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Surface Mining and International Mining | Clausthal University of Technology | Germany

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Association of Mineral Coal | GVSt | Essen | Germany

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Core Drill Bits

The rotating core drilling technique allows for extraction of almost undisturbed samples. In terms of rock drilling technique, the core drill set is a precision tool that is composed of both high-performance, as well as of less robust components. The professional composition of the core drill set ensures the required quality of samples and an efficient extraction process. In the planning regarding drill technique, a suitable core barrel type has to be selected. Essentially the core barrel type is determined by the final depth of the bore hole or the total length of the bore hole and the compactness of the rock mass to be penetrated. The actively working component of the core drill set is the core bit. Core bits with cutting elements from hard metal, as well as from natural and synthetic diamonds have established themselves for the exploratory drilling technique in hard rock formations. The spectrum of applications of the different cutting elements, as well as the constructive design of the bit body is mainly adapted to the compression of the rock, the homogeneity of the rock mass and the proportion of abrasive elements. A successful drilling process, i.e. realization of a high drilling progress with low wear of the drilling equipment, as well as extraction of samples of high quality, require an optimal adjustment of the respective core drill bit to the characteristics of the rocks or rock mass to be investigated. Basically each core drill bit is a tool with a high degree of specialization, which can only achieve its highest performance in a limited spectrum of applications. The various suppliers offer approximately 500 different types of core drill bits with cutting elements out of hard metal, synthetic, as well as natural diamonds and diamond slivers. Apart from the cutting elements, which determine the basic groupings of core drill bits, there are further constructive characteristics. These are various numbers, sizes and forms of the cutting elements, the design of mud channels, as well as the form of the shearing bit lip.

Drilling with (diamond) core drill bits in hard rocks requires a constant pressure and a constant circumferential speed of the cutting elements, as well as a continuous mud flow. Based on the cutting element, a pressing-cutting (hard metal and PKD-bits), a pressing-crushing (surface-set diamond drill bits) or a milling-grinding (impregnated diamond drill bits) rock loosening process is achieved. The drilling parameters of rotary speed, pressure, as well as...
mud flow rate are to be adjusted to the requirements given by the supplier for the respective drill bit. The optimum drilling parameters are derived from the material and the constructive design of the cutting elements, as well as from the diameter of the drill bit. In deposit appraisals, standardized double and wire-line core barrels of a core caliber of 44 to 146 mm are applied. Triple core barrel sets are equipped with a bit caliber of 44 to 146 mm. The core diameter results from the drill diameter and the dimension of the shearing bit lip. With a standard core drill set, core barrels with a diameter of 27 mm to 102 mm (wire line core barrel), 123 mm (double core barrel) and 131 (single core barrel), respectively, can be extracted. Information content and the reliability of information from the drill core sample increase with the core diameter. In planning for drilling, a balance needs to be found between the required information content and the ultimately increasing costs with increasing bore diameter. The most common bore diameters lie between 76 mm and 122 mm.

**Hard Metal Core Bits**

The cutting elements of hard metal bits consist of a carbide-metal alloy, e.g. tungsten carbide and cobalt, and are inserted as bolts or discs into the bit body. Hard metal bits are significantly less expensive than diamond core bits. Reasons are the more simple construction and the material of the cutting elements. The application area of hard metal bits is mainly confined to sedimentary hard rocks with low compression strength and low proportion of quartzite, as well as to salt and coal formations. Due to the lower mechanical resilience of the hard metal cutting elements, these bits are preloaded with less loosening energy, which leads to a basically lower drilling capacity than of diamond core bits. Furthermore the service life is relatively short, due to an unfavorable wearing quality. The preferred range of application of the cost-effective hard metal bits is the core extraction in the transition zone of loose to hardened sediment, as well as in the alteration zone of hard rocks. Compared to the diamond core bits, the various designs of hard metal bits are suitable for a broader range of geological conditions, so that interbedded strata can better be tackled. Hard metal core bits can be used in a technically and economically meaningful way in combination with single and double core barrels, as well as with drilling units in the lower performance segment of drill core extraction from horizons near to the surface. The periodic extraction of the drill core in single and double core barrels allows for a continuous control of the status of wear of the core bit, so that it can be replaced without affecting the drilling process.

Depending on the geological formation and the bore diameter, the optimum range of hard metal bits lies at rotating speeds of 90 to 450 rpm and a pressure of approx. 4 kN to 20 kN. A continuous mud flow of 40 to 300 l/min has to be maintained for adequate cooling of the cutting elements, as well as for cleaning of the bore hole bottom. Apart from a few exceptions, a clean clear-water mud is used for this.

**Core Drill Bits with Cutting Elements from Synthetically Produced Diamonds**

For the past few years two different types of synthetically produced diamonds have proven their worth as material for cutting elements in drilling technique. The two versions of cutting elements are often called poly-crystalline diamonds (PKD) and thermoresistent diamonds (TSD). However, other names from various manufactures are also being used, such as for example SYNSET for TSD-elements and STRATA CUT or SYNDAX for PKD-elements. One advantage of the production process of synthetic diamonds results from the adaptability of material characteristics to the foreseen area of application.

The constructive design of core bits with PDK cutting elements is geared towards the design of hard metal bits. The synthetic diamond substance of PDK cutting elements is applied to a platy or discoid base body out of hard metal. With this procedure it is possible to produce cutting bodies
of similar size than hard metal bolts, but with a higher wear resistance and sharpness. One disadvantage of PDK edges is their low thermal stability. The range of application of PDK core bits are soft to semi-soft sedimentary rocks without or with low quartzite content, e.g. limestone and mudstone formations. In this specialized area of application PDK bits can achieve an unrivalled drilling progress, compared to all other types of bits.

The operating parameters of PDK bits need a circumferential speed of approx. 0.8 to 1.7 m/s, so that, based on the bit diameter, rotary speeds of approx. 200 to 600 rpm need to be achieved. Due to the possible high progress of drilling and the low thermal stability of the PDK blades, high mud flow of up to 600 l/min are needed.

A further development in the manufacturing process of synthetic diamonds was originated by a material called thermoresistant diamond (TSD). While applied as cutting elements in core bits, separate thermoresistant diamonds are attached to the matrix surface. One advantage is the potential for technical design of the geometric form and size, as well as a limited conditioning of material properties. The range of applications, as well as the operating parameters and the constructive design are geared towards the subsequently introduced surface-set bits. The technical advantages of the TSD are opposed by a costly procedural and energy-intensive manufacturing process, so that core bits with natural diamonds maintain their importance as standard cutting tools.

**Surface-set Core Drill Bits**

The cutting elements of the surface-set core drill bits are natural diamonds, which have been sintered in the matrix. However, the cutting job is only done by the parts that protrude the matrix, the so-called exposure of each diamond. The range of applications for a surface-set core drill bit is determined by the size and the exposure, respectively, and by the number of diamonds sintered in the matrix. A technically and economically meaningful application of surface-set bits lies in rocks with compression strength of approx. 70 to 280 MPa. For softer rocks the less expensive hard metal bits or PDK bits are used, and for higher compression strength, impregnated diamond core bits are suitable. In an optimum application area of hard rocks of medium to high penetration stability the construction is adapted with regard to number, size and quality of the used diamonds, the form and material of the matrix, as well as the design of mud channels. The size of the diamonds is usually given in the stones per carat unit (spc). In soft formations bits with less stones are used (e.g. 10 -15 spc), which are bigger than in hard formations. In case the rock strength requires core bits with a stone number of more than 60 spc, it is more cost-effective to use impregnated bits. The size of the individual stones is...
between 2 mm (10-15 spc) up to 1.3 mm (40-60 spc), which are attached to the matrix in numbers of 8 to 33 stones per square cm. A further constructive characteristic of surface-set bits is the form of the shearing bit lip. This is offered in numerous variations by manufacturers. The three mostly encountered basic forms are shown in the following picture 6.

Depending on its diameter and density, the circumferential speed for surface-set bits lies between 0.8 to 3 m/s. Hereby the bits with smaller stones (e.g. 40 to 60 spc) are operated with higher circumferential speeds than bits with less of bigger stones. The pressure also varies, depending on the diameter and density, from 7 to 60 kN. As a basic principle, an adequate mud flow is necessary for all diamond drilling tools. In order to do so, a mud flow of 30 l/min to 300 l/min needs to be established. Solely clean and clear water without any solid content should be used as mud.

**Impregnated Diamond Core Bits**

The cutting elements of impregnated diamond core bits are slivers of synthetic and natural diamonds, which are distributed in high numbers over the entire matrix. The size of the slivers, the so-called graining, is specified like the size of stones of surface-set bits in stones per carat. Impregnated standard bits are offered with grainings of approx. 100 to 3000 spc. The slivers occupy a share of 20 to 35% in the hard metal matrix. The rock loosening process is only done by the protruding parts of the diamond slivers from the matrix surface. In contrast to the bigger cutting elements, slivers have no or only limited self-sharpening effects. The active slivers lose sharpness with increasing strain during the drilling process, which impedes the drilling progress. Each diamond-impregnated core bit has a constructively specified wear behavior, with the aim of achieving a running life that is as long as possible. After the defined abrasion of the hard metal substance, blunt diamond slivers are removed from the surface of the matrix and underlying unused slivers are uncovered.

One of the challenges for both manufacturers, as well as for users is the adjustment of cutting and wear characteristics of the impregnated matrix to the characteristics of the rock to be drilled. Hereby the rock-related wear of the diamonds is to be adjusted to the wear of the hard metal substance, through the selection of the applied alloying material, so that there cutting slivers are always protruding from the matrix surface, but no service life shortening wear of the matrix occurs. In hard and low abrasive formations, bits with a relatively soft matrix substance are suitable, so that their wear goes along with the high wear of the diamond slivers. Whereas in soft formations, core bits with a relatively hard matrix need to be applied, which allow for a longer footing of the slivers in the matrix. A matrix that is too hard for the rock characteristics principally increases the service life of the bit, but leads to a low drilling progress and can possible contribute to the so-called “polishing” of the bit-front-side (face). A polished bit describes a smooth matrix, which has no or very little protruding and cutting diamond slivers. In a bit which has a matrix that is too soft for the rock to be drilled, an excessive wear occurs, which reduces the service life of the bit. Due to the continuous uncovering of new and unused diamond slivers, a relatively high drilling progress is achieved, which however negatively affects the actual drilling result, due to the shorter service life and the resulting time for changing of bits, as well as due to the higher material usage.

The described desired and undesired wear characteristics relate exclusively to the face side of the bit, which is actually needed for the rock loosening process. The cutting-caliber of the outer- and inner diameter is protected by durable caliber-stones (natural and synthetic diamonds).

Contrary to the surface-set diamond core bits, the diamond slivers of the impregnated bit do not have a defined and protruding cutting edge (see exposure). The distance between the matrix and the bore hole bottom is so small, that a continuous mud circulation around the slivers cannot be definitely achieved. For this reason the impregnated matrix is placed on the bit body in usually radially tapered arrangements. The mud channels are arranged between the segments, so that an adequate cooling and cleaning of the sole is ensured. Two forms have established themselves
for the design of the shearing bit lip. For basic application in hard rocks, smooth and lightly rounded profiles towards the outer caliber are applied in friable formations. In hard and compact rock formations, ribbed profiles are used (as you can see in picture 7). These are more susceptible to changes in the application area, but offer a bigger matrix surface that is equipped with cutting diamond slivers. Compared to a smooth surface, the ribbed matrix surface achieves a higher drilling progress.

Compared to the previously introduced bit types, the application of impregnated diamond core bits requires high circumferential speeds of 2 m/s to 5 m/s. Based on the diameter of the bit, the drill string needs to rotate with rotary speeds of 400 rpm (bore diameter 146 mm) up to 2300 rpm (drill diameter 44 mm). A flow rate of approx. 20 to 300 l/min is needed for cooling and cleaning of the cutting surfaces. Like in other core drill bits the pressure varies from 5 kN to 90 kN, based on the diameter.

Pic. 6: Common forms of shearing bit lips

B-profile: Universal form, is suitable for almost all formations to be investigated by surface-set bits

P-profile: shearing bit lip with elevated directional stability, reduces deviations in borehole, but is susceptible to wear

F-profile: shearing bit lip in staged form, higher diamond density compared to the B-profile, and as such more points of interference, designed for higher drilling progress, but interference-prone in unstable mountains
Working with Core Drill Sets and Performance Data

Working with highly specialized core drill equipment requires not only meticulous planning for the selection of the drill set or the entire drill string, the rig, the bore hole construction, as well as the establishment of the location and the supply with required resources, but it also needs experiences and competent personnel at the drilling position. The composition of the drill set and the drill string are guided by well-defined goal criteria:

- Setting up a constant pressure on the core bit, over the entire drill distance
- Setting up a constant rotary speed that is adapted to the drill tool
- Feeding a continuous flow rate to the mud
- An efficiently working device or array of components for quick and secure recovery of the drill core and the constantly renewed preparing of the set for the following cored section.

In the search and exploration of mineral commodities, apart from the functionality, mobile and compact rigs with which remote drilling positions can be reached without high logistic expenses, are preferred. Dimensioning of a plant is determined by the expected strains of the drilling process and handling of the drill string, as well as the needed functionality. In core drilling technique, the carriage drilling equipment with top drive, drill pipe system, winch, and the scavenging pump has established itself in basic structures. The top drive serves for rotary drive, transfer of pressure or counter draw and feeding of the mud flow into the rotating drill rods.

In order to support a high flexibility in the application of different types of drill bits and diameters, the top drive of core drilling plants should support a rotary speed range of approx. 100 rpm to 2300 rpm. The torque to be overcome, which is composed of the momentum of the cutting work at the drill bit and the rod friction of the drill string at the bore hole wall, lies in the drilling process between 100 to 1000 Nn. Hereby the application of single and double core barrels generally require a lower torque from the top drive than a wire line equipment. This is due to the higher rod friction of the drill rods. The fitting moment of force through the cutting work at the core drill bit increases with drill pressure and lies between approx. 25 to 350 Nm, depending on the bit.

The top drive applies/regulates the entire energy needed for the cutting work. As such the pressure is created besides the rotary speed and the torque. Compared to the drill bit, the core bits require a low pressure, due to

As already explained, based on this criteria, suitable drill set equipment can be assembled. For handling and driving of the drill string a correspondingly configured drill tool is needed, which basically supports the following functions:

- Total length and the final depth of the core distance
- Volume/diameter of the core sample
- Rock characteristics of the rock formation to be penetrated and sampled

Pic. 7: Impregnated Diamond Core Bits with V-profile

Pic. 8: Standard profiles of the shearing bit lips of Impregnated Diamond Core Bits, left-side: ribbed V-profile, right-side: smoothed F-profile.
their smaller active surface and the effect of the cutting elements. According to the drill diameter and the type of the bit, the optimum strain of the bit lies between approx. 0.5 to 10 tons. With increasing drilling depth the drill string weight increases due to the feed up of the drill rods. In order to ensure a continuous pressure, the pressure has to be reduced with each drill rod. In case the weight of the string exceeds the permissible maximum load of the bit, the drill string will be kept on back pull by the top drive.

The drill rods are an often underestimated component of the drill string. They serve to transfer the cutting energy from the top drive to the core barrel set, the transfer of the mud, as well as the extraction of the drill core. An optimal drilling operation is not possible without the correct and reliable function of the drill rods.

The transfer of high rotary speeds of over 2000 rpm over a distance of up to 3000 m, through a driveshaft with a diameter of approx. 36 mm to 140 mm, poses a technical challenge. Ideally the drill rods are clamped on both sides, on one hand at the top drive and on the other at the bore hole bottom. The bore hole wall provides only limited conduct. In the transfer of such high rotation speeds
In the wire line procedure a winch is needed at the drilling tool to pull the inner tube. However, the winch needs to take up the corresponding capacity of wire length, in order to enable a speed which is as high as possible. The mass to be lifted is composed of the mass of the wire, the inner tube, drill core and possible of the mud column in the rods. The breakaway of the drill core from the bore hole bottom is not done by the winch. In order to do so, the entire drill string is lifted from the bottom.

Apart from mechanical parameters, the core drilling method requires a continuous and sufficient supply of the core drill bit with clean (clear water) mud. The mud is lead to the core barrel, gets out at the drill bit into the annulus and flows loaded by cuttings back to the surface through the annulus. This mud is usually a simple clear water mud, which should not contain any solid particles. In the double and wire line core barrel the mud is lead through this narrow annular space between the rotating outer tube and the fixed inner tube to the bit. In this delicate area even very small solid particles can do considerable damage to the core drill set. For this reason, in a circulating mud circuit, costly cleaning of the loaded mud is necessary. In many cases, in place of a circulating mud circuit, constant fresh mud is lead to the core barrel. Based on the bit type, over long distances, the smallest unbalances can lead to vibrations in the rods. Vibrations can significantly impede the quality of the drill core and can lead to material failure in the drill string. Principally core drill strings should ensure a running along the given bore hole axis, which is as centric as possible.

