

MINE SHAFT AND TUNNEL LINING





TAKEN TO PERFECTION BY EXPERIENCE

RELIABILITY. SAFETY.

DTS Group iron and steel lining for mine shafts and tunnels is successfully used in underground infrastructure projects all around the world, from Kazakhstan and Russia to Canada. It is fully customizable and may be adapted to all diameters, face shapes, sealing types and ground conditions. Based on nearly 80 years of experience, DTS Group is deeply committed to delivering individual lining projects quickly, precisely and reliably. Exactly where they are needed.

Cast iron and steel lining manufactured by DTS Group helps to build new underground mines, extend and repair metro and other civil tunnels worldwide for more than 75 years. For these years more than 550 000 metric tons of lining of all types were successfully delivered to the customers all over the world.

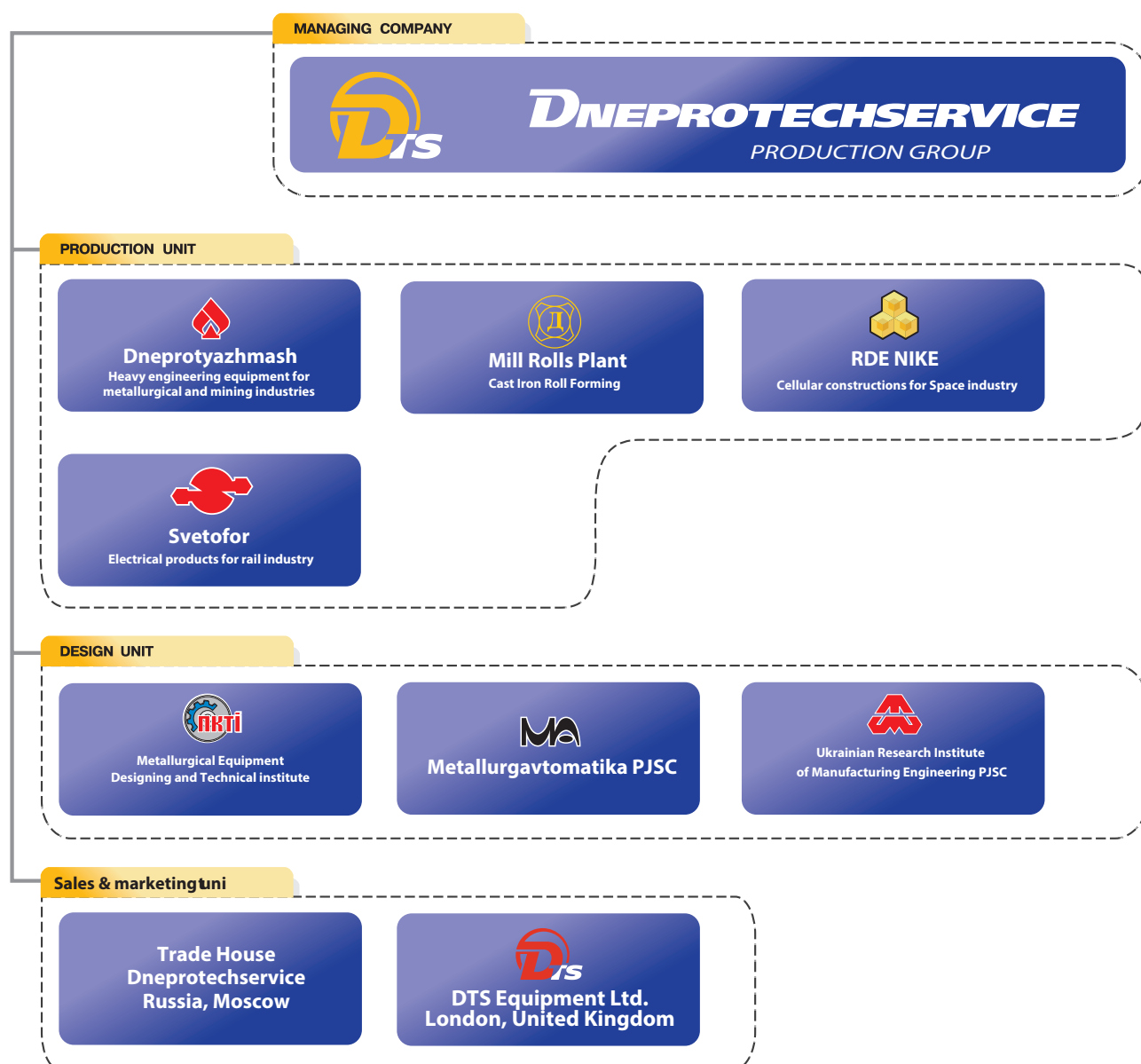
Based on this unique expertise and experience, we are working closely with our customers to develop tailor-made design solutions and provide the first class precise and reliable production.

For the foundry, which DTS Group is proud to have in its compound manufacturing metal lining, it all started in 1935 since the first order for cast iron tunnel lining rings for Moscow metro tunnels. Later, the separate iron foundry, casting conveyor, fabrication shop and specialized machining facilities were put into operation to enable a serial production of liner plates required.

