New Operation Control System Release for the Transrapid Test Facility, Emsland

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ABSTRACT: The principal task of the Transrapid Test Facility, Emsland lies in the continued testing and optimisation of the Transrapid technology for applications in mass transit and main-line transport, as well as for airport links, e.g. in Munich. In 2003 the Federal German Ministry for Transport, Construction and Housing (BMVBW) decided to upgrade it with selective measures, in order to permit realistic, automatic operation on the Emsland Test Facility. A further objective was to create a basis for fresh series of trials within the framework of the ongoing development of the Transrapid. In the paper below we show how important the contribution of the operation control system is, particularly with its signalling and safety function as the heart of the Transrapid system, in the attainment of these objectives. One of the major results of these efforts on the Test Facility is the awarding by the approval body for the first time in Europe of an approval for automatic operation in the high-speed sector.

1 INTRODUCTION

1.1 Point of Departure 2003

In 2003 the Transrapid Test Facility, Emsland had been in service for 20 years and undergone a number of development levels in all its subsystems. A feasibility study had revealed that there were two possible lines in Germany which could be run economically using the maglev technology. One of them, the Munich airport link is now awaiting construction.

In view of this, a technical environment needed to be created in which the upcoming refinements of the Transrapid system were able to be tested in automatic operation under realistic conditions with full technical protection by the operation control system. The Transrapid Test Facility, Emsland, therefore had to be upgraded to the current product platform.

1.2 Complete Catalogue of Measures for the Transrapid Test Facility, Emsland

The following measures were determined for the Facility and implemented in 2003 and 2004:

Propulsion system:

- Reequipping of the gate units in Substation 2
- Installation of new protection and control systems in the track switching stations
- Reequipping of Substation 2 to type I

Vehicle:

- Improvements to vehicle type TR08, e.g.
- Support skids with new slide linings

Guideway:

- Development and implementation of a suitable raised sliding surface for the concrete guideway of the Test Facility
- Dampening of the vibrations in the steel beams on the Northern Loop
- Minimisation of the temperature-dependent upward bending of the beams
- Fitting of a movable maintenance beam

Operation control system and radio:

- Upgrading of the operation control system to the current product platform, BLT4
- Installation of redundant radio coverage in the Southern Loop area

The description below deals exclusively with the implementation of the measures for the operation control and radio systems.

2 UPGRADING

2.1 Potential

In the years before 2003, the findings and lessons learned from operation of the Transrapid Test Facility, Emsland, were recorded and evaluated by the

Test Facility operator. The following potential for improvement was identified for the operation control system:

- Installation of redundant radio coverage in the Southern Loop in order to avoid radio failures
- Improvement of the radio coverage in the maintenance centre
- Enabling the planning and scheduling of trips even with unrestricted track-orientated speed profiles
- Increasing the robustness of the at that time existing system with respect to faults

2.2 Measures in Detail

In order to fully exploit the potential described, the following measures affecting the radio system were determined and executed:

- Installation of ten additional new radio masts in the Southern Loop
- Replacement of components in the centralised radio control unit (CRCU)
- Incorporation of a debugging PC into the decentralised radio control unit (DCRU) and use of new transmitting/receiving equipment on all radio masts of the Transrapid Test Facility.

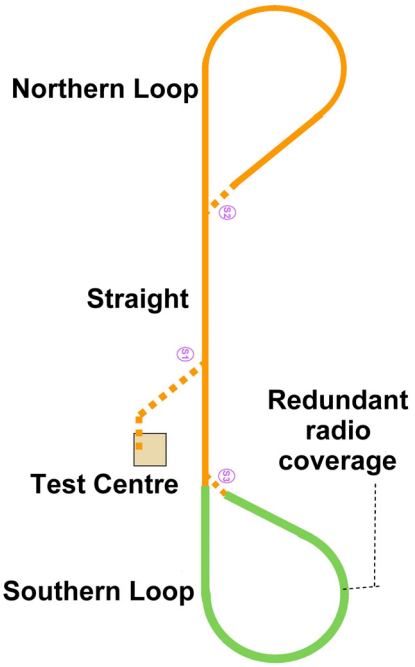

Figure 1: Layout of Transrapid Test Facility, Emsland

With regard to the operation control system, a decision was taken to upgrade the control centre to a modified communication structure, which involved e.g. installing a diagnostic computer and administration PC. The hardware of the following decentralised components was renewed and the associated software brought up to date: Decentralised Control System (DCC), Decentralised Safety Computer (DSC), Decentralised Transmission Computer (DTC), Decentralised Switch Module (DSM) and Decentralised Propulsion Shut-off (DPS); In the vehicle, the Vehicle Safety Computer (VSC) and Vehicle Transmission Computer (VTC) were replaced and supplied with new software.

