

CHECK OF OPERATIONAL RULES & REGULATIONS FOR THE TRANSPRAPID TEST FACILITY EMSLAND (TVE)

No. 16

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ABSTRACT: The TÜV Rheinland InterTraffic GmbH (TRIT) has been in charge of the safety assessment of the Emsland Transrapid Test Facility (TVE) for over 30 years.

On the TVE, a lot of technical components have been renewed or exchanged. As a result, the set of applicable rules & regulations and the staff responsibility has been revised. These documents have been examined by TRIT on behalf of the Approval Authority.

This paper explains the structure of the operational framework and points out which particular aspects have been considered during the examination carried out by the appointed Safety Assessor TÜV Rheinland InterTraffic GmbH:

- Handling of diesel motorised service vehicles,
- Movement and safeguarding of TR09 Maglev vehicle,
- Execution of maintenance tasks on the test track and in the maintenance area,
- Ensuring safety functions: balance between technical and operational measures.

This presentation summarises the final result of the assessment which was carried out in order to get the acceptance of the operational rules granted by the Authority in charge.

1. Introduction

The Transrapid test facility (“Transrapid Versuchsanlage Emsland”, TVE) was built from 1979 to 1987 for testing Maglev vehicles and related subsystems at high speed (see figure 1).



Figure 1: Transrapid test facility: Track layout

From the beginning, the TVE was subject to the law for test facilities (Versuchsanlagengesetz). According to this law, the Approval Authority is the “Niedersächsische Landesbehörde für Straßenbau und Verkehr” (NLStBV) within the state of Lower Saxony. In the course of the approval of the operation regulations according to §12 (4) of the law for test facilities (/1/) the Approval Authority appoints experts/ expert organisations to assess the TVE Rule Book and to supervise the observance of the operation regulations.

One of the two appointed expert organisation is the TÜV Arbeitsgemeinschaft Versuchsanlage Emsland (TÜV Arge VME), a joint venture of TÜV Rheinland Group and TÜV Nord Gruppe.

TÜV Rheinland InterTraffic (TRIT) as part of TÜV Rheinland Group examines technical subsystems, operational regulations and overall safety.

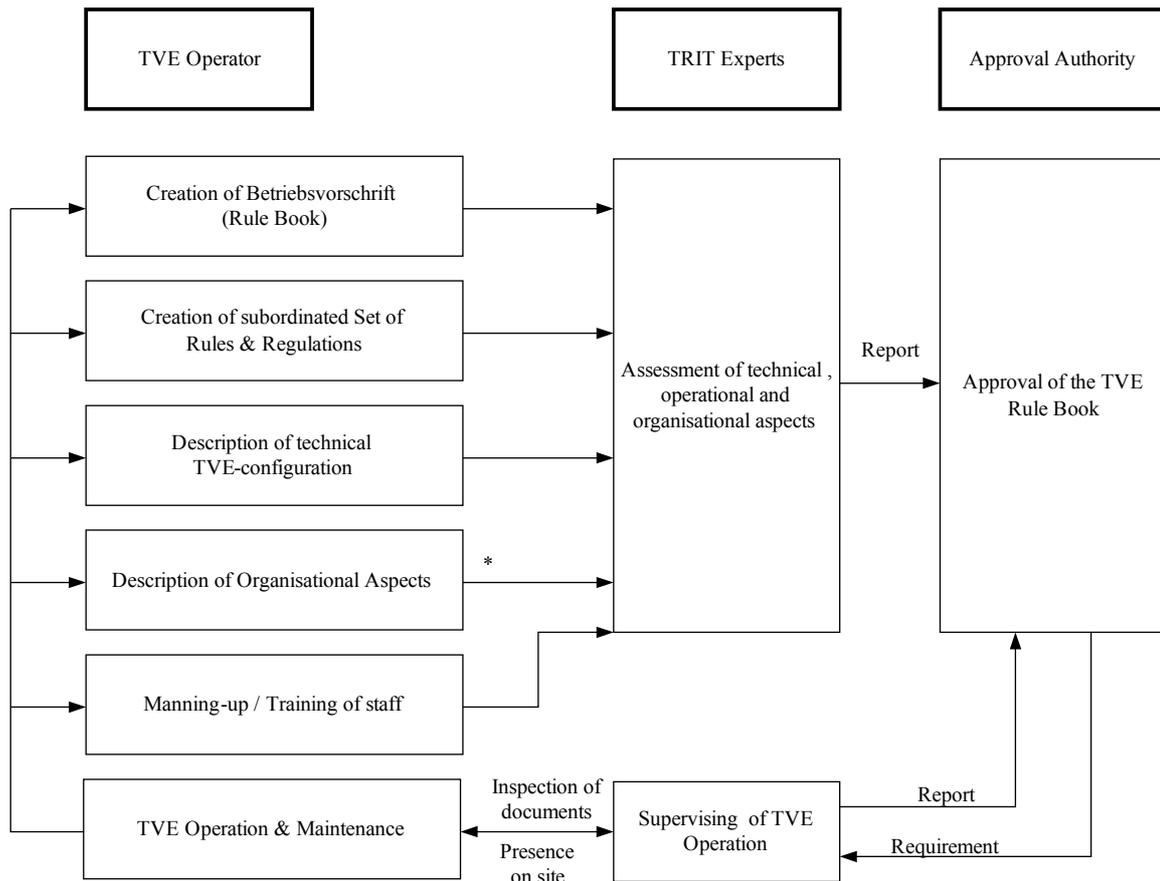
According to the Versuchsanlagengesetz (law for construction and operation for test facilities of guided transport systems) the

