




MINE SHAFT AND TUNNEL LINING

DTS at a glance:
• Two main manufacturing facilities in Ukraine and South Korea;
• Over 1500 employees as of 2024;
• Over 450 acres of manufacturing area;
• Combined revenue of $100M for FY 2023;
• Production output of 65,000 tons;
• World Class Supplier of Cast Iron lining rings for tunnels and mine shafts;
• Leading Supplier of Bulk Materials Handling Equipment;
• ISO 9001, ISO 14001, ISO 45001, KS A 9001, CE PED certified;
• Export to over 30 countries, including the USA, Canada and the United Kingdom;

Our main activities:
• Heavy Equipment and Machinery Engineering: Design and fabrication of machinery, processing equipment, and rigging for the mining, metallurgy, coking, power generation, coal industries, as well as bulk material transfer facilities and marine ports.
• Underground Constructions: Development and execution of projects for subway systems and the mining industry.
• Space: Manufacturing rocket launcher components, as well as designing and producing primary and auxiliary equipment for space launcher complexes.
• Innovation: Providing comprehensive services from pre–production models, technology development, to the manufacturing of new equipment and machinery tailored to meet our customers' needs.

Our complete facilities include:
• Steel mill;
• Iron foundry;
• Metal fabrication shop (forming, welding, & finishing);
• Mechanical assembly facility;
• Cast roll manufacturing plant.

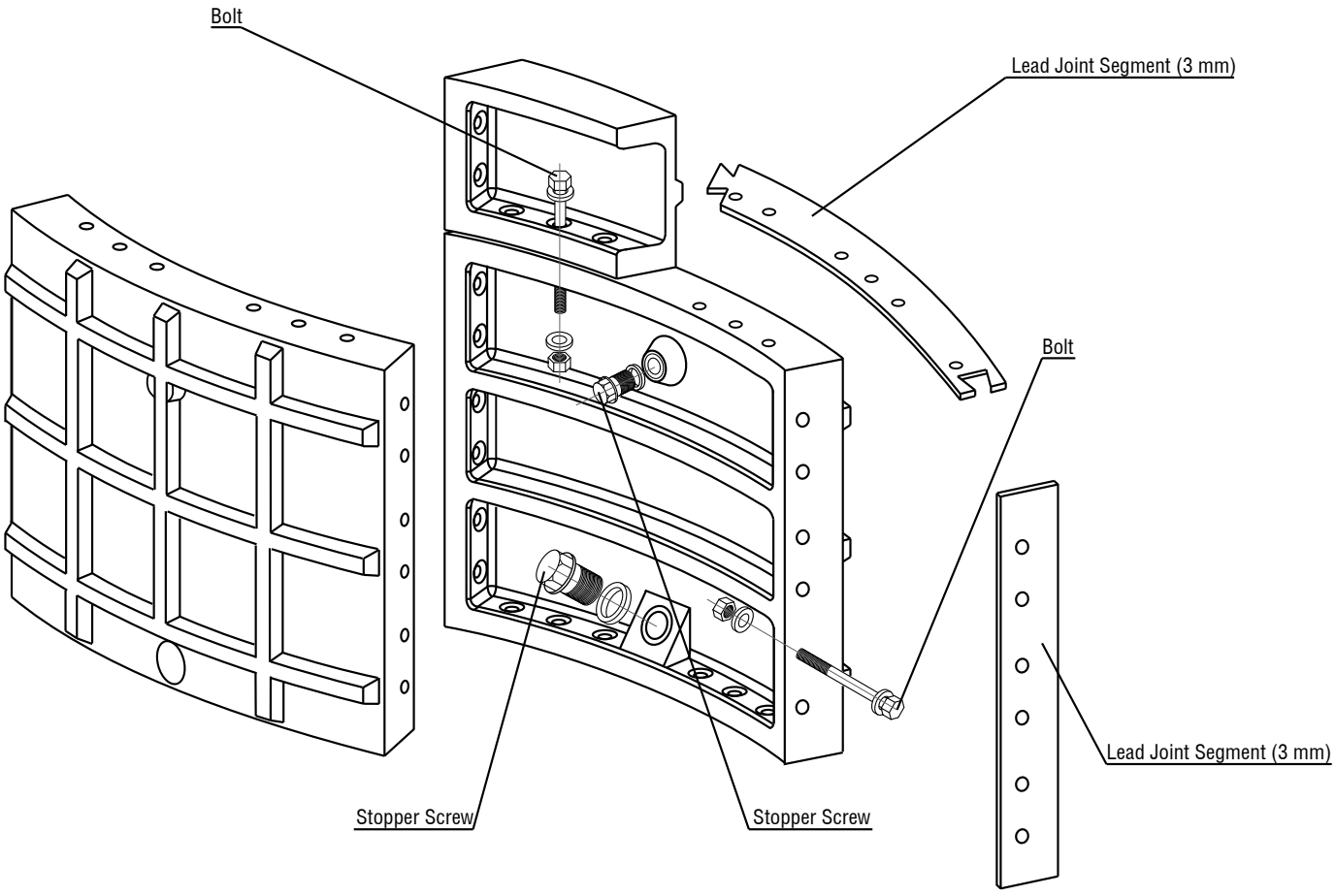
In addition, DTS operates the Design Engineering Institute of Technology, offering both basic engineering services and detailed design work for a wide range of equipment. Our specialists leverage their expertise to modernize existing equipment as well.

