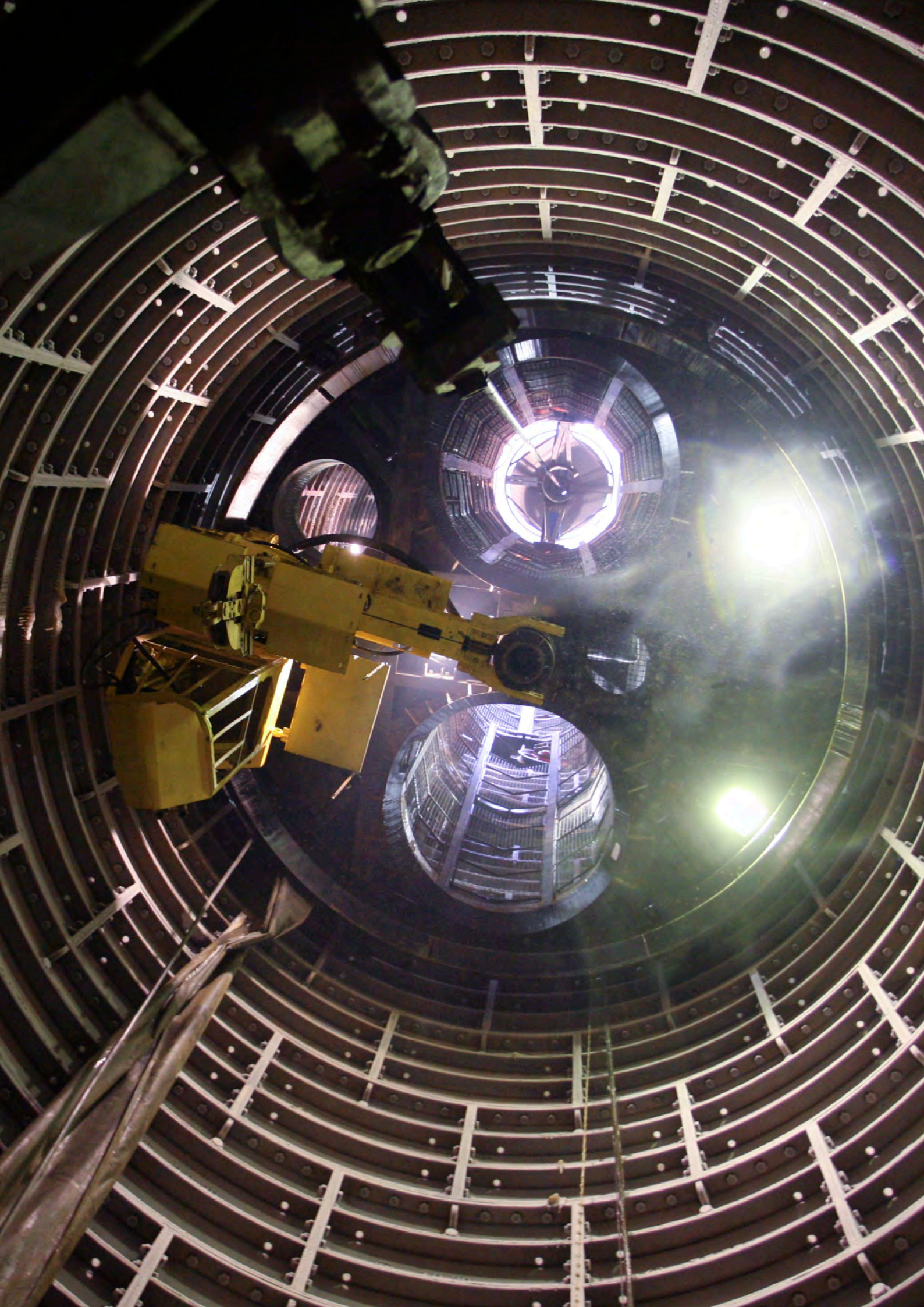


# MINE SHAFT AND TUNNEL LINING







**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.

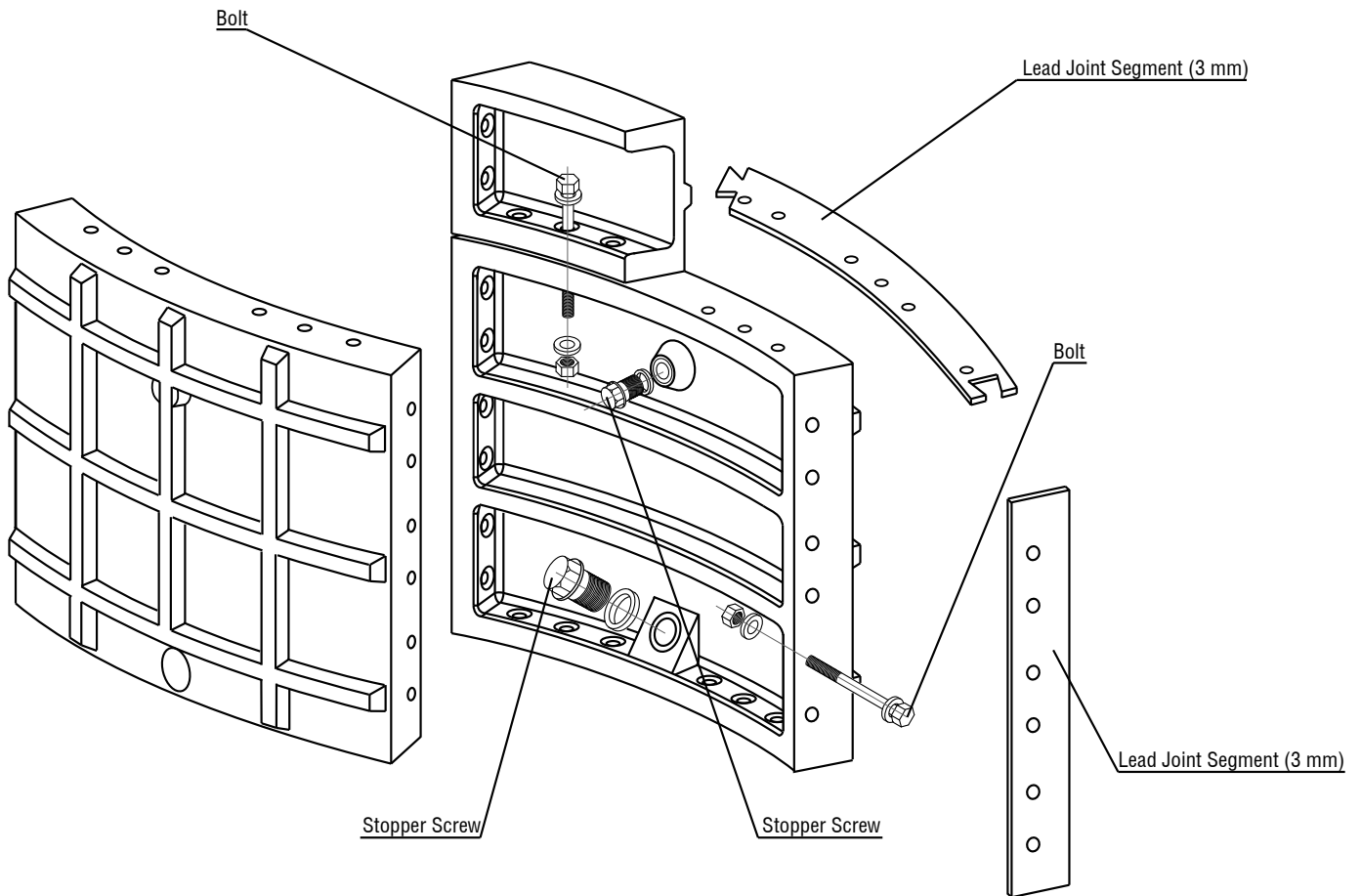
In addition, DTS operates the Design Engineering Institute of Technology, offering both basic engineering services and detailed design work for a wide range of equipment. Our specialists leverage their expertise to modernize existing equipment as well.