permission for TVE operation is granted, after the high-level Rules & Regulations document “Betriebsvorschrift” (Rule Book) is approved by the Authority. In addition, further requirements also requested by the Authority must also be assessed / judged by TRIT and sufficiently fulfilled by TVE Operator IABG.

In consequence, the experts of TRIT have inspected the

- High-level Rule Book issued by IABG,
- Safety related subordinated procedures and work instructions issued by IABG or Maglev industry,
- Documents related to technical subsystems and
- Documents related to Overall System Safety.

The whole process is depicted in figure 2. The assessment on technical subsystems and Overall System Safety is the topic of another presentation (No. 15) held by the same author at the Maglev 2008 conference.



* Emphasis is laid on TVE-Management, QMS, SMS

Figure 2: Roles and Tasks for TVE operation

2. Structure and Content of Rules & Regulations documents

The top level document (which is subject of approval by the Authority) is the so-called “Betriebsvorschrift”. It contains general definitions on TVE objectives, technical configuration, roles and responsibilities of TVE operation manager and operation & maintenance staff, a description of the applied Quality- and Safety Management System (QMS, SMS) and operational scenarios.

Aspects to be highlighted are:

- Organisation and qualification of staff, especially TVE Operation Manager (“Betriebsleiter”)
- Tasks, reporting and communication procedures

- Test runs with Maglev Vehicle TR09
- Movement of Service Vehicles
- System releases (after checks and modifications)
- Inspection and Maintenance tasks, especially handling access requests during operation
- Transition of responsibilities

to be applied in

- Normal situations (system status ok)
- Abnormal situations (degraded mode)
- Emergencies (Fire Protection, Evacuation & Rescue).

An overview is presented in figure 3.

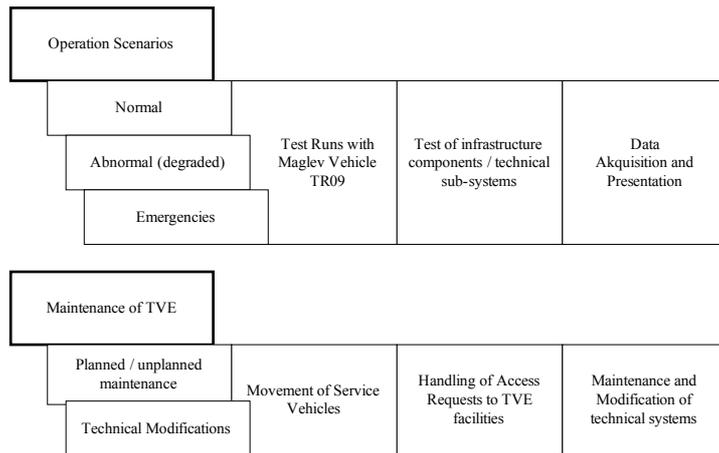


Figure 3: Aspects covered by Rules & Regulation documents

The structure of Rules & Regulations documents is depicted in figure 4.