The specific weight of the drill string/drill rods has a considerable influence on the dimensioning of the drilling plant (with prescribed target depths). If the goal is to apply a plant, which is as small as possible, there is a requirement for light and at the same time solid a stiff drill rods. The specific masses of drill rods to be used for single and double core barrels vary from 4.5 kg/m to 10 kg/m. The specifications also apply to the specific mass of wire line drill rods up to a diameter of approx. 90 mm (drill diameter 146 mm). Up to a diameter of 140 mm (for drill diameters of 146 mm), however, a specific mass of approx. 20 kg/m is achieved. Apart from the drill string load, (without uplift), the weight of the core drill set and the top drive, as well as possible contact to the moved drill string has to be considered while dimensioning the drilling equipment. Other than weight parameters that can exactly be determined, contacts to the moved drill string have to be estimated; however it should not exceed 25% of the drill string load.

### Drill string weight for diameter 60.0, 75.6, 90 and 122.6 mm (wireline core drilling method)

- "Diameter 60.0 mm (B)"
- "Diameter 75.6 mm (N)"
- "Diameter 90.0 mm (H)"
- "Diameter 122.6 mm (P)"

![Drill string weight for diameter 60.0, 75.6, 90 and 122.6 mm](image)

**Pic. 11:** Drill string weight for standard drill string by wireline core methods
the mud rates lie between 30 l/min to 600 l/min (usually between 150 to 200 l/min). In climatically adverse zones (pole area), or at drilling positions without direct access to water, the handling of mud can entail additional expenses, e.g. enclosures or additional drill water supplies- and storage.

In a drilling regime that is optimally adapted to the rock and bit type, a drilling progress of 1 cm/m to approx. 20 cm/min can be achieved with surface-set and impregnated diamond drill bits. With hard metal bits values of 1 cm/min to approx. 10 cm/min can be achieved. Under ideal circumstances and adjustments, a very high drilling progress can be achieved with the application of PKD bits in compact lime and mud stone formations. The desired service life of a bit lies in the area of 40 to 100 drill meters. An efficient drilling process, i.e. a long service life for a bit under a constantly high drilling progress- cannot be achieved without permanent control of drilling parameters, as well as without professional and immediate adjustment in changing circumstances.

### Bibliography


Univ.-Prof. Dr.-Ing. habil. Hossein H. Tudeshki studied from 1977 to 1980 at the Mining College of Shahrud (Iran); following several years of work in the mining industry, he completed his mining study at the RWTH Aachen in 1989. Since 1992 he was Chief Engineer at the Institute for Surface Mining (Bergbaukunde III) of the RWTH Aachen, mainly active in the field of open cast mining and drilling technique. He did his doctor degree in 1993 and qualified as a university lecturer in 1997. In 1998 the Venia Legendi was awarded to him be the RWTH Aachen for the field “Rock and Earth Open Pit Mining”. In November 2001 he was appointed as Professor for Surface Mining and International Mining at Clausthal University of Technology. He completed his studies successfully in 2007 and is engaged in silk as a research associate at the Institute for Surface Mining and International Mining at Clausthal University of Technology.

Dipl.-Ing. Heiko Hertel, born 1975, graduated in the years 1995 to 1998 trained as a well constructor. The activities of the well constructor he held until 2001. Immediately following the same year he began the study of Geotechniques, Mining and Petroleum Engineering at Clausthal University of Technology. He completed his studies successfully in 2007 and is engaged in silk as a research associate at the Institute for Surface Mining and International Mining at Clausthal University of Technology.

| tudeshki@tu-clausthal.de | www.bergbau.tu-clausthal.de |
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Qualitative Methods to Measure the Security of Supply

by Franz-Josef Wodopia
Association of Mineral Coal | GVSt | Essen | Germany

In recent years security of energy and raw materials’ supply issues have increasingly come to the fore of political attention again. Apart from qualitative analyses, various approaches were meanwhile developed to operationalise security of supply risks by means of individual indicators or sets of indicators and to measure security of supply by applying quantitative methods. This provides for intersectoral and intertemporal comparisons which are much more concise than in the past. At the same time this can make an important contribution to a more rational and more evidence-based energy and raw materials’ policy.

Introduction

Unfortunately it has been mostly unnoted in Germany. In the recent past, there has been a concept of the Rhenish-Westphalian Institute for Economic Research (RWI), which seemed to close this gap[3]. It is in fact identical with the IEA basic model. However, the vulnerability concept, which was commissioned by the German National Committee of the World Energy Council (DNK) and developed by the Energy Environment Forecast Analysis-Institute (EEFA) is less known[4, 5]. This concept surpasses the one of the IEA and the RWI, in the sense that it uses a mix of indicators, and gives the opportunity to discuss the vulnerability of important branches of the national economy.

Taking into consideration the availability of such concepts, it should now be possible to face the rather descriptive analysis of supply risks, or purely political assessments with strong scientific results. Therefore statements such as “coal is available everywhere and at any price”, should be a thing of the past. The same applies to the overemphasis or the downplaying of risks in the supply with natural gas.

Descriptive Analysis of Supply Risks

At the time of establishment of the European Community for Coal and Steel, the subject of security of supply has already played an important role. This was also the case within the framework of the European Union (EU), though the importance of the topic has been subject to variations. In the year 2006, within the framework of a European energy conference, Javier Solana, the Secretary General of the Council of the European Union and high representative of the common foreign and safety policy (GASP), noted: „The days of easy energy are over …“. He mentioned that the EU agreement of Lisbon, which was not yet supported by all member countries, would make the assurance of the security of energy supply its official goal. It should also be noted that Javier Solana was the Secretary General of the NATO before his assignment as “Foreign Minister”. He is a person who combines the various dimensions of supply guarantee like no one else.

Newer publications point to the fact that multi-dimensional concepts are needed. Economical, political and safety aspects have to be seen as a whole. As one example for the countless qualitative analyses regarding the topic of supply guarantee, only the very recent analysis of the Center for European Policy Studies (CEPS), a leading think tank in Europe, is mentioned here. The study is entitled „Long-Term Energy Security Risks for Europe: A Sector-Specific Approach“ [6]. This attempt is very close to operationalisation, in the sense that a multitude of important criteria are listed in one single table. Thus it becomes evident at one glance that there are more entries for the individual criteria of oil and gas than for coal and nuclear energy. The risks are differentiated by geological, geo-political, economic, environmental and technical aspects. The descriptions are pointed in a way that a sharp profile is created for each energy source, which can be compared to the profile of others. This study particularly reveals the current need for analyses on supply guarantee that are methodically better funded. 


Dependence on Imports as Criterion for Supply Guarantee

The common form of quantification of supply risks, which has been the only one up to now, was the calculation of the dependence of the national economy on energy imports. As an example, picture 1 shows the dependence on energy imports in the EU in the year 2005. It is made very clear that countries like Luxemburg, Ireland, Portugal and Italy are approx. 90% dependant on imports. This does not necessarily mean that these imports are insecure. In the reverse case, particularly for Great Britain, Poland and other East-European Countries, the dependence on imports is low. In this case, however, it can downright be noted, that the risks for these national economies, connected to imports, are relatively low. However, for countries with high dependence on imports, the criterion for the assessment of risks and the diversity of risks for countries are lacking.

In case differentiated by various energy sources, the potential supply risks are made even more clear (picture 2). Thus the trend for the individual energy sources can be determined. In the case of crude oil the dependence has always been high, despite the development of sources in the North Sea. The situation differs in the case of natural gas and coal. Here there has been a significant increase since the 90ies, and according to the estimation of the European Commission this increase will continue unabated until 2030. This applies to natural gas and even more to coal.

An assessment of the risks can be done by looking at the sources of energy feedstock, which is presented in picture 3 for the Federal Republic of Germany. Here it is evident that the German energy imports are supplied by a few countries, whereby the role of Russia particularly stands out. This land is the number one supplier for crude oil, natural gas and – unlike shown in picture 3- nowadays also for mineral coal.

But how secure or insecure are the deliveries from our main supplier countries Russia, Norway, the Netherlands, Great Britain, Libya, Kazakhstan and others?

In order to respond to this question there is a need for an index to assess the reliability of a supplier country. Within the framework of the “World Mining Data”, the Austrian Ministry of Economics has long provided diagrams that rely on an assessment system of the World Bank. The Association of Mineral Coal (GVSt) has taken up this form of reporting and combined the data with import shares of these countries in a table [7]. The risks of importing coal become particularly evident, if we differentiate by qualities, i.e. by boiler coal and coking coal (table 1). Nevertheless
Pic. 2:
Dependence on energy imports of the EU, according to energy sources, [7]

Pic. 3:
Deutschlands Energierohstofflieferanten 2006 in Mio. t SKE
(Federal Office for Economy and Export Control 2007; [5])
this approach lacks the last step of operationalization, i.e. the summarizing into a measure. This gap is being addressed by IEA, as mentioned above.

IEA study on interaction between security of supply and climate protection policy

For the first time, a comprehensive approach to operationalization of supply criteria was developed in the IEA information paper „Energy Security and Climate Change Policy Interactions“ by William Blyth and Nicolas Lefevre [2]. At the same time the paper assesses the effects of various climate protection strategies on security of supply. Unfortunately this approach attracted relatively little interest; parts of it were later even “re-discovered”. Above all, the authors tried to point out two important aspects:

- Physical market disturbances
- Price risks, which result from strategic control over energy resources in form of higher market concentration

What argues against statistical analysis is that usually there is not enough information available on underlying distribution. Therefore Blyth and Lefevre refer mainly to the concentration of the market power. In order to do so, they use a modification of the Herfindahl-Hirschmann-Index (HHI), which is the most used index for the measurement of concentration. One of the economic applications is the verification of a market dominating position of providers. The authors justify their choice of this indicator with this fact and point out that governments, in particular the US Department of Justice, use this indicator in merger control. HHI is calculated as the sum of squared market shares of the individual providers over the entire market. Thus providers with relatively high market share are considered disproportionally high, whereas providers with low market share are considered disproportionally low. Blyth and Lefevre introduced the Geopolitical Market Concentration Risk (GMC) index for geo-political risks for the energy source f as follows:

$$GMC_f = \sum_i \left( S_{if} \right)^2$$

*Formula (1)*

In this formula $S_{if}$ is the share of the provider i from the energy source f. $S_{if}$ varies between 0 and 100 %. In case the respective country itself produces the energy source, it is treated as an independent provider.

This index is being expanded to do justice to political stability of the provider countries. Hereby a risk-rating of the PRS Group (PRS Group International Risk Guide (ICRG)) is used, which is a private risk assessment institute that has emerged from US American university research. Blyth and Lefevre raise the question, whether a geo-political risk should also be assigned to OECD countries, but decide to consider them as risk-free. In case the political risk-rating of a country i is marked as $r_i$, the modified formula (1) unfolds the following definition:

$$GMC_f = \sum_i r_i \times \left( S_{if} \right)^2$$

*Formula (2)*

Table 1:
Political stability rank of coal producers
[BMWA, Vienna; World Bank 2007; [7]]

<table>
<thead>
<tr>
<th>Share of respective producing countries</th>
<th>boiler coal</th>
<th>coking coal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stability rank</td>
<td>2003</td>
<td>2007</td>
</tr>
<tr>
<td>Politically stable countries („stable“ - „fair“)</td>
<td>34,8 %</td>
<td>35,0 %</td>
</tr>
<tr>
<td>Politically unstable countries („critical“ - „extremely critical“)</td>
<td>65,4 %</td>
<td>65,0 %</td>
</tr>
</tbody>
</table>
The ICRG risk rating uses values between 0 for high risks and 100 for low risks. Most of the countries are rated with values of over 50, but there are exceptions. The values for Iraq and Nigeria, countries who play a role as oil-exporting countries, are around 30. In order to simplify, Blyth and Lefevre both inverted the values and expressed them as in percentage, so that they move in the same direction of GMC, (from formula 1). Values of \( r_i \) around 0 stand for low risks, values of around 100 for high risks. GMC values around 0 signalize complete competition and a risk-rating of 0, whereas for a monopolist with a rating of Nigeria there is a value of approximately 30.

The next step is to include the liquidity of the market into the measure. This is because restrictions of the change between suppliers have a ceteris paribus effect, like the increase of the market concentration risk. For this the parameter \( p \) is created, which is the relation of the entire market supply to the demand of the respective country. This indicator is above 100 \( \% \), in case the (unrealistic) case is excluded, that the market is not sufficient to cover the demand of this single land. The relation between market concentration risk and liquidity of the market can be expressed by including an exponential function \( P \), which leads to the formula (3):

\[
\text{GMC}_f = \left[ \sum_i r_i \times \left( S_{i,f} \right)^2 \right] \times e^{\left( 1/P_f \right)}
\]

*Formula (3)*

The authors exemplify the effects of this factor as follows: In case \( P \) has a value of 10,000 \( \% \), the correction factor of the formula is 1.01. However, if \( P \) is only 200 \( \% \), i.e. if the market offer is only double the demand of the country, the factor is 1.6. The risk indices, which lie between 0 to 100 \( \% \), can be significantly corrected with this method.

Apart from the separate consideration of supply risks for individual energy sources, the formula (4) finally suggests a consolidated measure Geopolitical Energy Security Measure (GES), in which the separate shares of the energy sources from the primary supply TPES serve as weights, whereas \( C_i \) stands for the usage of the primary energy source \( f \):

\[
\text{GES} = \sum_f \left\{ \left[ \sum_i r_i \times \left( S_{i,f} \right)^2 \right] \times e^{\left( 1/P_f \right)} \right\} \times \frac{C_f}{TPES}
\]

*Formula (4)*

*Pic. 4:* Primary energy consumption and fuel mix of 4 exemplary countries [IEA; (2)]
With this instrument the authors examine four categories of political influences on the energy supply:

- **Changes in the energy mix in the electricity generation**
- **Changes in the energy mix in the transport sector**
- **Improvements in the infrastructure of oil and gas supply**
- **Energy efficiency**

Blyth and Lefevre access four characteristic countries that have been anonymised, in order to avoid the impression that IEA touches the competencies of an OECD country. However it is evident that the countries are Australia, Italy, Great Britain and the USA. In fact, picture 4 shows one country of coal, one country with high oil and gas share and two countries with significantly different energy consumption and an energy mix, which is more or less balanced.

Following the effects on mainly the electricity sector are depicted. For modeling a higher application of a renewable energy source, a cross-national goal of a 5 % share of a renewable energy source is assumed for the year 2010, which will increase to 10 % in the year 2020 and to 15 % in the year 2030. Hydroelectricity is excluded in this example. Through this the countries achieve a doubling or tripling of the application of renewable energy sources in electricity generation, based on their initial situation. The influence on the measure derived from above for the entire security of supply (GES) can be extracted from picture 5.

---

**Pic. 5:**  
*A scenario of renewable energy sources and influence on security of supply [2]*

**Pic. 6:**  
*Nuclear scenario and influence on security of supply [IEA; [2]]*
In one infrastructural scenario it is assumed that the most significant suppliers beyond OPEC and Russia, i.e. Kazakhstan, Azerbaijan, Turkmenistan, the Ukraine and Uzbekistan can increase their share of the oil supply. It is assumed that these countries increase their extraction by 15, 30 and 50 % in the years 2010/2020/2030 respectively. By this the oil and gas extraction in the year 2030 will be increased by 50 %, compared to today. The result can be seen in picture 8.

In many OECD countries, the traffic and transport sector also has a considerable leverage on CO2 emissions and security of supply index. The share of this sector from the oil consumption is between 50 and 70 % for the examined countries. Two scenarios examine the influence of an increased application of bio fuel and natural gas. It is assumed that 5, 10 and 15 % of the oil consumption in the transport sector is replaced by these two alternatives in the years 2010, 2020 and 2030, respectively. As shown in picture 7, this scenario leads to the most explicit reduction of the supply risk of all other scenarios. This is mainly due to the high share of oil of these countries and the relatively high share of oil in the transport sector.

**Pic. 7:**
Scenario of bio-fuel and influence on the security of supply [IEA; [2]]

**Pic. 8:**
Oil infrastructure scenario and influence on the security of supply [IEA; [2]]
At this point it is important to note, that the supply risks of countries can be statistically dependent upon each other. The IEA authors shape this for both borderline cases, either the OPEC countries are suppliers or completely independent. Picture 9 shows the extreme influence of this assumption on the degree of security of supply. The study assumes that the OPEC suppliers are treated as suppliers.

![Pic. 9: OPEC countries as suppliers and as independent suppliers (IEA; [2])](image1)

The influence of domestic energy sources plays a big role in many OECD countries in the limitation of supply risks. In order to represent this, an exemplary increase of domestic production of fossil fuels by 5/10/15 % is assumed in the analysis period.

![Pic. 10: Scenario of domestic energy sources and influence on the security of supply ([2])](image2)

Picture 10 shows a significant improvement in the security of supply, particularly for country 4 (USA), since this country already has a relatively high share of domestic energy sources, and changes by the given percentages are accordingly high. The situation is reverse in country 2 (Italy), where there are little opportunities for expansion of domestic energy sources. Country 1 (Australia) is an important export land for the coal sector and does not import any coal. Therefore an increase in security of supply is not possible. Furthermore it only has a low oil production, so that an increase will only have
a small overall effect. These examples reveal the importance of a differentiated examination of the individual countries, in order to appropriately assess the reasons for the changes in the GES indicator.