No matter the size or scope of the project, our team has the knowledge and experience to meet our customers' needs and deliver innovative engineering solutions. Our entire staff is dedicated to customer satisfaction, with a commitment to quick responses to evolving customer demands, along with high–quality products that meet specifications and deadlines.

WE DO IRON RIGHT

LINING FOR MINE SHAFTS AND TUNNELS

BASIC INFORMATION

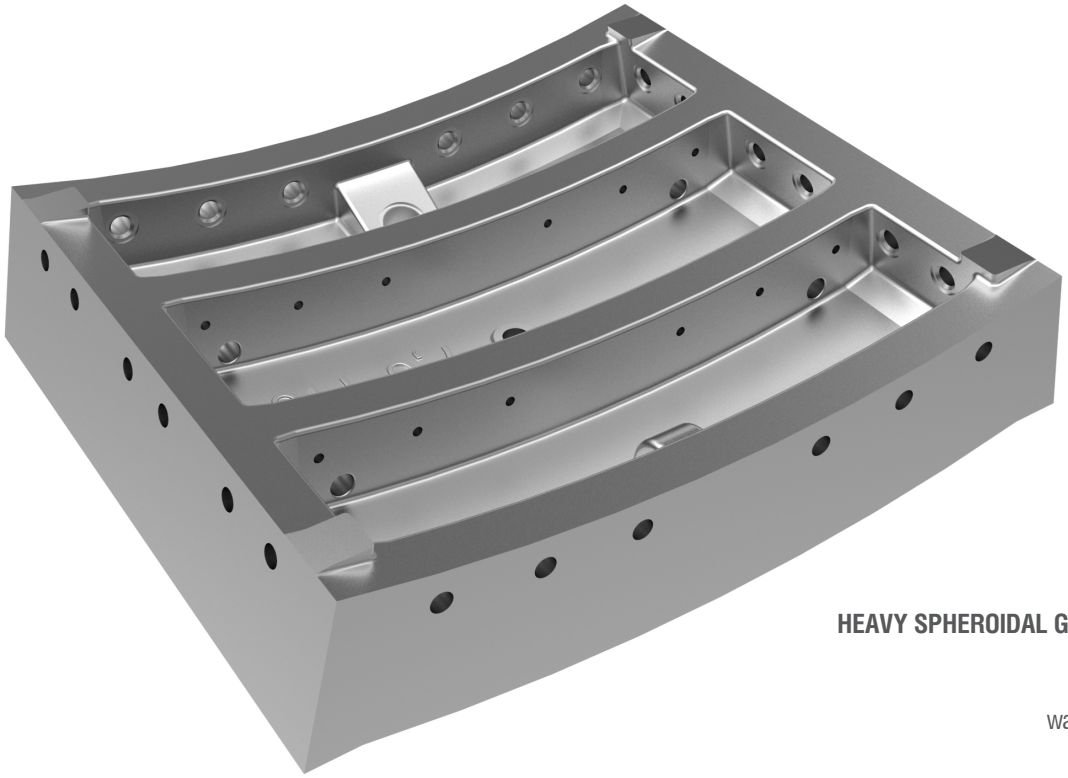


Metal liner (tubbing) is cast iron, cast steel or fabricated segment with flanges and screw holes on all sides, used as a sealing in mine shaft–sinking and tunneling. The metal tubbing support composed of metal tubbing rings.

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).

LINING FOR MINE SHAFTS AND TUNNELS

BASIC DESIGN



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

LINING FOR MINE SHAFTS AND TUNNELS

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)

LINING FOR MINE SHAFTS AND TUNNELS

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.

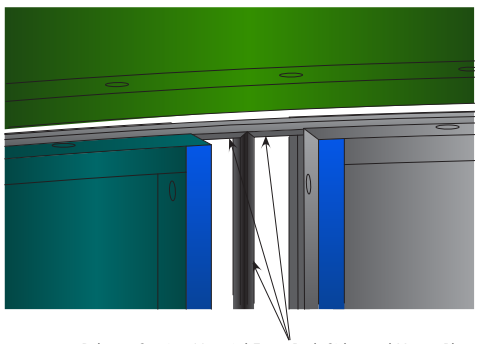
Vibration Resistance and Temperature Variance

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.



Polymer Seating Material From Both Sides and Upper Plate

QUALITY CONTROL