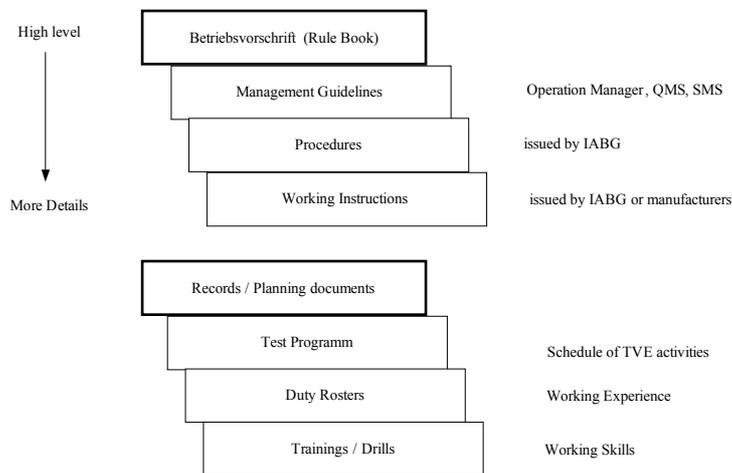


Figure 4: Structure of Rules & Regulation documents

Subordinated to the high-level “Betriebsvorschrift” are guidelines, procedures and work instructions. All safety related documents have been inspected by TRIT experts. Results are reported to the Approval Authority and copied to TVE operator IABG for information. The inspections were carried out in an interactive and iterative process containing some improvement / clarification loops.

The inspection was carried out to check whether the requirements contained in the laws, codes and standards (State of the Art) have sufficiently been regarded / covered. A selection of applied standards is listed in chapter 6 of this presentation.

The documents to be inspected were checked regarding their suitability to be a framework for operating and maintaining the TVE. Where deficiencies were revealed, remarks have been stated, which lead to conditions and restrictions to be observed.

3. Assessment Criteria for Rules & Regulation documents

3.1 Inspection of Rules & Regulation documents

The inspection of the documents is based on generally accepted rules and standards of technology and considers topics predefined by the employer in his order to be looked up by the Assessor. The

inspection carried out concentrates on the safety relevant requirements and mainly considers the following criteria:

- **Validity**
The given information must be free from errors.
- **Completeness**
The given information must cover all aspects to be taken into consideration.
- **Unambiguity**
All definitions of terms, statements and descriptions must be unambiguous. Ambiguous formulations are to be avoided. Terms must be used uniformly according to their definitions.
- **Consistency**
All statements and descriptions must be consistent to the document itself and in relation to other documents. Terms must be used uniformly according to their definitions.
- **Inspectability**
Sufficient information must be given in a clearly organised way. The inspectability is influenced by readability, scale, clarity, complexity and the contents.
- **Comprehensibility**
The comprehensibility is determined by a concise description of facts and relationships and a precise/uniform definition of terms.
- **Format and Structure**
Requirements concerning format and structure, e.g. document identification, validity (officially released, verified, draft version).

The above mentioned criteria have also been applied whether,

- Effects on overall safety (coverage of functional and safety requirements) are covered,
- The ratio between operational and technical measures is appropriate,

- Interfaces between technical subsystems and staff are clearly depicted.

Formal criteria have been checked by using checklists derived by TRIT.

For evaluation of the content, TRIT experts used their broad knowledge and experience gained during activities on TVE for over 30 years, on Shanghai Maglev Demonstration Line and on several high-speed and urban guided transport systems worldwide.

The documents have been checked regarding their suitability for their intended use. This also includes requests raised by IABG as well as safety related application conditions and operation & maintenance instructions issued by the manufacturers of the involved technical systems.