In this context the assumption of the authors, which assigns a uniform supply risk to the OECD countries, according to their domestic production has a clear effect. As per definition no effects can be expected by reducing the imports from OECD countries. Furthermore it should be critically noted that the authors very much concentrate on the OECD and OPEC block, respectively, and therefore partly exaggerate the results.

As a last example the analysis of an increase in energy efficiency is examined. According to this, it is assumed that the primary energy consumption is reduced by 1.3 %, 5 % and 8.7 % for the year 2010, 2020 and 2030 respectively from the year 2001. Compared to the goals of energy policy in the European Union these values are quite modest. Consequently, picture 11 reveals that the year 2010 shows a barely perceptible result. However, up to the year 2030, here also a significant improvement of the GEX index for the supply risk is achieved.

The IEA method is a very effective and exemplary instrument for analyzing the influence of decisions regarding energy policy, not only from the climate change point of view, but also with regard to their effects on the security of supply. Thus the triangular goal of energy policy is much more prominent.

The RWI-concept

Commissioned by the Department for Economic Affairs and Technology, the RWI developed a concept for operationalising supply risks of oil and gas supply [3]. The concept is based on the above-mentioned HHI and the assessment with risk parameters. As such it corresponds to the formula (2). For this RWI used the Hermes risk assessments. In this way the above-mentioned time-series, which are specific to energy sources, can be developed and compared. No standardization of the risk scale was made for these classifications, so that the results are intuitively not as plausible as the ones of the IEA. In a later publication Frondel et al. included the imported mineral coal and compared the situation of several countries [8]. In order to so, a risk classification of the OECD was used. The international comparison (picture 12) reveals that out of the G7 states only Italy has a higher risk index. Furthermore the index has been growing since 1978, whereas the index of Japan and France is falling. The risk indices of Great Britain, Canada and the USA all are significantly below the one of Germany. Therefore Germany doesn’t look too good in international comparison.
Following the results related to Germany are presented in particular. Picture 13 reveals that the supply risk for oil has more than doubled since 1978. Although the share of import from OPEC countries declined after the oil crises, the share of Russia increased. The supply risk for natural gas has increased more dramatically – it has quadrupled. This can be explained by the declining national extraction on one hand and on the other hand by the growing share of Russia and the declining imports from European neighboring countries. Nevertheless the security of natural gas supply can be categorized as better than the one of oil, both in terms of its tendency since the late eighties, as well regarding the absolute value of the indicator. The supply risks of mineral coal are clearly lower. Up to the early 90ies the risk was basically zero, due to the high share of national extraction. However, decisions regarding coal policy in the past decades lead to a continuously declining
domestic share of mineral coal quantity and a distinct decline at the beginning of this decade. Nevertheless, the supply risk for mineral coal is still significantly lower than for oil and gas. This is due to the mix of domestic coal and the acquisition of import coal from comparatively secure supplier countries.

In the year 2007 the lower house of the German Parliament concluded, that the subsidized extraction of mineral coal should be stopped by the end of 2018. By 30 June 2012 latest, the German Government will submit a report to the lower house of parliament, which will provide the basis for the parliament, to examine from the economic point of view, as well as from the point of view of security of supply and other goals regarding energy policy, whether coal mining shall continue or be stopped. In this regard it is of note, how the security of supply changes after the phase-out of the domestic mining. In its last annual report, the GVSt has done a forward projection of the RWI calculations to the end of this decade. Here they did not only take into consideration the phase-out of coal, but also the expected declining contribution of the domestic oil and gas extraction. Furthermore it was assumed that the supply structure is constant. The result is shown in picture 14. The supply risk with oil only lightly increases the one of natural gas gets close to the current level of oil. However, a dramatic increase can be seen with mineral coal, which is exclusively due to the phase-out of domestic mineral coal.

However the approach has a systematic shortcoming, in the sense that there is no differentiation of important consumption sectors, and only the primary energy supply is taken into consideration. In case steam and coking coal are differentiated, there is a predominance of Australia in this sector. Therefore it is not the high country risk, but the high market power that has to be assumed. Nevertheless the risk index for coking coal is clearly lower than the one for steam coal, since in this index the country risks strongly come to the fore. Therefore in picture 14 the risk indicator is solely given for steam coal. This indicator increases even more and almost reaches the value of natural gas in the future, the current risk indicator of natural gas will be exceeded. With reference to the application in the Power Industry, the advantages of mineral coal versus natural gas are lost after the phase-out of the domestic mining. The mix of domestic and imported coal fundamentally contributes to an increase in the security of supply.

![Pic. 14: Prognosis of oil and gas supply risks for Germany up to the end of the decade [7]](image-url)
Vulnerability study of the EEFA institute

While the HHI is methodically easy to use, it is only a measure, the broader descriptive approaches allow for optional conclusions and as such allow for political appraisals. By order of the World Energy Council the EEFA tried to close this methodical gap by developing a set of indicators [4]. In particular, the question of the EEFA study was: Is vulnerability measurable? How vulnerable are European economies? Answers to this question give important impulses for actions related to energy policy.

The indicator system of EEFA was further developed by the order of DNK of the World Energy Council (compare. C. Rolle; [5]). It encompasses dependency on imports, concentration of imports, volatility of process and the CO2 intensity. The energy intensity, next to the dependency on imports, is an important index to particularly examine the influence on individual branches. Picture 15 shows the energy intensity of the added value of selected European countries. The relatively low German energy intensity of added value reduces the supply risks by trend. For sure the efforts to increase energy efficiency have made themselves felt. On the other hand it can be noted that countries with high proportion of nuclear energy like France or Belgium or with own gas sources like the Netherlands show a significantly higher energy intensity of their added value. Since we are dealing with domestic or quasi-domestic energy sources, higher energy intensity by no means generally refers to supply risks. In fact, this case makes clear that in the mentioned countries have taken steps regarding industrial policy for a cost-effective energy supply and to increase the security of supply. It is precisely this picture that shows the importance of looking at a complete system and not relying on an indicator.

Furthermore the system of indicators encompasses the concentration on individual supply countries, the volatility of prices as a measure for cost risks, and the CO2 intensity as a measure for burden through climate protection measures. These indices are equally weighted and combined in one single measure. Picture 16 shows the result for the EU-15 in a long-term comparison since 1962. The break-outs from the oil crises are very clearly visible. However, the second oil crisis had a lower influence on the vulnerability index, despite the much higher price increases. This can mainly be attributed
to the diversification of energy sources and resources, but also to the reduction of the energy intensity. Even if today the vulnerability index is not as high as in the 70ies, a clear rising trend can be seen: The index has doubled since 1962, despite all measures taken to reduce vulnerability and despite EU integration.

However, the impact seems less serious than in the case of sole consideration of the HHI (picture 12). This is because it is the vulnerability that is in the forefront and not the supply risk. Further indicators like declining volatility of prices and CO2 intensity also influence the result.


**Pic. 16:**

**Prospects**

It would be preferable, if the extended set of indicators that was developed by EEFA would be linked to scenarios on energy policy, according to the approach of IEA, so that apart from general recommendations, very concrete political recommendations for action can be derived. With regard to the conflict of goals between security of supply and compatibility with the environment, such recommendations should always be linked to quantifiable statements. While presenting results of a scenario-analysis, a possible CO2 reduction in % should always be assigned to the change of a security of supply indicator, like the GES. This could be a task for further research activities.
Bibliography


Motivation for the Research Study

Sand and gravel is the raw material group with the highest demand, both in Germany, as well as worldwide, if mass is compared. In Germany alone more than 250 million tons of sand and gravel are used yearly, which are almost exclusively extracted from domestic deposits. This supply and consumption structure secures an economically and ecologically meaningful coverage of demand.

In the geological sense, sand and gravel are addressed as non-cohesive and unhardened sedimentary rocks. Deposits are located mainly in the north-German plain, the molasse basin, and along the big river valleys. Generally, a deposit is characterized by an enrichment of technically and economically mineable raw material in a confined area. Sand and gravel deposits that can be economically used have to possess special quality criteria. Picture 1 shows the inter-bedded strata of cohesive and non-cohesive formations, which are typical for soil.

A general goal of any undertaking to extract raw material, is the application of a cost-optimized mining technology, the complete retrieval of deposit reserves, the reduction of kerf-loss and the reduction of adjoining rocks in the resource. The basis of a successful achievement of these goals is definite and detailed knowledge about the composition of the mountains. In order to achieve this, exploration measures are carried out, both before and during the raw material mining. However, due to economic reasons, the efforts and expenses needed and the resulting information content is limited. The deposit model and the consecutive structural concept are developed through interpretation and interpolation of the data base. However, in practice these models often show deviations between the forecasted and actual deposit composition.

Ultimately, the visual address and the manual device control through the operating personnel are important for the extraction process. This is only possible in extraction and processing, in particular in dredging operations. The consequences often are a suboptimal management from the economic point of view, an excessive mass transport and additional work and expense during processing.

It is a few years that the Department for Surface Mining and International Mining has been working on an acoustic procedure for detection of soil and parting lines, the so-called GEO-SCANNER.▶

Pic. 1: Typical geological formations of inter-bedded strata in a soil deposit
The Measuring Principle

The method of the acoustic GEO-SCANNER is based on the principle of determining material-specific parameters of soil through sound amplitudes that are dependent on friction.

These mechanical oscillations are created during the working process of devices for loosening of rocks, displacing and probing. The oscillations that are initiated at the friction surface, spread in the entire solid body (impact sound) and produce bending waves at its surface. This elastic change of form can be recorded by piezo-electric acoustic sensors and be transformed into electrical signals. The sound impact that is produced through friction is characterized by the eigenfrequency of the resonating body and the amplitude level that is dependent on the application of energy. The formation of the impact sound is portrayed schematically in picture 2.

Procedure and Results of the Current Research

The current researches of the Department for Surface Mining and International Mining examines practice-oriented solutions of acoustic material identification for the raw material extraction industry, the survey of building sites, as well as for water and special underground engineering. The current researches are based on extensive laboratory and field tests, which have proven the general suitability of the acoustic method for detection of material. Picture 3 shows a measuring device with three vats-shaping resonating bodies, on each of which a vibration sensor is positioned.

During the test procedure the appliance is pulled over a distance of approx. 25 m on the layered soil. The individual tests of the test-run are repeated several times on a homogeneous and geo-technically analyzed and known type of soil. From the frequency of the reproduced individual tests that are run in constant conditions it is

Pic. 2: Schematic portrait of the physical basis of the acoustic method
possible to obtain reliable results on the acoustic characteristics of the respective rock type, after respective data processing.

During assessment the raw data sets, which are available as time-based data (see picture 4), are transformed into a frequency signal (spectrum).
A spectrum consists of single sequences - the consecutively recorded frequency signals. Accordingly spectrums are to be seen as three-dimensional data sets and offer the possibility of assessing acoustic pressure signals on a certain frequency band over the recorded way (see picture 5).

In order to determine material-specific reference values, individual sequences of a spectrum are combined to an average value. This value expresses the mean sound intensity of the homogeneous material type. In the graphical analysis these averaged spectrums are displayed in an array of curves. This method makes it possible to examine the scattering or accuracy of measurement. In further analysis the array of curves of other examined soil types are added.

As a result it is possible to make statements on the scattering, as well as on the selectivity. In picture 6 the analysis for three different material types from one field test is depicted (green: silt, yellow: fine sand, orange: coarse sand, pebbly). In each case, the average spectrums of a type of material form an array of curves which lie very close. However, the array of curves shows a big distance form each other, so that a high degree of separation is given.

These encouraging results could be achieved both in laboratory tests, as well as in field tests (picture 6) and form the basis of the current research and development work for the acoustic method in mining and excavation of soil. The research encompasses the application of the GEO-SENSOR in the equipment systems of dry-extraction and in the future also for dredging technology.

One example for the development work is the appraisal of the acoustic GEO-SENSOR with continuously working open cast large-scale equipment. For this reason a bucket wheel excavator was equipped with a measuring system consisting of a sensor, wireless data transfer and data
processing unit (picture 7). The advantages of the very robust and low scale equipped components of the acoustic method are seen in very rough operation conditions. The vibration sensor is attached in the clearance angle behind the cutting edge of an excavator shovel. This positioning, which is immediately at the sound source, enables an almost un-damped recording of the impact sound, which is generated by the loosening process. The signals are relayed through a radio link to the data processing unit by a rotating bucket wheel. This is placed in the protected control platform of the bucket wheel excavator. In the field test a range of soil from gravel to silt formations were examined.

Pic. 6:
Gliding mean values from spectrums of 3 test runs with 6 trial runs each

green: silt, 
yellow: fine sand, 
orange: coarse sand
The data analysis can be done with a close to real-time method, as well as with a separate method which is suitable to document results. As a principle, the raw signals run through the already explained steps of data processing. The material type is determined by matching of the processed signals with the acoustic fingerprints of characteristic soil, which is verified in a calibrating step. In the close to real time interpretation it is possible to address the matching of the recorded level of the amplitudes with a relational operator and display it by a corresponding visualization (e.g. color signals).

The results from these tests are presented in summary in picture 8, which shows a clear degree of separation of the signals that are recorded in gravel (auburn), fine sand (green) and silt (blue).

In the framework of a research project that is supported by AIF ZIM, the Department of Surface Mining and International Mining is working in cooperation with the Patzold, Köbke & Partner Engineers, Holm-Seppensen, as well as Meyer & John GmbH & Co., Hamburg. The goal is to develop a functional assistance system for the optimization of the cross-section of dredging equipment of the sand and gravel industry. With this assistance system it is possible to make a significant contribution to securing of ecological and economical sustainability of supply with the raw material sand and gravel, in which it is possible to remove non-usable material and to systematically approach gravely and sandy areas. The sensory material detection system is seen as application in the various methods of the established dredging technologies, without major limitation or change of their components and functions. The procedural method that is to be developed for the visual address should have a universal character. The various loosening tools of the individual dredging technology require a methodology of sound recording that is adjusted to the specific circumstances. It is under this aspect that the mechanically loosening tools - which are composed of one component, e.g. clamshell and pump dredger with cutting wheel - are viewed and developed separate from the hydraulically loosening tools.

Pic. 8:
Frequency response and different amplitude levels of the averaged sequences for a bucket engagement
At the end of the two-year research project the dredging sand and gravel industry should have a marketable assistance system with the potential of further automation processes at their disposal.

Bibliography


Univ. Prof. Dr.-Ing. habil. Hossein H. Tudehski studied from 1977 to 1980 at the Mining College of Shahrud (Iran); following several years of work in the mining industry, he completed his mining study at the RWTH Aachen in 1989. Since 1992 he was Chief Engineer at the Institute for Surface Mining (Bergbaukunde III) of the RWTH Aachen, mainly active in the field of open cast mining and drilling technique. He did his doctor degree in 1993 and qualified as a university lecture in 1997. In 1998 the Venia Legendi was awarded to him be the RWTH Aachen for the field “Rock and Earth Open Pit Mining”. In November 2001 he was appointed as Professor for Surface Mining and International Mining at Clausthal University of Technology. He already has over 25 years of experience in the field of project planning and cost-benefit analysis within the frame of various mine planning projects. The international tasks rendered by him mount up to more than 300 international raw material-related projects.

Dipl.-Ing. Heiko Hertel, born 1975, graduated in the years 1995 to 1998 trained as a well constructor. The activities of the well constructor he held until 2001. Immediately following the same year he began the study of Geotechniques, Mining and Petroleum Engineering at Clausthal University of Technology. He completed his studies successfully in 2007 and is engaged in silk as a research associate at the Institute for Surface Mining and International Mining at Clausthal University of Technology.

www.advanced-mining.com
Metso Dust Protection: AWARDS FOR THE DUST PROTECTION!

Classified Matter Dust Protection

For years Metso Minerals has been producing dust seal systems and constructions, which are being applied in mining and in the mineral processing industry. Besides the responsibility for the health of all personnel, there is a need to increase the availability of machines and reduce maintenance costs, respectively.

Saves Health and Device

Uncontrolled dust emissions usually increase the wear-off of machines and components of equipments and require unnecessary maintenance. Metso has achieved a dust sealing of almost 100% with its dust sealing system Trellex. Prefabricated standard elements can be adapted variably to the respective plant without much effort. Apart from the steel elements, sealing cloths, as well as rubber sections are being applied. The sealing also brings a noise reduction of 10-20%.

The flexible handling of Trellex dust sealing allows for enough leeway for the process monitoring without longer shutdowns. Therefore appliances for costly dust collection systems are often unnecessary.

