caterpillar Elphinstone R2900
Integrated tool carrier:
Caterpillar IT14F
Caterpillar IT924G
Caterpillar IT62G
Grader:
Caterpillar 12G
Charge up:
Normet Charmec 1610B
Normet Charmec 6705B
Light vehicles:
13 x various Toyota.

PROJECT SCOPE

The project comprises 24,000 m of trackless development with cross-sections varying from 5.3 x 5.3 m to 4.5 x 4.5 m, together with the extraction of some 1.5 million tonnes of ore.

The development performance and ore production rate recorded to date has matched the agreed time-plan. In March 2003 the mine achieved a monthly record output of 75,000 tonnes of ore.
Plans are now under way to increase the monthly development rate to 1,300 m and to step-up monthly production to 100,000 tonnes.

... Tamrock Solo 720

ORE BODY AND MINING METHOD

Production sources involve 5 relatively distinct orebodies. The mining method is predominately longhole open stoping with some handheld airleg slot stoping in the high grade narrow lodes. Generally orebodies are narrow and flat, dipping between 12 and 65 degrees. The mine is very development orientated due to low tonnages per vertical metre in any particular ore body.
Development is undertaken with 2 boom Tamrock Axera D07 Superdrill jumbos in the larger profile headings and 2 boom Tamrock Axera D06 jumbos in the smaller

profile headings. Average daily advance is approximately 30 m. Ground support involves split set bolting with meshing installed by a 2 boom Tamrock Powerclass jumbo. Development jumbos average in excess of 75 drilled m per percussion hour. The primary Axera D07 jumbo is equipped with 16ft/12ft split feeds and averages 32,420 drilled metres per month.
Following stope definition by diamond drilling and preparation of the stope ring design 55mm diameter and 76mm diameter long hole drilling is undertaken with the Mercury LC10 and Solo 720 production drills respectively. Production drilled metres average 12,250 drilled metres per month. Production blasting is carried out using pressure loaded Anfo explosive.
Blasted ore and waste is loaded with Elphinstone LHDs, the smaller capacity R1600 and R1700 units being used in stope strike driving and production. Teleremote operation of the LHDs is commonly used to load broken ore beyond the stope brow. For larger headings and truck loading Elphinstone R2900s are used.
Ore and waste is hauled to the surface by 55 tonne capacity Caterpillar Elphinstone articulated 4WD trucks. The ore is hauled up a 1:7 ramp to the portal, up the 1:7 ramp of the open cut and then 2.5 km along the surface to the ROM stockpile.

55-tonne Caterpillar Elphinstone truck

SAFETY SENSORS

At the top of the open cut ramp infra red sensors open up the gear box to allow the trucks maximum speed (45km/hr). On returning to descend the open cut ramp and underground the sensors lock the gearbox out so that a maximum downhill speed is limited to approximately 18km/hr. The trucks achieve average productivity rates in excess of 250 tonnes kilometres per operating hour.

SAFETY MANAGEMENT

Following the fast ramp up to full development and production the safety performance has been excellent with a current 12 month rolling lost time injury frequency of approximately 5 lost time accidents per million man hours worked. Stringent training procedures and comprehensive safety systems common to the Byrnecut organisation support the safety policy.

SUMMARY

The performance by the dedicated Jundee team, led by Project Manager John Wrensted, has been outstanding with development and production targets regularly exceeded. The client representatives have been extremely accommodating and this has been a major factor in the success of the project to date. Important for the ongoing future beyond the two year contract period (October 2003) is the safety performance and productivity. Safety, as mentioned above, has consistently improved whilst the client's cost per tonne has reduced significantly since Byrnecut commenced. Byrnecut Mining look forward to a long future at Jundee.

Steve Coughlan

Mining in Australia's north-eastern goldfields 800 km NNE of Perth

The Kempinski Resort and Albrechtshaus Retreat in the Harz Mountains

The heart of the complex: the Albrechtshaus building

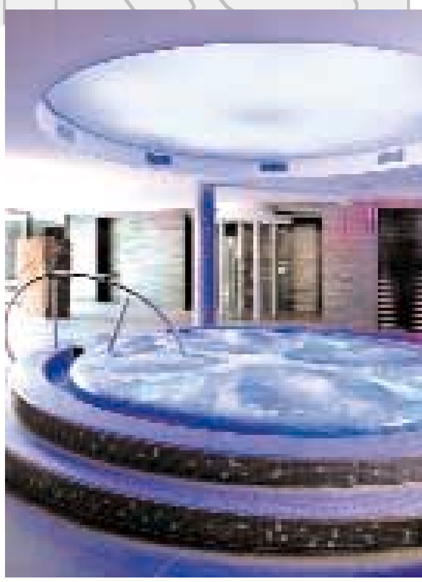
THE HISTORIC ALBRECHTSHAUS

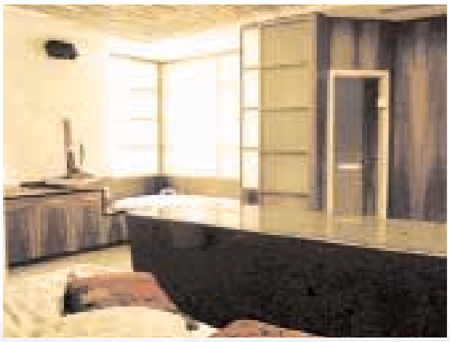
The Albrechtshaus has a long tradition and has been a centre of health care for some 105 years. Originally built at the end of the nineteenth century, when the tuberculosis bacillus was discovered, the building first served as a sanatorium for TB sufferers in the Stiege area and was named in honour of Albrecht, the then Prince Regent of Brunswick.

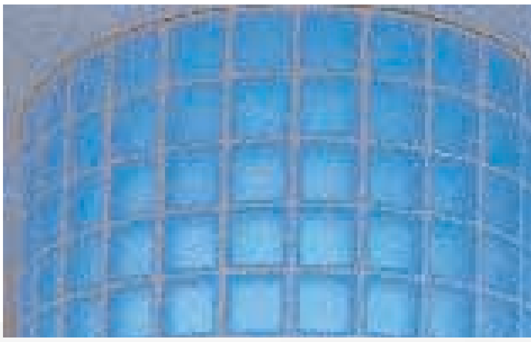
REVIVAL

In 1999 the property company GEI Grundstücks- und Immobilien AG signed a purchase agreement to develop a new hotel cum health and fitness complex on the site of the historic Albrechtshaus and clinic, which had closed in 1993. The LFI (State Subsidy Institute) of Saxony-Anhalt promised to contribute € 24.8 million to the total investment of approximately € 50 million with the aim of promoting a project that would create 110 new jobs.

The historic centre, which comprises a Nordic stave church that dates from 1905 together with the existing house, was to be extended by the construction of various administrative buildings, apartment houses, a café, a health and fitness centre with a bell-peal dome and other attractions to provide an accommodation capacity of some 150 rooms.







Impressions of the design of the new complex

THE KEMPINSKI HOTEL GROUP

GEI succeeded in obtaining the services of the Kempinski Hotel Group to manage the hotel and its facilities. With a design concept based essentially around regeneration and therapeutics the Kempinski project clearly stands out from the standard format of a luxury hotel. The architecture and interior are based on a mixture of oriental and monastic simplicity and with everything fitted out to the highest specifications the design is likely to set new standards for the health and fitness industry.

ARCHITECTONIC CONCEPT

The new design, which has been developed by architects Hartl and Heugenhauser from the "Atelier 3" firm of architects in Saalfeld, uses natural elements and locally-sourced materials and places an accent on hearing, sight, touch and meditation.

GENERAL CONTRACTOR

The new "project development" unit of the Jena branch of TS Bau GmbH began work on this ambitious new scheme in December 2002. Project management methodology, computer-aided quality management to DIN EN ISO 9000:2000 and an SAP cost-control system are all being used to coordinate the general contracting work in order to keep costs within the agreed investment of € 50 million. All contracts, orders, accounts and other records are to be drawn up in accordance with LFI guidelines for the auditing of financial statements and all accounts must be approved by a certified auditor.

DIGGING THE FIRST TURF ON 27TH FEBRUARY 2003

The Albrechtshaus project was officially opened by Dr Horst Rehberger, the Economics Minister of Saxony-Anhalt, on 27th February 2003. The Riesa branch of TS Bau then began the work of clearing the site. With the main construction work timed to begin in July 2003 and the hotel complex scheduled to open its doors in the spring of 2005 all those involved, namely the project team from architects "Atelier 3", the ACE engineering consultants (representing GEI AG) and general contractors TS Bau GmbH, were fully aware that there was still much to be done before the project's completion.

Dieter Bauer

Nordic stave church

Digging the first turf – 27th February 2003

Dismantling the old roller furnace

New lifting trough furnaces boost plant output: an ambitious construction project with a tight deadline

Access to a flexible and highly capable workforce was a pre-requisite for the successful completion of a project to construct a new lifting trough furnace at the Vallourec-Mannesmann Tubes plant in Düsseldorf-Reizholz.

Vallourec-Mannesmann Tubes GmbH, whose head office is in Dusseldorf-Rath, is a manufacturer of seamless steel pipes.

In order to improve productivity and increase plant capacity the company took the decision to undertake a construction project that would involve replacing the old roller hearth furnace with a much more efficient unit.

A few months later the plans had been laid for the installation of a new lifting trough furnace.

It was calculated that replacing the old roller heating furnace (charge weight 9 tonnes, length 8 m) with a more modern unit (charge weight 20 tonnes, length 10 m) would increase the plant's output by as much as 120%.

ROLLER FURNACE VERSUS LIFTING TROUGH FURNACE

Both types of furnace are used for the reheating of steel pipes – an after treatment process required for surface refinement.

In the roller furnace the pipes first pass over an inclined plane before entering the furnace and are then withdrawn by means of an extractor machine.

In the lifting trough furnace the pipes are laid in troughs of refractory material, which are subsequently advanced in increments of 325 mm by a hydraulically-powered lifter-transporter frame. The pipes are deposited in the furnace by means of a charging machine and are then removed by a discharging machine.

LIFTING

HOW DO THEY COMPARE?

In the roller furnace the pipes pass over the inclined plane in an uncontrolled manner. In fact this transfer does not always run smoothly and the pipes sometimes have to be helped on their way by a combination of poles and muscle power. With the lifting trough furnace the pipe is conveyed in a series of controlled movements. There is no risk of impact damage and plant production is significantly improved, instead of being disrupted when things go wrong.

Not much room for the excavators

Securing the foundations and armouring the bed-plate

PROJECT COMPLETED IN THREE PHASES

The Mülheim branch of TS Bau GmbH was awarded the contract for the furnace construction project in May 2002.
It was agreed with the client that the operation would be split into three distinct phases:

1. Demolition of the old roller furnace and excavation of the furnace pit.
2. Construction of the foundations for the steelwork required for the new furnace.
3. Installation of the new lifting trough furnace (flue gas duct, discharge table and conduit system) in collaboration with steel erectors SIAG.

Construction work began on 19th July 2002 and the project was scheduled for completion by the end of August. Such a tight deadline meant that the crews had to work around the clock.

During the first three weeks the work could be carried out during periods when the plant was shut down. However, after this the contractors had to work when the plant was in full production and a high level of flexibility and coordination was required so that the production cycle and the complex construction project could continue side by side.

STEP BY STEP

❑ *Phase 1*
It took only two days for the complete roller furnace unit (Figure 1), which

High-tech formwork systems for erecting bracket points and walls

With the plant working normally space is in short supply

Completed lifting trough furnace with integrated discharge table (bottom left)

weighed some 160 tonnes, to be dismantled, stripped and transported to a special disposal site for contaminated material. The furnace foundations then had to be dug out. This meant breaking up and removing some 3,500 m³ of earth, including 1,000 m³ of steel-concrete rubble – and it had to be done in a very short space of time.

The excavation work was complicated by the fact that the 13 m-high main stanchion for the gantry-crane track, which had a loading capacity of about 195 tonnes, had to be underpinned and secured to a height of 2 m so that the production flow could continue uninterrupted.

❏ *Phase 2*

Careful planning and accurate positioning was required when deploying the high-tech formwork systems, which accompanied each of the concreting phases. These forms, which were used for the bracket points and overhanging walls, had a total shuttering area of 2000 m². The formwork operation was also carried out in collaboration with SIAG.