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

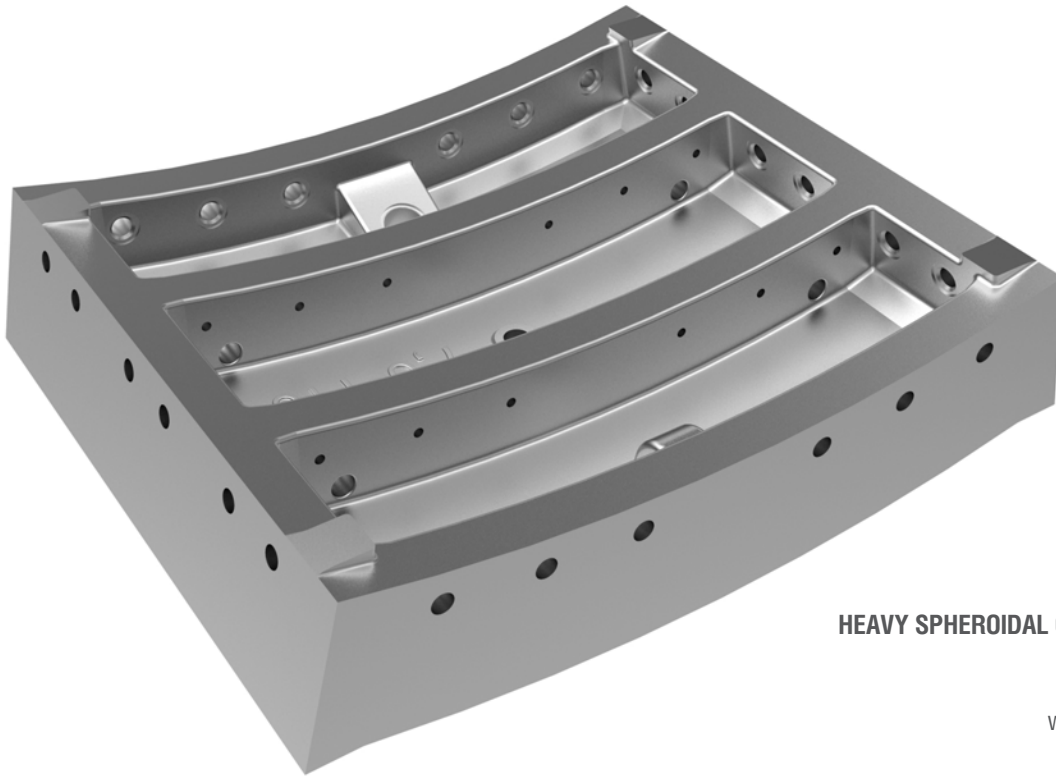


Metal liner (tubbing) is cast iron, cast steel or fabricated segment with flanges and screw holes on all sides, used as a sealing in mine shaft-sinking and tunneling. The metal tubing support composed of metal tubing rings.

The joint flanges are used to screw the metal tubing to a metal tubing ring, and the bearing flange is used to screw the rings to the metal tubing support. Sealing of different kinds may be applied between the flanges, and the kind of sealing is mostly stipulated by the purpose of the tubing. 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.