Awards for the Extraction Quota

The professional association of quarries has established an award system, which grants its members a 30% subsidy (maximum 30,000 Euros) on an investment in a Trellex dust control system. Thus this innovation of Metso Minerals falls within the lt. StBG formulated catalogue for the implementation of specific measures to improve operational health protection (corresponding to award group 3). Further information can be obtained via email: karl-heinz.rossmann@metso.com
Dust means trouble!
TRELLEX DUST CONTROL

Takes away the dust and noise in material processing

Large-scale mines and mineral processing plants produce large-scale dust and noise. And there is nothing positive to say about dust. It is an acknowledged health risk. It also accelerates the wear-off of machines and plants. Corrosion is also accelerated by dust. Dust makes maintenance and servicing more difficult and time-consuming. We deliver complete standardized solutions for dust control of screening machines, conveying throughs, chutes and other plant components, which produce dust. The elasticity of Trellex rubber allows for accurate to size enclosure in almost all types of plants. The elasticity makes the rubber insensitive to vibrations. The combination of Trellex dust sealing rubber and STM standard profiles allows for a construction, which can easily be opened in inspections, as well as for a very good sealing, and it ensures a long lifetime for your dust sealing system.

Advantages that save money

The Trellex dust sealing system almost completely encapsulates, provides almost total effectiveness, and is very close to a 100% dust proof construction. The Trellex dust protection system can be tailored to your plant with easy, standardized components and at reasonable costs, and you can also seal a combination of machines, like for example screening machines or crushers.

And there is another big advantage! Trellex dust sealing systems achieve a considerable noise reduction.
The easy and cost-effective Solution

Many decades ago Metso Minerals started to deliver dust sealing systems, which lead to a dramatic improvement in handling dust. The systems are based on three component types:

- Trellex dust sealing cloths and dust sealing canvas Gummiklemmprofile
- Rubber sections
- STM steel profiles

The drawings show how a normal screening machine can be enclosed with the Trellex dust sealing system. This system effectively retains the dust, so that it cannot reach the environment, the driving mechanism or the motor. During maintenance work at the screening machine the lightweight inspections covers and the upper frame can easily be removed. In principle the sealings are installed around the room, in which there is dust. STM profiles are needed, so that the rubber cloths and the rubber sections can easily be attached to the right locations. The rubber or canvas cloth is clamped with the rubber sections, so that a complete enclosure is achieved.

Dust exhaust

Through the application of Trellex dust sealings, rubber screen cloths and rubber lining, a quarry (capacity 500t/h) with a high proportion of silicum in its rocks manages to reduce the extracted air from 530,000 m³/h to 35,000 m³/h, the dust content from 25 mg/m³ to 0.5 mg/m³ and the noise level from 95 dB to 76 dB.

Metso returns from stock standard solutions for dust control of screeners, conveyors, chutes and other plant parts that produce dust.

Significant noise reduction

Green-line = noise level with Trellex dust sealing system and polymer sieve elements
Red-line = no dust sealing and steel screen panels
Black-line = permitted noise level
STM 27D upper framework

STM 8A handhold

STM 10A site profile of upper framework

STM 3D

sifter-site

STM 1A

hopper below screen

Dust is pushed downwards by depression

Cross section through a dust sealed sifter

Upper framework by RHS profile

Chute to a conveyor

Typical STM combination

STM 4-40

STM 3A

STM 4B-40

STM 3D

Chute to a conveyor
Conclusion

The Trellex dust sealing system ensures significantly less dust and noise, which means:

- An improved working environment
- Reduction of wear-off and corrosion
- Service and maintenance – safe, fast and easy

Adservice, press relations
Ralf Goffin
An der Wolfskaul 42 a
41812 Erkelenz | Germany
Tel.: +49 (0) 2423 89 08 09 0
Fax: +49 (0) 2423 89 04 42 9
eMail: ralf.goffin@adservice-web.de

Metso Minerals Germany GmbH
Kantstrasse 22 – 24
44867 Bochum | Germany
Tel.: +49 (0) 2327 54 44 43
Fax: +49 (0) 2327 54 44 91
eMail: karl-heinz.rossmann@metso.com
Internet: www.metso.com
Hanover, in November 2009. When it comes to transporting raw materials, spoils and other bulk materials in large quantities from point A to point B within a short period of time, then conveyor belts are the right equipment. This is also true because they require much less energy as other transport solutions. Furthermore, some conveyor belt systems don’t even consume energy but rather generate electricity. This clearly makes conveyor belts the leader in climate protection in conveyor technology. According to a study by the Clausthal University of Technology, it is possible to reduce CO2 emissions by 340 million tons in the next 30 years if the use of conveyor belts is stepped up in conveying raw materials. Without raw materials, we would still be living in the stone ages. They are an important basis of our civilization built on industry and technology and being a significant provider of energy, they keep our world in motion.
Raw materials keep the world in motion!

According to experts, the demand for mineral raw materials is increasing by four percent per annum. Worldwide, enormous amounts are being conveyed.

In the study entitled „Energy efficiency in conveyor technology and climate protection“ that was carried out by the Clausthal University of Technology and headed by Professor Dr. Hossein Tudeshki from the Institute of Mining Engineering, it was found that currently more than 12.3 billion tons of solid mineral raw materials per annum are being extracted and consumed worldwide. To convey this amount, an additional 28.84 billion tons of spoils must be moved. With regard to increasing energy prices, transport has become an important cost factor in the extraction of raw materials.

On top of that, there are the consequences for the environment and climate. Just the transportation alone within one mining area takes up 25 percent of the energy used for the entire extraction process.

„The operators of mining systems are therefore faced with the question as to which technical solutions are the most cost-effective and most reliable processes for transporting raw materials and spoils, also in view of climate protection“ says Hans-Jürgen Duensing, business unit head at ContiTech Conveyor Belt Group, the world leading manufacturer of conveyor belts. „Heavy-duty trucks represent the chief means of transporting bulk materials in mining and quarrying."

Thanks to their application flexibility, heavy-duty trucks will also play an important role in mining in the future. However, when it comes to energy efficiency and environmental protection, they are necessarily lagging behind. Then as so-called „discontinuous“ transportation equipment, they alternate between loaded and empty runs.

With an empty vehicle weight of up to 72 tons, the total mass moved to payload ratio is approximately 2.4:1 according to the calculations done in the study. „In view of the increasing energy prices and climate change, it is worth while thinking about alternatives“, says Duensing.
ratio of 1.2:1. This also affects the specific energy requirement. According to the study, a belt system needs merely 0.14 to 0.25 kWh per ton and kilometer. This corresponds to a fifth of the energy requirement of heavy-duty trucks and has a sweeping effect on the level of CO2 emissions. Operating a conveyor belt emits just 55 g of CO2 per ton and kilometer so that there is a reduction potential of 276 g per ton and kilometer.

"And I see a solution here in conveyor belt technology that is fit for the future, energy efficient and environmentally friendly. After all, it is not just a matter of extracting the resources from the earth, but also protecting the natural environment of our planet."

Clean climate with conveyors!

The following facts support this claim. As continuous transportation equipment, conveyor belt systems achieve a clearly better total mass moved to payload ratio of 1.2:1. This also affects the specific energy requirement. According to the study, a belt system needs merely 0.14 to 0.25 kWh per ton and kilometer. This corresponds to a fifth of the energy requirement of heavy-duty trucks and has a sweeping effect on the level of CO2 emissions. Operating a conveyor belt emits just 55 g of CO2 per ton and kilometer so that there is a reduction potential of 276 g per ton and kilometer.

ContiTech:
With 11.8 million tonnes of raw salt extracted each year, Zielitz is one of the world’s major potash mines.
Good perspectives!

What happens when conveyor belts are increasingly used in the conveying of raw materials, when their role is moderately but continuously extended?

The study has found that this would have extremely positive consequences for the environment. To calculate this, two conditions must also apply: the demand for raw materials continues to increase in the future by four percent, and the share of conveyor belt systems is continuously extended over 25 years from 30 percent to 50 percent in 2034. After that, this share is maintained. This would naturally have a direct effect on the amount transported. The specific amounts moved by conveyor belt systems then increases – with an average conveyor distance of 3,800 meters – in 30 years from currently 46.97 to 254.29 billion tons and kilometers in 2039 – in other words by more than a fifth. Behind these bare figures, there is good news for the environment. Professor Tudeshki makes this clear: „Compared to the status quo, more than 340 million tons of CO₂ could be reduced with the additional use of conveyor belts over the next 30 years.“.

This represents the CO₂ equivalent amount that the 15 member states of the European Union pledged themselves to achieving under the terms of the Kyoto Protocol adopted in 1997. Good prospects then. And not only in view of the environment and climate. The lower energy consumption also reduces the costs for conveying raw materials. „A business benefit that is a strong incentive for mining companies to increase their commitment to environmental and climate protection by stepping up their use of conveyor belt systems,“ says a convinced Hans-Jürgen Duensing. An advantage that is already being made use of by K+S Group, RWE Power AG in Jamaica. ➤
ContiTech AG
ContiTech AG, Hanover, is the world’s no. 1 specialist for rubber and plastics technology in the non-tire rubber sector. The company develops and produces functional parts, components and systems for the automotive industry and other important industries. The company has a workforce of around 21,000 employees. In 2008 it realized sales of about €3 billion. ContiTech is a division of Continental AG. With sales exceeding €24 billion in 2008, the Continental Corporation is one of the top automotive suppliers worldwide. As a supplier of brake systems, systems and components for the powertrain and chassis, instrumentation, infotainment solutions, vehicle electronics, tires and technical elastomers, the corporation contributes towards enhanced driving safety and protection of the global climate. Continental is also a competent partner in networked automobile communication. The corporation currently employs approximately 134,000 at nearly 190 locations in 35 countries.

MORE INFORMATION AND CONTACT:
ContiTech AG - Vice President Communications
Anja Graf
Vahrenwalder Straße 9
30165 Hanover | Germany
Tel.: +49 (0)511 - 938 - 11 90
Fax: +49 (0)511 - 938 - 14 02 5
eMail: anja.graf@contitech.de
Internet: www.contitech.de

ContiTech AG - Head of Technical Media Relations
Mario Töpfer
Vahrenwalder Straße 9
30165 Hanover | Germany
Tel.: +49 (0)511 - 938 - 13 04
Fax: +49 (0)511 - 938 - 13 05
eMail: mario.toepfer@contitech.de
Internet: www.contitech.de

ContiTech:
The headframe in Zielitz. The mine is located approx. 20 kilometres north of Magdeburg.
Für perfekte Sichtverhältnisse: Call the experts®


Optimum use of machine hours

Additional capacities are being freed through quicker moving, since valuable working hours are not wasted on costly and time-consuming relocation (2 to 3 km/h) of the excavator. The Sleipner transport system allows for a 4-6 time quicker relocation (10 - 15 km/h), which is an 80% reduction of the relocation time. Based on the type of application, the saved time can mean an additional capacity of 100 to 250 hours per year and machine.

Flexible relocation

Due to the improved mobility the maintenance and repair work can be done in the maintenance hall, instead of in the quarry, where the needed tools and devices are available.

Due to the quick relocation, a frequent change of loading points is not a problem any more. The loading can be planned optimally and according to the production requirements.
Easy and secure handling

During the relocation the chains are located at a height of 200 to 500 mm, which ensures a secure and stable transport. In case required, the operator can stop the run independently from the dump truck.

In case they have to be parked at a steep location, the automatic safety brakes offer additional security, as they prevent an inadvertent rolling of the Sleipner transport-units, even on slopes of up to 20%. Furthermore the working conditions of the operator improve, since the vibrations and the noise of driving with chains are almost completely omitted. A client-specific training ensures that the system is always used safely and efficiently.

Typical applications

Up to now excavators of 60 to 230 tons of weight have been applied together with a Sleipner. This year the product range is being completed with models for smaller excavators from a weight category of approx. 20 tons.

The same concept can be used for even bigger devices; therefore the aim is to deliver the first systems for the 350 to 500 weight category for next year.

Examples of application:

Sleipner transport system – pair of wheels

The Sleipner Transport systems consist of a pair of separate axles, on which the crawlers are driven on the ramps of axels.

Pulling vehicles are trucks or ADT’s, which excavators are loading. As you can see on the picture, the axles are positioned immediately near by at the loading site (distance 20-40 m) ready for the next transport.
Transport speed

The average transport speed is 10 – 15 km/h, depending on road and application conditions. In ascending and descending steep grades or slopes grades, depending on the rimpull and retarding performance of the truck, the speed is about 6-10 km/h. The highest allowed transport speed is 20 km/h with excavators under 100 ton and with heavier the maximum speed is 15 km/h.

Additional production capacity

Driving on crawlers – e.g. 1 km transport takes 30 min. without cooling breaks

Transport on Sleipner – e.g. 1 km transport takes 9,5 min. incl. driving on and down

At loading sites A and B about 20-40 m driving on tracks.

Thanks to fast transports 5-8 additional loaded trucks per transport.

Advantages for mine company and contractor

- Additional loading capacity increases effective working time loading capacity and additional production volume
- 2-3 times longer life length time of the undercarriage, savings in maintenance costs
- Service and maintenance operations can be carried out in the workshop
- Fast transportation from site to site allows flexible planning of loading
Applications and experience reports:

E Hartikainen Oy Finland CAT 375 and 345 / 90 ton

In the Nordkalk www.nordkalk.com quarry in Lappeenranta Finland, the annual mining volume of limestone and overburden is altogether about 2 Mt. Loading and transporting is carried out by the contractor E Hartikainen Oy www.hartikainen.com. The contractor’s equipment consists of CAT 773 dump trucks, CAT 375 (80 t) and 345 (48 t) excavators. The excavators have to be relocated 3-5 times a week and typical distances are of 0,2 - 4,5 km, sometimes even 4.5 km.

A characteristic of the quarry is that The roads are narrow, curves are tight and grades are 10 -11%. In addition hHard winter conditions are also a characteristic dominate a part of the year. The Sleipner Transport system is has been in operation since February 2003.

Nordkalk Ab Sweden PC 1100 and 1250 / 120 ton

The annual mining volume in the Nordkalk Storugs quarry www.nordkalk.com is about 3,5 Mt per year, which is loaded and transported with the quarry’s own equipment consisting of Komatsu PC 1250 (120 t) and PC 1100 (110 t) excavators and Komatsu HD 605 dump trucks.

The normal transport distances of the excavators are 1-2,5 km in within the quarry and 2,5-4 km from the quarry to the workshop 2,5-4 km.

The Sleipner transport system is has been in operation since February 2004 and it is a part of service contract from Swedish Komatsu dealer.

Peter Becker / Rheinkalk Germany CAT 5090 / 120 ton

The excavation volume is approx. 8 mio tons per year. The contractor Peter Becker www.peter-becker-grevenbroich.de is responsible for loading and transporting of overburden as well as the removal of topsoil in Rheinkalk Flanderbach quarry. The company used is using the transport system with CAT 5090 B front shovel (100 t), which was transported 0,2 -1,5 km 10-15 times a week with CAT 775 truck.

The Sleipner transport system was in operation from February 2004 to June 2007. Since June 2006 Rheinkalk carry out loading and transporting of overburden with own equipment.
Ghana manganese Ghana RH 40, 30 / 120 ton

In Ghana Manganese open cast mining the excavation volume lies at 10 – 11 mio tons per year. www.ghanaman.com use the transport system with RH 30 (80 t) front shovels and RH 40 (105 t) backhoes. The trucks are of Komatsu HD 465-7 (60 t). Typical for this mine are steep slopes and narrow roads. The system is in operation since December 2005.

Drummond Colombia Demag H 185 / 250 ton

In Mina Pribbenow open cast mine approx 25 mio tons of coal and 20 mio tons of (inertite)-rock is excavated per year.

Drummond Ltd. www.drummondco.com use the transport system with Demag H 185 S (220 t) backhoes and with CAT 785 / CAT 789 trucks. The typical transport distances in the mine are 0,5 – 3,5 km and 5-7 km to the repair workshop. The Sleipner transport system has been in operation since December 2005.

ICV Chile Collahuasi Liebherr R 994 / 250 ton

The yearly excavation volume is approximately 80 mio tons, which is mainly loaded with Bucyrus cable-operated excavators and Le Tourneau wheel excavators. ICV www.icv.cl works as a contractor in Collahuasi copper mine. The transport system is used for relocating Liebherr R 994A (230 t) shovel and R 984C (120 t) backhoe with CAT 789 (190 t) truck. Typical for this open pit mine are long transport distances (even 14 km) between the two mines, as well as dry conditions on an altitude of 4.500 m on the Andes. The Sleipner transport system has been in operation since May 2004. In April 2006 Liebherr R 994 had 16.000 operating hours and the wearing rate of undercarriage is about 20 %. The life length will be over 30.000 hours.
SALT WITHOUT BORDERS: THE CHILEAN SPL GLOBALIZES THE SALT PORTFOLIO OF THE K+S GROUP

The Chilean Salt producer Sociedad Punta de Lobos (SPL) is complementing the K+S group since 2006. To date, the purchase of the company has been the biggest acquisition in the history of the group and has contributed to further internationalize their portfolio.

Company Profile

SPL, which looks back on a more than centennial company history, had already taken significant development steps towards an international salt company at the time of its take-over by the K+S Corporation. It was already in 1885 that the businessman Arturo del Río purchased land in the Tarapacá-desert south of Iquique. The aim was to mine salt in the so-called „Salar Grande“.