Since then, DTS Group completed lining projects for mine shafts, metro tunnels, ventilation shafts and civil tunnels in Ukraine, Russia, Kazakhstan, Poland and Canada. Those projects included cast iron, cast steel, fabricated rings of different geometry with diameters ranging from 4.00 to 9.00 meters. We, in DTS, are committed to developing complex design and production solutions that will take our customers forward, by paving their way to success.

DNEPROTECHSERVICE scientific and production firm comprises a group of Ukrainian machine building enterprises. Specialization of the firm is: development, production, selling and maintenance of equipment, machines and facilities, creation of technologies for enterprises of cosmic and aviation branch, for enterprises of ore dressing, metallurgic, coke chemical, oil and gas, electro technical, automobile industry, energy and building industry, underground and mines, railroad and marine terminals.

DTS GROUP STRUCTURE



**DTS at a glance:**

- Over 2,100 employees as of 2016
- Four manufacturing plants based in Ukraine
- Total manufacturing area is approximately 450 acre
- Overall output is up to 70.000 tons in 2015
- Revenue US\$30M in FY 2016
- Quality Assurance system is ISO 9001:2008 certified
- World Class Supplier of Cast Iron lining rings for tunnels and mine shafts
- Leading Supplier of Bulk Materials Handling Equipment
- Exporting internationally to more than 30 countries including USA, Canada and United Kingdom

Our main activities:

- Heavy equipment and machinery engineering: Design and fabrication of machinery, processing equipment, and rigging for the mining, metallurgy, coking, and coal industries as well as for power plants and ports
- Underground constructions: Development and implementation of projects for the subway and mining industry
- Space: Manufacturing of rocket launcher components. Development and manufacturing of main and auxiliary equipment for space launcher complexes
- Innovation: Complete service from pre-production models, technology development, and manufacturing new equipment and machinery to serve customers' needs

Our complete facilities include:

- Steel mill
- Iron foundry
- Metal forming, welding, finishing
- Metal fabrications
- Mechanical assembly plants
- Cast Rolls Manufacturing

DTS has **Design Engineering Institute of Technology**, which can provide both basic engineering services as well as detailed design work for a wide range of equipment. The Institute specialists can also build on their experience to modernize existing equipment. Regardless of the need, our team has the knowledge and experience to serve our customers' needs.

Our staff is dedicated to customer satisfaction. This commitment includes:

- Rapid response to our customers' changing needs.
- High quality products delivered on schedule.

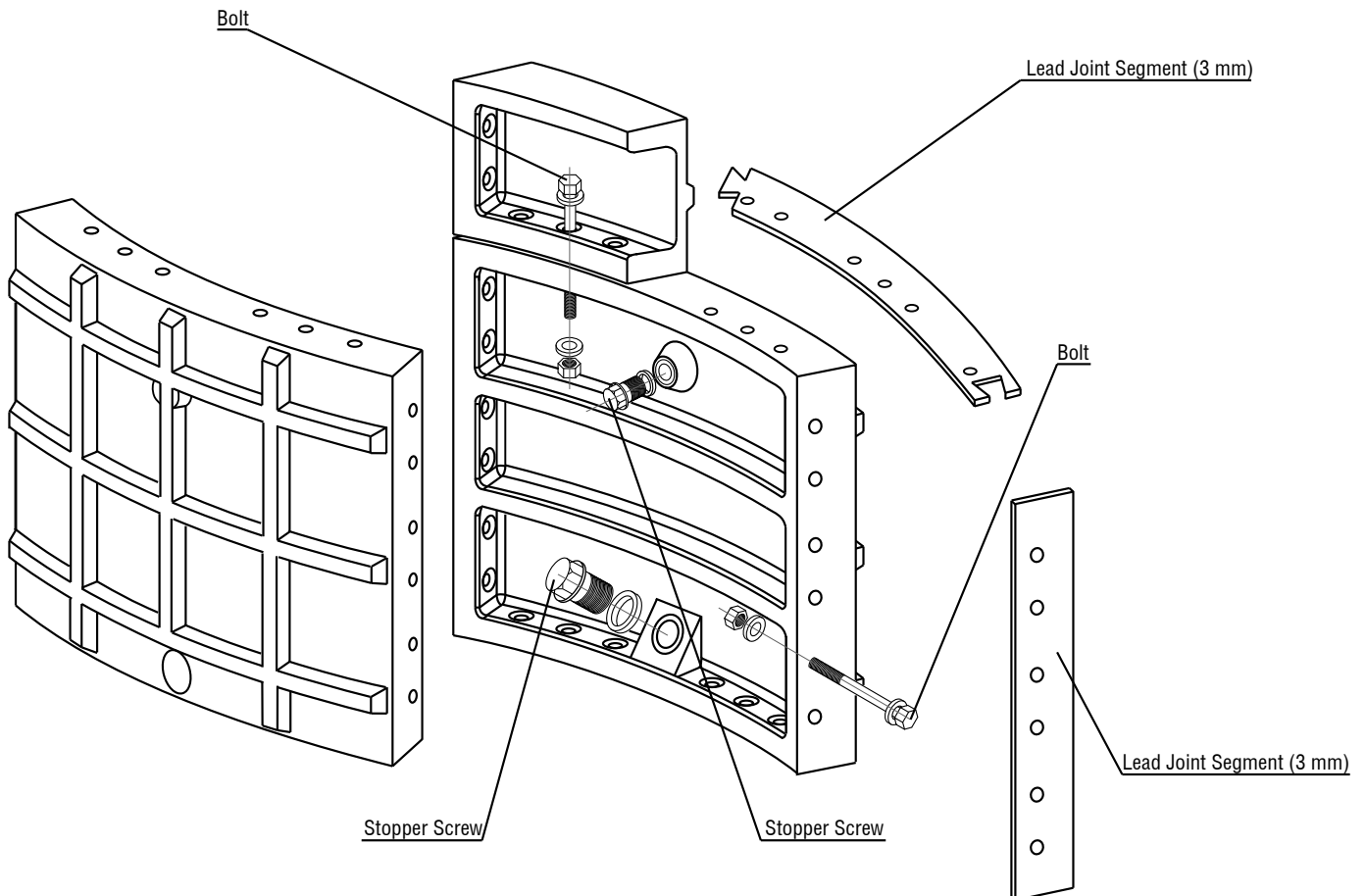
DTS success comes from our ability to meet our customers' needs. We continue to thrive by offering services that give our customers an advantage in their industry.