3.2 Observation of TVE operation

TRIT is in charge of the supervision of the TVE operation in order to report to the Approval Authority. This is to confirm whether all requirements

- Issued by the Approval Authority
- Stated by TRIT experts
- Written in Rules & Regulation (R&R) documents

have been observed or fulfilled during TVE operation.

It was also checked, whether

- The R&R laid down and inspected are feasible and reasonable in praxis,
- Staff is well prepared and manned up,
- Changes in the regulations, in technical systems and within staff are managed.

This was done by witnessing test runs, interviewing and observing staff members and participating in evacuation & rescue drills.

In detail, the assessor supervised on a spot-check basis whether TVE staff behaviour is in line with the Rules & Regulations documents. Some aspects to be highlighted:

- System releases of all involved subsystems,
- Supervision of test runs of Maglev Vehicle,
- Supervision of Service Vehicles movements,
- Access to control room and stations, protection of clearance envelope,
- Managing of records such as logbooks and duty rosters.

To evaluate the staff ability to handle the system safely and to prove the level of

qualification, the following are regularly evaluated on a spot-check basis:

- The implemented organisation,
- Existing training plans and already performed training activities (records),
- Certificates handed over to appointed staff members (authorisation of staff),
- Availability of standby positions.

The inspection process on Rules & Regulations documents carried out by TRIT is depicted in figures 5 and 6, the supervision of TVE operation was already presented in brief in figure 2.

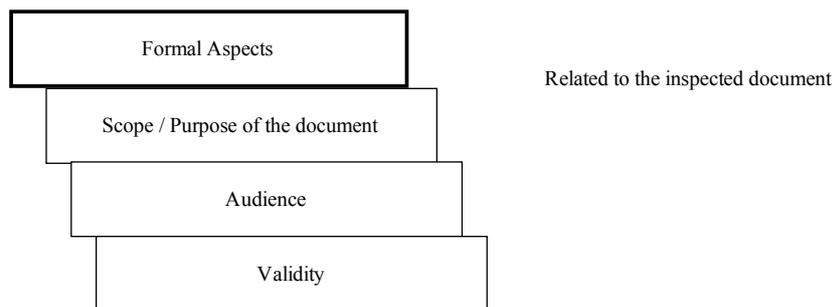


Figure 5: Inspection of Rules and Regulation documents (1)

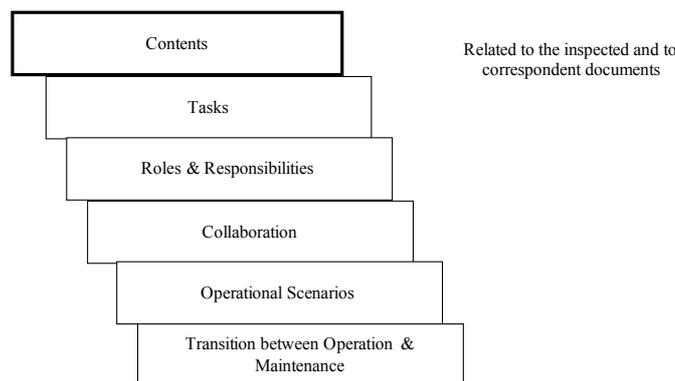


Figure 6: Inspection of Rules and Regulation documents (2)

- 4. Selected Aspects of TVE Operation
- 4.1 General remarks

In principle, safety functions shall be controlled by technical means.

During installation and commission, staff must not rely on the systems under test which are modified or completely new. To ensure safety, supervision by staff and additional (simple) safety equipments - already approved in advance - must be put into place accompanied by intensive staff training.

After commissioning and finishing all Safety Acceptance Tests, (almost) all safety functions should be completely controlled by technical means to avoid or minimise human errors.

However, the nature of TVE as serving as Test Facility characterised by lot of

modifications in the technical configuration requires a permanent presence of staff dealing with safety functions.

4.2 Characteristics of TVE Vehicles and Infrastructure

Some characteristics of TVE for operating the various vehicles and to monitor the system status are presented in figures 7 to 9.