The easily accessible mining district extends over 5 x 45 kilometers, with a depth of between 60 to 120 meters, and it is thus one of the biggest salt deposits in the world. 1905 can be seen as the birth year of SPL, when del Río founded the „Compania Explotadora de las Salinas de Punta de Lobos“ company. From the start the company advanced to the most important salt producer of Chile, and – measured by capacity – to the most important salt producer of the entire South-American continent.

The cornerstone of the presently strong international orientation of the business was set in the sixties, when a separate terminal was built for salt freighters in the nearby Patillos harbour, only a few kilometers away. The first shipment from this terminal in 1965 was the kick-off of for the development of a large-scale bulk business with the salt freight for recipients, also in North America. The loading of loose goods outmatched the time-consuming and costly loading of packed goods in sea transport. Today the biggest ships of the world can be loaded with freights of up to 170,000 tons in the deep sea port of Patillos.

Moreover the port is practically available for salt shipment every day of the year.

A further important component for stabilization of the export business was the acquisition of the shipping company Empremar 1995. The acquisition primarily served the purpose of achieving independency of service providers in the international shipping traffic. Today Empremar is a central element of the SPL logistics concept.

But it is not only the marketing and logistics activities that forms the international image of the enterprise, there is also production outside Chile. In 2003 the new owner group around the Chilean Investor José Yuraszeck and the US American Citigroup acquired the Brazilian sea-salt producer Diamante Branco, who primarily produces for the domestic market, but also for the sales to Europe and Africa.

One of the most important business fields for SPL is the export to North America, particularly in the U.S. Primarily offshore areas in the north-east of the country are supplied. The company daughter ISCO, with its domicile in Clark Summit in Pennsylvania, takes care of the development of SPL shares in the road salt and industrial salt market of North America.

Today the SPL group is lead by Karl-Georg Mielke, who has previously managed the sister company esco – european salt company, as well as having a leading function in the K+S company Compo. Furthermore Mielke, together with esco-director Reinhard Dust, heads the entire salt business area of the K+S group through the Holdingfirm K+S Salt GmbH with domicile in Hanover.
In the report year 2008 the entire SPL group had a turnover of over 280 million Euros. Further goals are, among others, the stabilization and expansion of the market position in South and North America, as well as the optimization of production and logistic. Only a few months ago a new port section was taken into operation under the name Patillos II, and since August 2008 the docking ships now have a second loading ramp at their disposal. With this the harbour capacity for SPL has doubled to 12 million tons per year. For the ongoing year further investments are planned in the Mine.
North-Chile: Extreme in Climate and Geography

The northern part of Chile is characterized by a very broad expansion of the Andes cordillera with its elevated planes and the up to 6,500 above sea level, partly active volcanoes. The region can be divided into several zones that run from north to south. The coastal region begins with a cliff line and the coastal cordillera, a mountain range that rises up to 2,500 m above sea level. The long subsidence area of the „Depresión Central“ is east of it, and gives way to the pre-cordillera and the high cordillera („Altiplano“). The exceptionally high aridity is formative for the entire region. The permanent snow line lies at 6,000 m and as such is one of the highest in the world. The extreme dryness of this area is caused by the Humbolt-stream. Humid pacific airmass flows over the relatively cold Humbolt-stream zone and releases moisture as rain over the ocean, before reaching the South American coast. As a result of the warm conditions over the desert region the relative humidity goes further down, so that there can almost be no rainfall. Only thick coastal fog („Camanchaca“) sporadically occurs.

Generally the Atacama desert in North Chile, which encompasses the area of the coast cordillera and Depresión Central, can be called one of the driest regions of the earth [1]. It is formed by numerous basins with no outlet to the sea and optimum climatic conditions for the formation of salt lakes. In addition there is a high potential of soluble minerals in the volcanic rocks, which are transported into these dips with the surface- and ground waters. This high dryness leads to evaporation and precipitation of various salt minerals. Such dips, in which there is an episodic, although seldom flooded level, are called salars. They mostly have to a greater or lesser extent a thick salt crust with an underlying salt body that sometimes is impregnated with mineralized ground water. Often these salars show a clear zoning with regard to the distribution of the various minerals. Most of these salars are continental hydratogenous rocks, whose salt does not have a marine origin. Apart from a salty clastic crust, they can also exhibit open sheets of water and lagoons. Next to the salars there are also temporary andine seas, which are in an initial stage of evaporate formation.

The deposit: Geological Background

The Salar Grande de Tarapacá is unique. Contrary to the other salars of the Pampa de Tamarugal, it is located in an intra montane basin of the coastal cordillera and not in the Depresión Central. It is absolutely dry up to the deepest point of the basin and shows no zoning in the salt minerals. The hydratogenous rock consists of a rock salt layer with a depth of up to 100 m with 99% NaCl content. The surface consists of a brown colored clay and silt layer, which due to the influence of the coastal fog, shows rounded slat structures and bloomings (Picture 2).
In the upper 30 m of the salt rock body an intensive clefting, which is characterized by clayey interlayer, can be seen. The formation of the Salar Grande is still not completely clarified, but it is assumed that it is the remainder of a fossile Salar, which is in connection with an extensive Ice Age sea \cite{2}. The sea probably covered the entire area of the Pampa de Tamarugal.

**Salt mining with tradition in the Salar Grande**

Historically seen the mining of salt in the Salar Grande started at the end of the 19th century. Initially only small prospection with no economical significance were built. The earliest known explorations on the distribution of salt deposits are from the year 1890. The preparations for mining started in 1905 and the first salt was obtained in 1907.

One of the bigger open cast operations is in Rio Seco, which has been established at the north-western border of the Salar Grande. At the production plant numerous houses made from rock salt and wood were built, in which workers lived, sometimes with their families. In times of prosperity around 1940 Rio Seco even had a hospital ward and a school.

At that time, like today, the main problem was to overcome the mountainous region of the coastal cordillera to transport the salt to the coast. Therefore convenient roads through the mountains determined the location of the open cast. In Rio Seco the mined raw salt was transported over the mountains to the port with a funicular from the beginning (Picture 3).

At that time the salt was mined from the upper 10 to 15 m of the Salar, therefore it had a high proportion of clay. In order to clean it, part of the salt was diluted in seawater and evaporated in the basins under the sun. After that it could be packed in bags, loaded on small, open ships and transported along the coast southwards (Picture 4).

**Sociedad Punta de Lobos (SPL)**

Today SPL has mining licences, which cover more than 97% of the entire salar area. The production of SPL started in the northern part of Salar Grande with the Lobera open cast mine. In order to meet the demand for rock salt with high chemical purity for the Brazilian market, a second open cast mine called Shonita was established. However, due to quality reasons, it was abandoned in the late 80ies and is now being used as outside dump for backfill. The open cast mine Kainita was started south-east of Loberas, as a substitute for Shonita (Picture 5).
Pic. 4:
Barges for the transport of bagged salt. Photo: SPL

Pic. 5:
View of the SPL mines Loberas (background left), Kainita (front) and Shonita (background right). Photo: SPL
Area of the open cast mine lies in the most northern tongue of the Salar Grande. Apart from the rock salt goafs, two processing plants with roller crushers, mills and screening units, as well as with conveyor belts and shipments are installed (Planta 1 und Planta 2, Picture. 6). The buildings for the management, security, canteen, maintenance and personnel are next to it on the site. The transport firms maintain several halls for storage of spare parts and machines, as well as for repair and maintenance of their vehicles and equipment. Close to the processing plant there are areas for interim storage of pre-products.

Exploration of deposits

Securing the availability of raw material is an important part of production planning. A core drilling plant is being used for exploration. For better mobility it is attached on a light truck. Goal of the drillings is obtaining a core on the entire salt thickness in the front end of the coalface (Picture. 7).
The machine is designed for drillings of more than 100 m. Mostly the drillings are done per dry drilling method with blast drilling fluid. The drill cores are divided into sections of 1 meter and stored in conventional drill core box. After the geological assessment the sections can be sampled for the chemical analysis. Important criteria for description of the cores are, above all, the mineralogical composition, the crystallinity, the clay content and the occurrence of fissures.

Based on these data and the results of the chemical analysis the management plans the detailed mining process. In addition to exploration of the immediate coalface, large-scale assessments are also carried out in the Salar Grande. In particular the geological situation in other areas under license of SPL are explored with this drilling equipment.

**Mining and Production Process in open cast mining**

In open cast mining, the extraction of salt starts with the conventional technique of drilling and blasting. In this part of the Salar it is possible to build 6 benches with a thickness of 10 m each. In addition, the 7th bench is built to balance level differences in the bed, since here the total thickness of the rock salt can reach up to 10 m. The blast bore hole is exclusively set vertically, with the help of two machines with a carriage of 12 m and 17 m, respectively (Picture 8). The grain size of the rock salt is decisive for the drilling template of blast holes. Each bench is usually blast in the full range.

After blasting the raw salt is transported with special open cast dumpers with a loading capacity of 48 t to the handover area at the crushers. Shovel loaders are used to place them of the roll crusher plant. The road to the processing plant foes first over the individual access roads to the beds in the open cast mine and later over leveled streets on the Salar surface. Shipment and transport in the open cast mine is done by staff of a contractor. ▶

**Pic. 8:**
Blast-hole drilling machine during drilling of a bench. Photo: SPL
The raw salt is crushed in the roller crusher. Further crushers and hammer mills bring it to a certain grain size. After the fine fraction is separated, the salt is converted into an integral product with exactly defined grain sizes with the help of screening plants. This integral product is shipped onto a heavy duty truck through a funnel silo. Before leaving the open cast site for the Puerto Patillo harbour, the salt is covered in the transporter.

The transport of the integral product to the harbour has to be done through a public road. The payload of 62 t leads to a total weight of the heavy duty truck of over 90 tons (Picture 9).

Processing and shipment in Puerto Patillos

In the port the industrial salt is further processed with the separation of the integral product into six separate grain sizes. For this a further milling and screening plant is available (Planta 1). A part of this industrial salt is packaged in the packing stations of Puerto Patillos and transported with trucks.

In order to produce textile salt, a salt washing plant is used, where the remaining clay proportions are washed out. An optically controlled sorting plant is available to sort out dark particles. The product salt which is designated for the transport by sea is transported from the storage area in the port to the sloping dump of the shipping planes, according to the graining and material requirements. The conveyor belts of the docks-outrigger can be loaded with shovel loaders.

The salt reaches the loading space of the ship via conveyor systems and with the help of Cleveland cascades (grain-protecting pouring device) (Picture. 10).
The two loading appliances in the port of Puerto Patillos have a capacity of max. 1,600 t/h and 2,000 t/h respectively. The establishment of the second loading bridge not only created additional capacities, but also reduced the very expensive waiting times of ships. This optimization of the port logistics also has a cost-saving effect in the seasonal peak periods (e.g. road salt season).

**Mind amounts**

Yearly production amounts lie at 7.5 million tons of raw salt. Approximately 5 million tons of the products are marketed after the processing cycle, either as bulk goods or packed. This mass is dependent on the sales of road salt, which shows a strong seasonal fluctuation. Due to the availability of the new loading bridge, production capacities are planned to be increased in the future.

**Open Pit Planning**

The salt rock body in the part of Salar Grande, which is currently being mined by SPL has a thickness of 65 – 70 m. The mining is done in 6 benches of 10 m each, so that the salt is extracted as completely as possible (Picture 11).

Within the deposit the layered salt shows certain fluctuations in its composition, which is particularly important with regard to the host rock elements. These are, for example, terrigenous contaminations from the surface, which mainly consist of blown-in clays and volcanic ashes. A thin layer of this brown material covers the entire Salar and deeply penetrates the salt deposit through the network of fissures (Picture 12).
Pic. 11:
View of the mine front in the open pit Loberas. Photo: Author

Pic. 12:
Fissure filled with clay material in the mine front of the open pit Loberas. Photo: Author
The amount of contamination strongly decreases from top to bottom. Often in the first bench there is so much clay, that it is even not suitable for the road salt production and has to be completely relocated. In both open cast mines the bench 2 and 3 are mainly used for the mining of road salt. There are relatively high quality-requirements for chemical salt regarding the sodium sulfate content, which can be found in rock salt in form of thenardite inclusions. Therefore the low sulfate contents in the Kainita open pit lead to preferred mining of salt for the chemical industry. However, the quite frequent occurrence of clayey fissures are again disadvantageous for the industrial salt. Due to the fact that in the open cast mine Loberas, the proportion of clay in the salt is lower and the sodium sulfate content is higher, this mine mainly produces industrial salt. During the detailed mining planning the chemical analysis determines which areas of the coal face are suitable for which product. This correlation of particular quality-steps is the basis for further processing into various products.

Product range of SPL

SPL, together with consumption products of the brand „Super Sal Lobos“, is market leader on the Chilean market. It also supplies the entire South American region with a broad range rock- and sea salt products. Mostly road salt, as well as industrial and common salt is exported to North America. Packaging is partly done directly in the packing stations in Puerto Patillos. From there the salt is brought to the market with trucks. Additional amounts are further processed at other sites of SPL. The pre-product is brought with ships from Patillos to the SPL packaging stations in San Antonio, Talcahuano und Puerto Montt. In these factories a multitude of various packaging sizes is manufactured for industry and end users. The product array ranges form small packages of table salt and fishery salt up to salt-tablets, highly pure pharmacological salt and partly dyed textile salt. The food salt program is also complemented by the Biosal product, in which half of the sodium chloride is replaced by the potassium chloride, in order to support and low-sodium diet. A further special product is very fine fishery salt for salmon breeding operations near Puerto Montt, which gain increasing importance.
Taking advantage of SINGLE-PASS DRILLING

by Brain Fox | Atlas Copco

The easy way to get more blast holes per day

Large rotary drills have been in use for years around the world in mining applications. In many open pit operations, these large drills were equipped with electric power and long towers for drilling benches in a single pass. Today, these features are being added to smaller equipment. Let’s look at the benefits of single-pass.

Longer towers

The drilling of large diameter holes, generally considered to be greater than 9 inches in diameter, is done predominantly with rotary blasthole drills. One of the reasons for this is that larger diameter tricone bits allow for large bearings to handle high pulldown forces to drill through hard rock quickly. These high pulldown loads require a heavy tower structure to transmit these pulldown forces to the drill bit. Further, this high pulldown must be offset by sufficient mass to keep the drill rig from lifting off the ground. The resulting rig is therefore quite heavy.

With a heavy, durable rig already dictated by a large hole diameter, drill designers are able to take advantage of the large platform to offer longer towers capable of drilling benches in one pass. This often drives a change in structural design and supporting components such as undercarriages, but the basic rig envelope doesn’t change. Drilling a hole in one pass has many advantages.
Elimination of rod changing time

Adding a rod may take 45 to 60 seconds depending on the size of the rig, and taking the rod back off may take 60 to 90 seconds. The extra time for removing a rod is due to the extra cycle required to lower the head to pick up the next rod.

The effect of rod changing time is more dramatic in soft material, as shown in Fig 1. Surprisingly, it is the large metals mines that pioneered the use of single-pass drills, even though they may see limited productivity benefit. In extremely hard rock such as that encountered in taconite, the single-pass benefit might only be 3 percent. At the other extreme would be very soft coal overburden. This material can be drilled with claw-type bits at rates of 400 meters/hour or more. In this situation, a singlepass drill would yield an overall productivity gain of over 25 percent.

Simplified operation

Even in situations where the productivity gain from eliminating rod changes is relatively small, there are benefits. Operators don’t have to worry about the rod changing operation, which consists of 10 actions to add a rod and 13 actions to remove a rod. Eliminating these tasks during each hole reduces the chance for errors such as crossthreading the tool joints on the drill rods or dropping a rod. Tasks such as changing a bit in the middle of the hole or reaming the hole to clear out cuttings are much simpler when you don’t have to add or remove rods. These factors could increase overall productivity by a few more percent.  

Fig 1. Comparison of single-pass and multi-pass drilling. 1 = Time lost for rod adding and rod removal, 2 = Lost productivity for multi-pass drilling.
Less maintenance

The carousel and wrench systems used routinely in multiple-pass operation are high wear items due to the nature of their operation. While they may still be used on single-pass drills, especially for changing drill bits, they see a much lower duty cycle. As mentioned above, tight drill tool joints can be a problem. Improvements in break-out wrench systems have helped address these issues, but it is still common to see joints that can’t be broken by on-board wrench systems.

Given the advantages above, why wouldn’t every drill be built as a singlepass? Obviously, it isn’t practical to build a unit to support a 70 meter hole in coal overburden. It may be possible, but you’d end up with a unit with a mast as long as a dragline boom. The expense of such a unit would probably never be recovered with the operating cost savings.

Safety factors

As towers grow in length, the supporting mainframe and undercarriage must grow as well. To maintain the structural life and reliability of smaller multiplepass units, proper safety factors must be used in the design. The result is a larger and more expensive machine than customers are willing to buy. An example would be the move from the DM-M2, a multiple-pass unit with 35-foot drill rods and a gross weight of about 57 tons, to the single-pass Pit Viper 271 for 16.7-meter holes. The Pit Viper 271 weighs in at around 80 tons.