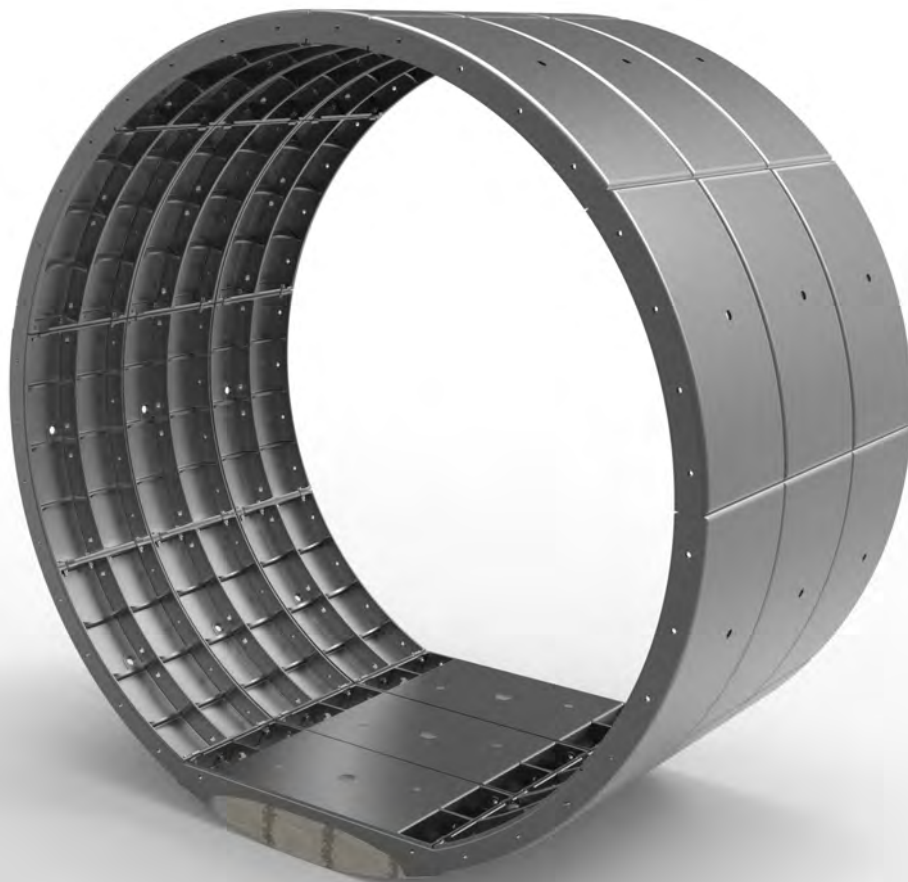
### LINER TYPES:

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.

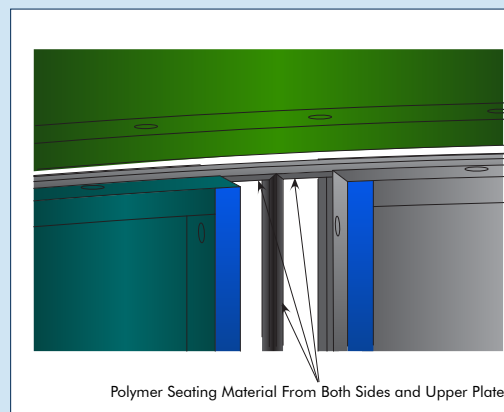
### Vibration Resistance and Temperature Variance

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.





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 9001:2015.



### CERTIFICATE OF REGISTRATION QUALITY MANAGEMENT SYSTEM

This is to certify that  
The Quality Management Systems of  
**WOOSUNG METAL CO., LTD.**  
at  
99, Haeseong-gil, Seongyeon-myeon, Seosan-si, Chungcheongnam-do, Korea

Certificate No. AK13QM1480

Standard ISO 9001:2015 / KS Q ISO 9001:2015

Scope of Certification

Manufacture of mechanical components for pump, valve, vehicles&welding(pipe),  
Machining Processing, Assembly

• Issue Date : 03/01/2024

• Certification Date : 05/01/2012

• Valid Date : 04/01/2027



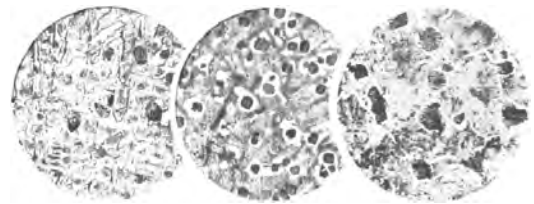
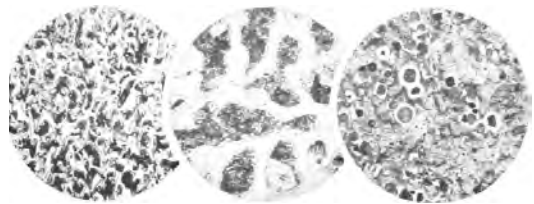
*Min Chul Choi*  
Chief Executive, AK Registrars

This Certificate has been issued by AK Registrars.  
1809 Pn, 122, Gwanak-ro, Seoul, Korea (06051)  
TEL: 82(0)2-6940-1001 FAX: 82(0)2-6940-1002

This certificate will be put back to prevent misuse. If the certificate is suspended due to the expiry date of the certificate,  
AK Registrars was recognized by the Korea Accreditation Support Center (KASC) as a quality management system certification body.  
certification number: KAD-QC-41.  
This certificate is a mark indicating that the certificate holder is continuously recognized by the International Accreditation Association.