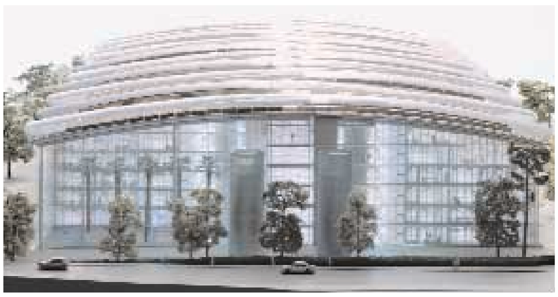
The construction phase included placing 800 m³ of special concrete designed to withstanding operating temperatures of around 250° C, along with 30 tonnes of anchor bars and boxes. This work had to be completed very quickly if the operation to assembly the new furnace was to begin on time by the middle of August.

❏ *Phase 3*

With the contracted assignment having been fulfilled before the agreed target date the contractors were able to undertake a number of additional tasks. The installation of an additional flue-gas duct, a discharge table for finished pipes and furnace connections to the drainage system completed the overall project.

Another successful project for the TS Bau files – and for the client.

Marco Roggenbuck



Laying the foundations for modern workplaces

The foundation-stone has now been laid for Lufthansa's new administration building at Frankfurt Airport at a ceremony attended by the Minister-President of Hesse, Roland Koch, and the Mayoress of Frankfurt, Petra Roth.

Communication and transparency are to be the key themes of the new building, which has been designed by Dusseldorf architects Ingenhoven, Overdiek and Partners. An essential remit for the design team was to create the best possible working environment. The new building will have a segmented layout, creating interposed cavity spaces with planted courtyards that will help block out noise and other emissions. Natural ventilation will be used to create a pleasant interior climate and a high-quality workplace environment. The inner gardens will feature landscapes borrowed from all five continents – as diverse as Lufthansa's many international links.

The new office block, which will be constructed using glass, timber and stone, is to be designed as a "low energy building", which means that it will only use one third of the energy normally required in a "conventional" structure.

This prestigious project is being carried out by DIG Deutsche Innenbau GmbH in a joint venture with the partner company BauTec GmbH & Co KG. The building will be delivered as a "turn-key facility", complete with high-grade metallic ceilings, false floors and partition walls, and will be plastered, painted, finished and tiled throughout.

Edin Alibasic

Tree surrounds retain the nautical flavour

Heilbronn Shopping Centre gets a Facelift

TS Bau's involvement in Heilbronn city centre continues with another contract awarded in 2002 to renovate three more shopping streets (the Fleiner, Klara and Kilian Strassen) covering a total of more than 6,000 m^2.

A special feature of the Heilbronn city centre project has been the use of textured concrete-stone paving contrasting with guttering and pavement steps in "Celtic Blue" mottled granite. This imaginative mixture of artificial and natural stone has given a special ambiance to the whole area.

Segregated construction zones ...

The sand-blasted paving slabs (dimensions 36 x 24 x 14 cm) were laid on a bed of stone chippings resting on filter fabric; this in turn was supported on a 15 cm-thick concrete drainage layer overlying a 20 cm-thick frost-screen/base course. The paving teams were assisted by a vacuum lifting device when laying the heavy slabs.

To blend in with other refurbished areas all surrounds and edge facings, which were constructed in dark anthracite-coloured pre-cast steel concrete, retained the nautical flavour used on the previous contracts. High-quality playground equipment was also installed at various points along the new thoroughfares. These brightly-coloured eye-catching facilities should provide a source of pleasure for children and adults alike.

The contract had specified that local residents, business people, customers and suppliers should have continuous access to their premises throughout the construction period. This was a tough assignment as far as site logistics were concerned, yet the planning team and site workforce proved well up to the challenge.

A careful plan was conceived to divide the busy pedestrian area into 14 different zones, which were then worked-on in groups of segregated units.

The completion of the project meant a facelift for another part of Heilbronn's town centre – just in time for the annual Christmas Fair.

Jörg Romankiewicz

... and minimal disruption to shoppers and businesses

Residential Property as an Investment Opportunity – right in the heart of Vienna

Vorsorge Immobilienentwicklung-Verwertung GmbH is a new property development and marketing company that has been set up jointly by Östu-Stettin and Dr. Jelitzka + Partner GmbH.

Operating as part of Östu-Stettin's Vienna branch, the new business venture is engaged in project development, with the focus on Vienna's property market.

The company's first purchase was a property in the central inner-city area, which was acquired in November 2000. Located on the Grimmelshausengasse, which is a tranquil residential street in the foreign-embassy district, the building is a mere five minutes' walk from Vienna's city centre and is directly adjacent to a small park. Schloss Belvedere and the city park are also a short walk away. The district has excellent transport links, with metro, bus and tram stops close by, while Vienna Schwechat international airport is only a 30-minute train ride away from the nearby Landstrasse/Wien Mitte railway station.

THE PROJECT

In order to ensure that the project ran smoothly an in-depth planning study was carried out before the construction phase began. Project owners, architects, contractors and marketing specialists were all involved in this collaborative exercise, which was considered essential for the

construction of a residential complex capable of meeting all the requirements of future buyers. The decision to demolish the original property created the space and freedom of scope needed to construct a new building with a functional floor layout and an appealing exterior.
The new property comprised a two-level underground parking lot, a ground floor, six upper floors and three attic storeys. The rear of the building opens out on to a lawned inner courtyard containing a number of well-established trees and shrubs; this heaven of peace and tranquillity is of special benefit to those with west-facing balconies and terraces. The use of glass frontages onto the street aspect ensures that the rooms are bright and well-lit. Most of the 38 dwellings have balconies and the roof apartments are also equipped with air-conditioning and automatic sun-shade systems.

INTERIOR DESIGN

The building has been equipped to a very high standard. Apart from the bathroom/WC area, each apartment is fitted throughout with high-quality parquet flooring in oak or maple. The internal door elements extend to ceiling height and include glass fanlights. Most of the doors leading to the terrace areas are designed as sliding units in order to open the living space up as far as possible to the greenery of the inner courtyard. All anterooms, bathrooms, WCs and storage rooms feature suspended ceilings with spotlights.
The spacious bathrooms are equipped as standard with marble flooring, bath, shower unit, towel radiator and double wash-stand complete with eye-catching fittings of the highest quality. The properties also feature fully-equipped kitchens, with oven, extractor hood, refrigerator and dish-washer, and each apartment is provided with an internet connection, SAT receiver and video intercom system.

MARKETING

The property was marketed in a professional way by project partners Dr. Jelitzka + Partner, with both private buyers and property investors being targeted. As the project name suggests, the property was built primarily as a contingency purchase for investors. Residential property is now more than ever being seen as a safe fixed asset – a traditional resource that has always proved to be inflation-proof. With the international stock market on a roller-coaster ride and interest rates at an all time low, investing in property has never seemed so attractive.

PROJECT TIMETABLE

Demolition began in November 2001 and the construction phase progressed according to schedule. By the time the framework structure had been completed about half of the apartments had already been sold, which meant that these residences could be completed taking in line with client requirements.
With the building project attracting a great deal of interest about 90% of the apartments were sold by the end of 2002. Two-thirds of the new owners are private residents, with the remaining third property investors.
The apartment block at No.12 Grimmelshausengasse was completed on schedule at the end of January 2003.
The world of project development is both an opportunity and a challenge.

Maximilian Höller

Office Campus Gasometer

– on the way from Vienna airport to the city centre –

between the Erdberg and Simmering districts, a new office block – which will be one of Vienna's biggest – stands on the site of a former nursery garden (the Erdberger Mais) and directly opposite the historic gasometer.

With the shopping and entertainment facilities of the Gasometer Centre easily accessible via the Kirschgarten bridge, the new complex boasts a wide variety of restaurants and modern conference rooms and also has direct access to the local tube station (U3 – Gasometer).

PROJECT SCHEDULE AND STRUCTURAL DESIGN

In July 2002 Östu-Stettin (Vienna branch) was commissioned as the main contractor for the project. The building was to be erected on the 16,900 m² site in two distinct construction phases. The contract specified a construction period of 29 months, with the two phases being

One of Vienna's largest office buildings

View of the construction site

Light and glass ...

dovetailed into each other in such a way that completion could be guaranteed for October 2004. Work on the first section – comprising 20,820 m² of office space – began in early August 2002 and this is to be completed according to contract in February 2004. Construction phase 2 is scheduled to commence in mid-2003.

The local ground-water conditions meant that the contractors had to create a watertight foundation pit using sheet piles with bitumen seals on the street side and partition panels at the flanks. Approximately 70,000 m³ of material was excavated and removed from the site in the course of construction phase 1. Filter wells were used during this phase to lower the water table temporarily by 4.5 m so that the underground levels could be constructed.

In order to ensure sufficient load-bearing capacity for the final building the foundation plate was given an overall average thickness of 2.2 m. Because of the building's direct proximity to public thoroughfares, and in order to ensure maximum protection from water ingress, the two underground garage levels, which were to accommodate 700 parking spaces and 5,500 m² of storage space, were designed according to regulations known as "white hull" structures.

The upper storeys, which are to be constructed on a steel-concrete skeleton framework, will ultimately have a double rib-type floor plan. Composite steel posts will be incorporated into the supports in order to keep the column diameters as small as possible. This arrangement will create efficient and flexible space for future tenants with open office areas measuring 15 to 18 m across. The new office building will have six upper floors with a total office space of 51,130 m².

... set the tone

INNOVATIVE PLANNING

The main design remit was communication, each floor and office area will be accessed by way of glazed internal traffic routes in a wide variety of designs to create horizontal ”lines of communication”, while a total of 17 personnel lifts will ensure quick and easy travel between floors.

Impressively-designed plazas will create an imposing framework for the entrances to the new complex.

FLEXIBLE OFFICE SPACE

The overall concept is in keeping with the highest standards required by international tenants and investors and will provide future occupants with office facilities that are second to none, while the furnishings and fittings are all based on the latest techniques of interior design.
The building will be fully air-conditioned, with air-duct double floors and suspended cool-flow ceilings being used in the design. The office zones can be organised as single-floor or multi-floor units, depending on requirements. The internal configuration best demonstrates the flexibility of the overall concept with every type of layout possible – from open-plan to conventional office units. Indeed the only areas whose location cannot be moved around at will are the washroom facilities, the network control rooms and the units housing the building’s technical services.

Each office layout can be adapted to suit the demands of the occupiers and tenant fit-out is facilitated by a predetermined grid arrangement that offers a wide range of wall panels and partitioning systems to choose from.

The modular design selected for the new office building calls for a high level of teamwork and innovative thinking not just on the part of the main contractor but from all those involved in the project.

The Office Campus Gasometer building has again provided Östu-Stettin with an opportunity to display its proven know-how in the general construction sector.

Walter Diplinger

Kirchenwald tunnel at the Vierwaldstaettersee

Lopper mountain installation site

The original section of the A2 Swiss national highway between Hergiswil and Stansstad, which runs lakeside along the Vierwaldstaettersee, has always been plagued by the threat of serious rockfalls. As this problem can never be totally solved, the Cantons concerned decided to run the existing road beneath the Lopper mountain ridge and to create an underground link with the A8 to Interlaken – the Kirchenwald tunnel.

The Kirchenwald tunnel project was contracted out to a number of companies, including the joint venture for tunnel section 321 – comprising Batigroup, Bilfinger + Berger, and Frutiger and Garovi. This group then had to engage the services of a specialist company capable of constructing the ventilation shaft section. This contract comprised the construction of a pilot shaft approximately 4 m^2 in cross section and 130 m in length, the subsequent extension to a diameter of 6.5 m with support system, the installation of a sealing layer and inner lining of cast-in-situ concrete and the construction of a 16 m-high air outlet stack.

A TALL ORDER ...

This air shaft is a important part of the tunnel ventilation and evacuation system. While widening the shaft at the Acheregg portal to the abovementioned excavation diameter of 6.5 m meant that a second air shaft would not be required, this part of the project had to be carried out under the following exceptional conditions:

1. There was no access available to the shaft head. This constituted the greatest challenge to the project engineers.
2. The access road to the assembly station 40 m beneath the shaft head is narrow and winding and can only be negotiated by solo vehicles.
3. Blasting could only take place Monday to Friday between 6 a.m. and 10 p.m.
4. Noise restrictions limited the amount of work that could be done on Saturdays and overnight. There was a total ban on Sunday working.
5. The shaft lining had to be constructed using a sliding shutter system.
6. With the project starting in April 2002, the client specified that the work had to be completed before the onset of winter (no later than the end of November 2002).