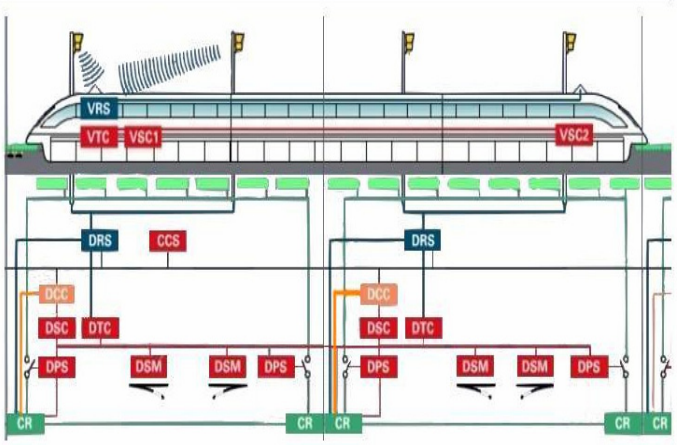

Figure 2: Components of the operation control system

2.3 Implementation and conclusion

The upgrading of the operation control system was planned with a very tight timescale and only minimal standstill periods. Broadly speaking, the project was executed in the following steps: From June 2003, concurrently with the manufacturing of the hardware in the plants and delivery of the new components for the Test Facility, the old ones were progressively removed. Then followed the installation and commissioning of the hardware up to the end of November 2003.

The configuration data for the Transrapid Test Facility was added to the new BLT4 software and the software tested at the System Test Centre at Siemens Transportation Systems in Brunswick (Germany). In the course of the testing, over 2,500 test cases were processed, 90% of these using automatic test methods. Next, the BLT4 software was validated in direct interoperation with the radio system, propulsion system and vehicle in comprehensive tests on the Test Facility, and approved for productive application, by test engineers from Siemens Transportation Systems. As early as the beginning of 2004 we were able to carry out the first runs at 400 kph.

Before the final approval for train operation with full technical protection, it was necessary to have the system assessed by the German Technical Inspectorate (TÜV)- Rhineland, and successfully perform several-month-long safety trials with the cooperation of the IABG (Industrial Systems Operating Company), and under the observation of TÜV- Rhineland, and the Federal German Railways Office (EBA).

The object of the safety trial was to acquire a confirmation of the specific safety functions of the operation control system under real operating condi-

tions, create a greater level of confidence and uncover potential for improvement. For this purpose, a safety trial plan was drawn up and agreed with the operator, TÜV and DB Magnetbahn (maglev subsidiary of German Railways). The observations made and performance levels attained in the safety trial were documented in a safety trial report. Finally, on the basis of this, the results were evaluated by TÜV- Rhineland, in an assessment report. In the safety trial alone more than 100 operating scenarios were tested and over 63,000 km covered in intensive normal operation in accordance with a timetable, without the occurrence of a single safety-relevant incident within the field of responsibility of the operation control system. A new standard was set with the safety trial performed. The efforts on the Test Facility were crowned with the awarding by the approval body for the first time in Europe of an approval for automatic operation in the high-speed sector.

In order to demonstrate the operational suitability of the system for revenue service, DB Magnetbahn compiled a demonstration-of-compliance programme based on the agreed functional specifications, to be performed on the Test Facility. This programme comprised a large number of individual compliance tests and several long-duration tests lasting weeks. The programme was completed within approx. two months and the required functionality demonstrated. In the long-duration tests, the timetables of both the Metrorapid project in Northrhine-Westphalia and the Munich airport link were used. In the individual tests, compliance was demonstrated for, among other things, continuous runs of over four hours' duration. The distance covered by the latter corresponds approximately to a trip Shanghai – Beijing. To demonstrate the reliability and availability of the overall system, a three-month-long trial then followed in the 4th quarter of 2005 using the German Railways' timetable under the observation of DB Magnetbahn. The results confirmed the attainment of the high reliability and availability requirements. In the operation in accordance with the DB timetable, nine trips were carried out punctually between 8:30 a.m. and 2:50 p.m. each day from Monday to Friday in "automatic" operating mode, in addition to the necessary movements to and from the stabling tracks, thereby achieving a continuous daily running performance in fully automatic operation of at least 840 km.

3 RESULTS AND HIGHLIGHTS

3.1 Results

The targets set for the upgrading of the radio and operation control systems were fully met. The upgrading produced a hitherto unattained operational stability, with availability and reliability figures exceeding 98%.

