Further Development Programme for the TRANSRAPID of the Federal Ministry of Transport, Building and Housing

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Abstract

Due to the results of the prepared feasibility study in the year 2002, regarding the application of the German Transrapid track, Munich Main Station - Munich Airport as well as Dortmund - Düsseldorf on the technical, operational and economical execution of the two tracks, the BMVBW (German Federal Ministry of Transport, Construction and Housing) decided to continue the development of the High Speed Maglev System in an economical and ecological direction. With regard to the Program for Further Development (WEP), the High Speed Maglev System should be technically modified for application into regional transport and also for a fast high quality point to point connection (airport connection) to be realised.

The presentation gives an over-view of the structure and content of the Program for Further Development, illustrates the achievable development status and provides an outlook on further developmental measures.

1 The Overall Programme of the Federal Government

Since 1972, the development of the high-speed Maglev technology has been promoted by the German Federal Government. Since 1983, this technology has been tested and operated for demonstration purposes at the Emsland Transrapid Test Facility (TVE) for long-distance passenger transport.

In 1994, the planning process for a Transrapid line between Hamburg and Berlin was initiated. The Maglev planning was changed in February 2000 because it had become apparent that the traffic flows between the two cities would not develop to the extent that had originally been forecasted. At the same time, it became clear that there was a demand for a fast and environmentally friendly means of transport for

- links between airports and city centres, and
- regional transport services between big cities.

The Federal Government, the German railway undertaking DB AG and the system industry concluded a basic agreement on the further handling of the German magnetic levitation technology, by announcing at the same time that the Federal Government would launch a development programme for the optimization and application-oriented further development of the Maglev technology.

In 2000, the Federal Ministry of Transport, Building and Housing therefore initiated a programme to ensure the future application of German magnetic levitation technology and establish Maglev transport. The programme consists of the following elements:

- further development programme to optimize the magnetic levitation technology with regard to its use in regional transport and, in particular, the identification of cost reduction potentials,
- feasibility studies to evaluate and select national commercial lines,
- operation and maintenance of the Emsland Transrapid Test Facility for the ongoing system development, demonstration and operation simulation for commercial lines,
- cooperation with the United States of America and the People's Republic of China to support the worldwide marketing of the Maglev technology and to create uniform safety and approval standards.

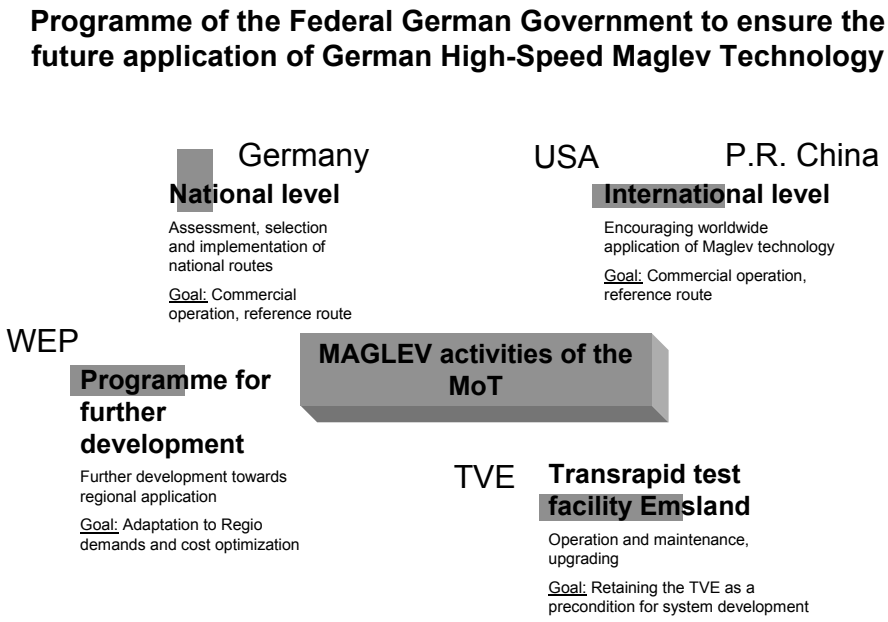

Fig. 1: Elements of the Federal Transport Ministry's programme to ensure the future application of Maglev technology

Within the framework of this magnetic levitation programme activities are focused on the further development of the high-speed Maglev system, above all on the subsystems vehicle, propulsion and energy supply, operations control technology and guideway with maintenance. This also serves the purpose of improving the economic efficiency of the system considerably through further development, thereby reducing investment and life cycle costs.