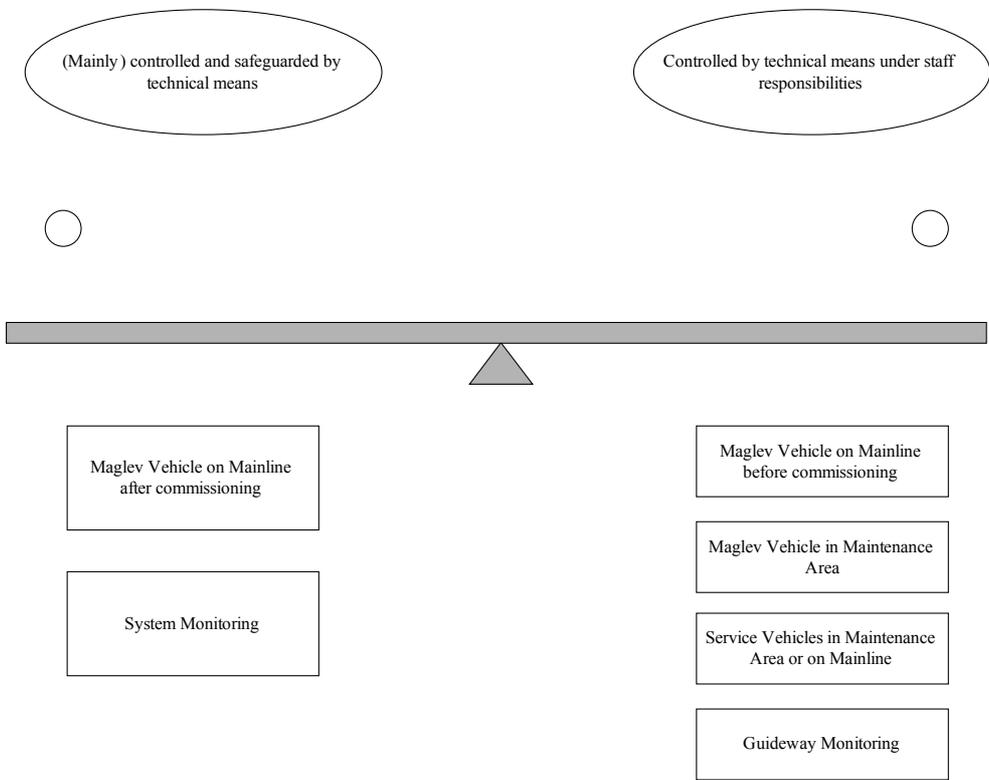


Figure 7: Balance between Technical and Operational Measures

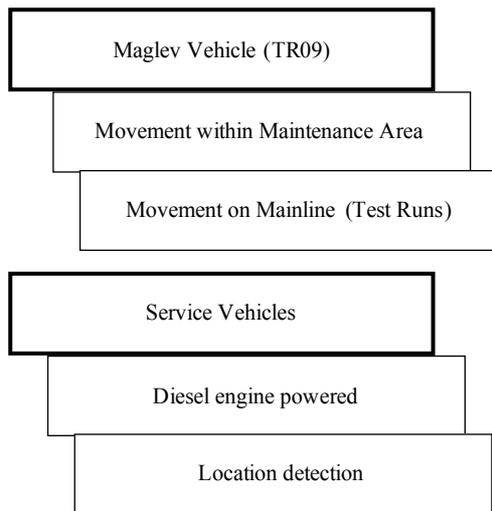


Figure 8: Technical characteristics of Subsystems on TVE (1)

Some aspects to be treated during TVE assessment are:

- Maglev Vehicle : New vehicle on TVE, labelled “TR09”
- Supporting technical means for operation:
 - Operation Control System: Modified
 - Propulsion System: Modified
 - Guideway: Some beams completely new constructed
- Service Vehicles: Manually driven, supervised in staff responsibility
- Supporting technical means for operation
 - GPS (Global Positioning System) and radio communication for vehicle position detection
 - ZBR (“Zusatz-Betriebsleittechnik Radfahrzeuge”): Fail-safe cable link to exclude simultaneous movements of Service Vehicles and Maglev Vehicle