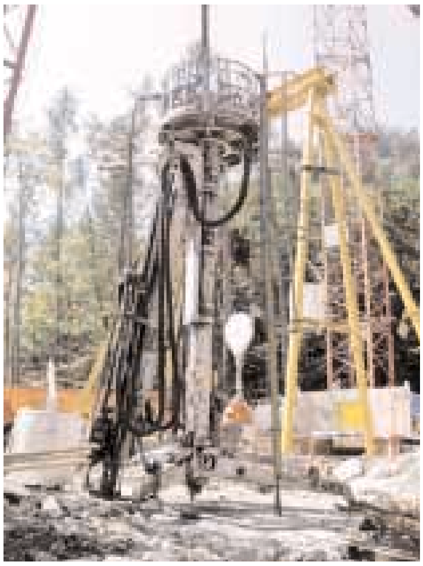
... REQUIRES AN UNORTHODOX RESPONSE

It was quickly recognized at the planning stage that under these basic conditions it would not be possible to meet the project deadline by normal means. A system had to be found by which the available resources could be employed to best effect, while at the same time significantly reducing the time required for the different working cycles. The successful development of such a concept, and its positive presentation to the client and project owners, represented a major factor in the award of the contract.

The main details of this construction project are:

1. *Construction of a pilot shaft from a 15 m-high chamber using an Alimak*
   By synchronisation of a number of working cycles normally performed in sequence, including the erection of the shaft head and the construction of the pilot shaft, the project gained an extra 4 weeks.

Installation site



Headframe and drill rig

2. *Extension of the pilot shaft using a high-performance shaft boring machine*
   The deployment of a machine from the Australian company Hydromatic Engineering resulted in a two- to threefold increase in sinking performance, thereby achieving a time gain of a further 2 months.

3. *Use of existing infrastructure from the sinking phase for the installation of the shaft seal and the construction of the inner lining using a slip forming system*
   These measures also meant a time gain of 2 to 3 months.

However, the combined deployment of these operating systems and methods placed increasing demands on the sinking installation. In view of the space constraints, success could only be achieved through the use of special tactics.

The decision was taken to install a cableway system with a 5 tonne payload in order to supply the shaft head. Helicopters were employed in the construction of a turret crane with a payload capacity of 15 tonnes, which would be used for transferring materials and equipment at the shaft head itself. The hoists and scaffold winches were set up on steel platforms in the transloading area some 120 m from the shaft head, as their main components were too heavy to be transported to the shaft site.

Sliding scaffold with multi-deck sinking platform

This decision also freed-up space at the shaft head, which was extremely limited. The installation of an intermediate column support for the rope winding system, combined with a video-camera facility to allow the winch operator to monitor the main operating zones, served to dispel any safety reservations on the part of the authorities.

The adaption of a tried and tested shaft installation, consisting of a headgear unit that could be quickly constructed using pre-assembled parts together with a multi-deck sinking platform that could be adapted to the pre-set shaft diameter, allowed the shaft extension work to be completed in an extremely effective manner.

FAULT ZONE FAILS TO DISRUPT SINKING PERFORMANCE

Despite having to cross a 30 m-long fault zone, the project achieved an average sinking rate of 4.5 m per working day. In line with expectations, an excavation rate of 4 m per working day was also attained

Sliding shaft system

in the pilot-shaft zone, where the Alimak method was employed. During the installation of the shaft lining the plan of work was intentionally modified to allow drainage channels to be installed at the same time as the pouring of the in-situ concrete in conjunction with service-platform operations. With the lining installed at the rate of 5.5 m in 24 hours using the sliding formwork system, the performance recorded here too was as planned.

The various procedures described above added to the operational performance of the project and proved to be a great technical success. With the completion of the air chamber in late October 2002 these measures constituted a key factor in ensuring that the Kirchenwald ventilation shaft project was successfully delivered on schedule.

Dipl.-Ing. K. Maderthaner

Second Herzogberg Tunnel

poses a challenge for tunnelling engineers

The A2 South Autobahn is one of the main highways linking the Greater Vienna area to eastern and southern Europe. The motorway is currently used by an average of 20,000 vehicles per day – and the number is growing.

The existing A2 South Autobahn, which was completed in the 1970s, runs entirely through mountainous terrain and comprises a single pipe with two-way traffic lanes. As part of a road-tunnel renovation programme a second pipe is now to be constructed to create a four-lane route for south-bound traffic. This operation will include the reconstruction and modernisation of the existing tunnel structures.

The contract for the Herzogberg Tunnel (south pipe), which measures 1,956 m in length, comprises the construction work for the main pipe, four link tunnels and a breakdown area. Renovation work in the north pipe will not begin until the south pipe has been completed.

CONSTRUCTION PHASE

On 20th April 2001 the contract to undertake the construction work was awarded to a bidding syndicate under the commercial leadership of Östu-Stettin Hoch- und Tiefbau GmbH. The tunnel excavation work commenced on 16th July 2001 and breakthrough was achieved on 12th October the following year. According to the revised works progress schedule the completion deadline for the south pipe project, including the renovation of the north pipe, is now set for the autumn of 2004.

The Herzogberg Tunnel was driven by conventional drilling and blasting using the New Austrian Tunnelling Method.

The drivage runs up-gradient from west to east, with the crown section first being excavated to the mid-tunnel point, followed by the bottom profile. The roof section was then driven out to its eastern breakthrough point. The remaining work on the lower profiles and connecting tunnels was carried out after the main roof section had been completed. Work on the inner tunnel lining also began at the same time in a west to east direction.

The tunnel drivage was undertaken as a continuous operation and the main machines used were an LH 932 tunnel excavator, a Volvo 180 D free-steered loader and an AC 353 S triple-boom drill jumbo. The tunnelling debris – 160,000 m^3 in total – was transported out by four GHH dumper trucks for temporary storage at the west portal, before being delivered as part of a continuous cycle to the final disposal site.

Temporary tunnel support was provided by wet-sprayed concrete applied by a Putzmeister WKM 103 manipulator. A site-owned mixing plant was installed at the west portal for the supply of the 30,000 m^3 of wet-sprayed concrete and 45,000 m^3 of structural concrete required for the tunnel.

Sealing work at the heading face

LOCAL GEOLOGY PRESENTS A CHALLENGE

The Herzogberg Tunnel runs through metamorphic strata of the coral crystalline series, which constitutes a major part of the mid-east alpine cap rock. The alpine sheet upthrusts and more recent Tertiary basining have in places resulted in steeply-inclined major fault lines with close-grained mylonites, along with finely-fractured phyllonitic rock.

The effect of weathering over geological ages has produced deep-seated structural disaggregation and subsurface disintegration, which has reached the tunnel level at the portal areas and along the main fault lines.

Tectonically highly-stressed, fragmented, phyllonitic gneiss was encountered in the two major fault zones (the Modriach fault and the Verbruch fault). Thick mylonite bands were found primarily in the area of the Verbruch fault.

Excavator and shotcrete manipulator at the heading face

HEAVY WATER INGRESS

The fault lines were affected by heavy water inflow of as much as 20 litres per second. In the water-saturated, detrital fault zones this resulted in a serious inrush of mud-like flow of rock into the tunnel cavity. The tendency of the strata to fluctuate very quickly between "hard rock" and "soft rock", which was especially pronounced in the critical zones, also hampered the tunnelling work. In these areas the only solution was to bring the two main machines (the tunnel excavator and the shotcrete manipulator) right up to the roadhead at the same time so that the newly-exposed rock faces could be sealed off very quickly.

The strata encountered along most of the tunnel route also displayed an unfavourable parting-plane structure. This affected tunnel profile stability and resulted in repeated and in some cases serious overbreaks and falls of ground from the heading face and side-walls. The excavation work was also obstructed by the problem of large blocks of stone suddenly slipping from the tunnel face.

In view of the severity of the problems being encountered as the tunnel advanced towards the Verbruch fault, the project engineers took the decision to excavate this section of the drivage under

Erecting a tunnel screen pipe

a tunnel screen pipe. Three such screen-pipe systems were used (each 15 m in length, including overlap) and the 36 m-long section where the geology was especially difficult was successfully crossed without any problems arising.

This delicate operation called for a high degree of flexibility in carrying out the excavation work, with the strata having to be exposed and then immediately supported in a number of subcritical areas.

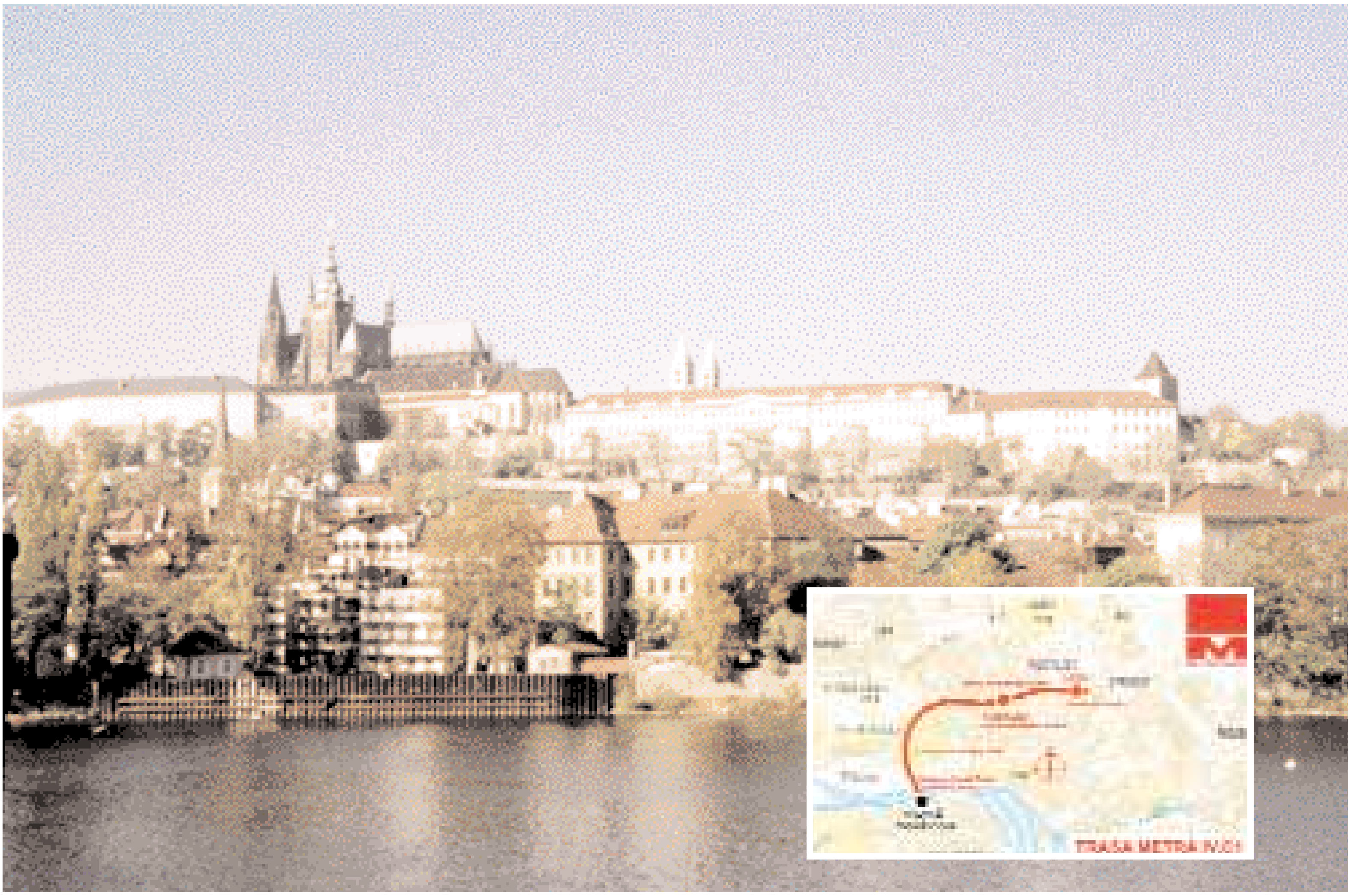
PROGRESS TO DATE

The inner lining work, which commenced in November 2002, is currently being carried out in parallel with the construction of the tunnel floor and abutment for the concrete lining, which is being installed using an arch-section formwork vehicle. This will be followed by the installation of the tunnel drainage system, the partition walls for the tunnel recesses, the cable ducts and kerb-stone surround and the carriageway structure itself.

A temporary diversion scheme is to be introduced in early 2004, with all traffic then being directed through the new tunnel pipe.

Once this scheme is up and running, reconstruction work can begin in the north pipe. This will include the demolition of the inserted ceiling, concrete reconditioning and the renovation of the drainage system. This work is expected to take about six months and the Herzogberg section of the tunnel is then due to be opened to traffic in the autumn of 2004.

Dieter Schnepf



New Metro project for the City of a Hundred Spires

Prague builds the world's first single-track tube station

The Prague tube system is now being extended by a new 3,981 m-long Metro C IV section that will connect the northern suburbs to the city centre. The new line starts from the existing Nadrazi Holesovice station and passes beneath the Moldau river before rising to the Kobilisy and Dablice districts.