The following text gives an overview of the objectives and the present status of the further development programme.

2 Preliminary Remarks on the Further Development Programme

For adapting the Transrapid as a long distance means of transport to the requirements of a modern high-speed point-to-point link it is absolutely necessary to develop it further. In part, this can also be justified by the fact that the development of this long-distance transport system was completed more than 10 years ago and part of the present-day requirements may be derived from progressing market standards which, by now, are regarded as a matter of course for a modern, convenient means of passenger transport over short distances.

Focal points of the further development programme defined by the Federal Ministry of Transport, Building and Housing are therefore:

- The adaptation of the magnetic levitation technology to the requirements of regional transport,
- the reduction of investment and operating costs and
- the closing of development gaps.

The Federal Ministry of Transport, Building and Housing formed two consultant groups for the overall system and the guideway to identify and describe potential further development measures and tasks. The consultant groups included representatives from the system companies Siemens AG, ThussenKrupp Transrapid and Transrapid International, IABG as operator of the Emsland Test Facility, the DB AG as potential operator of the magnetic levitation system, the Eisenbahn Bundesamt as approval authority, Dornier Consulting as project advisor of the Federal Ministry as well as various external experts. This selection of members ensured full coverage of the available Maglev technology know-how. The members submitted various proposals with subjects for further development, with substantiation and identification of the objective.

Building on the results of a coordinated process of evaluation it was possible to gradually commission various concept analyses in preparation of further technical development.

Even without the availability of concrete operator requirements, this procedure has proved necessary and successful, since it enabled research institutions working independently of manufacturers to produce their views of deficits and development requirements. The results achieved contributed to enabling the further development to be effected more specifically.

In 2002, the feasibility study for the lines Munich central station – Munich airport and Dortmund – Düsseldorf was completed. In this study, first requirements for high-speed regional links and airport feeder services were developed. In addition, DB AG submitted first operator requirements. The operator requirements provide a good basis for the definition of necessary further developments.

The preconditions had thus been fulfilled to realize all individual development measures already identified or still to be identified for the further development programme, within the framework of the two overall projects “Further Development of the System Technology” and “New Development of a Cost-Reduced Guideway”, for which a pan-European invitation to tender was launched in August 2002.

3 Further Development of the System Technology

3.1 Procedure

The essential objective of the project "Further Development of the System Technology" is the technological development for the operation of the Transrapid both in long-distance transport and shuttle services as well as the realization of cost-reduction potentials in the subsystems vehicles, propulsion, operations control technology and energy supply.

The project "Further Development of the System Technology" is to be carried out in four stages as follows:

Stage I: Concept development

Stage II: Development and construction stage

Stage III: Production of a prototype

Stage IV: Approval.

3.2 Stage I

The stage of concept development served the purpose of developing, based on current requirements and the current status of the Maglev system, the adaptations which are absolutely necessary for the realization of a high-quality point-to-point rail link. The development subjects identified in this process then underwent more precise planning and were optimized from the beginning in terms of economic efficiency.

The studies carried out in stage I are based on the current status of the magnetic levitation system technology and the relevant procedures and standards in accordance with the system documentation generated for the Berlin-Hamburg project.

To identify the additional requirements for short distances, such as Munich, the airport feeder line or the feeder line to Las Vegas, a large number of documents were consulted. In this context, the results of the "Feasibility Study for Maglev Lines" and of the "Regional Impact Analysis Munich", the "Project Requirements Catalogue Bavaria" and the DB AG "Performance Specifications" have taken into special consideration. An Additional source has been the knowledge gained in the realization of the first commercial line in Shanghai.

All requirements compiled as a result of these investigations were examined as to their cost reduction potential.

As a next step, the focal activities, which are crucial for the realization of a commercial line, were derived from the sum of all development requirements. This was followed by a combination of development requirements relating to the same component of a subsystem.

For laying down an order of priority for the development subjects the systems industry has proposed an assessment according to technical and economic aspects. In terms of technology the strongest weighting must be applied to those projects, which are absolutely necessary for technical reasons. In order to guarantee the target of the currently discussed commercial lines schedule constraints were to be taken into consideration. From the economic point of view development tasks need to be accelerated which reduce the cost-driving factors (both in investment and in operation) considerably and the cost-benefit ratio of which is as positive as possible (effort for the Further Development Programme, benefit of the Munich project).