Many smaller rotary drills operate on slopes that could not be considered firm and flat. While single-pass drills might be capable of operating on a minor slope (less than 10 percent), they will generally have a higher center of gravity than their multiple-pass equivalent, reducing the stability of the unit. This is often the operator’s perception as the unit may be capable of slopes that might be substantially more. However, many factors must be taken into account when determining whether to operate on a particular slope. Ground conditions are rarely a single plane. Instead, they are compound angles of widely varying rock size and type. Most operators err on the side of limiting the slope they will attempt to navigate. Thus, single-pass drills are viewed as being limited to flat benches only.

As we say at Atlas Copco, we are committed to our customers’ superior productivity. We will continue to develop single-pass units for smaller diameter operations. While we have several smaller units already capable of singlepass (the DM25SP and DML-SP), they are rotary table drive units. They utilize lightweight towers on relatively small base units by locating the feed and rotation mechanisms towards the bottom of the tower. The drawback of this design is that rotation is accomplished through a rotary table drive that engages a fluted kelly bar, driven mechanically by drive pins. The Kelly bars are very expensive due to the fluting milled into them, and if the material is abrasive, they wear quickly and result in high operating costs. However, in soft applications, they are a great option.

As most of our applications involve harder, abrasive material, we are looking to develop tophead-drive units with longer towers. Adding to our fleet of large single-pass units, as outlined in Fig 2, we are testing the new Pit Viper 235. It is equipped with 40-foot drill rods and can single-pass drill 12.2-meter holes, which is ideal for many metals operations. In designing this unit, the engineering team strived to address the perceived stability issue that turns some mines away from single-pass. The result is a unit that is more stable than our DML with 35-foot drill rods and a 9.5-meter capability. We encourage our customers to look at singlepass drilling as it is one of the easiest ways to get more holes per day.

<table>
<thead>
<tr>
<th>Rig</th>
<th>PV-235</th>
<th>PV-271</th>
<th>PV-351</th>
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<tr>
<td>Hole range</td>
<td>152-251 mm (6-93/4”)</td>
<td>171-270 mm (63/4-105/8”)</td>
<td>270-406 mm (105/8-16”)</td>
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<tr>
<td>Single pass depth</td>
<td>12,2 m (40ft)</td>
<td>16,8 m (55 ft)</td>
<td>19,8 m (65 ft)</td>
</tr>
</tbody>
</table>

Fig. 2: Single-pass Pit Viper rigs.

Brain Fox is Vice President, Marketing at Atlas Copco Drilling Solutions. He is a key member of the team behind the development of the Pit Viper series.

Contact/Email: brain.fox@us.atlascopco.com | www.atlascopco.com
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INNOVATIVE: COST-SAVING ACCESSORY IN VEHICLE LEASING
LeasePlan offers GPS- fleet management system

The specialist for fleet leasing is the first leasing company in Germany who has included a telematic system in its product portfolio. With C-track, LeasePlan focuses on a perfected fleet management system, which has been tried and tested in the market for over 25 years. With the system LeasePlan customers increase the efficiency of their fleet — and all this can easily be done with only one leasing rate.

The collaboration was officially sealed at the transporter forum on the Nuernburgring towards end of October: LeasePlan is the first renowned leasing company in Germany which is so innovative to extend its portfolio towards Telematics. A forward-looking step, since due to the increasing cost pressure, there will be less and less businesses that can do without positioning systems. Now the clients of the expert for finance leasing of automobiles, transporters and utility vehicles can also lease this valuable service component: C-Track of Digicore, the specialist for GPS-supported fleet management, which has over 25 years of market experience. The cooperation of the two giants in the industry LeasePlan and Digicore allows many businesses an uncomplicated entry into the Telematics “savings box”: The combination of real-time location and user-friendly reports on routes, stops, mileage, road performance, etc. optimizes procedures, eases logistical processes and applications planning, and reduces overtime, costs for fuel and wear-off of vehicles.

LeasePlan clients benefit from this innovation in the fleet pampering program of the service-strong business. In this regard the size of the fleet does not make any difference. A handicraft business with six vehicles benefits as much from a fleet management system as a business with 40,000 vehicles. The Telematic component can also be leased in one rate. Without the need for the costumer spend time to get information in the market, he will get a complete and reliable, cost-effective product - readily installed and ready to go.

Innovations at C-Track: Quicker, more intelligent, clearer — the premiere on the forum of transporters

Up to now it has been impossible to monitor fleets of fifty and more vehicles at one glance. To verify whether they all started on time, none of them has left the motor idly running, or nobody has left the fixed area, is impossible. The new model KPI of Digicore cleverly filters all data. Immediately the C-track user registers at the monitor, whether everything is “within the bounds”.

Plan Track® depicts all data of already existing applications planning software on a map and links them to real-time information, so that you know who has completed which task and where. This market innovation which has been exactly tailored to the target group of the transporter forum was presented by DigiCore, the manufacturer of the fleet management system C-Track, on the Nuernburgring in October.

The visitors of the transporter forum had a concentrated overview over the market of box wagons and transporters of up to 3.5 tons of permitted gross weight in October on the Nuernburgring. At the interface of fleet management software and telematics, innovations increasing efficiency were waiting for buyers, managers and fleet managers: Right at the time of its launching, the trade visitors could test the new features of the sophisticated, user-friendly and growing system at the booth of DigiCore, the manufacturer of the modularly designed fleet management system C-Track.
Giant fleet at one glance:
Module KPI of C-Track

The new C-Track Module KPI from DigiCore helps to keep the overview, particularly with big fleets. Fifty and more vehicles require a tight filtering of incoming data and a compact illustration. Only in such circumstances it is possible for the fleet manager to quickly judge the overall performance. First the „Key Performance Indicators“ (KPI), which are decisive for the economic success of a business, are defined. These include for example start and end of work, driving behavior, time expenses for tours, as well as the ratio between official and private use of vehicles. Individual key values can also be created, in order to exactly tailor the information system to specific corporate tasks.

Like on a dashboard the pointer of the tachometer goes to the green, yellow and red sectors and clearly shows the situation of the respective parameter. (see Screenshot 01+02).

Screenshot 02.

Screenshot 01: Wie auf einem Armaturenbrett zeigen die Tacho-Nadeln mit grünem, gelbem und rotem Sektor klar erkennbar an, wie sich der jeweilige Parameter jetzt gerade verhält. (Abb.: DigiCore)
For example, if the start of work is at 7 o’clock, you will set 7.05 as limit of tolerance, which is still considered on time. You set the upper limit for the green area at 25% and for the yellow area at 50%. In case over half of the workers start later than 5 minutes, the pointer stands in the red field. The controller immediately sees this. He can react, inform and counteract at an early stage. If only a few per cent of the drivers are too late, the director of operations knows that every thing is on track and in the green area. Tolerance values and limits between the colors can be set individually for each parameter.

Only, if a parameter is in the yellow or red area, more information is needed. You can then enter the next level in KPI with a click on the tachometer: The corresponding graphics with the values for each individual of the fleet (see Screenshot 03+04+05).

The colors help to quickly identify runaway values. For example, in case one vehicle has left the given geographic area or a certain route, the respective driver can immediately be identified and piloted back. In case someone leaves the motor running for an unnecessarily long time, then the fleet manager can ask him in exactly the right moment for a more energy-efficient driving behavior.

The transparency obtained with the KPI dashboard alarms in case of failures, disruptions and non-compliance, in real-time. The cause can quickly be found and counteracted timely. In the diagram on driving behavior the various columns show speeding, jamming the break, too long idle times and breakdowns. (see Screenshot 04) All field courses of action are managed more economically with KPI.
Knowing right now what is happening outside: Planning help in real-time

With the additional module Plan Track®, disposition courses are supported more intelligently by C-Track. The operations manager can view all external business processes in one glance and at all times – this is transparency to an extremely high degree. Integrated into the in-house logistic- or assembly plan, Plan Track shows all client orders, as well as the current locations of the external staff and their order lists in the map mode of C-Track. (see photograph 01).

Green triangles symbolize successfully completed orders, orange means that the staff is still working on the job and red means the job still has to be done. On demand Plan Track differentiates between different order types, for example installation, maintenance and repair. This overview helps the director of operations to quickly filter the appropriate staff for the new location. Problem spots and bottlenecks stand out at an early stage, so that the manager can react timely.

Plan Track clearly and concretely exemplifies the application planning of an operation on a monitor and links it to the up to date status through the fleet management system C-Track. The prerequisite is that the data between two programs are exchanged through an XML interface. As such the controller sees with one glance, where the assemblers currently are located, which jobs they already have completed, and what workload still lies ahead of them. Order lists can be adjusted to the actual circumstances and optimized, incoming emergencies can be assigned quickly and efficiently.

DigiCore’s Modul Plan Track® makes use of the existing planning software in a business and expands its use:

It illustrates the combined data with the actual work status, so that the logical processes in the operation can be optimally organized and run more economically. Based on the need, this integrated system can automatically control and complete the entire order transaction, from receipt to completion – valuable and time saving for enterprises with many jobs in a day. ►
Communication Aid and a co-driver, who is familiar with the place:
The Navigation module

For enterprises with a big deployable radius is helpful to expand the C-Track with the “Connecting Navigation” navigation unit (see photograph 02).

With this the vehicle is automatically lead to the next place of action. The connection between navigation and black box particularly eases the communication between the controller and the driver: The display shows the driver any new assignment. In case he confirms it, the system shows him the way to the target location with language statements and card display. In order to get traffic information, the function “driver-info” needs to be activated. With the help of a touch screen, already saved assignments can be chosen in the menu under “my stops”. This list is produced in the back office and transferred to the navigation-unit. The driver has the option of responding to the controller with his own notification, either freely or with standard texts like “yes, I accept”.

Background:

DigiCore is the manufacturer and sole distributor of the fleet management system C-Track. The clients, who receive qualified consultation from DigiCore staff, can choose tailor-made solutions for their specific problems and needs from a sort of add-on system. Once you get in with an easy web-based basic solution, you can smoothly “grow” and at any time can upgrade to more extensive and elaborate functions. While doing so, there is no need for a change in hardware. The functions of C-Track are further developed in close dialogue with the users, and in case needed, they are adjusted to respective problems of the clients.

Whether for a single computer user or a complex network, whether 3 vehicles or 30,000 – C-track always pays off and increases the efficiency of field work for at least 8%.

DigiCore’s strengths like quality, reliability and experience are rooted in the fact that technical development, sales and service that is beyond sales(!) are combined under one roof. Concentrated know-how from a quarter of a century in the market makes the globally operating enterprise a dinosaur in the young telematics field. ►
Fleet management system (FMS)

What is important in buying a fleet management system (FMS), so that it pays off in the long run:

- **Established manufacturers with many years of experience** offer a perfected FMS and more security, so that even after five years they can upgrade systems of the clients and assist in problems.

- **Immediate and qualified service** is crucial for stable and reliably functioning systems. Suppliers who combine sales, consultation and technique under one roof, are in an advantageous position. Many problems can already be solved via remote maintenance.

- **Not everything to be bought new**: Some suppliers use components of already existing soft- and hardware in an enterprise, eg. Software for application planning or navigation. These can be integrated into the FMS through an intersection. Information is depicted in a linked manner, there is a paperless data flow, and processes are optimized.

- **Individually instead of standard packages**: Manufacturers of modularly designed FMS find solutions which are tailored to the requirements of the client. The client chooses the functions important to him, uses an FMS which is adapted to his hardware architecture, and in the ideal case, can grow with the product.

- **User-friendliness**: Reports and announcements (logbook, running time, idle time, braking characteristics, speed, mileage, fuel consumption, service notes, etc.) should be arranged clearly and should be able to be handled intuitively. Fleets with fifty vehicles require a tight data filtering and compact depiction on several detailed levels, so that the overall performance of the fleet can be judged in one glance at any time (for example the C-Track module KPI of DigiCore).

- **Theft Protection**: An FMS only functions as a safety lock, if the accumulators in the black box see to it that after disconnecting the batteries, the position can be followed. Messages about disconnection of batteries or fierce vehicle movements which come to the server should be transferred per SMS to mobile end-devices like a mobile phone.

MORE INFORMATION AND CONTACT:

**Press-Inquiries: Beate Wand**
Tel.: +49 (0) 177 838 94 16
eMail: presse@digicore-deutschland.de
Internet: www.digicore-deutschland.de

**DigiCore Germany GmbH**
Gewerbepark 18
49143 Bissendorf | Germany
Tel.: +49 (0) 54 02 / 70 28 25
eMail: info@digicore-deutschland.de
Internet: www.digicore-deutschland.de

** LeasePlan Germany GmbH**
Hellersbergstraße 10b
41460 Neuss | Germany
Tel.: +49 (0) 21 31 / 132 200
eMail: marketing@leaseplan.de
Internet: www.leaseplan.de
Komatsu Germany GmbH

THE NEW KOMATSU D65EX/WX/PX-16 DOZER!

Komatsu introduced as part of a field test, the two new Dozer D65-EX-16 and D65-WX-16:

The new Dozer D65EX/WX/PX-16:

The new D65-16, available in three standard configurations (EX-WX-PX), offers highly increased fuel efficiency combined with top productivity and Komatsu reliability. This 21 tonnes machine can be equipped with the patented Sigmadozer® blade, an INPAT blade or a straight tilt blade (PX only). A perfect choice for site preparation and work on road construction or home building sites, the D65-16 includes a new cab, an improved power train with automatic gearshift transmission and a fully automatic lock-up torque converter. It also retains many of the innovative features of the popular Komatsu D155AX-6 dozer.

The automatic gearshift transmission and full automatic lock-up torque converter are the key to the machine’s overall improved performance. Constant monitoring of application requirements allow the system to engage the torque converter when high torque is needed, or to lock-up the torque converter automatically and supply 100% direct drive during less torque demanding working conditions, thus reducing the overall fuel consumption by up to 10%.

Additionally, the operator can choose between different engine power modes, allowing additional fuel efficiency. For most applications, the “E-mode” will be the best choice: while still doing the job in a quick way it gives additional fuel saving. The “P-mode” is only needed for heavy duty digging and ripping applications. Power train components are sealed in a modular design that allows them to be removed and installed without oil spillage, thus making servicing work clean, smooth and easy.
Taking advantage of experience acquired with the previous launch of the blade on the D155AX-6 in December 2005, Komatsu optimized the Sigmadozer® blade design to make it a 100% versatile blade with the best performance in productivity, grading and spreading. Available on the EX and WX versions of the D65-16, the blade middle section acts like a V-shape bucket for ideal and aggressive penetration. On the other hand, the special V-shaped lateral blade edges pushing the material continuously towards the centre, combined with the deep blade curve, largely increase the effective blade capacity. At the same time the combination of the flat cutting edge with the standard pitch function offers a perfectly flat cutting edge for top grading performance. In overall, the Sigmadozer® blade gives more than 15% increase in dozing productivity compared to a conventional Semi U blade.

A straight INPAT dozer blade with a highly durable box structure is also available for all models (EX-WX-PX), making this dozer the perfect tool for a wide range of applications. Komatsu offers optionally a foldable version of the INPAT blade for the WX and PX version, which guarantees a transport width of 3 metres, allowing easy transportation between different jobsites.

The D65-16 features Komatsu’s innovative Parallel Link Undercarriage System (PLUS), with rotating bushings combined with heavy duty double seals among other key enhancements. Komatsu has in the meantime plenty of field experience with the PLUS-equipped dozers offering in
many applications a doubling of the undercarriage life time compared to conventional systems available in the market. In all cases this field-proven PLUS undercarriage shows a significantly lower undercarriage repair and maintenance cost.

The newly designed comfortable cab - with a fully adjustable air suspension seat - is ROPS/FOPS integrated and offers the best-in-class visibility. The cab spring and damper mounts isolate the operator from the machine body to suppress vibrations and lower irritating noise levels. High pressure rise and full automatic air conditioning prevent dust from entering the cab and provide a comfortable environment at all times. A large user-friendly, and multi-lingual LCD colour monitor enables safe, accurate and smooth work.

KOMTRAX™ - Komatsu’s satellite monitoring system - is fitted as standard on the D65-16. This exclusive system helps you to monitor all the essential machine information of this dozer directly through internet on any remote computer. A variety of search parameters are available to precisely determine the machine’s status: it can be tracked in the field and its production output can be optimized through increased efficiency and pro-active maintenance. KOMTRAX™ is a tool that helps to manage a whole fleet of Komatsu machines easily and cost effectively.

Quick Specs:

- **Engine:** EU Stage IIIA emission certified SAA6D114E turbocharged after-cooled diesel (EPA Tier III)
- **Engine power:** 164 kW (220 HP)

<table>
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<tr>
<th>Modell</th>
<th>Blade type</th>
<th>Blade capacity</th>
<th>Operating weight</th>
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<tr>
<td>D65PX-16</td>
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<td>21.860 kg</td>
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</table>
Operations at Letšeng – the world’s highest diamond mine – push ahead around the clock at this internationally famed operation, which continues to yield gemstones of magnificent quality.

In discovering the origins of the world famous Lesotho Promise, a 603 carat gemstone of remarkable quality, visitors to Lesotho’s Letšeng Diamond Mine have to travel steep winding roads surpassing 3 200m before reaching their destination. On arrival, the view is majestic, with sweeping vistas of snow capped peaks in all directions bearing testimony to this remarkable geological find, first discovered in 1957.