Prague, the capital of the Czech Republic, straddles the Moldau river and has a population of some 1.21 million. The first university was founded here in 1348. Famous buildings, such as the Hradcany, the castle buildings with the imposing St. Vitus Cathedral, the Parliament building and Charles Bridge, have all established "Golden Prague's" reputation as the City of a Hundred Spires. The new Metro Project will help join the outer suburbs and their surrounding areas to the city centre and its completion in 2004 should also help relieve traffic congestion in this part of the city.

PROJECT DESCRIPTION

The ambitious new scheme is divided into the following construction phases:

- Single-track sections with tunnel diameter of 5.2 m
- Single-track sections with tunnel diameter of 5.6 m
- Twin-track sections with a number of pass-by points
- Kobilisy station building (single-track).

Östu-Stettin Schalungsbau was contracted by the main construction companies

Metrostav and Subterra to plan, design and manufacture all the formwork components required for the project.

OPERATING EQUIPMENT AND TECHNICAL PROCEDURE

In order to keep formwork efforts limited, and thus to reduce the overall cost of the project, an assessment was made of various combinations of different formwork systems. The possibility of using a single formwork car to concrete several profile sections was also examined.

After detailed discussions with the chief planning engineer and client, which included specific time schedules for the different working sequences, the following contract performance was agreed:

- 1 x formwork car for 5.2 m-diameter section
- 1 x formwork car for 5.2 m-diameter section, extendable to 5.6 m
- 1 x reinforcement car for the twin-track section of track (also extendable)
- 1 x formwork car for twin-track section
- 1 x formwork car for single-lane station.

The two all-hydraulic formwork cars constructed for the single-track tunnel sections were 6.0 and 7.5 m in length. The extension elements needed to expand the shuttering to a diameter of 5.6 m are mounted on to the formwork shell and fixed into position from inside the canopy.

Tunnel crown viewed from below with sliding support brackets and hydraulic tunnel concreting machine

Twin-track pass-by point with transition to single-track section

One of the main advantages of the system is the speed at which the formwork can be re-set. This is made possible by the fact that all the pressure struts can be backed off in just one hydraulic movement to release the form for the next section.
The hydraulic formwork car for the twin-track section was designed so that the arch form could be extended with minimum effort. The tunnel is widened out gradually for a distance of about 100 m before changing over to a single-track section. This is achieved by using inserts at the tunnel roof and by fitting similar pieces to the abutment brackets and compression members. These inserts are 270 mm, 1052 mm and 1960 mm in width.

THE WORLD'S FIRST SINGLE-TRACK TUBE STATION

The station, which is 31 m below street level, has a profile section of about 220 m^2 and is 148 m in length.

Formwork car with up-front reinforcement car in the pre-cut assembly chamber

Östu-Stettin Schalungsbau designed and built a special all-hydraulic arch formwork car for the new tunnel project – the first time that the company had ever worked on such a profile.

The 155-tonne formwork system is 9.6 m in length and has a circumference of 30.5 m. The roof height measured from the top of the rail is 10.5 m.

The formwork car was dismantled into separate sections and transported via a shaft to the workplace, where it was re-assembled with the help of hoisting gears. In spite of the difficult working conditions, careful preparations and excellent teamwork on the part of the site crew ensured that the installation was assembled and ready for service in only 14 days.

Östu-Stettin Schalungsbau has been specializing in the construction of shuttering cars and formwork components for 20 years. As a result of the know-how acquired from in-house activities and from working with other companies within the TS Group, as well as with third-party clients, ÖSS formwork systems have undergone a process of continuous development and have become increasingly adaptable. Östu-Stettin Schalungsbau's success is due to meticulous planning and the availability of an experienced and motivated workforce – a powerful combination that means that the branch can now tackle even the most difficult assignments.

Harald Pacher

Striking the formwork – all pressure struts are released simultaneously by hydraulic action

The project continues ...

These words closed the Report 2002 account of the largest construction project ever undertaken in the Hungarian town of Sopron. With the country poised to join the European Union, the Vienna-Bratislava-Sopron area will shortly have access to a major new conference centre with room for some two thousand people.

BUILDING ON A MAJOR SCALE

As an important development for the entire region, the project has been followed with great interest both by the PHARE CBC programme (the EU's pre-entry programme for new applicant countries) and by the local authorities, who are the main investors. Restoring a new-Renaissance style building that was erected in 1896 and is currently the subject of a strict architectural protection order, and giving it a new sense of vitality, required not only clever planning, solid financial backing and some brave decision-making but also a team of highly-skilled and experienced design and build specialists. The work of the project planners was not made any easier by the fact that the Casino Austria, a gaming casino had to remain fully operational throughout the building phase. This part of the thousand square-metre project has already been described in detail in Report 2002.

The Conference Centre has a usable floor space of 9,000 m^2, which is spread over two basement floors, the ground floor and six upper storeys. The different levels are served by four passenger lifts and two goods lifts. A new main stairway has also been incorporated into the building.

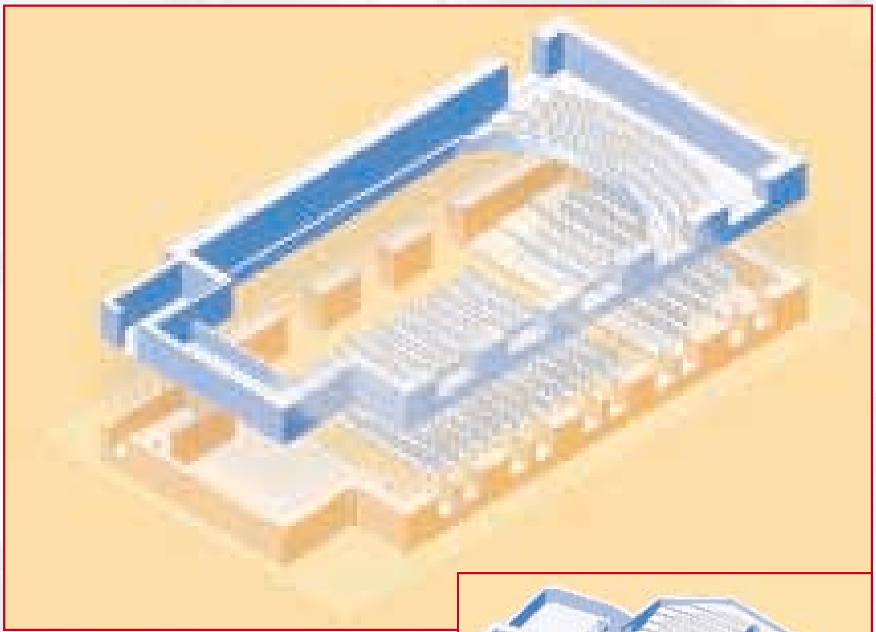
A decision had been taken that the Centre's concert hall would also be rebuilt during the conversion phase. This 800-seater facility, which was to retain the unique acoustics of the Liszt concert room, was divided into eight sections. Each of the rooms was fitted out with contemporary light fittings and conference facilities.

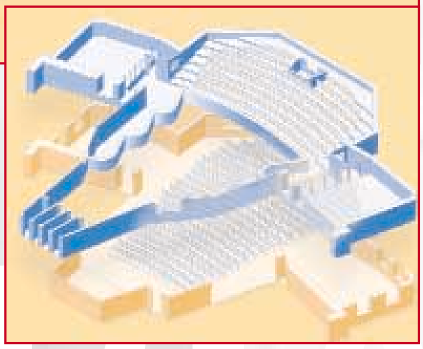
The entire project had to be completed to a very tight 16 months deadline – an undertaking that was not made any easier by the fact that the contractors had to expect a number of structural anomalies dating from the 1960s, when the building had been part-restored. The contract included the renovation of the neo-Renaissance façade, the restoration of the Saint Margarethen limestone caryatids, the replacement of the outdated design features and the reconstruction of the south wing.

TRACES OF A PAST LONG GONE

During the excavation work the contractors unearthed the ruins of the Roman wall of Scarbantia. The site was then taken over by archaeologists searching for traces of Roman inhabitation. Visitors can now follow the tracks of the Roman invaders along the granite streets and cobblestone lanes which characterise this part of the town.

The Saint Margarethen caryatids are statues of hard limestone that are mined at St. Margarethen near the town of Eisenstadt in Austria. These female statues are known as caryatids in Greek mythology and the figures adorn the main façade of the building.





The successful completion of the renovation and façade replacement work is a testimony to the skills and experience of the Stettin-Hungaria workers. The restoration of the stone rendering on the old building called for painstaking and detailed work by skilled craftsmen. The brickwork on the south wing of the building was also given a high-quality natural-stone finish. With the completion deadline looming a suitable material was found in the form of Jurassic limestone blocks mined in Germany. After suitable preparation and dressing by expert stonemasons, the new limestone now blends in harmoniously with the rest of the imposing building.

HIGH TECH WITHIN OLD WALLS

The digital DNC sound and video equipment, which is from one of the world's leading suppliers, meets all the requirements of a modern simultaneous-interpreting facility. The projection equipment and remote-controlled cameras installed in the main Szechenyi Room can monitor all events via a studio link-up and provide sound and vision transmission from the main conference hall to other rooms in the Centre.
A modern telephone switchboard with 250 networked computers provides a 1,000 Mps broadband data transmission service.

The Centre is equipped throughout with Galaxy 512 safety technology.
An array of some 400 sensors are used for the Aritech FP2416 addressable closed-loop fire alarm system.
The theatre and conference rooms are beautifully lit by state-of-the-art Lutron lighting technology.

The Centre was officially handed over to the site owners on 26th October 2002 – an event at which Stettin Hungaria GmbH was one focus of attention with the company being awarded the Pro Kultura Sopron MCMLCVII medal in appreciation of the quality of the restoration work. Whilst the accolade went to Stettin Hungaria GmbH, the award was really given in recognition of the skills and commitment of the company's workforce.

The new Conference Centre, which had until recently been a busy construction site, has in the course of the last few months already hosted a number of successful events.

Attila Kerekes

New Tauern line

can now take twice as much trans-Alpine traffic

The Tauern line, which is part of the Salzburg – Schwarzach-St. Veit – Villach route, is one of the most important and most frequently used of all the rail crossings through the Austrian Alps.

As well as extending the existing line from single-track to twin-track operation, the project also includes a certain amount of track correction work. Project phase III, which is currently under way, involves the construction of the Birgl and Kenlach tunnels, an emergency rescue tunnel for the Birgl tunnel, two frame-supported openings and various retaining walls with a total length of about 250 m and up to 11 m in height.

BACKGROUND

The crossing over the Tauern range has been known since Roman times, as various road remains show. A trans-Alpine Tauern line was first suggested as a response to the dramatic increase in north-south traffic movements in this area in the late 1700s.

The Imperial and Royal State Railway began construction work on the Tauern line in October 1901. The through line was first opened on 5th July 1909, with the mountain section measuring a total of 75 km in length. The track on the north side has to overcome an altitude difference of 635 m, while the southern ramp has a total drop of 683 m. The maximum gradient is 2.7 %.

The mountain section includes twelve tunnels (total length 12,770 m), 20 bridges (total length 1,191 m) and 26 viaducts (total length 1,814 m). In 1930 the decision was taken to electrify the Tauern

Embankment filling work behind the Bad Hofgastein railway station. The scaffolding in left in the embankment after the placement operation

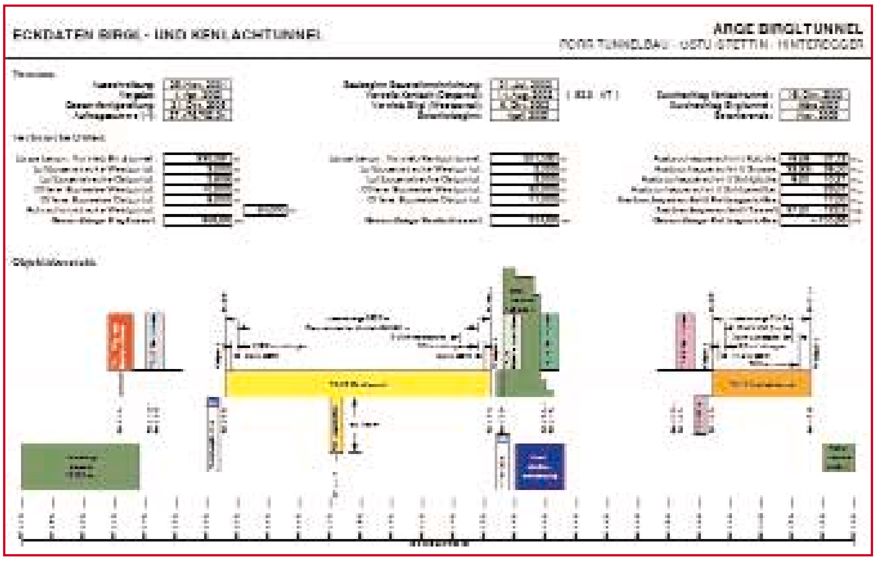
100 years ago …

Bridge scaffolding over the Anger gorge

line and the whole route was completed and operational by 15th May 1935.