The assessment was based on the following five criteria:

- Technological necessity,
- necessity due to schedules,

- investment costs,
- operating costs over a period of 30 years,
- cost-benefit ratio.

The objectives are briefly described below.

3.2.1 Overall System

Basics of the Maglev System / Updating of the Maglev System Documents

The generic Maglev system documents are updated in consideration of

- results of already completed and current projects of the further development programme,
- experience gained in efficiency-boosting measures and the operation of the Emsland Transrapid Test Facility,
- experience gained in the construction, initial start-up and operation of the Shanghai commercial line,
- the state-of-the-art.

Besides the operation as a long-distance transport system the requirements to be met by a regional transport system were taken into account as another application of the Maglev system in the updating process.

At the suggestion of the Federal Railway Office accepted technical rules of the construction and operation of the Maglev System Regulations in connection with the update of the Maglev system documents were developed. The generally accessible technical rules serve the purpose of providing a basis building on a wide range of expert knowledge, which will be used in future by the Federal Railway Office to check the Maglev system documents.

The "Rules for the Maglev System Technology" to be newly developed defines the system basics and interfaces. Without reviewing the system documents a new project and further development will not be possible. The Rules of Technology are also required for type approval.

Diagnostics of the Overall System

It is the objective to develop a continuous diagnostics concept on the basis of the existing subsystem diagnostics, which permits central control by means of a uniform design and pattern. This concept will lead to increased safety, availability and economic efficiency.

To this end, the procedure for the diagnostics of the overall system will be established in stage II; example and prototype scenarios will be developed which will make it easier for the subsystems to be become integrated in the diagnostics of the entire system. In stage III the functioning of the interfaces in the overall system will be tested on the Emsland Transrapid Test Facility by means of selected operational scenarios.

Safe Stopping Guideway Element

This development serves the purpose of realizing a technical solution to permit:

- shorter guideway lengths in terminal stations, maintenance and yard tracks,
- reduction of journey times,
- smaller terminal buildings and thus
- a reduction of the investment volume.

3.2.2 Propulsion

Innovation Motor Regulation and Control

The realization of this subject may entail the following advantages:

- Standardization of the hardware, resulting in simpler repair and spare parts logistic,
- reduction of technology costs due to large number of units made in series production,
- improvement of communications technology and simpler remote-controlled maintenance and diagnostics.

Standardized Converter Unit

With the new converter concept based on Integrated Gate Commutated Thyristor technology considerable improvements can be expected to be achieved:

- operating cost reduction with energy regeneration by Active Front End,
- investment cost reduction of around 15 %,
- output increase by around 10 %,
- improvement of the "Mean Time between Failure" value for a high-power converter unit by around 23 %,
- reduction of the space required for a propulsion unit in alternating-step method by around 20%,
- increase in efficiency.

3.2.3 Operations Control System

Overlapping Sections

With overlapping sections it is possible:

- to increase the number of train sequences,
- to reduce the number of substations and motor sections, resulting in
  - investment cost reduction and
  - a reduction of maintenance costs and work.

3.2.4 Vehicle

Vehicle Frame

The dimensions and arrangement of the boarding doors are determined with a view to ensuring smooth passenger boarding. The layout of the interior provides sufficient luggage storage space. Storage in luggage containers is taken into consideration.

Contactless On-Board Power Supply (Inductive Power Supply)

Compared with the conventional contact-based power supply (catenary) the technical, operational and economic advantages are as follows:

- Avoidance of noise emission,

- reduction of the aerodynamic resistance,
- avoidance of operating risks in winter time (ice formation, freezing),
- smaller losses in power supply,
- no mechanical wear or corrosion of mechanically stressed parts,
- reduction in maintenance work,
- investment cost reduction.

3.2.5 Guideway

Automatic Guideway Diagnostics

Automatic guideway diagnostics permits the early detection of damage to the guideway and, consequently, a reduction of repair work.

Transmission of Vibrations into the Substructure

In the case of guideways in urban areas vibrations transmitted into the substructure must be reduced. In tunnels, the mass spring-system may be a dimensioning factor. It is therefore urgently required to identify an appropriate mass-spring system for the Maglev system.

Optimization of the Guideway Beams and Bearings

It is the objective to improve the functionality of the system and to reduce the production costs by a design for series production. Since the guideway accounts for a considerable share of total investments even a comparatively small reduction of the guideway costs will lead to a considerable reduction of total system costs.