Owned jointly by London Stock Exchange listed entity, Gem Diamonds (70%) and the Kingdom of Lesotho (30%), this is a complex operation, with the loading and haulage component carried out by a 100% Caterpillar equipment fleet run by specialist contractor, Matekane Mining Investment Company (MMIC).

As John Houghton, Letšeng’s assistant general manager responsible for production explains, it’s critical that the earthmoving fleet keeps pace with the mine’s 365 day 24/7 programme, despite the constant threat of inclement weather. “Snow, which can fall at any time of the year, can close in suddenly, bringing temperatures down to as low as minus 15 degrees Celsius, but that doesn’t slow down the mining operation, which remains at full tilt,” says Houghton.

Lesotho entrepreneur and managing director of MMIC, Sam Matekane, secured the contract mining account for Letšeng in October 2007, and MMIC currently has approximately 200 personnel on site, supported by a technical maintenance team of 26 from Barloworld Equipment. (Barloworld Equipment is the exclusive Caterpillar dealer in southern African.) The mine’s technical capabilities have been further enhanced following Letšeng Diamond Mine’s R8 million investment in new workshop facilities.

Despite the challenges of a depressed global economic climate, Letšeng remains one of the few mines around the world that hasn’t stepped back on production. Mining is intense, entailing the excavation and haulage of around 450 000 t per month of kimberlite and around 660 000 t of country rock (basalt), with extraction occurring in two places: at the main pipe and the satellite pipe, both of which have currently reached a depth of around 120 m.

Final depths for the satellite and main pipe are estimated at 450 m and 550 m, respectively, with an estimated life of mine at current production volumes of more than 30 years. Output on a daily basis equates to approximately 37 000 t of which around 22 000 t is waste and the rest ore,
the latter being processed via the mine’s two dense media separation plants.

“The stripping ratio on the satellite pipe is around 4:3:1 (or 4.3t of basalt for every ton of ore),” expands Houghton, illustrating the importance of the effective planning and utilisation of the earthmoving fleet.

“When you consider that Letšeng typically yields below 2 carats per 100 tons it’s clear that we expect maximum efficiency from MMIC and our process plant contractors to keep working costs at a minimum.”

Cat 740’s thrive at altitude

Currently, Letšeng Diamond Mine carries out a standard drill and blast programme, followed by excavation and overland truck haulage, in this case using MMIC’s Caterpillar 740 articulated trucks (ATs).

MMIC’s Caterpillar fleet includes eighteen 740 ATs - 17 of which are constantly in production, with one in reserve - with the oldest Cat 740 AT in operation having already recorded 30,000 hours (or around five years in service). Added to these units are two Cat 385C and two 365 hydraulic excavators; support equipment in the form of two D6 and D8 dozer, respectively, and a Cat 824 wheel dozer; two 140H motor graders; two 980 front end loaders; two wheeled excavators, comprising a 316 and a 318 unit, both fitted with hydraulic hammers; plus a 730 converted to a water cart. Dozers are used on the waste dumps; to control the pit floors; and for tailings processing, with the bulk of their efforts focused on rehabilitation, namely, topsoil stripping and stacking.

“The success of our relationship with MMIC depends on close teamwork to ensure that Letšeng’s production targets are maintained and exceeded,” explains senior salesman, Tom Ferreira, from Barloworld Equipment’s Bloemfontein branch. Ferreira covers the Lesotho region and is responsible for the Letšeng account.

A view which MMIC’s contracts director, Ferreira Coetzee, says is supported by Sam Matekane’s decision to opt for a 100% Caterpillar fleet to maximise service and after-sales support.

“Given the challenging underfoot conditions, the Cat AT’s are far better suited than rigid off-highway trucks in this terrain due to their all-wheel drive capability, especially during the heavy snowfalls traditionally experienced in the autumn and winter months,” explains Coetzee. “As
production ramps up going forward, we anticipate that MMIC will need to expand its 740 fleet to around 30 units to keep pace with Letšeng’s demand.”

MMIC works on a three shift system, with the average truck haul distance estimated at around 2,3km. Productivity improvement assessments are ongoing and include maintenance of the haul roads and underfoot conditions at the loading and tipping sites.

With the Cat 740s taking care of the haulage, the core responsibility of loading these class leading workhorses are the Caterpillar 385 and 365 hydraulic excavators.

“The Cat 365 units are used to load the kimberlite (typically a blend of ore from the main and satellite pit) – utilising some 45% of the AT fleet – with the Cat 385s loading the basalt,” says Coetzee. “The blast size ranges at around -750mm for the basalt, and -450mm for the kimberlite ore, with fragmentation at between 5 and 10% for oversize, which is where we use our Cat wheeled excavators for final size reduction. Obviously, the objective is to minimise the amount of rehandling needed to optimise efficiencies.”

As a possible allied extraction approach, Coetzee says that the mine is also considering the use of a “rip and load” methodology following an in-depth feasibility study conducted by Barloworld Equipment in conjunction with Caterpillar’s Work Tools Centre in The Netherlands. Kimberlite has a relatively low UCS, so rip and load (using a specialised bucket incorporating an excavation ripper) could, in certain applications, contribute to a reduction in the need to blast in specified mining areas.

In the meantime, the quest for the next Lesotho Promise, and its famed predecessor, the 601 carat Lesotho Brown (named for its distinctive colour) continues around the clock, joining a steady stream of Letšeng diamonds that are today worn by some of the world’s best-known celebrities.

Adds Houghton: “There are more than 100 kimberlite pipes in Lesotho, but only a handful are said to be diamond bearing. Letšeng has certainly proven to be the most successful.”

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**About Caterpillar**

For more than 80 years, Caterpillar Inc. has been building the world’s infrastructure and, in partnership with its worldwide dealer network, is driving positive and sustainable change on every continent. With 2008 sales and revenues of $51.324 billion, Caterpillar is a technology leader and the world’s leading manufacturer of construction and mining equipment, diesel and natural gas engines and industrial gas turbines. More information is available at www.cat.com.
Reduce weight, increase safety: This was the requirement for the novel material trailer, which was recently introduced by Ackermann Vehicle constructions in Oschersleben.

It is hardly anywhere else in the transport industry, that critical borders are (inadvertently) exceeded more quickly. “To transport heavy material is a challenge for driver, holder and loader. “, says Thomas Maasberg, the Executive Director of Ackermann. “In case the vehicle is overloaded or the freight glides, everybody is responsible.” If this would only be an infringement of regulations, maybe it could be accepted. “However, if it comes to an accident, the liability question can threaten existences.” What many people do not know: Strictly interpreted, the operation license and insurance coverage becomes void in cases where the vehicle is overloaded. With a completely new designed material trailer, Ackermann is aiming at bringing all concerned to the safe side.

Payload Profit of up to 1.5 Tons

Things that could be achieved, if only the payload is taken into consideration: The ready-to-go 18 ton trailer only weighs 2,840 kg. Even if one does not use the options to save weight, the trailer still has a relatively low weight of 3,100 kg. “This is an increase in payload and load reserves of up to 1.5 tons, as opposed to conventional trailers”, Mr. Maasberg happily states. “To our knowledge, no other manufactures is offering this”. The aircraft construction brought the inspiration to achieve these values without loss in braking load and twist: The chassis has cut-outs in places, where the structure has to bear almost no load.” In addition, steels of higher quality and weight-optimized aggregates were used.

One of the highlights is the one-piece load area, made from composite material. Its covering layer consists of sanded GFK (glas fiber laminate). This material is not only 50% lighter than the common wooden bottoms, Mr. Maasberg also confirms that “The coefficient of sliding friction, which is important for the inhibition of gliding, is extremely high. This is a safety factor that is maintained, even in wet conditions. As a side-effect, the earth cannot swell, become soiled in cracks or abrade. Heavy blow damage can best be recovered by the transporter himself: With a two component adhesive, a durable and cost-effective solution."
Another novelty can be found centered in the load area: The heavy-load anchoring rail, which can be clamped in all directions through tie-downs. This is particularly practical for partial loading. Each separate clamping point holds two tons. Complementary sliding blocks can be set, which can also be locked from all sides. “For loading of single-bulk in shortest time with highest security”. This safety bottom can only be obtained from Ackermann, respective patent applications have been filed. Further clamping points are integrated in the outer frame, which encompasses a loading area of 7,100 X 2,480 mm. The side wall stands at 1,000 mm, the front wall is 1,200 mm high.

High tech and smart solutions can also be found in other areas of the vehicle. And it is not only weight and security that benefit from this interplay. The special chassis-construction improves the driving stability, and the innovative mix of material reduces resonances. In other words: The trailer is less noisy. In taking the argumentation further, we come across lower fuel consumption and higher environmental compatibility. Ackermann has already delivered the first material trailer.

About Ackermann Vehicle Construction Oschersleben GmbH:
The Ackermann enterprise, which was established in 1850, is one of the oldest enterprises in the German utility vehicle industry. With the market entry of the American Fruehauf-Group in Europe, the manufacturer traded under the name of Ackermann-Fruhauf. After the bankruptcy of Fruehauf in the year 1995, Ackermann again became independent. Trailers and constructional systems are manufactured in Oschersleben for numerous branches of the industry, for example for the logistics of fresh- and frozen services, the building industry, as well as for furniture transporters. The company employs around 140 staff, who manufacture approximately 1,500 vehicles and achieve a turnover of 18 million Euros, per year.

MORE INFORMATION AND CONTACT:

Ackermann Fahrzeugbau
Oschersleben GmbH
Thomas Maasberg
Ackermannstraße 1-5
39387 Oschersleben | Germany
Tel.: +49 (0) 39 49 / 931 - 0
Fax: +49 (0) 39 49 / 931 - 299
Internet: www.af-oc.de
Divers Applications for Terrestrial Laser Scanning (TLS)!

It is impossible to imagine the development of exact 3-D models without terrestrial laser scanning as a basis. Whether mobile or static, TLS is efficient, cost-effective and accurate. During the past 10 years the laser scanning technology has gained a strong position and offers many possibilities for planning and control. In surface and underground mining, in surveying, in architecture, in surveying industrial facilities and even on Mars and in space. 3-D models from data of laser measurements are increasingly being used. However, apart from the known fields of application, exact 3-D models are also being used in many more, sometimes extraordinary fields.

Inauguration of Barack Obama, Security Planning with 3-D Model

The inauguration of Barack Obama with the traditional car convoy is considered as one of the safest major events around the world. The Capitol Hill and the distance to the White House were checked with hitherto unthinkable precision for possible security gaps. Important lines of sight, optimal positioning of the security forces and possible escape routes were recorded through 3-D model which was developed at short notice.

In order to develop this “3-D Security Model”, the LYNX Mobile Mapper of the Canadian company Optech was used, a kinematic laser scanning system, which makes the terrestrial laser scanning mobile through coupling high-precision GPS-locating, motional adjustment through IMU and specially developed high-performance scanners. During scanning additional high-resolution pictures were taken and were referenced automatically to the respective data.

Production specialist Janos Faust from the German exclusive distributor geo-concept can easily overcome the concern regarding the flood of information.

“It is natural that loads of data are generated, but the almost automatic processing of the data offers quick and meaningful results. All this is very far from the classical data analysis, which is complicated and long.”

According to Faust, management of the technique is a piece of cake, due to the trend-setting software package (DASHMap, Lynx Survey).

When it comes to the analysis of data, the DASHMap software makes use of its special qualities: quick, reliable and accurate. The data are exported into one of the many supported formats, which can be handled by DASHMap. On the other hand Lynx Survey makes the work even quicker and more effective. Google Earth based planning, on-the-
fly mapping control and real-time system monitoring are among its repertoire.

The Lynx Mobile Mapper was the perfect choice to meet the high demands of the inauguration of the 44th U.S. President. No streets had to be blocked for the measurement within the shortest period of time. The system is highly mobile and can be installed on a vehicle, where it can gather highly accurate 3-D data at speeds of up to 100 km/h. At the driven speed of 50 km/h a mean point by point distance of approximately 10 cm was achieved. This means that the recordings could be done with running traffic, which both increased the security of personnel, as well as reduces the costs, e.g. for street blockades.

Compared to conventional surveying methods, this is a clear advantage for LYNX: Mobile TLS is quicker and significantly more cost-effective at comparable accuracy! The extremely high security requirements of the American administration were even exceeded: Manholes, street situations and bottlenecks- the conditions could be recorded in detail, displayed in the shortest possible time, and could be included into the security concept.

Surveying of the Providence Harbour for Plant Documentation and Stability Analysis

The high-precision TLS performs well, not only on land, but also on water. As an example, the docks in Providence Harbour, Rhode Island were surveyed. The aim of this exercise was to explore the possibilities of applying three-dimensional models for the stability analysis of the shore and plant documentation. Another requirement was to integrate available bathymetric data (i.e. undersea maps with currents, high resolution sonar profiles of the bottom of the ocean and sediment profiles) into the models.

The challenge was to gather and integrate huge amounts of data along long distances of the coastline. This was a task which could be solved perfectly with the ILRIS 3D-HD Laser scanner of Optech. It was particularly important to achieve a specifically high density of points of less than one centimeter. Due to the many different perspectives it was possible to create an almost shadow-less cloud of points, which was also an explicit requirement. The goal was to measure the complete docks as accurately as possible, so that future requirements could also be met. In order to achieve this, the exact trajectory of the scanner
was needed during the measurement test run, as it was in the example of the Lynx mobile mapper.

For the measurements, the scanner was installed on a boat, to be transported along the measuring section. The optimal module „Motion Compensation“ des ILRIS 3D-HD allows the collection of the trajectory through integration of high-precision RTK-GNSS-data und IMU-measurements. This balances the movement of the scanner along the boat distance and the movement of the waves. The result is an extremely high resolution and selectivity, particularly for a kinematic scan from the water.

But the decision for the ILRIS 3D-HD Laser scanner is based on further characteristics. It is highly integrated, extremely compact and portable. All components lie well protected under the robust outer casing. Therefore the scanner can live up to the highest demands, it is fully trail-and sea worthy.

In order to record the shore from the water, long distances have to be bridged. This is no problem with the dynamic operating distance of the ILRIS 3D-HD Laser scanners, which lies at three to 1.800m - a characteristic, which still is unparalleled in the market.

“ You can always work effectively at a safe distance and over wide areas”, Janos Faust from geo-concept explains. And last, but not least, Optech also scores in the area of safety and security. This is because “the lasers are absolutely safe for eyes in all operating distances”, says Faust.

The task was solved to complete satisfaction within only two days. The 3-D Model was at the disposal of the ordering party, only 35 minutes after the scanning. The coast institute of the Rhode Island University and the Costal Resource Management Council (CRMC) were quite impressed!
Laserscanner ILRIS 3D-HD
Port in Providence Harbour, Rhode Island
from the aerial view
Mobile, Geo-referenced Measurement of Roadways and Infrastructure of the Railway

TLS is seen as the quickest and most cost-effective solution for comprehensive measurements, mappings and 3-D modeling. Therefore the idea of also using this technique for documentation and maintenance of railway systems seems obvious. But the question is, whether mobile TLS from a running wagon can offer enough accuracy and richness of detail? It should be noted that railway is about details! It’s about the composition of the rail track, the situation of switches, and the inventory of signposts and constructional elements. Furthermore potential obstacles, which could endanger the operation, like vegetation, also have to be recorded in unobstructed space.

The response to the question, whether enough details can be delivered, is:
Yes, TLS delivers excellent results. And this not only for the mentioned requirements, but also for further tasks. The measurements have shown that TLS can also make an important contribution to increasing efficiency and safety in route planning and observation. This was proven by a study of the Aerial Data Service (ADS), a provider of photogrammetric services.

“The results were so convincing, that ADS promptly acquired an Optech laser scanner”, said Janos Faust

In order to conduct the study a maintenance vehicle of the railway in Tulsa, Oklahoma was equipped with the LYNX Mobile Mapper, the mobile TLS system of Optech. Over a distance of 5.5 km the surroundings were scanned, connected to GPS information and analyzed during the run. The results were, among others, topographic profile maps, which can for example be used for planning of new routes. With their help the volume needed to raise or lower another railway track onto the correct level can be calculated more efficiently. Taking into consideration that many trains cannot deal with more than 2% of incline, the elevation profile of the surroundings is extremely important.
Das Unternehmen

The geo-konzept Company was established in 1992 and is a reliable partner in measurement, planning and control of large diameter bore hole blastings. The applied technologies reach from highly accurate terrestrial laser scanning through adapted planning software to processing of geo-referenced data. The application of the bore hole probes and high expertise in application of GPS-systems perfects the picture. Further business areas are the application of precise GPS in the agriculture, remote sensing (multi-spectral aerial photographing and assessment), mobile GIS, as well as provision of services and software development.

Beteiligte Unternehmen

Optech Inc. is the world market leader for development, manufacturing and support of high-quality laser supported monitoring instruments. The company offers systems for the laser measurement for end-users, air-supported systems for cartography, 3D-modelling, mine control, industrial plant documentation and space travel.