THE PROJECT

The 960 m-long Birgl tunnel starts off at the west-facing flank of the Thomersbach trench at the Loifarn abutment of the bridge over the Thomas rift valley and re-emerges at Birglbauern on the western slope, where the local gradient is about 30 degrees. The tunnel rises throughout its length at a continuous gradient of 2.76 %. The top rail edge is at an altitude of 651.1 m at the eastern portal and 677.4 m at the western portal.



Key data and project breakdown

A cut and fill system is used for the installation of the tunnel pipes in the preliminary excavation zones, with the tunnel profile matching the geometry of the inner arch in the deep-tunnel section. The cast in situ concrete ring is fully enclosed in plastic sealing strips and backfilled throughout.

The cut and fill method is used for an 8-m section at the east portal and for 16 m at the west portal. Each cut-and-fill portal section connects with a 3 m-long aerial arch section. The 930 m-long deep-tunnel section is being excavated in a series of separate benches using the New Austrian Tunnelling Method.

The new 314-m long Kenlach tunnel starts about 100 m to the west of the Mursanger trench and terminates close to the west portal of the existing Kenlach tunnel. The tunnel has a continuous gradient of 2.58 %. The east portal is situated at a left-hand curve in the line. This is then followed by a right-hand curve with a radius of 1,500 m and a 54 m-long transition curve close to the west portal.

SPECIAL CONDITIONS

The contract prohibited blasting between the hours or 10.00 p.m. and 5.00 a.m. and further special precautions were required because of the danger of avalanches between the Birgl tunnel west portal and the Kenlach tunnel east portal. In periods of very wet weather the installation site

Bench drivage in the west-portal area of the Birgl tunnel


Erecting the first screenpipe at the west portal of the Birgl tunnel

was also threatened by mudslides from the Thomas water course.

GEOLOGY

Most of the Birgl tunnel runs through Graywacke strata. The sedimentary rocks in this area have a slight metamorphic overprint.
The west portal and adjoining 80 m-long tunnel section lie in the Tauern north-boundary fault zone. The line of the fault is characterized by thick cataclasite beds, though adjacent rocks are also severely affected in this way at a local level.
The major part of the tunnel passes through limestone shale, calcareous phyllite and local inclusions of green schist.

The Kenlach tunnel lies in the Permo-Mesozoic strata of the gorge limestone area. This zone has mainly been created by low metamorphic rocks. The tunnel itself is situated in the southwards-dipping flank of an east-west fold structure.
The dominant strata consist of lime-rich shale and phyllite and the western section of the tunnel drivage is formed from tectonically heavily superimposed serpentinite.

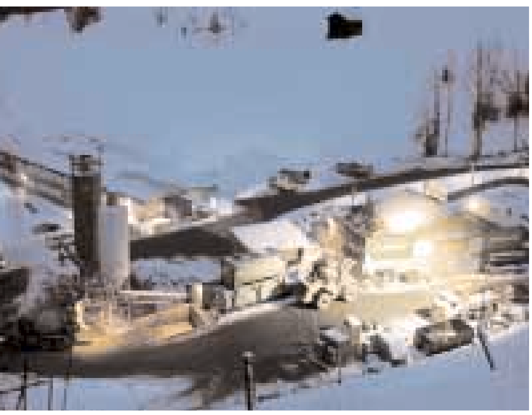
SITE POSITION

Project phase III, which was commissioned by the Austrian Federal Railways, involves the extension of the Tauern line through the Salzach valley section, beginning at Salzburg and passing through Bischofshofen, Schwarzach-St.Veit and the Tauern tunnel (Böckstein) to its terminus at Villach.
The new tunnels are sited on the southern slopes of the Salzach valley to the west of Schwarzach-St. Veit station.

IMPLEMENTATION OF WORKS

The project commenced with the mobilisation of the construction site below the planned west portal of the Birgl tunnel. The preliminary excavation for the Kenlach tunnel east was completed at the same time and then driven out at a rising gradient from east to west.
The excavated debris was used to provide fill material for site surfacing work and for

Site equipping stage



Rockbolting work in the crown section of the Birgl tunnel

Bench drivage in the Birgl tunnel

the construction of various site roads. The preliminary excavation for the west portal commenced in parallel with the drivage work at the east portal. A 15 m-long screen pipe was used to ensure a successful breakthrough from the east drivage. A major consideration here was that Schwaigbauer farm was located directly above the Kenlach tunnel drivage and this severely hampered the blasting work. Another factor was that the old Kenlach tunnel, which was still heavily used, had to be protected from the vibrations generated by the blasting operation.

The preliminary excavation work for the Birgl tunnel west portal also commenced at this stage of the project. Because of the geologically difficult Tauern north-boundary fault the excavations had to be secured with 500-kN IBO rockbolts, nine 650-kN permanent "free-play" bolts 35 to 40 m in length and a 10 cm-thick layer of shotcrete. The subsequent 90 m of tunnel were then driven to the dip under the protective screen pipe. The geological conditions in this area required the installation of a temporary tunnel-crown floor arch, which was followed by a sunken tunnel floor arch.

A total of 6 screen pipes each measuring either 12 or 15 m in length were used for the tunnelling operation. Each screen pipe required 29 to 33 individual pipe sections to be bored in (0.5 – 0.55 m between pipes) and then injected with a cement suspension (5,300 – 32,800 kg per screen pipe). The overlap at each individual screen pipe was 3 m. Two screen pipes were each fitted with an inclinometer at the tunnel roof.

After the drivage had crossed the Tauern north-boundary fault the limestone-shale zone was excavated in bench sections using the crown and bench drivage method. A careful blasting routine ensured that there was little or no damage to local buildings, the control drift or the Brandstatt equalizing reservoir operated by Tauernkraftwerke AG, which had a holding capacity of some 1.8 million m^3. A milling machine was then used to extract the floor section in both the Birgl and the Kenlach tunnels.

CENTRAL PROJECT SITE

The two tunnel workings were supplied with equipment and materials from a central project site, comprising a two-storey site office for the client and contractor, living and sleeping quarters for the workforce, workshops and a shotcrete dispatching plant.

LOOSE-ROCK DRIVAGE

The excavation work in the loose-rock zone was carried out under the protection of the screen pipes using a Liebherr L 932 T tunnel excavator. The drivage face in this part of the tunnel could only be excavated in segments. Because of these difficult conditions IBO rockbolts and steel mesh reinforcement had to be installed, immediately followed by a layer of shotcrete, to secure the tunnel face. The tunnel roof section was supported with lattice arches, two layers of steel mesh reinforcement, a 30 cm layer of shotcrete and a temporary crown floor arch in shotcrete. The rockbolting work was performed by an Atlas Copco 352 L2C drill jumbo.

Shotcrete spraying in the crown section of the Birgl tunnel

TUNNEL DRIVAGE PLANT AND EQUIPMENT

The following items of plant and equipment were deployed for the excavation of the Birgl and Kenlach tunnels

	No	Diesel/kW	E/kW	Total kW
Atlas Copco 352 L2C drill jumbo	2	115	160	320
Liebherr 564 free-steered loader	1	183		183
Liebherr 522 free-steered loader	1	74		74
CAT 966 F 11 free-steered loader	1	164		164
GHH dump truck type MKA 30.1	3	206		618
L 932 T tunnel excavator	2	132		264
LH A 912 elevator platform	1	70		70
Aliva AL 500 (2 x 146 kW) shotcreter	2	36	292	364
Mobile mixer	3	230		690
Diesel compressor (8.5 m³)	2	30		60
Duct fan (1700 mm diameter)	1		250	250
Total power output of tunnel plant (kW)		1.240	702	3.057
Workshops:				
Truck-mounted crane	1	310		310
Refuelling truck	1	141		141
Tractor	1	35		35
Total power output of workshops plant (kW)		486		486
Birgl depot:				
20 TO excavator	1	117		117
Bomag 22 TO roller	1	88		88
Four-axle truck	2	341		682
LH 732 crawler-mounted loader	1	132		132
Total power output of depot plant (kW)		678		1.019
Total plant (kW)				4.562

		Transformers
Site equipment:		
Transformer station I	30 kV / 0,4 kV	500 kVA / approx. 400 kW
Transformer station II	30 kV / 0,6 kV	1250 kVA / approx. 1000 kW
At tunnel portal:	Kenlachtunnel:	Birgltunnel:
Transformer station	400 kVA / ca. 320 kW	630 kVA / approx. 505 kW
Underground:		
Transformer station		400 kVA / approx. 320 kW

ROCK DRIVAGE

The solid-rock drivage work was carried out using a careful blasting scheme designed to minimize strata degradation. Pulls of 1.7 to 2.2 m in length are currently being taken at the rate of 4 to 5 per day. Tunnel arches were omitted when crossing the compacted rock zones. Layers of shotcrete 15 to 25 cm thick have been applied in conjunction with either 1 or 2 layers of steel mesh.

DEWATERING

The low rate of water inflow in the rising Kenlach Tunnel has presented no real problems for the drivage operation. To date the dipping Birgl Tunnel has only had to cope with small quantities of mine water and service water and this has been pumped out to the surface using a continuous pumping system operating through settling tanks. The water is then allowed to flow into the receiving stream via a neutralization plant.

SHOTCRETE

The shotcrete is applied using a thin-stream "wetcrete" process. The aggregate material first passes through an on-site metering unit before being delivered to the mobile mixer for processing. The metering system essentially consists of components taken from a concrete mixing machine, though without the mixing paddles. This is known as an MIC (Mixed in car) system.

The shotcrete is applied using an Aliva AL 500 mobile shotcreting rig, which comprises an on-board accelerator-proportioner pump, air compressor and Aliva 285 rotary spray machine.

TUNNEL PROGRESS AS AT END OF JANUARY 2003

The main excavation and support work for the Kenlach Tunnel was completed at the time of going to press. The Birgl tunnel drivage had at this stage achieved 310 m in the crown section (excavation and support work) and 172 m in the benches.

SAFETY TUNNEL

In keeping with the new safety standards now applying to Alpine tunnel construction projects the contract includes the excavation of an emergency exit tunnel running outwards from the centre of the Birgl tunnel. The safety tunnel measures about 150 m in length and has a cross-section of approximately 17 m^2.

SEALING, INNER SHELL AND SUPPORT SYSTEM

The tunnels are lined with a screen cover that extends down to the side-wall drainage channels. The sealing system consists of a support material, protective fleece with drainage function and a 2 mm-thick sealing film. Jointing strips are fitted into the gaps between the floor slabs and arch segments.