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 tubbing. 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 9001:2015.

CERTIFICATE

TIC

for the management system
according to ISO 9001:2015

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, 49000, Dnipro
Ukraine

Scope

Design and manufacturing of machinery and equipment for metallurgy and coke oven production, ore mining plants, unloading equipment, metal lining for tunnels and mine shafts, ingots and shape casting, common purpose equipment

Certificate Registration No.: TIC 15 100 96570
Valid until: 2021-08-27
Valid from: 2018-08-28

Audit Report No.: 3330 2ENX M0

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

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

TÜV THÜRINGEN

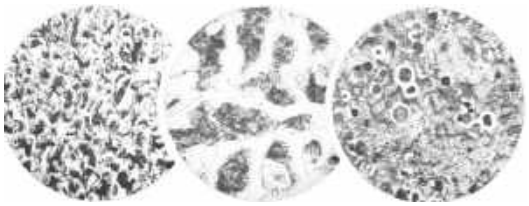
Jena, 2018-08-24

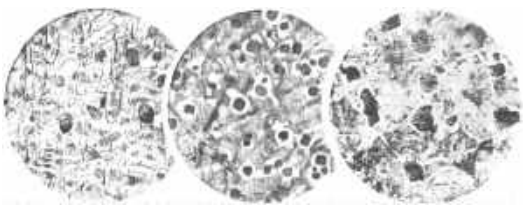
IAF

DAkkS

OUR POLICY:

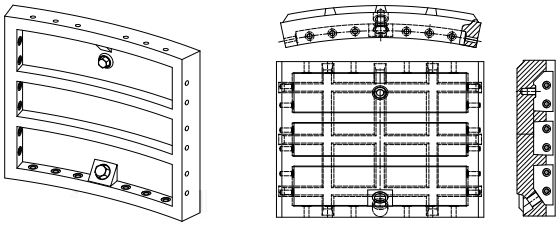
- ✓ Ensuring customer satisfaction by means of meeting the requests and expectations
- ✓ Training and education of our employees
- ✓ Follow–up with global technological developments and implementation of these trends within our production process.
- ✓ Relationships with suppliers and clients are based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