We are looking for long term projects and joint ventures that will lead to mutually beneficial business relationships.

WE DO IRON RIGHT

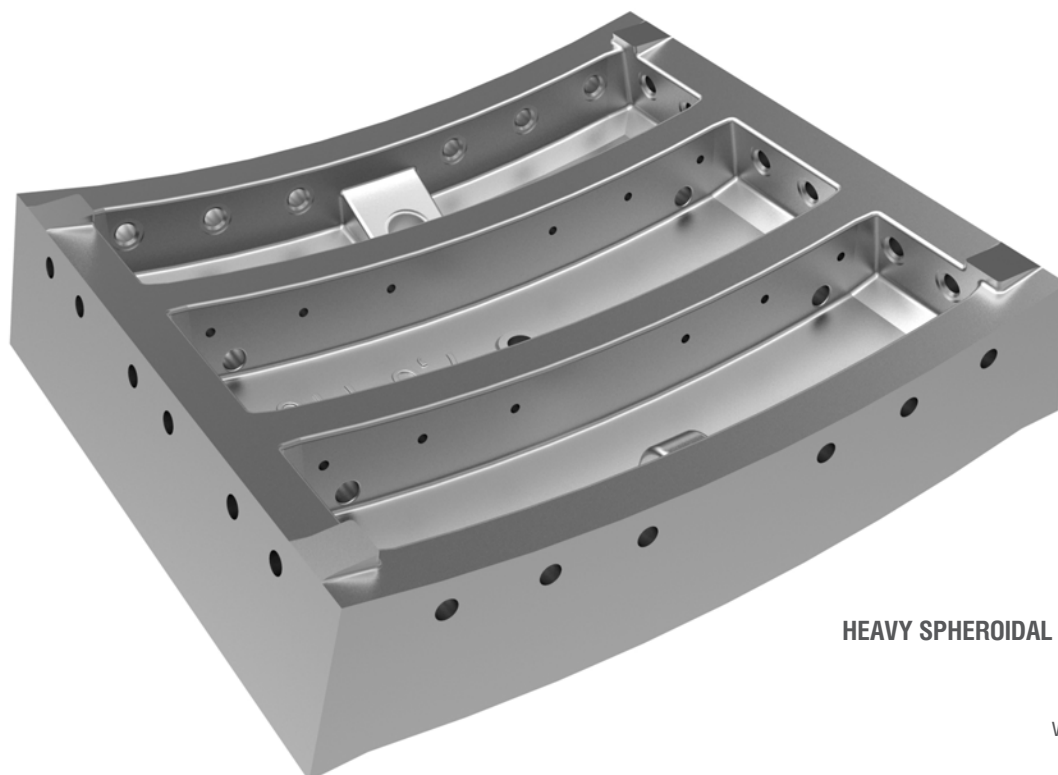
LINING FOR MINE SHAFTS AND TUNNELS

BASIC INFORMATION



Metal liner (tubbing) is cast iron, cast steel or fabricated segment with flanges and screw holes on all sides, used as a sealing in mine shaft-sinking and tunneling. The metal tubbing support composed of metal tubbing rings.

The joint flanges are used to screw the metal tubbing to a metal tubbing ring, and the bearing flange is used to screw the rings to the metal tubbing support. Sealing of different kinds may be applied between the flanges, and the kind of sealing is mostly stipulated by the purpose of the tubbing. DTS has experience and ability to design and supply its liners with both traditional sealing: lead gaskets, lead rod, rubber gaskets, and newer, more flexible polymer sealing (refer to Waterproofing section for details).



