

# System Safety Verification of the Shanghai Maglev Line

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Staff Preparation  
Transrapid

## Abstract

The paper describes the assessment tasks carried out by TÜV InterTraffic for the Shanghai Maglev Project to ensure safety of the overall system prior to the Revenue Service which started in 2004. The assessment concluded with a recommendation in order to apply successfully for the Operating Licence. The licence was granted by the Chinese Approval Authority.

## 1. Introduction

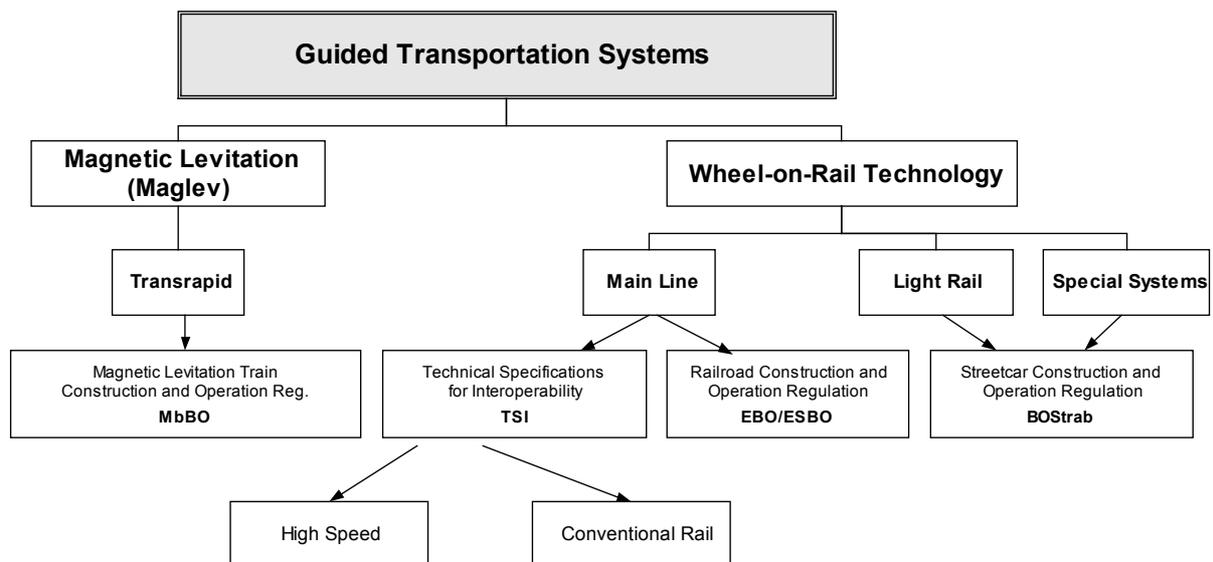
The construction of a magnetic levitation train route between the international airport of Pudong and the city of Shanghai is the first commercial application of the Transrapid magnetic levitation train.

TÜV InterTraffic as member of TÜV Rheinland group is a global assessor for all safety - critical issues of the Transrapid Maglev train. The assessor has a lot of experience with railway systems and accompanied the design, test and introduction of the innovative Transrapid technology over a period of 25 years.

The field of work and a selection of projects carried out are shown on figure 1 and 2.

- **1965** Inspection of interlocking systems for open pit mining trains at Rheinbraun, Germany
- **1975** Project accompanying inspection of driverless people movers (C-train, M-train)
- **1977** Beginning of the safety evaluation of Maglev system Transrapid
- **1984** Operation of the first driverless operated guided transport system for public transport in revenue service, Inspection of the ATP-system H-Bahn Dortmund
- **1989** Passenger transport system Sky Line at Frankfurt International Airport, Inspection according to project progress
- **1994** Accreditation of ISEB by Eisenbahn-Bundesamt (EBA) as Inspection Body
- **1997** Continuous Inspection and Acceptances of the Metro Copenhagen
- **2002** Foundation of Global Rail Consult and Rail Test Ltd.

**Fig. 1: TÜV InterTraffic involvement in rail technology**



**Fig. 2: TÜV InterTraffic Business Mission**

Due to this outstanding expert knowledge and long practical experience TÜV InterTraffic as member of TÜV Rheinland Group and part of the joint task force Arbeitsgemeinschaft TÜV Transrapid has been selected to carry out several assessment tasks. The assessment was done on behalf of the Consortium Transrapid Project Shanghai (CONS) founded by Transrapid International (TRI), Siemens and ThyssenKrupp as well as the Chinese Maglev Operator SMTDC (Shanghai Maglev Transportation Development Company) to assure safe operation during the commissioning phase and prior to the Revenue Service which started in 2004. Based on the assessment, the Chinese safety authority SHTPCH (Shanghai High Speed Transrapid Project Construction Headquarters) issued the Operating Licence.