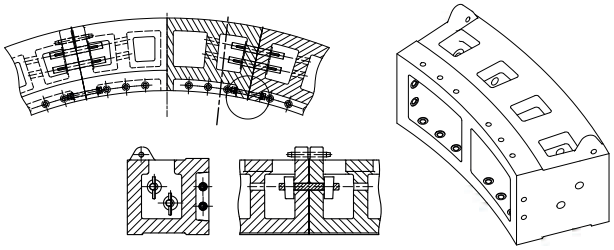


LINING FOR MINE SHAFTS AND TUNNELS

DESIGN AND ENGINEERING



Conventional mine shaft liner



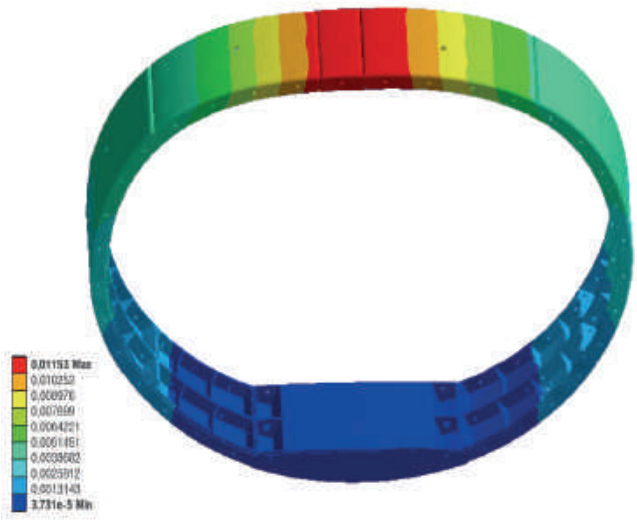
Keilkranz liner to drive off water from the shaft

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 3Dimaging in SolidWorks. Phisical 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.).

LINING FOR MINE SHAFTS AND TUNNELS

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.

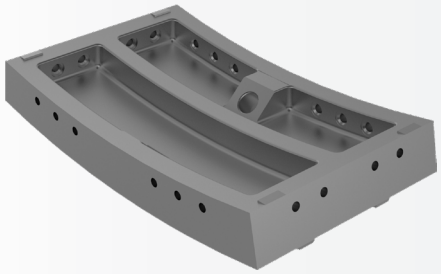
DTS Role:
In September, 2012 PJSC "Dneprotyazhmash" (DTS Group liners manufacturing plant) was awarded a contract for supply of 3,700 tons of SGI liners for production and servicing shafts of BHP's Jansen mine through the Blairmore formation.

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)
SGI 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.

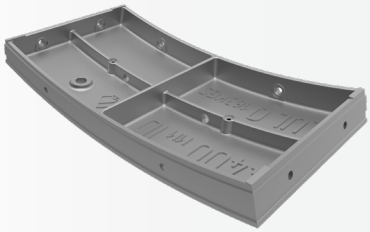
Transport for London appointed the joint venture Ferrovial Agroman Laing O'Rourke (FLO) to design and build the NLE, and construction started in early 2015. The new stations are due to be operational by 2020.

DTS Role:
In April 2016 PJSC "Dneprotyazhmash" (DTS Group) was awarded manufacturing and supply contract for delivery of 740 tons of SGI 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 mahined 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)



UNDERGROUND TUNNEL CASE STUDY

LINING FOR MINE SHAFTS AND TUNNELS

REFERENCE LIST FOR THE PRIOD OF 2007–2024

MINE SHAFT Lining Projects Reference List, 2007-2024

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
UNITED KINGDOM								
ANGLO AMERICAN	Woodsmith Mine	Potash	7.5	100	3000	200	8000	2019–2024
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	21,058	1,556	53,635	

TUNNEL Lining Projects Reference List, 2008-2024

CUSTOMER	PROJECT	TYPE	DIAMETER,M	QTY, PCS	WEIGHT,T	PERIOD
RUSSIA						
Transinzhstroy JSC	Moscow Subway	Cast Iron	4,0–9,5	48,404	20,925	Ongoing
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	Ongoing
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						
Azertonnelmetrostroy 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	

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