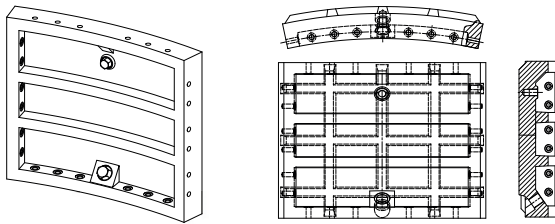
### OUR POLICY:

- ✓ 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.

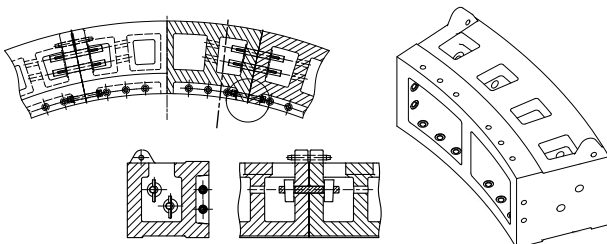


# LINING FOR MINE SHAFTS AND TUNNELS

## 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

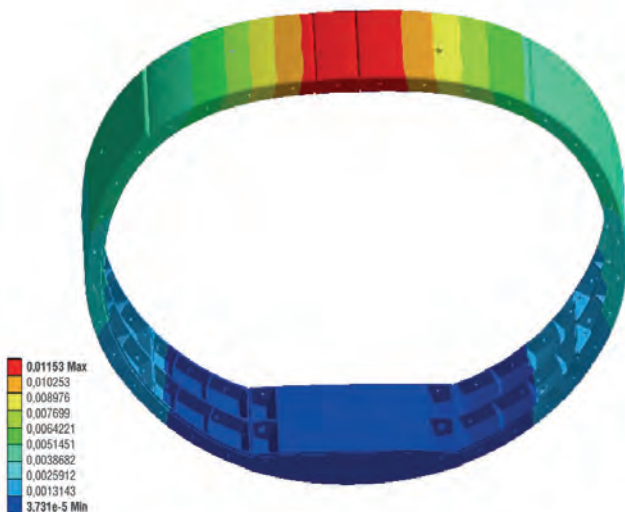
##### Tubbing Rings Stress-Strain Behavior Analysis

#### DTS Role:

Geometrical modeling of lining rings was performed by its 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.).





# 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.

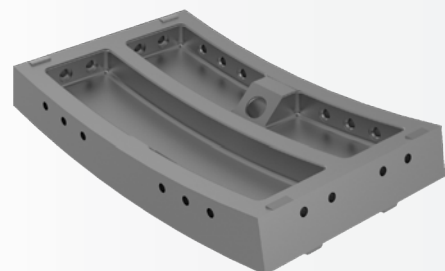
The Blairmore formation extends from approximately from 430 m to 490 meters below ground and comprises a sequence of clean sandstone interbedded with shales at 1 200 – 1500 psi making the layers unstable with the need for stronger, more durable waterproof lining for Blairmore formation zone.

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.



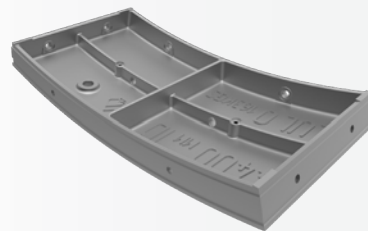
### DTS Role:

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 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 2007–2024

### 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    | 6.25–9.5    | 100           | 9000     | 600        | 24000     | 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                           |                       |                  |             |          |           |           |
| Transinzhtstroy JSC              | Moscow Subway         | Cast Iron        | 4,0–9,5     | 48,404   | 20,925    | 2015–2020 |
| 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 |
| Tunnelstroykomplekt JSC          | Moscow Subway         | Cast Iron        | 5,49–9,5    | 101,252  | 68,136    | 2015–2021 |
| 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                   |                       |                  |             |          |           |           |
| Ferrovia 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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www.dts.equipment

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