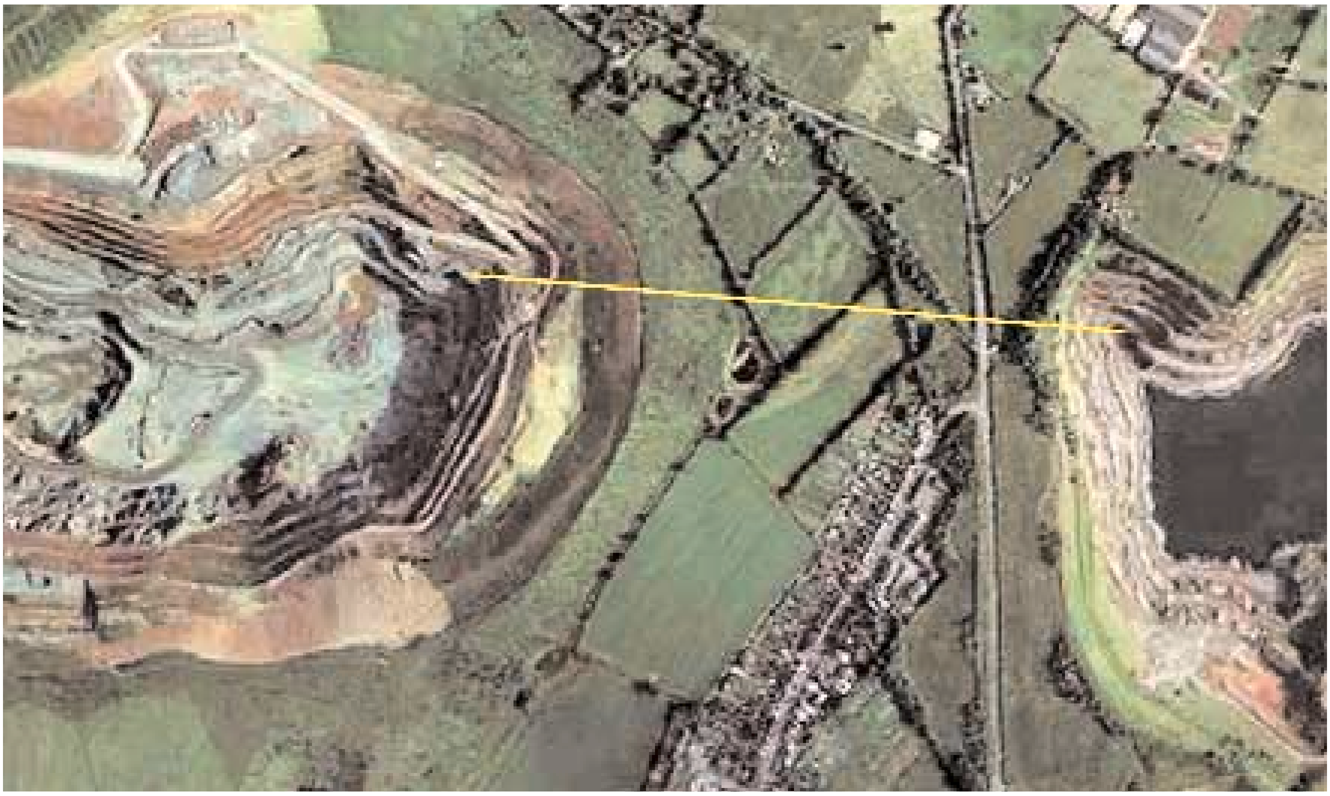
The inner lining of cast-in-situ concrete has a tie-block length of 12 m. Spacer blocks of different lengths are required in order to adapt the block spacing to the tunnel geometry (transition from open-trench section to deep-tunnel section). The thickness of the inner lining varies from 25 to 40 cm, depending on the geological and geotechnical conditions. The first blocks installed at the start-point and end-point portals are designed as reinforced units in accordance with structural design requirements. The remaining blocks are usually non-reinforced. The floor slabs installed in the deep-tunnel section and in the cut and fill section are generally provided with reinforcement.
Emergency alcoves and recesses for technical fixtures and equipment also have to be constructed at regular intervals along the tunnel, while cable ducts with integrated water pipes for fire suppression have to be installed along both sides of the tunnel for the provision of safety, telephone and electrical services.

The new tunnels represent a key part of the Austrian Federal Railways project to develop the Tauern line into a modern high-speed link across and through the Alps.

Walter Scheiber

Rockbolting work at the Kenlach tunnel pre-cut (east portal)

Ariel photograph of the New Cliffe Hill Quarry (left) and the Old Cliffe Hill Quarry (right) with the line indicating the direction the tunnel will take.



New Tunnel Access to Old Cliffe Hill

The expansion of Thyssen Technical Services, part of Thyssen GB's Mining Division, into civil engineering type works is a strategy aimed at transferring know-how from the coal mining sector, once the core activity of Thyssen GB. The plan is to develop this market utilising in-house technical competencies to replace the diminishing mining volume as the coal industry continues to downsize.

A testimony to how Thyssen Technical Services has succeeded in using its existing competencies in a different market is the award of the Cliffe Hill Quarry contract, near Leicester in the UK, from the client Midland Quarry Products Ltd, which is part of the Anglo-American Group.

TUNNEL SOLUTION

The client's objectives for this contract were numerous, but their primary concern was to minimise the environmental impact of the long-term development of the quarrying activities at their site in Leicester. They needed to consider how best to exploit the 60 million tonnes of high quality porphyritic microdiorite (granite) road stone reserves which remain at their Old Cliffe Hill Quarry site adjacent to their current quarrying activities.

Thyssen were invited in at an early stage to help develop ideas for access options between the old quarry and the current established facility at New Cliffe Hill, some 5 km away by road, by means of a 711 m long tunnel.

Following the initial competitive tendering procedure, Thyssen were chosen to work with the client throughout the latter part of 2001 to finalise the plans. Following subsequent further investigation work Technical Services advised and agreed with the client to lower the planned tunnel horizon to where it could be driven wholly through the granite structure. This would give greater cover from the overlying marl and the increased tunnel stability would help minimise the risk and the exposure to cost.

PRELIMINARY WORK

The original planning consent had been for a tunnel that was much nearer the surface and was to include some cut and cover through the marl, with the entire tunnel length being excavated by a conventional roadheading machine. The proposal to drill and blast presented new and different problems with regard to seeking local government approval. The key issues in this respect were the proximity of houses to the line of the tunnel, the relatively shallow depth of 45 m-50 m from surface and the blasting vibrations from excavating the 9 m wide by 6 m high, finished cross-section.

Following detailed submissions to the relevant authorities, planning consent was received in mid-2002 and the contract started in August 2002. During the mobilisation, Thyssen undertook environmental base line surveys for noise, dust and vibration, the results of which were then used for measuring Technical Services' performance, throughout the project, in controlling these environmental hazards.

It was proposed to develop the tunnel by driving from both ends simultaneously towards the middle. A series of boreholes, together with two seismic surveys, were drilled along the centre line of the tunnel to better delineate the horizon of the granite/marl interface. The results of this caused a re-assessment of the New Cliffe Hill tunnel exit portal, lowering its position to the 120 m AOD (Above Ordnance Datum) level from 134 m AOD.

The consequences of this warranted a speedy and well planned excavation by the client of some 250,000 tonnes of rock, which was originally to have been left in place. The use of pre-split blasting techniques not normally employed at this site has created an excellent position from which to commence drivage of the tunnel from that end. Actual tunnelling works commenced mid-January 2003.

A SMALL LAKE IS PUMPED DRY

Meanwhile, in the old flooded quarry the entry portal was fixed at the 150 m AOD horizon, some 2.0 m above the water level. An estimated 1.9 million m^3 of water had accumulated in the quarry over the last 20/30 years since production ceased. To lower this body of water by 50 mm per day required pumping 3000 litres of water per minute. This in itself required the client to consider further environmental issues, as the only available watercourse was a relatively small stream that was susceptible to large variations in flow. To maintain the integrity of the stream and its associated

wildlife the contractors have to adhere to maximum flow rates, with the result that it may take the client 1 to 2 years to completely drain the quarry subject to rainfall levels. The quality and purity of the water was tested prior to its being pumped into the stream.

View across the old quarry to the tunnel entrance.

Photograph showing John McMurdo, the Project Manager, standing next to the Atlas Copco machine.

Tunnel Portal with Atlas Copco L2C Drilling Jumbo.

TUNNELLING BEGINS

Following detailed design and planning by Technical Services the difficulties of establishing the portal beneath an existing pre-blasted and weathered quarry bench were overcome and routine tunnel drill and blast operations were underway by the end of September 2002. At the time of writing the physical performance is 100% ahead of tendered programme in this section of works, some 150 m of tunnel excavation have been completed.

An Atlas Copco Rocket Boomer L2C with conventional surface shovel loaders is being used for the drilling and muck shifting operations. The ground support/ type requirements are assessed after each blast by Geotechnical Engineers, though the support system essentially comprises 4m-length x 33mm-diameter fully galvanised Dywidag resin-bedded re-bar bolts (satisfying the 50 year design requirements). Intermediate bolting and varying thickness of shotcrete cater for different rock conditions dependent upon the 'Q' values they are assigned. The tunnelling operation from New Cliffe Hill is a mirror image of this using similar plant and equipment.

MEETING ENVIRONMENTAL REQUIREMENTS

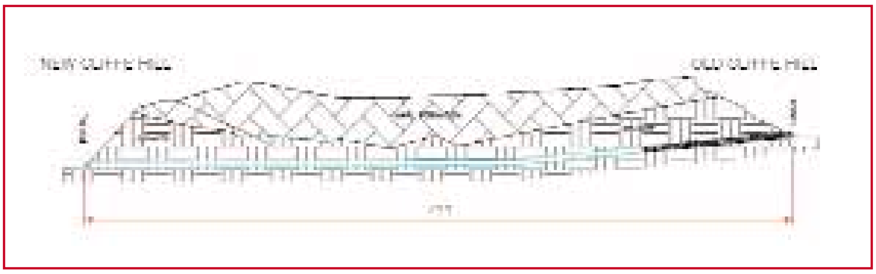
As operations move further away from the portals the focus on environmental concerns change from noise and dust at the surface to an emphasis on ground vibration due to blasting. Two vibration monitors have been placed within 5 m of the nearest properties and a third as close as possible to a point 20 m ahead of the round being fired, in line with the tunnel, to indicate the effects of each blasting operation. Close control of the maximum instantaneous charge (MIC) by varying the hole length/diameter and detonator type/ spacing has allowed the detonation of rounds longer in pull than envisaged at tender stage, which in turn means better than contract performances. The planning consent for vibration of 6 mm/sec^2 peak particle velocity (ppv) was underscored by a contractual target of 4 mm/sec^2 and this has been met and beaten on each successive blast to date.

To maximise efficiency on site the skills and competencies available within the Thyssen Schachtbau Group are being utilised to good effect. Two skilled hard-rock jumbo operators have been resourced from Australian company Byrnecut Mining Pty Ltd, a 70%-owned subsidiary of the Thyssen Schachtbau Group.

The tunnel works at the moment are well ahead of schedule and the completion date has now been set for September 2003.

Alun Jones
Sylvia Cramer

A schematic of the tunnel cross section, with the red line indicating the progress made.



New Road Link to Travellers Rest in Carmathen

Thyssen were awarded the contract for the construction of a grade separated junction between the Travellers Rest and the busy A40 trunk road west of Carmathen by the Transport Directorate of the Welsh Assembly Government (the devolved parliament for the Wales region of the United Kingdom).

Aerial WAG Photo – Aerial view of completed contract
(reproduced with the kind consent of the Transport Directorate of the Welsh Assembly Government)

The award of the contract for the construction works was initially received in November 2000, though a series of unforeseeable problems increased the scope of the operation and it finally turned out to be one of the largest civil engineering projects ever undertaken by Thyssen Construction Ltd. The project was extremely successful, not only in satisfying the needs of the client but also our business objectives.

ENGINEERING IN UNSTABLE SUBSOIL

The contract works involved the construction of a grade separated junction over the existing live A40 London to Fishguard trunk road in order to provide safe access to a new livestock mart development, agricultural show ground and other local developments. This required the construction of a two-span reinforced concrete bridge, associated approach roads and a revised interchange on the north side of the A40. The A40 is one of the key transport arteries of the region carrying ferry traffic to and from the Irish Sea Ports of Pembroke and Fishguard. It also forms part of the E30 European long distance route from Central Europe to Ireland.

The level of the challenge faced by the construction team became apparent during the construction of the approach roads on the south side, which included the construction of an embankment over an existing peat bog that was in excess of 20 m deep. This embankment was to be constructed gradually at a predetermined rate, with an additional six months settlement allowance. It was observed, however, that during the diversion of overhead electric lines the new electricity poles installed in this area had sunk by approximately 2 m in two days under their own weight. Worse was to come: when highway construction started in this area a 20-tonne excavator sank up to the cab within hours of commencing work.

Working closely with designers Parsons Brinkerhoff and Highways Engineers from the Welsh Assembly Government, the design of the works at the bog was altered considerably, with various methods and types of filling and geotextile reinforcement being deployed. The settlement of the embankment under construction was monitored and the design revised on a regular basis to allow construction to progress. As a result of these problems and the ensuing redesign it was also necessary to divert a major gas and water

Earth moving operation

Bridge construction works

main away from the area of potential settlement. Construction works on the northern portion of the site away from the bog were completed on time to allow removal of the contra-flow traffic management on the A40 for the summer tourist traffic.

It had originally been programmed to construct the embankment in 12 weeks, plus a 26 weeks allowance for settlement. As a result of the changes required due to the ground conditions in this area it eventually took 14 months to complete the embankment, extending our tender programme from 44 weeks to 78 weeks. The embankment is still continuing to settle at approximately 8 mm per week, some 8 months after its completion in May 2002.

Whilst there were undoubtedly other engineering solutions to the problem, which would have greatly reduced or even removed the risk of continued settlement, it was agreed by all parties that the chosen solution represented the best value to the client and was achievable without compromising the scheme objectives.