HEAVY SPHEROIDAL GRAPHITE IRON LINER

MINE SHAFT TYPE

ring OD: 7.0 m

wall thickness: 110 mm

weight: 4,235 kg

LIGHT GRAY IRON LINER

TUNNEL TYPE

ring OD: 5,49 m

wall thickness: 20 mm

weight: 638 kg



PRODUCTION PROCESS

Cast metal tubbings are cast in molds and worked on the flanges with the following screw holes drilling. Fabricated segments are bent from the pre-defined, prepared steel sheet with roll sheet-bending machines, with the following welding of the flanges.

DTS Group possesses unique capabilities of turnkey design and production of metal segments of all diameters (1 m – 12 m), ground conditions and process technologies (cast, fabricated). When selecting the optimum liner material and process technique it is important to consider not only geological condition, but also the other projects parameters which might be crucial.

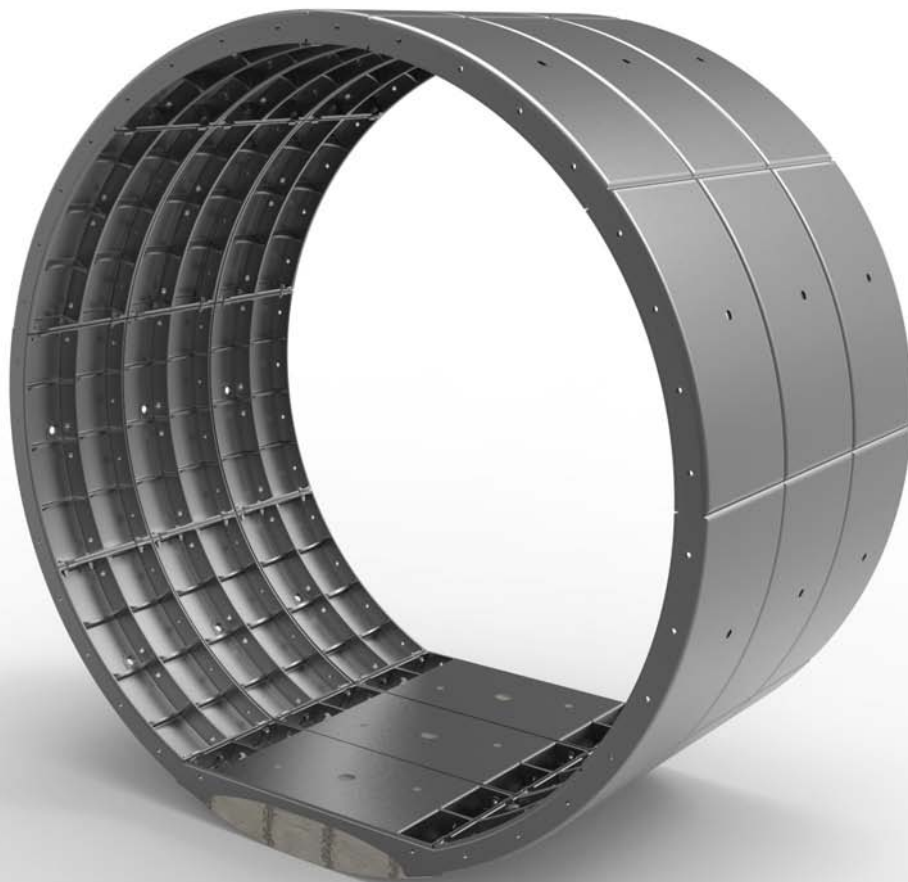
LINER TYPES:

By material and production technique the segments are split into:

- ✓ Cast iron (spheroidal graphite, lamellar graphite) liners
- ✓ Cast steel liners
- ✓ Fabricated steel liners

By application and design, segments are split into:

- ✓ Mine shaft liners (thicker, usually 1.5 m high)
- ✓ Tunnel liners (thinner, usually about 1 m high)



PRODUCTION PROCESS



PRODUCTION PROCESS STAGES:

- ✓ **MOLDING:** green sand or no-bake process
- ✓ **CASTING:** induction and cupola furnaces
- ✓ **FETTLING:** electro-hydraulic fettlers, shotblasting

- ✓ **MACHINING:** specialized machining lines, CNC controlled
- ✓ **COATING:** painting, slushing, greasing
- ✓ **STORAGE:** dedicated warehouses, protective packaging



LINING FOR MINE SHAFTS AND TUNNELS

INNOVATIONS IN WATERPROOFING TECHNOLOGY

Apart from traditional waterproofing methods like lead or rubber gaskets solutions, DTS Group in partnership with Contech Engineered Solutions (USA) is proud to present their polymer waterproofing solution implemented in mine shaft lining.

Contech Shaft Lining Waterproofing System

The Contech Shaft Lining System utilizes a seamless, spray applied polymer seal that is recessed around the perimeter of each panel. As the liner is constructed and the panels are bolted together, the polymer seals of each panel are aligned and compressed as the bolts are tightened. This permits the bolts to be tightened so that all load transfer is through the steel to steel contact of the panels.

Watertight Seal

A chemical activator is applied to the seals just prior to assembly which allows the seals from each panel to bond together and become one monolithic seal shortly after the panels are assembled. The formation of the monolithic seal means that the watertight performance of the seal is not dependent upon maintaining a high compression level between the mating surfaces as is required for traditional elastomeric gaskets.