## 2. Purpose of the System Safety Verification

The System Safety Verification (SSV) is defined in [3] as verification of the requirements, parameters and boundary conditions fixed in the Safety Concept, Approval Declarations and Rules & Regulations for Operations and Maintenance in order to close possible gaps in the proof of safety process.

The SSV is therefore seen as final assessment step enabling the Maglev Operator to apply successfully for the Operating Licence as pre-requisite for starting the commercial operation of the Maglev (see figure 3). A lot of assessment activities on technical subsystems and operational instructions have already been carried out in advance during the development process.

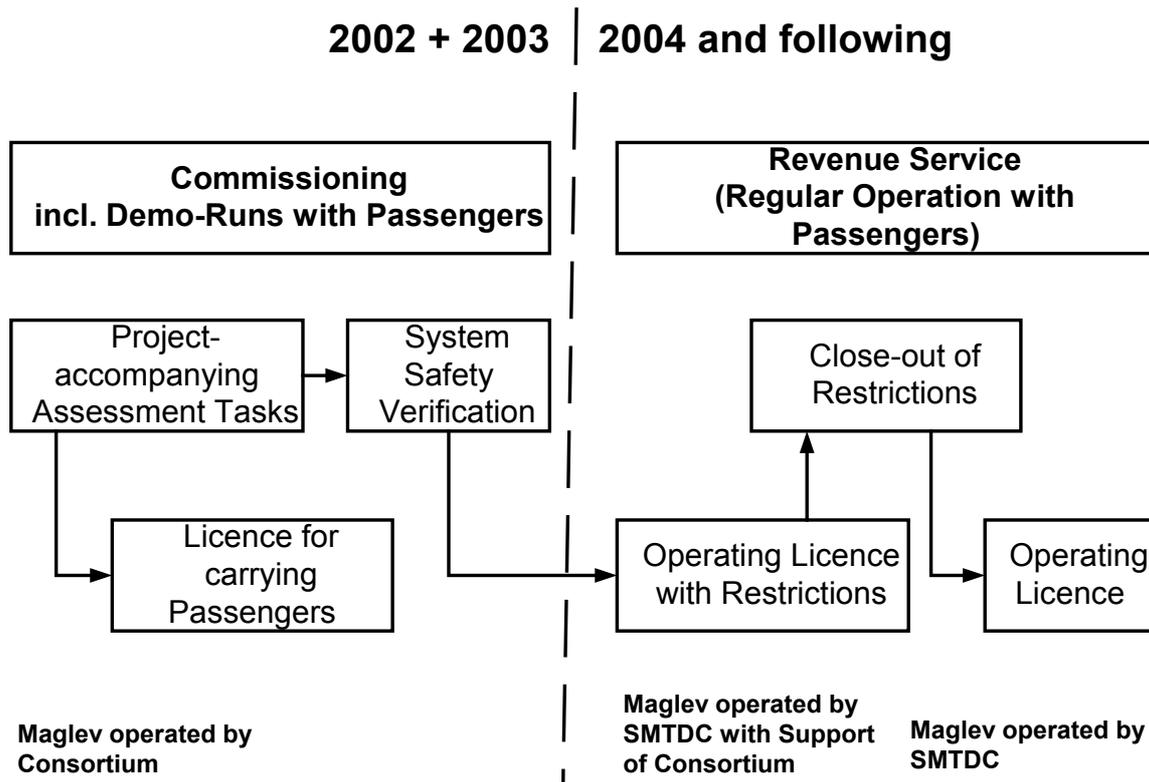


Fig. 3: Assessment approach in the different phases of Maglev operation

## 3. Extent of the System Safety Verification

Central part and basis of the SSV is the Safety Concept for the Shanghai Maglev Transrapid Project (SMTP) which is agreed between CONS and SMTDC. It splits the entire safety in

- safety of the technical systems,
- safety of operation & maintenance.

The assessment itself was carried out in the offices of TÜV InterTraffic and on site. The activities in Shanghai were supported by CONS, SMTDC, IABG and the local branch TÜV Rheinland (Shanghai). It dealt with the deliveries and services within the responsibility of the German suppliers and their interfaces to Chinese contributions. The Chinese deliveries and services (e.g. construction of the guideway, operation and maintenance facilities, manning-up & readiness of staff) were not assessed since this is within the responsibility of the Chinese suppliers.

The extent of the SSV is depicted in figure 4.