A TAILBACK-FREE ZONE

Another major aspect of the scheme was traffic management. It was of crucial importance to maintain traffic flows on the A40 during the period of bridge works, carriageway reconstruction and the lowering the east bound carriageway by 2 m over an 800-m length. Also important was the need to accommodate local traffic to the mart, the show ground area and Johnstown village. In order to achieve this in the safest manner possible Thyssen proposed the temporary closure of the slip road at the Travellers Rest. In order to communicate our proposals to the local community and others who might have been affected by the road closure and resultant diversion, we staged a public exhibition at the Johnstown community centre to present our proposals and reasoning for the road closure. We have to thank the local residents and the local authority, Carmarthenshire County Council, for their support on this matter, which enabled us to implement our chosen method of traffic management.

THE NEW BRIDGE

The bridge spanning the A40 comprises two spans totalling 46 m in length. It is a conventional simply-supported structure with integral abutments and a deck construction consisting of pre-cast concrete beams with insitu infill. Reinforced concrete abutments were clad with locally sourced masonry to blend in with the rural location. The project

Main bridge girder being delivered

included earthworks operations that required the deposition of approximately 20,000 m^3 of granular fill, together with 1,400 m^2 of asphalt road construction. Contract works also included the diversion of various apparatus owned by statutory authorities, landscaping and the provision of street lighting.

COOPERATION THE KEY TO SUCCESS

The delays to progress and cost increases experienced on this project could have so easily resulted in conflict and contractual disputes. It is therefore beyond doubt that the key to the success of the operation has been the excellent working relationship on site between the Designers (Parsons Brinkerhoff), the Client (Welsh Assembly Government) and Thyssen's site team working together within an informal partnering agreement.

Thyssen's continued business objectives are to be profitable and to achieve client satisfaction. This was certainly achieved on the Travellers Rest Project and there is no doubt that TGB's reputation has been enhanced as a result. The client's satisfaction was further demonstrated by the fact that the final account was settled quickly and amicably.

Derek Bird
Sylvia Cramer

Placing geotextile reinforcement in the peat-bog area

Offshore Oil and Gas Industry

Subsea Christmas Trees and protection structures revolutionize oil and gas extraction

Over the past 12 years Thyssen Engineering Limited (TEL) has played a key role in the supply and development of some of the best cutting-edge technology currently employed in the oil and gas industry. Through its client base, Thyssen Engineering has provided a design and fabrication service to some of the leading suppliers of subsea equipment for major offshore oil and gas projects around the world.

During the past twenty years the offshore oil and gas industry has witnessed tremendous changes in terms of innovation and working practices, many of which have resulted in exploration taking place in areas of the world previously thought unviable.

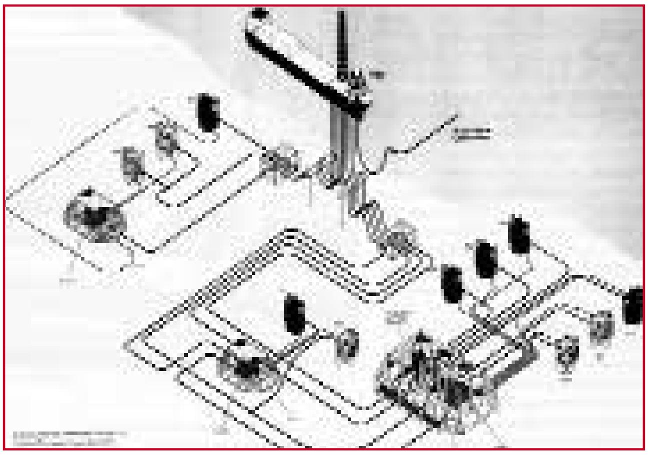
Deepwater discoveries account for less than 5% of the world's current oil-equivalent resources. This figure is now increasing, with the resources are of increasing interest, as they are predominately concentrated in non-OPEC countries and consequently constitute an important part of the world's oil reserves. Furthermore, since 80% of the world's surface is water, it is not surprising that there should be an increase in the ratio of water-based production to land-based production.

OIL AND GAS EXTRACTION

The traditional method of retrieving oil from beneath the sea-bed involves placing oil platforms in fields and laying pipelines to move the product to onshore processing facilities. This method of extraction is extremely expensive and payback depends on the field producing for twenty years or more. Although it may have been known from seismic surveys and geological reports that other reserves existed in the same field, these deposits were often deemed too difficult and costly to access with the technology available at the time.

The increasing availability of sophisticated materials, navigational aids and major increases in technical knowledge have allowed "step changes" to be made in the way oil and gas are retrieved from oil fields. Subsea-structure fabrication is now an area in which Thyssen Engineering has become extensively involved. Rather than placing massive and expensive oil platforms within the oilfield, the modern practice is to drill the wellheads with a temporary floating oil rig. Once the wellhead has been drilled and secured, 'Christmas Trees' are placed over the bore-

Schematic showing the relationship between the FPSO and the Christmas Tree units on the sea bed



Ready-assembled Christmas Tree in the workshops

hole. The 'Christmas Tree' is effectively an extremely complex tap, which can be turned on and off as required. In most cases the oilfields have numerous wellheads, all of which require control mechanisms. This is the role of the Christmas Tree.

SUBSEA COMPONENTS

The modern method of oil and gas retrieval utilises a multi-tree system placed on the sea bed. These systems are connected by subsea pipelines to manifolds, which act as multi-way valves in ensuring that the oil is diverted to the correct point of collection. To avoid the major costs imposed by a fixed oil-drilling platform the crude oil is collected by surface ships, which are known as FPSOs (Floating Production Storage and Offloading vessels). These ships provide a basic processing facility to ensure that the oil is safe to transport. Once the oil has undergone this initial processing it is transported to an onshore location either by pipeline or conventional oil tanker.

When major fields are discovered, and these warrant the cost of a fixed platform, then the traditional method is still employed. Indeed where this is the case it is still possible to have smaller oilfields within the main field where oil is extracted using the method described above, the difference is this case being that the oil platform serves as the processing facility.

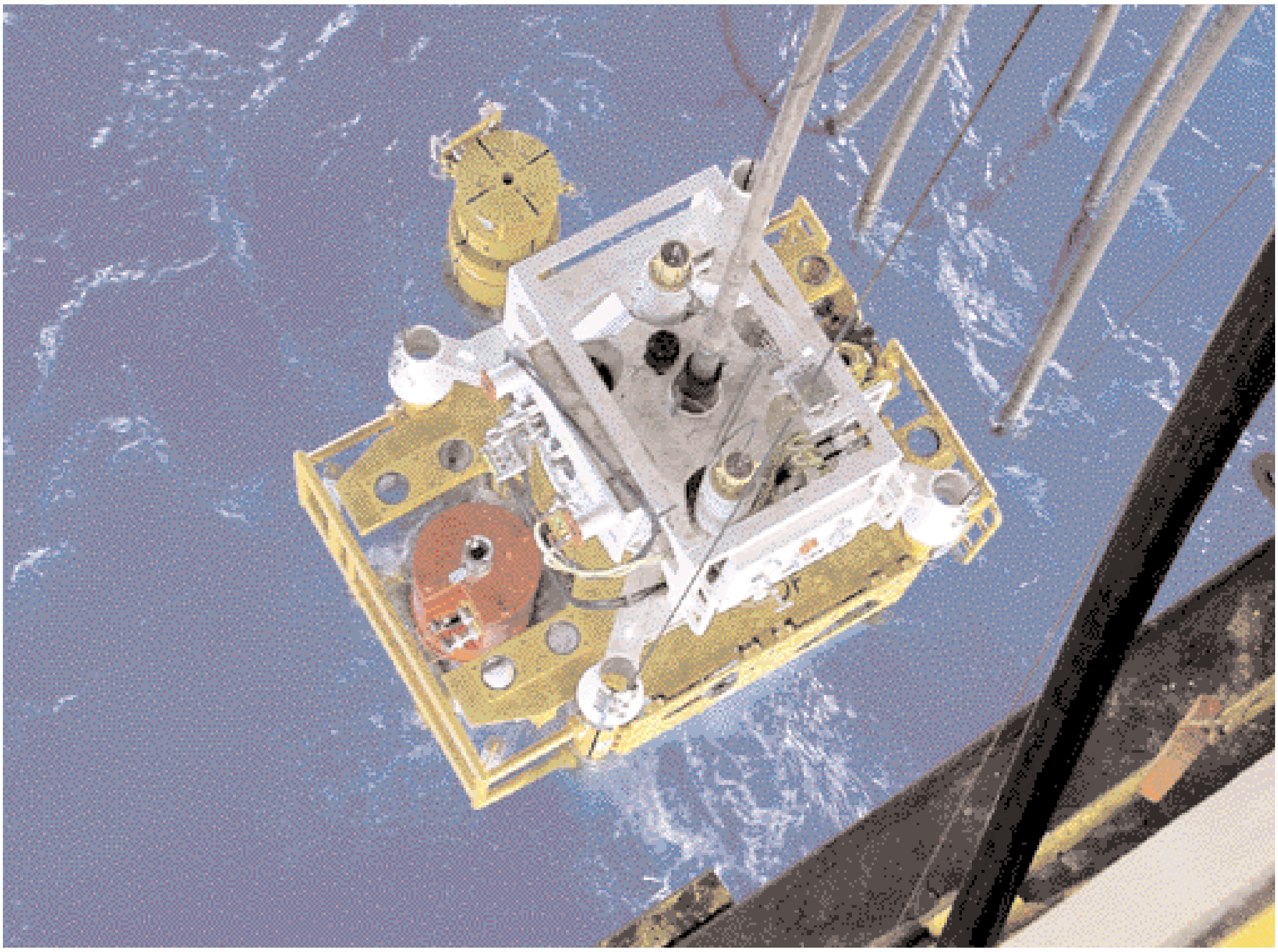
In recent years most of the subsea products manufactured by TEL for clients were destined for use in the UK area of the Continental Shelf, which primarily means the North Sea. Although the environment here is a hostile one, the water depth to the seabed is relatively shallow – a fact which meant that the installation and subsequent operation of the equipment was handled by conventional technology. Since then new oilfields have been discovered all over the world, including major finds in West and North Africa, the Gulf of Mexico, the Caspian Sea and off the east coast of Canada.

SUBSEA TECHNOLOGY HAS A FUTURE

In some cases subsea equipment is being deployed at water depths in excess of 1,200 m, which is far beyond previous limits. This has given rise to other problems, including equipment installation and retrieval and low temperature operation, all of which have had to be taken into consideration by Thyssen Engineering when fabricating and testing its products.

The oil and gas industry has always been cyclical and dependent on world events.

Christmas Tree being launched off the back of an FPSO



Rov positioning a Christmas Tree on the sea bed

However, subsea technology is increasingly seen as a cost-effective solution for the recovery of oil and gas – which is good news for Thyssen Engineering.

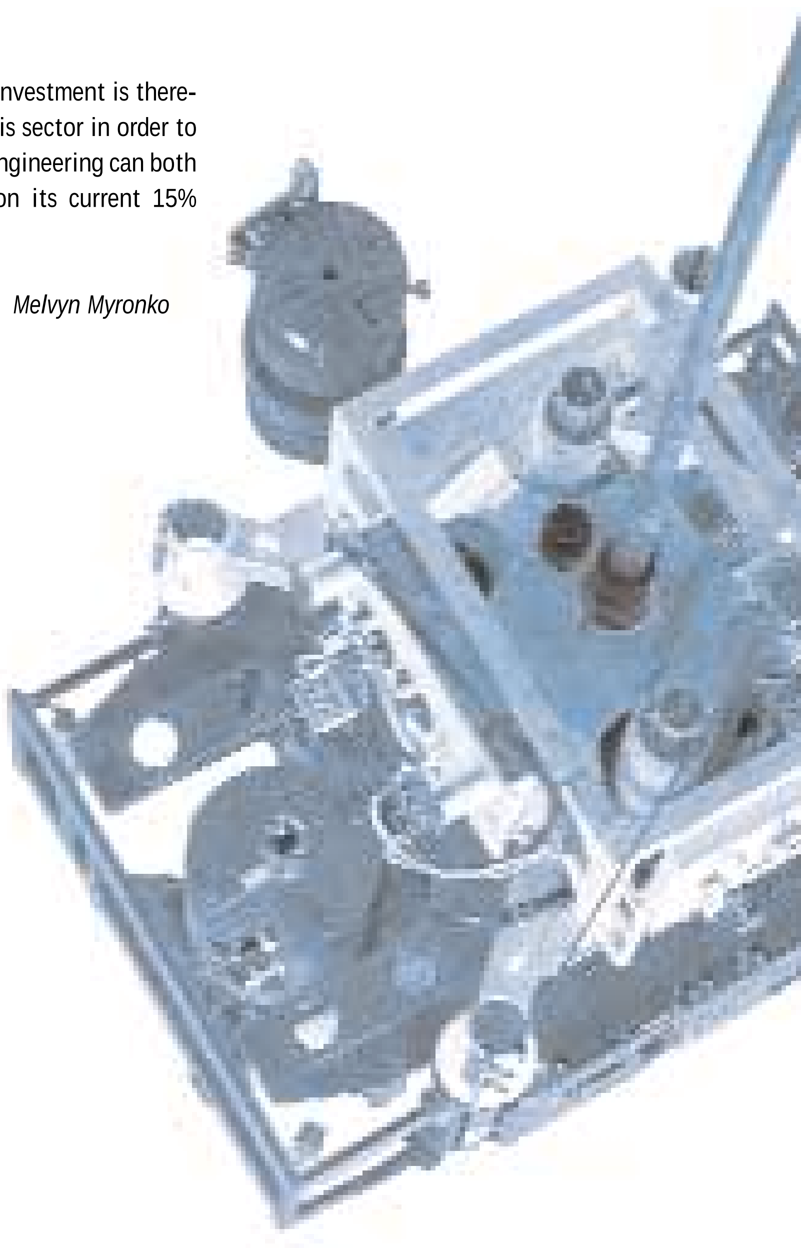
Over the past twelve years Thyssen Engineering has manufactured many hundreds of subsea structures, including Christmas Trees, flow bases, over-trawlable structures and drilling and production/injection guide bases. A key element in the success gained by Thyssen has been the ability to develop new ideas in conjunction with its clients; this applies especially to cost-effective methods for the creation and development of the supply chain that enables "fast track" deliveries to be achieved.