Over time, minor movements within the liner due to thermal expansion or contraction, vibrations, bolt relaxation, minor earth movements or other actions can lead to a decrease in the compression at an individual joint within the system. Since the watertight performance of a traditional gasket is wholly dependent upon the force with which the two sealing surfaces are being pushed together, any loss of compression through the joint will decrease the ability of the gasket to hold back the pressure of the water behind the liner.

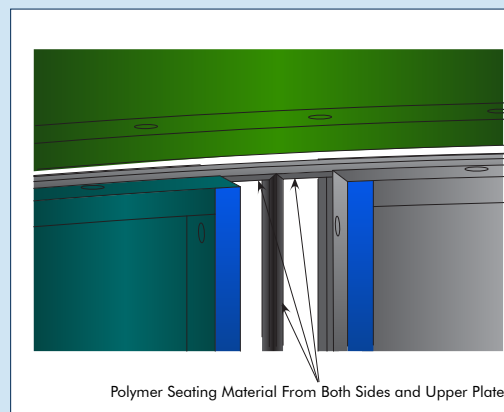
Vibration Resistance and Temperature Variance

Unlike traditional designs, Contech ShaftLiner is not affected by vibrations caused by the running of skips up and down the shaft. The polymer seal has a high strain capacity, allowing it to accommodate movement within the shaft. The vibrations will be absorbed in the elastic material, thereby alleviating stresses on the steel and polymer bond. This elastic material helps provide a flexible water seal that can accommodate minor movements within the shaft due to thermal effects, vibrations or other causes without affecting the shaft's watertight seal.

With the Contech sealing technology, both the short and long term performance of the seal is improved because the watertight performance of the sealing system is not reliant strictly upon maintaining compression through the joint. This is what allows this sealing system to perform at such high pressure levels. Current testing has demonstrated that the seals can withstand 2,000 psi of water pressure with no leaks. Additional testing is currently ongoing to establish the upper performance limits for the seals.

System Detail

The Contech shaft lining system is comprised of fabricated high strength steel or cast iron panels incorporating milled flange surfaces around all four sides of each panel. Bolt holes within the flanges permit rapid assembly of the system. A continuous polymeric seal is recessed within the flanges around the perimeter of each panel. Upon assembly, the seals from adjacent panels are aligned to provide waterproofing for the system.



Our manufacturing and inspection processes ensure customers have the highest quality castings in the industry.

Sand, resin, hot metal, and machined dimensions are tightly controlled and continuously monitored. Which results in minimal variation from casting to casting, ensuring low reject rates and continuous interchangeability of your liners.

A staff of nearly 300 professionals, from QC/QA engineers to external auditors, work around the clock to monitor and assess our production process. Quality checks include product and process inputs and outputs, as well as peer reviews of foundry processes.

Quality control is performed at all production stages: it includes chemical composition, structure, hardness and geometrical dimensions control of the tubing. Besides, there is continuous implementation of ultrasonic NDT tests.

DTS approaches continuous improvement through two avenues. First, it is our culture that has been developed over many years. We hold to the belief that everything we do can be improved. Second is the involvement of our people. We believe that employee engagement is essential to our continuous improvement process. Continuous improvement is not only what we do, it defines who we are.

Quality control system and processes at the plant are certificated according standard EN ISO 9001:2008.

CERTIFICATE



for the management system according to ISO 9001:2008

The proof of the conforming application with the regulation was furnished and in accordance with certification procedure it is certified for the company



PJSC "DNEPROTYAZHMASH"
3, Sukhoi Ostrov, 49600, Dnepropetrovsk
Ukraine

Scope

Equipment design and production for metallurgy, ore-mining plants, electric power stations, coke-chemical production, common purpose equipment, ingots and shape casting

Certificate Registration No.: TIC 15 100 96570

Valid until: 2015-08-27

Valid from: 2012-09-06

Audit Report No.: 3330 2ENX G0

Initial certification: 2003

This certification was conducted in accordance with the TIC auditing and certification procedures and is subject to regular surveillance audits.

A. Dordel
TÜV Thüringen e.V.
Certification body for
systems and personnel



Jena, 2012-09-06

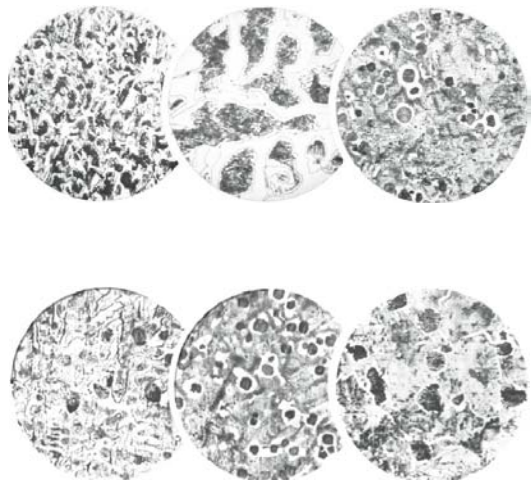


Original certificates
are branded with a hologram.