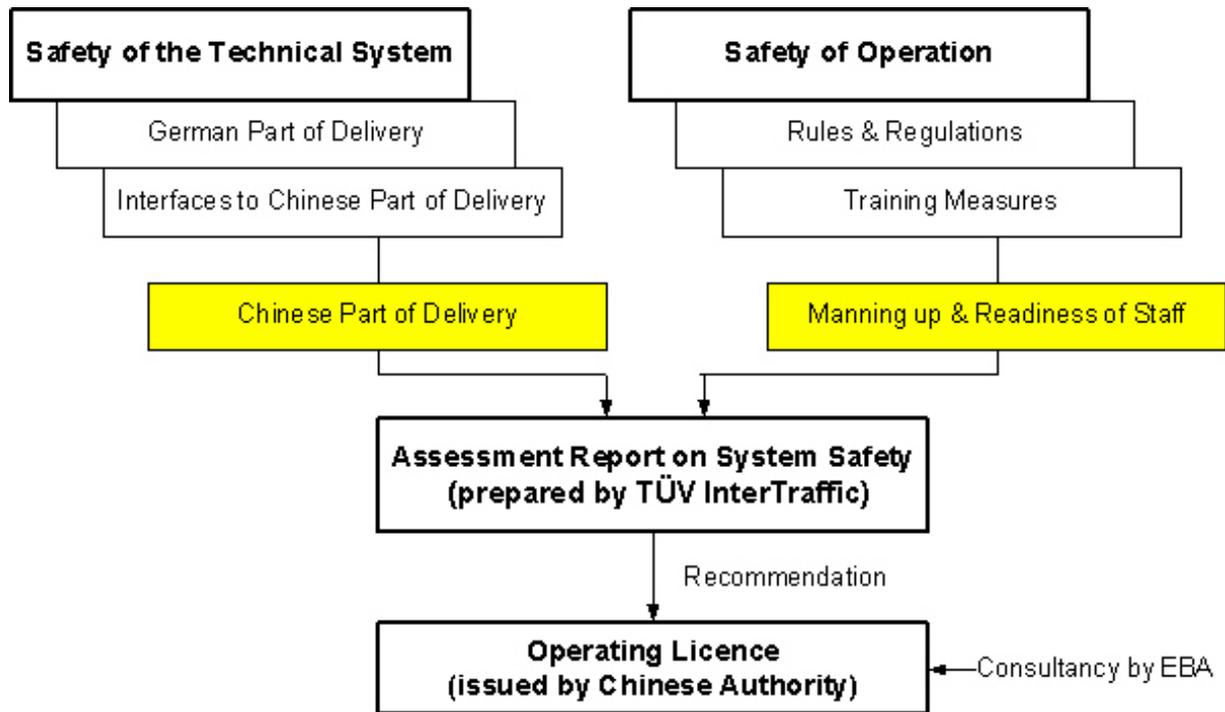


Fig. 4: Extent of the System Safety Verification

#### 4. Detailed Assessment Tasks

The assessment in the course of the System Safety Verification was divided into inspection of documents and inspections on site.

The document inspection of the Safety Concept submitted by CONS comprised the following:

- Formal inspection,
- detailed inspection of the contents (using criteria checklists),
- spot-check inspection of the contents of referenced documents,
- verification of the status of safety relevant assessment reports, certificates, declarations of conformity and approvals for all technical subsystems, operational instructions and training measures.

During the assessor's presence on site visual inspections and tests of system functions have been carried out.

The visual inspections referred to

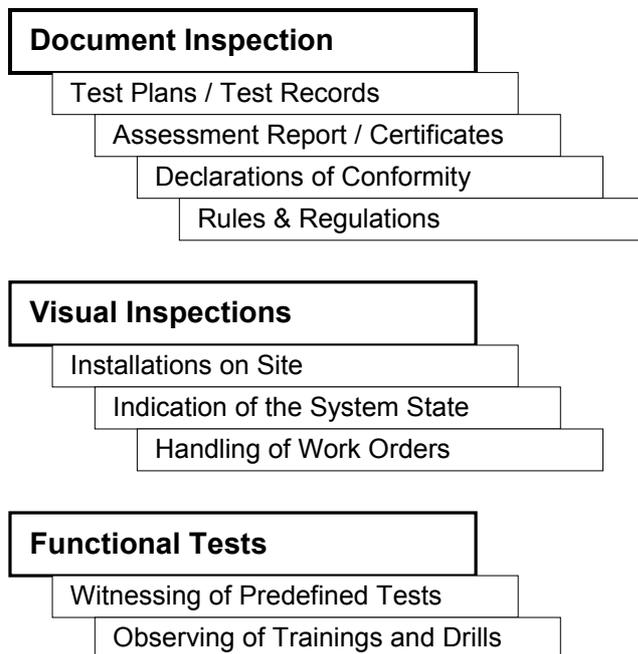
- the installations of technical equipment with safety functions,
- appropriateness of diagnostics and test devices,
- interfaces between operations and maintenance (approach, sharing of responsibilities).