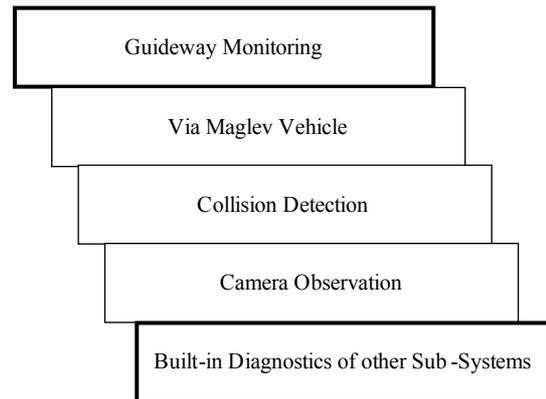


Figure 9: Technical characteristics of Subsystems on TVE (2)

All train movements in the Maintenance Area (see figure 10) are conducted in full personal responsibility of staff. Service Vehicles are Diesel-powered; Maglev Vehicle will be moved by means of a separate low-power converter at low speed in this area.

A simultaneous operation of Maglev Vehicle and Service Vehicles is excluded by technical means. If not all Service Vehicles are locked in pre-defined parking positions, traction power for Maglev Vehicle will be cut-off by safety equipment.

On the mainline of the guideway (please refer to figure 1), IAGB has implemented a lot of diagnostic systems

- To monitor the guideway geometry,
- To watch the guideway proximity,
- To detect all vehicle’s locations,
- To discover non-authorized access into the clearance envelope.

These measures shall guarantee safe hovering conditions and minimize risks of collisions.

In other technical subsystems, various built-in diagnostics are in place to monitor the system status and to assure high system availability.

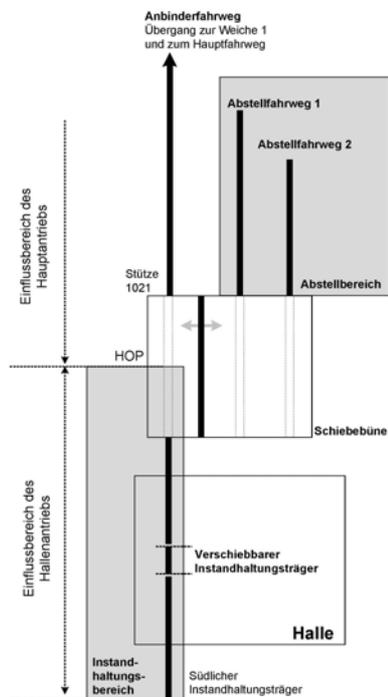


Figure 10: TVE Track Lay-Out (Maintenance Area)

5. Outlook

Due to well prepared work and close communication of IABG, Maglev Industry, TRIT experts and Approval Authority, all tasks could be finished successfully.

The Approval of TVE Rule Book as prerequisite for TVE operation for the new Maglev Vehicle TR09 and modified technical subsystems was granted. TR09 and other technical systems have started test programs to proof their suitability of use.

As per beginning of September (date of issue of this paper) the comprehensive tests of all new technical systems and operational regulations are ongoing.

TÜV Rheinland InterTraffic GmbH has shown its competence in the assessment of complex technical systems with human interactions. The company's aim is to service clients nowadays and in future in an effective and cooperative way.

6. References

- /1/ Gesetz über den Bau und den Betrieb von Versuchsanlagen zur Erprobung von Techniken für den spurgeführten Verkehr (Versuchsanlagengesetz) vom 29.01.1976, zuletzt geändert am 31.10.2006
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- /3/ Ausführungsgrundlage Magnetschnellbahn Gesamtsystem, Ausgabedatum: 15.02.2007 MSB Fachausschuss Gesamtsystem
- /4/ Ausführungsgrundlage Magnetschnellbahn Gesamtsystem, Anlage 4 Regeln für Betrieb, Ausgabedatum: 15.02.2007 MSB Fachausschuss Gesamtsystem

7. Key words

Transrapid Test Facility, examination, operational instructions, operational staff, acceptance of Rule Book