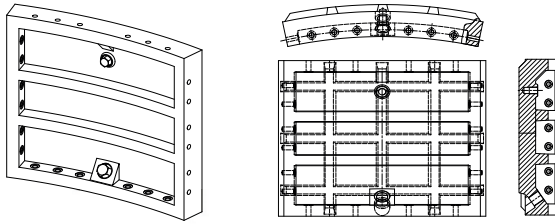
The current validity can be demanded at our homepage www.tuv-thueringen.de
Zertifizierungsstelle des TÜV Thüringen e.V. • Ernst-Ruska-Ring 6 • D-07745 Jena • ☎ +49 3641 399740 • ✉ zertifizierung@tuv-thueringen.de

OUR POLICY:

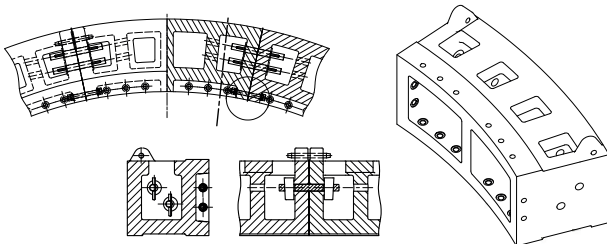
- ✓ Ensuring customer satisfaction by means of meeting the requests and expectations
- ✓ Training and education of our employees
- ✓ Follow-up with global technological developments and implementation of these trends within our production process.
- ✓ Relationships with suppliers and clients are based on mutual benefits.
- ✓ Measuring and analyzing data and ensuring the continuous improvement and development of our products.
- ✓ Aim at environmentally friendly production.



DESIGN AND ENGINEERING



Conventional mine shaft liner



Keilkrantz liner to drive off water from the shaft

FLEXIBLE AND INNOVATIVE

With a team of more than 100 highly qualified design engineers, DTS is sure to satisfy customer's needs with custom liner and ring designs for all areas and applications tailoring them for any geology and pressure based on the input information provided by the client or its design contractors.

DTS design engineering services include but are not limited to:

- adaptation of client's provided drawings for DTS plants production process;
- detailed design and engineering from scratch (based on the input information from the customer);
- finite elements analysis of the ring in conditions stipulated by the project's geology (to determine possible weak points of construction)

FINITE ELEMENTS ANALYSIS CASE STUDY

MOSCOW SUBWAY TUNNELS

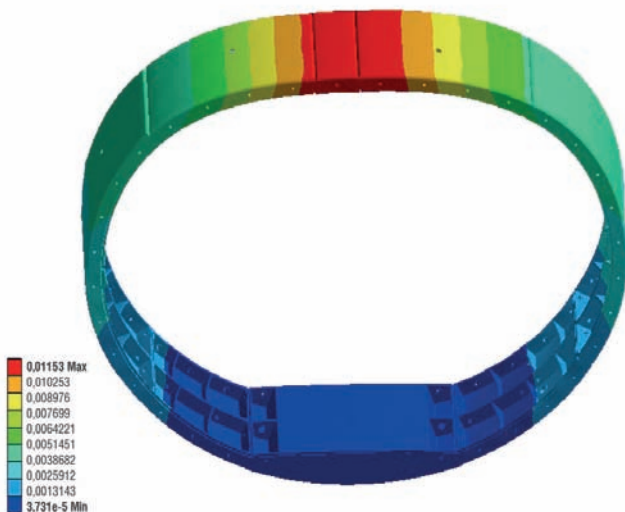
Tubbing Rings Stress-Strain Behavior Analysis

DTS Role:

Geometrical modeling of lining rings was performed by its 3D imaging in SolidWorks. Physical modeling – in ANSYS. Method of lining ring stress-strain behavior research – is Finite Elements Method (FEM), applied by ANSYS WORKBENCH. Physically linear task has been solved.

Defining of lining ring load-carrying, which complies to SNiP requirements, is performed by numerical experiment. At each stage of such calculations vertical load value was corrected. Finishing of the numerical experiment for the lining ring is checked by vertical load value, at which tension exposed by lining ring was not more than nominal one according to SNiP requirements.

Lining ring calculation results for the recommended calculated cases and defined limit value of loads were shown as isometric lines of overall strains and tension distribution. All pictures contain strain values in meters (m), and tension – in Pa (N/sq.m.).



MINE SHAFTS CASE STUDY

BHP BILLITON'S JANSEN POTASH PROJECT

SGI Liners for Production and Servicing Shafts



PROJECT DATA

- ✓ Number of Shafts: 2
- ✓ Shafts Depth: 1,000 m
- ✓ Commodity: potash
- ✓ Shaft-sinking Contractor: DMC Mining Services

Project Description:

The Jansen project is an underground potash development project located in east-central Saskatchewan, approximately 140 km east of Saskatoon.

Owned by BHP Billiton, the mine will be the world's largest potash mine, producing 8 million tons of marketable potash annually at full capacity.

The project has advanced to the feasibility study in February 2011 and is scheduled to begin first production in 2018. Development of the mine to full capacity will be carried out over three phases, at an estimated cost of over \$12bn. The mine will operate for an estimated life of more than 50 years.