There were no radio system failures in the Southern Loop or faults when changing area. An exceptional robustness of the system was achieved, not only with respect to incorrect input, but also with respect to faults in general and the results obtained are comparable with the standard of the functioning line in Shanghai.

3.2 Highlights

The following goals and results achieved deserve special mention:

- Reliability greater than 98%
- Availability greater than 98%
- 24 hours' continuous operation
- 4-hour non-stop run (corresponds to 1000 km)
- First approval in Europe for automatic train operation in the high-speed sector
- Punctual operation according to a timetable to the satisfaction of both passengers and organisers
- More than 220,000 km covered in automatic operation in 2004 and 2005
- Approx. 90,000 passengers in 2004 + 2005

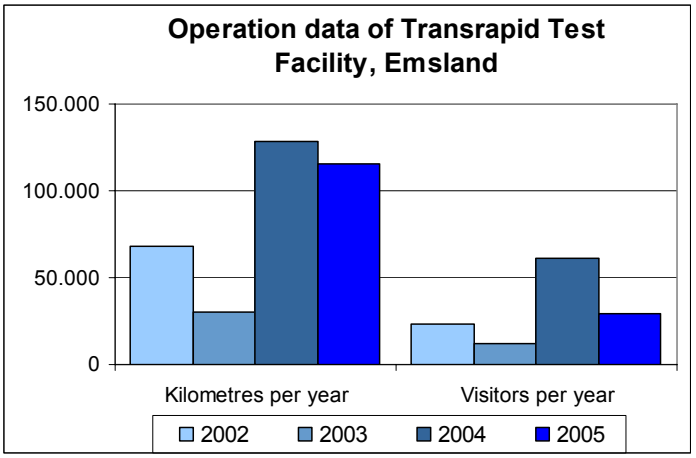

Figure 3: Kilometres travelled and visitors per year

4 CONCLUSION

The planned upgrading measures were completed in 2004 to the satisfaction of all involved parties. In 2005, the agreed functionality, reliability and availability were demonstrated by means of the tests derived from the agreed functional specifications and the trips in trial service of DB AG.

This success story owes itself not only to the operation control system, but also especially to the good and close cooperation between the involved parties: the Federal German Ministry for Transport, Construction and Urban Development (BMVBS, formerly known as BMVBW), German Railways

(DB AG), DB MB, TÜV, the approval body, Transrapid International GmbH (TRI), ThyssenKrupp Transrapid GmbH (TKT-TR), Industrial Systems Operating Company (IABG) and Siemens Transportation Systems. This is a sound basis for the forthcoming projects, particularly in Germany.

Fitted with the upgraded systems and incorporating the know-how of the companies involved, the Transrapid Test Facility, Emsland, is well equipped for the challenges ahead. New innovative refinements in the guideway, vehicle, propulsion and operation control system areas can be tested for feasibility and suitability and optimised in a stabile environment on the Test Facility. A new era began already at the start of 2006.

5 REFERENCES

[1] Jörn Schlichting & Manfred Müller, The Transrapid Radio System, Signal + Draht (97) 1+2/2005

[2] Frank Schünemann, Die Betriebsleitttechnik des Transrapid, ZEVrail Glasers Annalen, Sonderheft, Oktober 2003 (The Operation Control System of the Transrapid, only available in German)

6 ABBREVIATIONS

- *BMVBW* = Federal German Ministry for Transport, Construction and Housing*
- *BMVBS* = Federal German Ministry for Transport, Construction and Urban Development*
- *CCS = Centralised Control Station*
- *CR = Converter*
- *CRCU = Centralised Radio Control Unit*
- *DB* = German Railways*
- *DB MB* = German Railways maglev*
- *DCC = Decentralised Control Computer*
- *DPS = Decentralised Propulsion Shut-off*
- *DRCU = Decentralised Radio ControlUunit*
- *DRS = Decentralised Radio System*
- *DSC = Decentralised Safety Computer*
- *DTC = Decentralised Transmission Computer*
- *DSM = Decentralised Switch Module*
- *EBA* = Federal German Railways Office*
- *IABG* = Industrial Systems Operating Company*
- *OCS = operation control system*
- *TKT-TR = ThyssenKrupp Transrapid GmbH*
- *TRI = Transrapid International*
- *TÜV* = German Technical Inspectorate*
- *TVE = Transrapid-Versuchsanlage Emsland*
- *VRS = Vehicle Radio Station*
- *VSC1 = Vehicle Safety Computer 1*
- *VSC2 = Vehicle Safety computer 2*
- *VTC = Vehicle Transmission Component*

* German abbreviation