



## **Thessaloniki metro construction:**

### **SELI TBMs successfully face several challenges. As of July 2009, excavation at full speed.**

*After crossing four metro stations and under-passing a six-hundred year old mosque with top-level risk of caving in,, the two EPB TBMs are now advancing regularly with a daily output of 18.75 m/d and 16.05 m/d, respectively.*

SELI TBMs, which are involved in Thessaloniki metro construction, entered into full production in July 2009. Excavation is now proceeding regularly.

The South TBM output has increased from 6.7 m/d in April 2009 to 18.75 m/d in August 2009. Maximum output of 27.00 m/d was reached on 28<sup>th</sup> August 2009.

The North TBM output has increased as well, from 5.35 m/d in April 2009 up to 16.05 m/d in August 2009. Maximum level of 22.46 m/d was reached on 5<sup>th</sup> August 2009.

In early 2009, excavation of the first stretch proved to be complex and was slowed down by several challenges facing the TBMs.

Complicating work even more were several critical situations: crossing four stations, the presence of historical buildings and a shallow geology of sand, clay and sandy clay. Primary grouting was carried out using the bi-component technique.

The South TBM passed through the first four metro stations where only diaphragms were completed; the station body will be excavated at a later stage. SELI-AEGEK personnel, however, discovered unexpectedly that diaphragm reinforcement was made of iron, rather than fibreglass, as previously believed, in two walls of the first two stations. The second TBM in the North found steel reinforcement in one diaphragm wall of the same station.

As a consequence, the TBM was still for an extended period while personnel undertook an extensive maintenance campaign under hyperbaric conditions to remove iron and substitute the damaged tools.

In one week, a record 8 hyperbaric interventions were carried out under a pressure of 1.7 bar. The North TBM faced the further challenge of passing under the 15<sup>th</sup> century Alkazar mosque.

The religious building showed a top-level risk of falling equal to 3 and an extremely frail structure, as proved by several extended fractures on the dome and on walls. This was due to the fact that the mosque had been enlarged and recast several times and suffered earthquake damage. A further critical event then occurred: while building up the diaphragms of the station next to the mosque, the variation of the hydro geological balance caused the structure a differential crush of 55 mm, concentrated at the angle under which the TBM passed.

The TBM successfully passed under the Alkazar mosque in late August 2009.

On the whole, excavation proceeded in an extremely controlled and optimal way thanks to strict application of excavation and control procedures, constant parameter analysis and the organisation of periodical meetings with operators.

## TBM EXCAVATION SPECIFICATIONS:

Average production per month	South TBM	North TBM
Apr. 2009	6.7 m/d	5.35 m/d
May 2009	12.53 m/d	12.07 m/d
June 2009	12.30 m/d	11.90 m/d
July 2009	17.40 m/d	17.70 m/d
Aug. 2009	18.75 m/d	16.05 m/d
<b>Average output since start of excavation</b>	<b>12.47 m/d</b>	<b>14.17 m/d</b>

### THESSALONIKI METRO: project specifications

Thessaloniki metro construction was commissioned by the Greek company, ATTIKO METRO A.E., based in Athens.

In 2007, the commissioner awarded design, construction and commissioning of the project to an Italian-Greek JV composed of AEGEK SA, IMPREGILO SPA, ANSALDO TRASPORTI SPA, ANSALDO BREDA SPA, and SELI SPA.

The contract, valued at € 958 million, includes the following works:

- Construction of 13 new stations
- Construction of an Operation Control Center (OCC)
- Connection works of the Metro line with the trains depot
- Construction of the Main Administration Building
- Supply of trains for the transportation of passengers.

SELI is in charge of boring two 7.7-km twin tunnels, utilising two EPB TBMs driving from two opposite portals. These machines are equipped with special safety systems and AFS for the automatic injection of bentonite to the front face in the event of a pressure decrease.

The final tunnels will have an internal diameter of 5.30 m and an external diameter of 5.90 m and will be lined with 30cm-thick precast concrete segments.

Geology along the alignment is comprised of stiff clay, silty clay, gravel, clay.

The new metro line will run at a max. depth of 27 m from the west side of the city at the "New Railway Station" as far as Nea Elvetia Terminal Station on the east side.

Once completed in 2013, the metro line will support a transportation capacity of 18,000 passengers per hour for every track and a train frequency of 90 seconds.

Works started in early-2009 and will be completed in 2012.