On system level a set of test cases have been defined by CONS and TÜV InterTraffic. Special focus was laid on interfaces between the various sub-systems. For each test case, the created

- test specifications defining the purpose and process of the test,
- test reports describing performance and outcome of the test

have been judged in detail. The assessment results have been reported to CONS and SHTPCH.

The complete approach is summarized in figure 5.

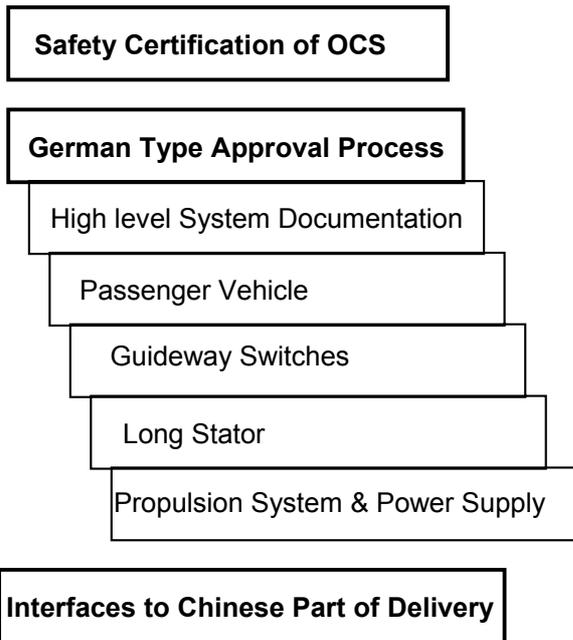


**Fig. 5: Assessment tasks of the System Safety Verification**

Examples of test cases carried out for checking the system behaviour and diagnostics are:

- check of passenger vehicle functions under various conditions (emergency brake, exit and section doors),
- check of fire alarm and emergency call equipment in passenger vehicles and stations,
- fault injection in locating system, guideway switch sensors, operation control system,
- participation in emergency and rescue exercises.

Regarding the safety of the technical systems, previous already performed examinations on subsystem level, which split mainly into the Safety Certification of the Operation Control System (OCS) and the German Type Approval process, have been taken into account (see figure 6). The Chinese contribution (Construction of the Guideway, Stations, Maintenance Facilities, manning-up of appropriate staff) is part of a separate assessment carried out by the Chinese suppliers.

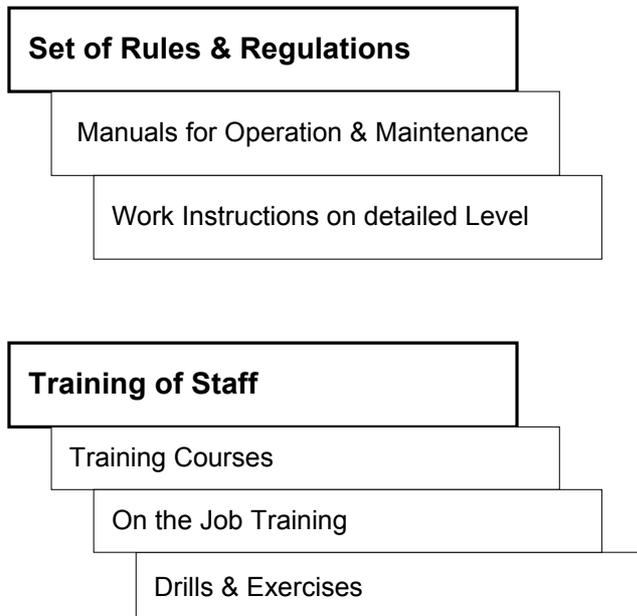


**Fig. 6: Technically related assessment tasks**

Concerning the Safety of Operation,

- the necessary Rules & Regulation documents for operation and maintenance (both high-level manuals and detailed work-instructions) have been inspected in detail,
- the performed training measures for preparing the Chinese operating staff have been evaluated on a spot-check basis (audits with trainers and trainees, locking up of training programs and records).

This process is depicted in figure 7.



**Fig. 7: Consideration of staff preparation**

## 5. Results and Outlook

The comprehensive system knowledge and outstanding experience of the TÜV experts made it possible to carry out the necessary works under a very tight time schedule. It must be highlighted, that the safety of the Shanghai Maglev line was ensured at any time of the various life-cycle steps.

A summarizing assessment report on the System Safety Verification containing the approach, test results and several restrictions to be observed during the train runs was prepared by the assessor and handed over to CONS and the approval authority SHTPCH. The report concluded with a recommendation to grant the Operating Licence under obedience of the stated restrictions. Based on this, the Operating Licence was granted by SHTPCH.

For the removal of the stated restrictions a follow-up process was agreed between SMTDC and CONS for the German part of delivery and services. This process was also supervised by TÜV InterTraffic.

It is a great success seeing the first commercial Maglev application running in Shanghai!

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