The contract to construct two mine shafts at the Jansen Potash project was awarded to DMC Mining Services in December, 2010.

DTS Role:

In September, 2012 PJSC "Dneprotyzhmash" (DTS Group liners manufacturing plant) was awarded a contract for supply of 3,700 tons of SGI liners for production and servicing shafts of BHP's Jansen mine through the Blairmore formation.

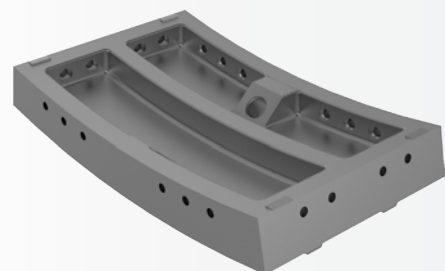
The Blairmore formation extends from approximately from 430 m to 490 meters below ground and comprises a sequence of clean sandstone interbedded with shales at 1 200 – 1500 psi making the layers unstable with the need for stronger, more durable waterproof lining for Blairmore formation zone.

DTS successfully manufactured and delivered all amount of liners, all of which were successfully accepted by the customer quality control team on the manufacturing plant.



LINING DETAILS

- ✓ Tubbing Zones: approx. 60 m per shaft
- ✓ Tubbing QTY: 1,888 segments (118 rings)
- ✓ Total Weight: 3,700 tons
- ✓ Dimensions: Ring OD 8,33 m, H: 1 m, Thickness: 100 mm
- ✓ Material: EN-GJS-600-3 (BS EN 1563)



LINING FOR MINE SHAFTS AND TUNNELS

UNDERGROUND TUNNEL CASE STUDY

London Underground Northern Line Extension (NLE)

SGL Liners for Step Plate Junctions, Cross Passages & Cross Passage Opening Sets



PROJECT DATA

- ✓ Number of new stations: 2 (Nine Elms, Battersea)
- ✓ Extension tunnel length: 3.2 km
- ✓ Set for operation: in 2020
- ✓ Main Contractor: Ferrovial Agroman Laing O'Rourke JV

Project Description:

The Northern Line Extension (NLE) from Kennington will provide the fast, high capacity transport link needed to support a major increase in the number of residents and businesses based in Nine Elms on the South Bank. It will provide two new tube stops within the area – one will be located at Nine Elms on Wandsworth Road and another at Battersea Power Station.

Transport for London appointed the joint venture Ferrovial Agroman Laing O'Rourke (FLO) to design and build the NLE, and construction started in early 2015. The new stations are due to be operational by 2020.



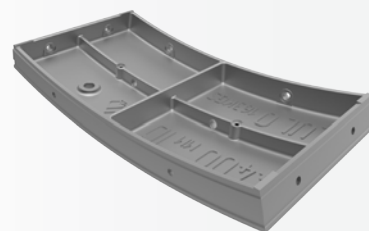
DTS Role:

In April 2016 PJSC "Dneprotyazhmash" (DTS Group) was awarded manufacturing and supply contract for delivery of 740 tons of SGL liners for a new step plate junction at Kennington Loop, as well as cross passages between 3,2 km twin running tunnels and cross passage opening sets of internal diameters 6.5, 9.5, 4.4 and 5.2 meters respectively.

The watertightness of the lining system was maintained with the use of traditional lead wire caulking as well as gaskets made of hydrophilic rubber laid in the groves machined all around the edges of all segments.

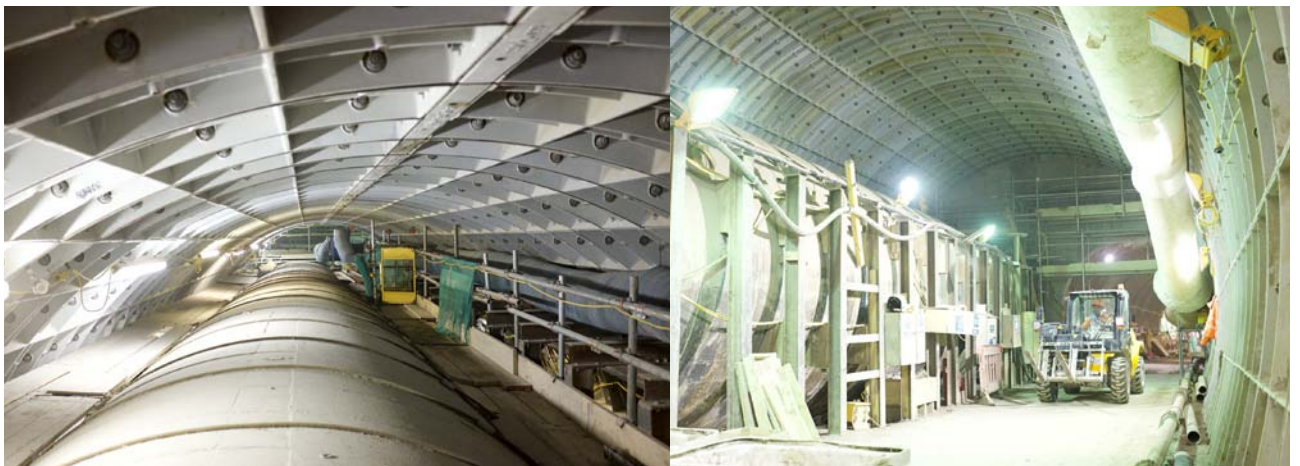
LINING DETAILS

- ✓ Tubbing QTY: 2,867 segments (~150 meters)
- ✓ Total Weight: 740 tons
- ✓ Dimensions: ID 4.4–9.5 m; H 0.6–1.6 m; S 15–30 mm
- ✓ Material: EN-GJS-600-3 (BS EN 1563)