MORE INFORMATION AND CONTACT:

geo-konzept GmbH
Gut Wittenfeld
85111 Adelsberg | Germany
Tel.: +49 (0)8424 - 8989 0 | Fax:+49 (0)8424 - 8989 80
eMail: geo@geo-konzept.de
Internet: www.geo-konzept.de

Optech Incorporated
300 Interchange Way
Vaughan, Ontario | Canada, L4K 5Z8
Tel.: +49 1 905 660 0808 | Fax:+49 1 905 660 0829
Internet: www.optech.ca

This is information, which can easily be delivered by a topographic map.

The vegetation along the railroads is of particular interest: Roots can damage the rail tracks, branches can protrude into the ramp, bushes can interfere with the operation. Here again exact 3D models deliver the data for economic and correct decisions on the time of felling, shortening and cutting.

The study of ADS reveals: terrestric, mobile laser scanning offers railway operators numerous possibilities to work more economical, secure and efficiently. Further studies have been commissioned and confirm the great potential of the Optech Mobile Mapper.

Press-Inquiries
Dipl. Journ. Sascha Matterstock
Tel.: +49 (0)8424 - 8989 77
Fax: +49 (0)8424 - 8989 80
eMail: smatterstock@geo-konzept.de
Internet: www.geo-konzept.de
MB S.p.A., the Vicentine enterprise that is globally leading with manufacturing and sale of jaw crusher shovels, and whose entire production is deliberately “Made in Italy”, continues its expansion with the opening of its first branch office in Germany. The German market that had been giving important signals to the Executive Director Guido Azzolin from the beginning, can now interact directly with the Italian enterprise on German soil. This is a challenge, which the enterprise has decided to tackle, due to its deep knowledge of the German Market, which requires initiative, product quality and service: characteristics for which the Vicentine enterprise has been known for years.

**MB Germany Opens!**

Its commitment to absolute quality, its striving for continuous improvement, as well as a business philosophy which aims at satisfaction of the client – these are values which are being observed by MB since its establishment, and which turned into prerequisites for the opening in Baden-Württemberg. The German branch will offer its clients the capability and the expertise of the Italian team with its excellent client service that has always been the strength of the enterprise. In fact MB Germany was established with the aim of offering even more support and technical help to its German clients. Furthermore an on-site storage provides for satisfaction of various client needs. Since the enterprise is also aiming at being constantly at the service of the client, it is possible to also watch the demonstration of the jaw crusher shovel in the German branch and thus get to know the function and innovative technology of the products. After prior contact with Mr. Michael Sancarlo, the Head of the branch office, all jaw crusher shovels responding to the needs of the client can be demonstrated.
Managing director Azzolin is not worried about the distance and explains in an encounter at the occasion of the inauguration of the branch: “Nowadays technology and advanced communication are the most important locomotion vehicles in the world of business, and we have used all these by focusing on the ‘Just-in-time’ concept in both client management, as well as in reporting.

Herr Azzolin continues: “The inauguration of the German branch was great. There were crowds of guest and we happily observed the enthusiasm that the new branch had evoked, both in our regular, as well as in our potential costumers.

Although it is too early to talk of ideal results, the first signs are in favour of a positive development of the German branch. We have opened this branch in Germany with the modesty and determination of a person, who knows that he has a successful product to offer, and we have all prerequisites for a big success. Our presence on the ground sets a further strong signal for the ones who wish us to do so.”

The branch is only the first expansion over the national borders. Although the products of the enterprise from Breganze previously have been known and sold in other European countries and in the US, there are already plans for new branches, and France is one of the main candidates for the next opening.

The idea, which was only generated in the year 2001, about the technical and functional development of innovative MB products, has again proven to be successful. This means a development, which - thanks to continuous research and the work of a team of highly qualified experts- has lead the products to internationally acknowledged top quality and to a turnover of over 20 million Euros.
ASARCO Ray, a property of ASARCO LLC, has increased its fleet of T 282 B diesel electric, AC drive mining trucks to 13 units after the recent commissioning of four new ultra class trucks.

The 400 short ton payload trucks will be utilized to move higher quantities of material more efficiently at the Ray open pit mine, as older and smaller capacity haulage equipment is gradually phasing out of operation. The Liebherr T 282 B mining trucks are equipped with MTU/DDC 20V4000 diesel engines and Michelin 56/80R63 low profile tires. In the mining industry, strong product support is the key to success. With that in mind, Liebherr has been focusing heavily on customized service structures with each equipment sale as the basis for a long lasting partnership with customers. In case of ASARCO Ray mine, Liebherr offers 24/7 technical support, parts warehouse and an office on site, in addition to three service trucks.

Located approximately sixty miles southeast of Phoenix, Arizona, the Ray Operation consists of a 250,000 ton per day open pit mine with a 30,000 ton/day concentrator, a 103 million pound/year solvent extraction-electro winning operation with associated maintenance and administrative support infrastructure.

LIEBHERR
Internet: www.liebherr.com
In Service in Jamaica –
CONTITECH SUPPLIES CONVEYOR BELT FOR BAJXITE!

World’s largest RopeCon® system ensures excellent environmental compatibility, very high safety and low operating and maintenance costs.

Hanover, in September 2009. The production of bauxite – an ore from which aluminum is extracted – makes up some two thirds of Jamaica’s export sales and employs nearly 4,000 persons on the Caribbean island, making Jamaica the fourth largest bauxite exporter worldwide.

To further improve the conveyance of bauxite, an American aluminum manufacturer uses the RopeCon® system, which sets new standards with regards to environmental compatibility and energy efficiency. ContiTech supplied the conveyor belt for the world’s largest RopeCon® systems to date – installed by specialists Doppelmayr Transport Technology GmbH – and also arranged for the belt splice directly on site.

The system was put into operation in the south part of Jamaica. The Rope-Con® is designed to convey some 1,200 tonnes of bauxite: From Mt. Olyphant where the bauxite is mined, the material is conveyed over a distance of 3.4 km and a drop in height of 470 m to the valley, where it is processed – record. Dr. Regina Gensigora, head of Engineered Products at the Conti-Tech Conveyor Belt
Group, explains: „The RopeCon® concept is of advantage wherever high conveying capacity is required across impassable terrain, wooded areas or wide rivers. „The main advantage is that the original site such as here on Mt. Olyphant remains to a great exchanged unchanged – no trees have to be cut down, no roads built, and there is no noise and dust from endless truck traffic.”

A minimum of dust and noise, low operating and maintenance costs – these were the requirements placed upon the RopeCon® systems, which have been satisfied fully. As it turned out, the topography of Mt. Olyphant played a decisive role here. Since the material is conveyed over a decline, electric energy can be generated from the braking force. The RopeCon® system combines the advantages of tried-and-tested ropeway technology with that of conventional conveyor belts.

The new kind of long-distance conveyor belt from ContiTech is basically a belt with sidewalls and integrated sets of wheels that travel on guyed carrier cables which are guided over supports. In this way, the system is lifted above the ground, requiring just a minimum of space. This presents significant benefits.

„For instance, obstacles such as houses, roads or rivers can be crossed without a problem. Nearly all traveling parts return to the station, where they can be repaired and maintained easily and, above all, cost-effectively,“ explains Dr. Gensigora. Furthermore, the material is at full rest, which has proven to be highly advantageous in view of the bulk material characteristics. „After the material as been unloaded, the belt is turned, running through a special device so that the dirty side once again faces up and no remnant material or dust can fall off,” adds Dr. Gensigora.

The ContiTech belt used in the RopeCon® system on Mt. Olyphant is precisely 6.8 km long, making it the world’s largest flatbelt with sidewalls. „And when it came to environmental compatibility, we were even able to exceed our customer’s expectations: We not only reduced the space required to a minimum and eliminated 1,200 truck trips per day, thus saving fuel and reducing emissions of CO2 and fine particles, but thanks to the topographic
situation on Mt. Olyphant, the RopeCon® generates roughly 1,300 kW an hour from braking. This energy can then be returned to the power network,” summarizes Hermann Frühstück, managing director of Doppelmayr Transport Technology GmbH.

The entire system was supplied from Europe. The belt itself was shipped in 21 containers 40 feet long, and then spliced together on site. The carrier cables were delivered on 6 cable drums, the two heaviest of which weighed 85 tonnes a piece. The system was set up by Doppelmayr; ContiTech was responsible for the vulcanization of the belt.

After the initial test runs, the RopeCon® conveyor system on Mt. Olyphant was already able to demonstrate its stability and high safety standards. Just a few days before the system was turned over to the customer, a Hurricane ripped through the Caribbean island with wind speeds of up to 249 km/h. It did very little to the system and belt, so the RopeCon® could be put back into operation right after the required safety checks. The customer’s expectations in this regard were also exceeded, as the system ran perfectly.

ContiTech:
The RopeCon® system combines the advantages of tried-and-tested ropeway technology with that of conventional conveyor belts.

MORE INFORMATION AND CONTACT:

ContiTech AG - Vice President Communications
Anja Graf
Vahrenwalder Strasse 9
30165 Hanover | Germany
Tel.: +49 (0)511 - 938 - 11 90
Fax: +49 (0)511 - 938 - 14 02 5
eMail: anja.graf@contiotech.de
Internet: www.contitech.de

ContiTech AG - Head of Technical Media Relations
Mario Töpfer
Vahrenwalder Strasse 9
30165 Hanover | Germany
Tel.: +49 (0)511 - 938 - 13 04
Fax: +49 (0)511 - 938 - 13 05
eMail: mario.toepfer@contiotech.de
Internet: www.contitech.de
Innovative and Efficient Solutions
for challenging tasks in extraction, surface mining and surface forming.

T1255 Terrain Leveler

Vermeer has transcribed its long-standing experience in the area of rock mills into its new surface mill. The **T1255** is characterized by protected technology, intelligent design, excellent production and system stability. Meanwhile the Terrain Leveler can process an area of up to 3.7 m width and 61 cm depth in one single run.

The machine has been designed to ablate all kinds of rocks, gypsum, coal and other material (e.g. concrete). This is done using a big, hydrostatically steered milling drum, which ablates the rock in a more efficient way and with a higher cutting depth. **The result:** More coarse material with a low proportion of fine fraction.

www.vermeer.de

Vermeer Deutschland GmbH
Puscherstr. 9
90411 Nuremberg, Germany
Tel.: +49 (0) 911 5 40 14 0
Fax: +49 (0) 911 5 40 14 99
## 2010
### THE AMS-EVENT CALENDER

#### January 2010

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Location</th>
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<tbody>
<tr>
<td>19 - 21 Jan</td>
<td>EUROGUSS 2010</td>
<td>Nuremberg, Germany</td>
<td><a href="http://www.euroguss.de">www.euroguss.de</a></td>
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<tr>
<td>21 Jan 2010</td>
<td>Security UNDER GROUND – technical and legal aspects from planning to</td>
<td>Leoben, Austria</td>
<td><a href="http://www.bvo.unileoben.ac.at">www.bvo.unileoben.ac.at</a></td>
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<tr>
<td>26 Jan 2010</td>
<td>10. KBU – Symposium on Economic and Environmental: The new water and</td>
<td>Aix-la-Chapelle, Germany</td>
<td><a href="http://www.kbu.gdmb.de">www.kbu.gdmb.de</a></td>
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<td></td>
<td>nature conservation law</td>
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<tr>
<td>27 – 28 Jan</td>
<td>4. Colloquium „conveying in mining” 2010</td>
<td>Leoben, Austria</td>
<td><a href="http://www.bvo.unileoben.ac.at">www.bvo.unileoben.ac.at</a></td>
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<tr>
<td>28 – 29 Jan</td>
<td>In dust and lumps of the mineral and secondary raw materials industry</td>
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#### February 2010

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<tr>
<td>02 – 05 Feb</td>
<td>World of Concrete 2010</td>
<td>Las Vegas, USA</td>
<td><a href="http://www.worldofconcrete.com">www.worldofconcrete.com</a></td>
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<tr>
<td>03 – 05 Feb</td>
<td>Euroforum Asphalt 2010</td>
<td>Berchtesgaden, Germany</td>
<td><a href="http://www.edumine.com/pd/valuation">www.edumine.com/pd/valuation</a></td>
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<td>03 – 05 Feb</td>
<td>44. Metallurgical Seminar: Special and Precious Metals</td>
<td>Hanau, Deutschland</td>
<td><a href="http://www.kbu.gdmb.de">www.kbu.gdmb.de</a></td>
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<td>04 – 05 Feb</td>
<td>Raw material efficiency and innovation</td>
<td>Nuremberg, Germany</td>
<td><a href="http://www.ict.frauenhofer.de">www.ict.frauenhofer.de</a></td>
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<tr>
<td>11 – 12 Feb</td>
<td>Metallurgy India 2010 / Tube India International 2010</td>
<td>Mumbai, India</td>
<td><a href="http://www.messe-duesseldorf.de">www.messe-duesseldorf.de</a></td>
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<tr>
<td>18 – 20 Feb</td>
<td>Metal &amp; Steel 2010</td>
<td>Cairo, Egypt</td>
<td><a href="http://www.metaledgelex.com">www.metaledgelex.com</a></td>
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<tr>
<td>17 – 20 Feb</td>
<td>MTB Oil and Gas – Dubai</td>
<td>Dubai, United Arab Emirates</td>
<td><a href="http://www.coplandevents.com">www.coplandevents.com</a></td>
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<tr>
<td>03 – 05 Mar</td>
<td>2. Day of NE-Metallurgy</td>
<td>Goslar, Germany</td>
<td><a href="http://www.kbu.gdmb.de">www.kbu.gdmb.de</a></td>
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<td>09 – 11 Mar</td>
<td>Sensorgestützte Sortierung 2010 / Sensorbased Sorting 2010</td>
<td>Aix-la-Chapelle, Germany</td>
<td><a href="http://www.sortieren.GDMB.de">www.sortieren.GDMB.de</a></td>
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#### April 2010

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<td>13 – 14 Apr</td>
<td>GeoDrilling 2010</td>
<td>Peterborough, United Kingdom</td>
<td><a href="http://www.geodrillingshow.com">www.geodrillingshow.com</a></td>
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<tr>
<td>14 – 16 Apr</td>
<td>Mining World Russia 2010</td>
<td>Moscow, Russia</td>
<td><a href="http://www.eventseye.com/fairs">www.eventseye.com/fairs</a></td>
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<tr>
<td>19 – 24 Apr</td>
<td>BAUMA 2010</td>
<td>Munich, Germany</td>
<td><a href="http://www.bauma.de">www.bauma.de</a></td>
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Planning for Sustainable Mining

PARTICIPANTS
The Department of Mining Engineering of the Universidad de Chile and the Mining Centre of the Pontificia Universidad Católica de Chile, are pleased to invite executives, academics, professionals and technical experts to participate in the IV INTERNATIONAL CONFERENCE ON MINING INNOVATION - MININ 2010, to be held on 23 – 25 June 2010, in Santiago, Chile.

OBJECTIVES
MININ 2010 is organised to provide an international forum where experts may analyse and discuss innovations and recent developments in mine planning, operations optimisation, equipment development and management of the mining business. The Conference aims to:
• Promote the exchange of best practices and experiences applied to mining processes
• Discuss emerging trends and developments and identify best practices in the mining industry
• Promote the development of an interdisciplinary international network for technical collaboration and exchange among professionals engaged in the planning and development of mining processes

ABSTRACT SUBMISSION
Prospective authors are invited to submit a 300 word abstract in English, until 11 October 2009, to minin@minin2010.com The abstract must be in MS Word, including a 100 character title, full author’s name, position, company, business address, phone number and email. If accepted, a full article up to 10 pages long will be required by 23 November 2009. All final papers accepted for publication will be included in the Conference Proceedings. The technical program will be comprised of oral and poster presentations; the form of presentation for each paper will be decided upon the receipt of its final version. English–Spanish simultaneous translation will be provided during the Conference, thus, the oral presentation may be made in either language.

AREAS OF INTEREST
— Mine Planning
— Sampling and Geostatistics
— Geomechanics and Geotechnics
— Mine Unit Operations
— Optimisation of Mining Processes
— Expansions and New Projects
— Integrated Mine Management
— Mineral Economics
— Innovation Management

DEADLINES
ABSTRACT SUBMISSION 11 OCTOBER 2009
NOTIFICATION TO AUTHORS 23 OCTOBER 2009
FULL PAPER SUBMISSION 23 NOVEMBER 2009
COMMENTS TO AUTHORS 30 DECEMBER 2009
FINAL PAPER SUBMISSION 29 JANUARY 2010
EARLY REGISTRATION 23 MARCH 2010

EXECUTIVE COMMITTEE
Diego Hernández
CHAIRMAN
MININ 2010
BHP Billiton, Chile

Carlos Barahona
EXECUTIVE DIRECTOR
MININ 2010
Gecamin, Chile

Romke Kuyvenhoven
TECHNICAL COORDINATOR
MININ 2010
Gecamin, Chile

ENQUIRIES
Isis Galeno
MININ 2010
EVENT COORDINATOR
Gecamin, Chile
Telephone (+56-2) 652 1514
Fax: (+56-2) 652 1570
E-mail: minin@minin2010.com
www.minin2010.com