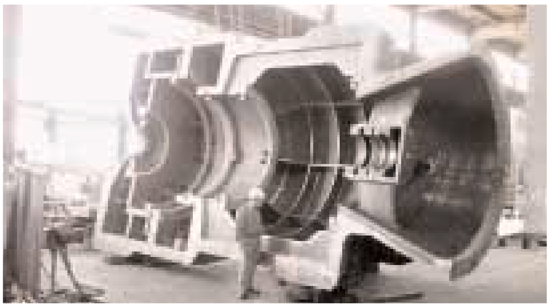
As the industry continues to move forward Thyssen Engineering is constantly looking to improve not only the quality of the product but also the client/supplier relationship, which is essential when supplying high specification goods on a fast-track basis.

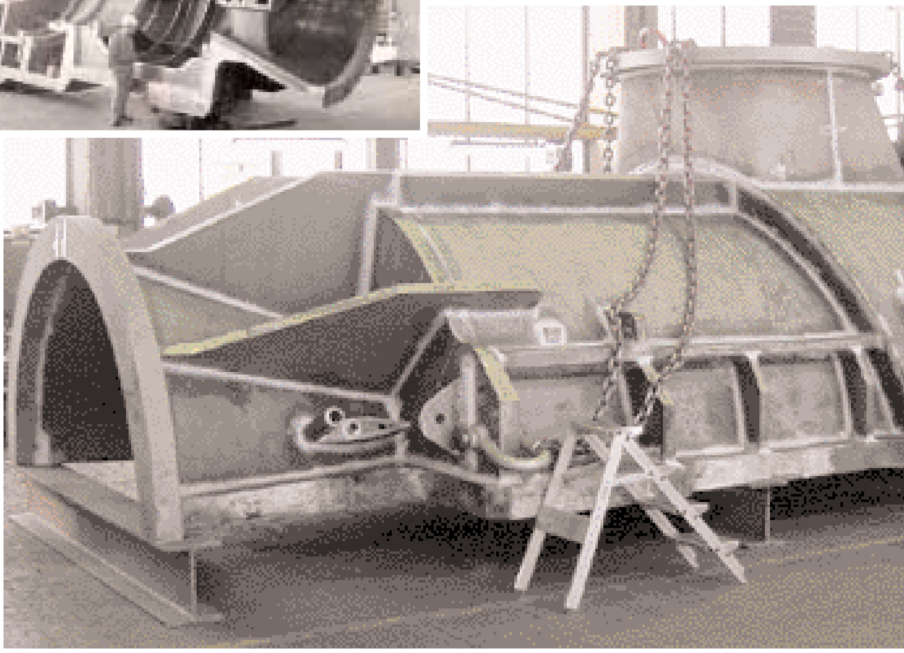
IN CONCLUSION

Thyssen Engineering has now established itself as a strategic supplier to many of the world's leading providers of subsea solutions – and the future looks good, with new oil fields coming on stream each year, all of which will require new subsea equipment. Ongoing investment is therefore being made in this sector in order to ensure that Thyssen Engineering can both maintain and build on its current 15% market share.

Melvyn Myronko







Never out of breath
– a new development in compressor technology

In May 2002 TS Technologie + Service (T + S) was contracted by Duisburg-based Siemens AG Power Generation Industrial Applications to supply the welded structural steelwork for a compressor housing comprising a top and bottom section and axial intake.

The compressor housing measured 9,000 x 4,700 x 10,000 mm and the finished weight of the overall structure was 106,000 kg, with about 160,000 kg of material being used in the construction.

As the structure was a prototype version, T + S only had access to general drawings for the design and manufacturing of the necessary components. The company had to work in close collaboration with the client when preparing the detail and single-part drawings and inventory plans.

700,000 M³ PER HOUR AT 7.5 BAR – A SENSATIONAL PERFORMANCE

The fabrication work began in June. The highly-motivated crews were initially organized on a 2-shift working cycle, which subsequently became a round-the-clock operation. The nature of the contract was such that very high quality standards had to be maintained right from the word go.

After stress-free annealing and sand blasting, the compressor housing was delivered to Siemens AG in September for further machining work.

Subsequent consultation with the contract client confirmed that the compressor had passed its initial trials with flying colours and had in fact exceeded expectations. With a capacity to draw in 700,000 m^3 of air an hour and compress it to a pressure of 7.5 bar the new unit is expected to open up substantial new market opportunities for the Duisburg-based power station specialists.

Large Picture:
Finished bottom section (weight approx. 60 tonnes)

Picture left and right above:
The need for high-quality, cost-effective welding meant that the entire structure had to be rotated into the required position.

Picture bottom:
All seams were welded to the highest quality standards. Seam flanks and finished welds had to undergo visual inspection and surface crack testing.

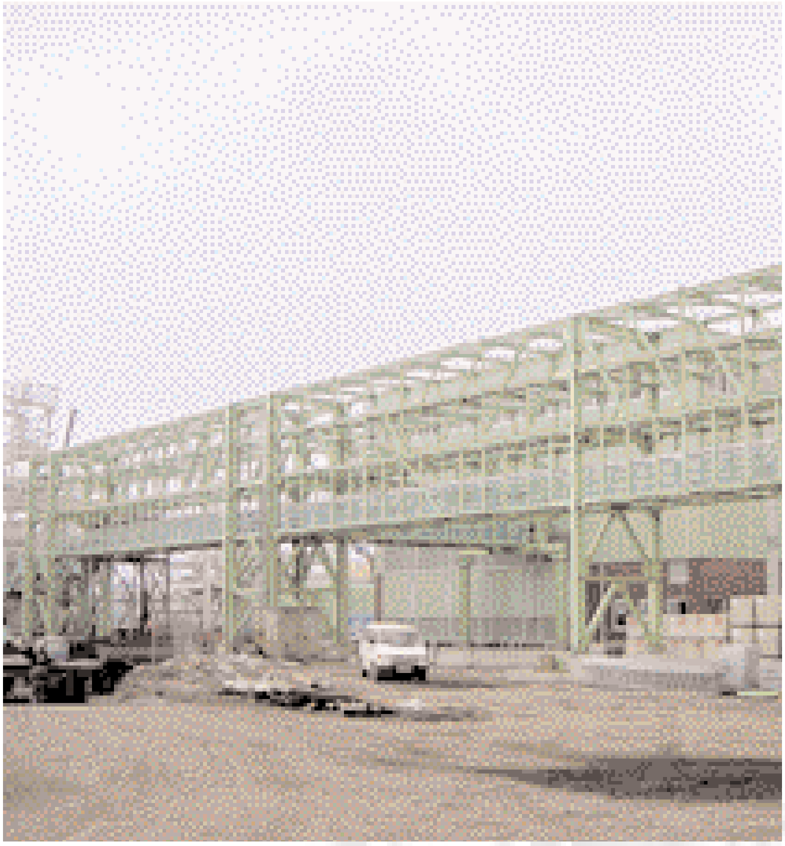
With legal requirements now specifying the use of sulphur-free fuel in many parts of the world, "lean burning installations" of this type are now very much sought after. The Duisburg company predicts an annual demand of ten units a year for compressors of this performance category.

We wish Siemens Power Generation well with their new product and if the volume of business lives up to predictions, T+S steel fabrication services will be ready to meet the challenge.

Wolfgang Katritzke
Dieter Böhmer

New pipe bridges

for the world's most up-to-date coking plant



The blast furnaces and sintering plant operated by Duisburg-based ThyssenKrupp Stahl AG will now be supplied with high-grade metallurgical and crushed coke from the giant new state-of-the-art Carbonaria coke works that has recently gone into production in Duisburg-Schwelgern.

The new coking plant, which has been fitted out with the latest technology capable of meeting the toughest environmental requirements, commenced production in early 2003. The installation comprises two batteries of 70 furnaces, each of which is bulk fed through 4 charge holes. The plant has a coal throughput of up to 10,600 tonnes (wet) and 9,540 tonnes (dry) per day, which is equivalent to about 3.5 million tonnes a year.

COKE-MAKING ON A LARGE SCALE

The connecting pipes and cables supplying the new plant with hot and cold water, fresh water, gas and electricity were to be carried on three truss bridges weighing a total of 611 tonnes. These structures were also to be designed to accommodate inspection visits.

The contract to supply the pipe bridges and associated pipework, for which the client (ThyssenKrupp Stahl AG) had requested a one-stop service from design to installation, was awarded to TS Technologie + Service GmbH (T + S) in April 2002.

The contract specification included static analysis, design and testing of structures, as well as the final assembly work.

The work was finished on schedule on 23rd August 2002. The successful completion of the project led to a follow-up contract for T + S to construct a wet-quenching bridge with a total weight of some 60 tonnes.

TS Technologie + Service – performing reliably for your success.

Heinz Seramour

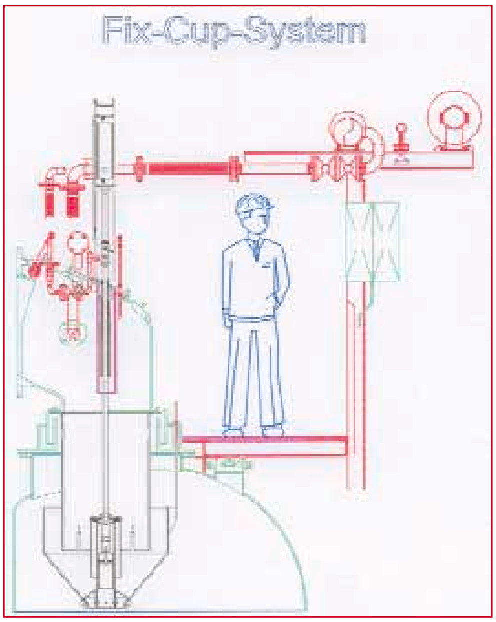
Fix Cup system for Duisburg coke works

Fix cup battery

The new "fix cup" system installed at the Carbonaria coke works in Duisburg is designed for the control and regulation of the flue gases produced in the coke-oven battery.

The coking plant uses an air-exclusion process to convert specially prepared coking coal into high-quality blast-furnace coke. The raw gases produced during the coal carbonization process are delivered through ascension pipes on the oven top to a collecting main for transfer into the gas cleaning plant. The single-chamber pressure regulating system, which includes the Fix Cup apparatus, is located between the ascension pipe and the collecting main and this system ensures a controlled release of the raw gas from the oven battery to the main.

In April 2002 Thyssen Krupp Stahl AG awarded TS Technologie + Service GmbH the contract to fabricate 140 complete fix cup systems – one for each of the 140 ovens that constitute the two 70-oven batteries. The units are 80% high-grade steel and are produced by a very high-quality machining process.



THE TOTAL PROJECT COMPRISED:

- the manufacture of 140 fix cup systems (approx. 90 t materials input)
- on-site assembly (carried out by TS Technologie + Service assembly department)
- alignment and commissioning of the systems.

The fix cup systems were still undergoing manufacture, assembly and commissioning when the client requested that a number of design modifications be carried out. The new specifications were given fast-track attention and were implemented to the company's complete satisfaction.

Customer satisfaction is the key to our success.

Maik Koch
Certified Mechanical Engineer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