LINING FOR MINE SHAFTS AND TUNNELS

UNDERGROUND TUNNEL CASE STUDY



LINING FOR MINE SHAFTS AND TUNNELS

REFERENCE LIST FOR THE PRIOD OF 2007–2017

MINE SHAFT Lining Projects Reference List, 2007-2017

CUSTOMER	PROJECT	COMMODITY	DIAMETER, M	THICKNESS, MM	QTY, PCS	RINGS, PCS	WEIGHT, T	PERIOD
CANADA								
DMC Mining Services	Jansen Mine	Potash	8.4	100	1,888	118	4,177	2012–2013
POLAND								
KGHM POLSKA MIEDZ SA	SW-4 Mine	Copper	7.5	50	639	47	991	2008
RUSSIA								
EuroChem	Usolsky	Potash	7.0–8.0	50–60	1,545	119	3,803	2012–2015
EuroChem	Kovdorsky	Potash	7.0	60–80	689	23	1,603	2012
EuroChem	Gremyachinsky	Potash	7.0	110–120	6,109	470	26,787	2011–2015
Rostov Coal Company	Bystryanskaya	Coal	5.1	22	3,628	330	2 074	2008
Norilsk Nickel	Nickel Mine	Nickel	9.0	30	1,505	100	1,859	2008
Apatit JSC	Kirovsky Mine	Apatite	6.0	60	308	28	576	2008
Gaiskiy GOK	Gaiskiy Shafts	Copper	7.5	50	448	32	734	2008
ALROSA	Udachny Mine	Diamonds	8.0	50	1,308	87	2,623	2007–2015
KAZAKHSTAN								
Kazchrome	Donskoy GOK	Chrome	8.0	60	630	42	1,399	2009
TOTAL MINE SHAFT LINING					18,562	1,387	44,283	

TUNNEL Lining Projects Reference List, 2008-2017

CUSTOMER	PROJECT	TYPE	DIAMETER, M	QTY, PCS	WEIGHT, T	PERIOD
RUSSIA						
Transinzhtsroy JSC	Moscow Subway	Cast Iron	4,0–9,5	48,404	20,925	2011–2015
Eurasian Pipeline Consortium	Moscow Subway	Cast Iron	5,49–9,5	32,087	21,376	2013–2015
Evrakor PJSC	Moscow Subway	Cast Iron	5,49–6,5	11,952	14,884	2012–2015
Tonnelstroykomplekt JSC	Moscow Subway	Cast Iron	5,49–9,5	101,252	68,136	2010–2015
Engeokom Group	Moscow Subway	Fabricated Steel	6,35	229	359	2013
Chelyabmetrostroy JSC	Chelyabinsk Subway	Cast Iron	10,5	240	252	2011
Baltprofsnab LLC	St.–Petersburg Subway	Cast Iron	10,5	10,673	6,404	2013–2015
UKRAINE						
Dneprometrostroy JSC	Dnepropetrovsk Subway	Cast Iron	5,49–6,0	869	806	2011–2013
AZERBAIJAN						
Azertunnelmetrostroy SC	Baku Subway	Cast Iron	5,49–7,5	36,458	24,104	2008–2013
UNITED KINGDOM						
Ferrovial Agroman, Laing O'Rourke	London Underground	SGI	6,5; 9,5		667	2016–2017
TOTAL Tunnel LINING				257,187	157,913	



OLEXIY ZINOVIEV, FOUNDER & CEO

Rapid increase in infrastructure growth and mobility and escalating hunger for the Earth's resources to support it, presents humanity to a unique challenge in terms of historical proportions. Underground mines, tunnels and metro systems of all kinds are being built all around the world in a scale previously unseen.

As humans, we can not ignore it. As engineers, we have to face it with steadfast pioneering spirit, inherent to our kind when dealing with future's most pressing challenges. This approach lies deep in the basis of DTS values, mission and corporate social culture.

Ever since the acquisition of the liners manufacturing plant by DTS in 1994 (the plant itself produced iron tubing since 1935) we are deeply committed to underground infrastructure developing by continuing to thrive to develop the underground metal lining production for tunneling and shaft-sinking, which would be as flexible, as the changing needs of our clients.

We are lucky to possess a group of world's most experienced professionals in both manufacturing and engineering areas, and it is them who ensure our leading position and innovative potential in the industry, making them the most valuable DTS asset.

We are looking forward to collaborating on any of your projects.

OUR CAPABILITIES — ARE THE SOURCE EXPANDING YOUR POTENTIAL.

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