Presently, JR East has Shinkansen lines that stretch outward in five directions. Furthermore, one of the lines is going to be extended from Morioka to Hachinohe in December 2002. The Shinkansen has a mission of providing passengers with faster and more comfortable services. One of the most important challenges is to minimize the travel time on each line within the network. To meet this challenge, we are committed to promoting research and development to establish technologies to ensure higher speeds and greater safety and to improve friendliness to the environment and riding comfort, thereby winning the status of the “World’s Best Shinkansen.”

1 Introduction

JR East has extended Shinkansen lines to form a high-speed network that reaches out in five directions. Our mission is to provide faster and more comfortable transportation and at a reasonable price. Especially, reducing the time required for a journey is one of the most important services that can be provided by a high-speed railway. Turning now to the situation overseas, operation at the maximum speed of 300 km per hour has been achieved in one country after another. Commercial operation at the speed of 300 km per hour is planned in Germany this year, and another commercial operation at the speed of 350 km per hour is planned in Spain with the goal of being completed in 2004. In this way, high-speed networks are steadily being established throughout all of Europe. Against this backdrop, we are aiming for the target of upgrading our Shinkansen to the world’s best by further increasing the cruising speed while staying in harmony with the environment and further improving riding comfort.

2 High-speed railways in Europe

Our Shinkansen was a pioneer among the world’s fastest railways. This was then followed by the steady progress in the high-speed railways of Europe exemplified by the TGV in France, ICE in Germany and many others. High-speed commercial operations have been put into service in six countries around the world. The maximum speed of 300 km per hour is the basis for newly opened lines such as the TGV Atlantic, TGV Tallis (Paris to Brussels), Eurostar (Paris to Marseilles) and ICE (Cologne to Frankfurt). Scheduled for the future, construction of new lines are being planned in Spain, Italy and France in addition to the ICE line in Germany (Cologne to Frankfurt) that is to open for services in 2002. Especially, the new line being planned in Spain (Madrid to Barcelona) will have a maximum speed of 350 km per hour. In these countries, the construction projects are being implemented with consideration given to the maximum speed of 300 to 350 km per hour.

3 History of the development project for higher speeds

3.1 Development of a low-noise high-speed test car (STAR 21)
The STAR 21 is a 9-car train built in fiscal 1991, where the followings
were concepts of the development:

- Stable high-speed running performance
- Lower noise
- Reduced weight

The results of this project can be found in achieving high-speed running performance at the maximum speed of 425 km per hour, the highest speed achieved in Japan, and in making progress in environmental technology through a great variety of tests conducted for environmental protection. Further, the car weight reduction technology and main circuit technology through a great variety of tests conducted for environmental protection have made considerable headway. These achievements are reflected in the later mass-produced commercial cars.

**3.2 Bogies jointly developed with Deutsche Bahn AG**

In 1996, JR East and Deutsche Bahn AG (DB AG) started the joint development of high-speed bogies. The bogies of JR East were shipped overseas and the running performance at speeds of up to 365 km per hour were verified using the high-speed car ICE2 of DB AG. This joint development made it clear that there were differences in the bogie development process, and we were able to acquire the techniques of developing bogies using the stationary tests on rolling stock test stands. The techniques we acquired through this joint effort are currently being utilized in the development of the next-generation high-speed bogie.

**3.3 High-speed running test on the Series E2-1000**

The cars in the Series E2-1000 are the improved version of Series E2 for commercial operation to Hachinohe. For this improvement, we employed the low-noise pantograph, low-noise insulator and active suspension that we have been developing.

In the spring of 2001, a high-speed running test was conducted at 320 km per hour to verify these new technologies and the environmental protection technologies.

This test has confirmed that there is a prospect of achieving certain results with the progress of subsequent development.

## 4 Major issues in the research and development of high-speed cars

A further increase in speeds on the JR East Shinkansen is accompanied by a great variety of issues yet to be solved. Major issues can be summarized as follows; “Higher running speeds”, “Ensuring safety”, “Measures for environmental protection” and “Improvement of passengers’ comfort”.