Track-Switch Devices

For future planning, a major choice of variants for crossovers and track-switch devices is available.

The quasi-commercial tests are to prove the availability, maintainability and operating safety.

Tunnels (Aerodynamics and Radio)

For application projects envisaging the operation of the Transrapid in urban areas the operation in tunnels is to be ensured.

Better utilization of the data rate is to be used for the implementation of additional services (e.g. on-board video control).

3.3 Further Procedure in Stages II to IV

In stage II, the development tasks identified in stage I will be implemented. The activities will be focused on the engineering processes of the work packages, up to preparing the detailed technological documentation (construction specifications for the individual subsystems and components); they will serve as a basis for the activities required in stages III and IV.

Stage III will comprise the planning, procurement, production and implementation requirements to realize the Maglev System prototype chosen.

In stage IV, the theoretical and, as far as is feasible on the Emsland Transrapid Test Facility, experimental proof needed for the approval procedureswill be established and the approval of the Federal Railway Office will be applied for.

4 New Development of a Cost-Reduced Guideway

For the planned commercial lines, the guideway requirements need to be changed considerably. This relates in particular to vehicle loads and the number of load changes. The operation of the type-approved beams on the Emsland Transrapid Test Facility has shown that there is still a considerable optimization potential.

This Further Development Programme thus has the objective of developing technically improved guideway beams and achieving a substantial cost reduction compared with the present types of guideway beams.

The Federal Ministry of Transport, Building and Housing thereby wants to have the rights of use for one of each of the Maglev systems (types I to III), to make them available to the project management institution in Bavaria for use, if required, in the invitation to tender for the construction requirements for the Maglev System.

The project is subdivided into three sections:

Section 1: Type I guideway beam, elevated (l = 24,8 m)

Section 2: Type II guideway beam, at-grade (l = 12,4 m)

Section 3: Type III guideway beam, at-grade (l = 6,2 m)

4.1 Step 1 "Negotiating Procedure"

The work required for each section included the presentation of a basic concept or design of a Maglev guideway beam at optimized costs as well as a bid relating to steps II to IV. In particular, the following had to be submitted:

"Basic Concept":

- Presentation of basic concepts for new or improved type I, II or III beam construction systems with substantial reduction of the production, operating, inspection and maintenance costs.
- Description of the advantages and disadvantages of the proposed concepts, compared with existing beam construction systems.
- Description of the required development work.

"Designs":

- Description, explanation and drawing of the designs
- Concept for production engineering and processes
- Economic analysis
- Detailed list of quantities

4.2 Stage II "Development and Construction"

The work optimized in stage II comprises the development and construction of a guideway beam for the Maglev system, which is mature for production. This includes:

- Type, components, materials, fasteners, coatings
- Static calculation and proof that the guideway beams fulfil the technical requirements
- Certification of approval of the construction materials, other materials and components used

- Design of the prototype production and assembly technique and procedure, including the guideway equipment, as well as presentation of a series production concept
- Design for logistics, installation, assembly and implementation of the prototype on the Emsland Transrapid Test Facility
- Complete assembly manual with instructions for the production of the prototypes

4.3 Stage III "Construction of Prototypes"

The work comprises all required planning, procurement, production and implementation processes for building the prototype of a Maglev system guideway beam selected in stage II and the necessary equipment. This includes all work packages required for the production, equipment, delivery, installation, implementation, testing, technical and operational acceptance as well as the elaboration of reports and system documents.

4.4 Stage IV "Evidence of Approval"

This work includes, in particular, furnishing the necessary theoretical and technical proof. This especially comprises the testing of the Maglev system guideway beam components on test stands and of the Maglev system guideway beams at the Emsland Transrapid Test Facility, as well as the commitment of the contractor to obtain type approval assurance from the Federal Railway Office.

5 Prospects for the Future

Within the framework of the Further Development Programme for the Maglev system technology, the core technology will be developed. The planned development measures will make an important contribution to realizing the envisaged commercial line in Munich and to ensuring high-qualification jobs and technology know-how in the German system industry. For example, it should be possible to offer this innovative long-distance and regional transport system with its hitherto unprecedented technological standard also on other European, Asian and American markets. The realization of a commercial line in Germany will strengthen the confidence in this system and is therefore of paramount importance for Germany as a high-tech industrial location.