### 4.1 Higher running speeds

To realize high-speed running, it is necessary to ensure the car power required for high-speed and wayside equipment corresponding to it. To ensure stable high-speed running under any weather conditions, it is essential to analyze wheel-slip in the power running mode and slide motion in the braking mode, and to establish a high-level adhesion control technique.

In the electric-current collection system, running in one-pantograph per trainset running mode is required in order to reduce noise, as will be discussed later. The major point is how to ensure stable electric-current collecting performance with one pantograph alone in high-speed travel.

To achieve this, we are concentrating our research and development efforts on the aspects of both pantograph and contact wire.
Further, it is also important to establish an effective maintenance technique for the wayside facilities and cars, in response to the high-speed requirements.

4.2 Ensuring safety

Needless to say, it is the prerequisite for a high-speed system to ensure the level of safety equal to or even higher than the current one in high-speed travel. To achieve this, the first requirement is to ensure running safety and reliability of the sub-systems directly related to traveling such as the bogies, wheel sets and brakes. In our subsequent development, we will make a thorough verification by testing a prototype product on the rolling test stand as well as on an actual car, in addition to giving consideration at the time of designing and performing simulation tests. Through this effort, we are planning to verify the reliability of these components. Further, the strength of the existing tracks and structure will be sufficiently verified. Moreover, we will make further studies to ensure sufficient stability against external disturbances such as earthquakes, strong wind and snowfall.

4.3 Countermeasures for environmental protection

Strict standards against wayside noise are set by the Environment Agency (current Ministry of the Environment) in order to protect the environment. For this reason, in order to increase the current speed, it is necessary to develop new technology for environmental protection countermeasures. New technology for environmental protection measures in regards to Shinkansen is at an advanced level at the present time. In order to reduce the noise in high-speed travel, a breakthrough in technology is essential to reduce all noises that are generated, including the electric-current collection noise and aerodynamic noise. The major issues with electric-current collection noise and aerodynamic noise are reducing the number of pantographs, developing low-noise pantographs, and decreasing the noise reflected from the sound barrier to the car body. Micropressure wave requires overall development efforts including development of less costly and more effective wayside measures in addition to optimization of the leading profile by using the 3-D fluid-mechanic simulation.

In any case, it can be said that the measures for environmental protection are a very tough bottleneck.

4.4 Improvement of passengers’ comfort

For “Improving passengers’ comfort”, our goal is to achieve a level beyond that of the SNCF (TGV) or DBAG (ICE3) even during high-speed running. Namely, we are making efforts to become the “world’s best” in the literal sense of the word. To ensure greater riding comfort at higher speeds than the current Shinkansen, it is necessary to develop the structure of a new car body and bogie from scratch.

To put it more specifically, we are committed to developing a low-vibration next-generation bogie and a noise preventive car body structure for blocking entry of noise into the car, as well as low-noise under-floor equipment.

5 Subsequent course of action for solving issues

We have discussed the issues involved in the research and development required for higher speeds. We have almost completed the work of extracting issues and evaluating the level of the current technologies corresponding to such issues. We have already started development of constituent technologies. Issues involved in “higher Shinkansen speeds” are found over a great many fields including cars, control, tracks and electric power. Each factor must have a close tie-up with others over an extensive range. To promote this project, we have established a project team where the Research and Development Center serves as Secretariat. Fortunately, our Center is staffed with research workers covering all required fields of technology. The overall capabilities of these staff members in our Center are expected to make a significant contribution to achieving the objective such as increasing the traveling speed. To handle the development items involved across multiple fields including measures for environmental protection, verification of safety and development of a contact wire/pantograph system and improvement in riding comfort, a working group comprising specialists in each technical area will be organized to carry out the development.

6 Conclusion

We have introduced our efforts to develop the “World’s Best Shinkansen”. The Research and Development Center of JR East Group will focus all its energy on increasing the speed and depth of development. To attain success in this development, we are determined to make a concerted effort by turning company-wide efforts toward one definite direction. At the same time, we will have a close tie-up with the Railway Technical Research Institute, universities and other external research institutes as well as related manufacturers in the industries.