High-Speed Rail Operations in Japan

Takao NISHIYAMA
Director of Japan Railways Group New York Office
New York, NY, U.S.A.
Contents

- Introduction
  Transportation Planning
  Train Variation and Efficiency

- Risk Management for High-Speed
  - Control center management with an integrated system
  - Safety design and safety management for high-speed
  - Improvements in reliability
<table>
<thead>
<tr>
<th>Line</th>
<th>Section</th>
<th>Length (miles)</th>
<th>Max. Speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tokaido</td>
<td></td>
<td>343.4</td>
<td>168</td>
</tr>
<tr>
<td>Sanyo</td>
<td></td>
<td>400.2</td>
<td>187</td>
</tr>
<tr>
<td>Tohoku</td>
<td></td>
<td>392.6</td>
<td>171</td>
</tr>
<tr>
<td>Joetsu</td>
<td></td>
<td>188.6</td>
<td>150</td>
</tr>
<tr>
<td>Nagano</td>
<td></td>
<td>72.9</td>
<td>162</td>
</tr>
<tr>
<td>Kyushu</td>
<td></td>
<td>85.5</td>
<td>162</td>
</tr>
<tr>
<td>Sub Total</td>
<td></td>
<td>1483.3</td>
<td></td>
</tr>
<tr>
<td>Akita</td>
<td>Converted</td>
<td>79.1</td>
<td>81</td>
</tr>
<tr>
<td>Yamagata</td>
<td>from narrow</td>
<td>92.3</td>
<td>81</td>
</tr>
<tr>
<td>Sub Total</td>
<td>to standard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1654.7</td>
<td></td>
</tr>
</tbody>
</table>

*Length: mileage in revenue service
Population and Alignment in JR East

- **East Japan**
  - Tokyo (12.9 million)
  - Greater Tokyo (34.6 million)
  - Sendai (1.0 million)
  - Morioka (0.3 million)
  - Aomori (0.3 million)
  - Akita (0.3 million)

- **Northeast Corridor**
  - Greater New York Tri-State (18.8 million)
  - Greater Boston (4.5 million)
  - Greater Washington DC (5.3 million)
  - Providence (0.2 million)
  - Baltimore (0.6 million)
  - Philadelphia (1.4 million)

- **California**
  - Greater Los Angeles (12.9 million)
  - Los Angeles (8.0 million)
  - San Francisco (4.2 million)
  - San Jose (1.8 million)
  - Sacramento (0.5 million)

Population: Million
Transportation Planning

Train Varieties

- **Commuter High-Speed Trains**
  We offer commuters 16 double-decker high-speed trains during rush hours for the region within 100 miles from Tokyo.

- **Fastest High-Speed Train**
  We operate one ‘fastest’ high-speed train per hour that passes all other high-speed trains along the route.

- **Coupled High-Speed Train**
  We operate coupled trains, with one train section running on converted conventional lines, so that passengers do not need to transfer between trains.

Train Efficiency

- **Reduced Turn-Around Time**
  We have reduced the turn around time at Tokyo Station to 12 min.
Within a 100-mile radius from Tokyo, the number of commuters from suburban areas into the city has increased tremendously over the past 20 years.
High-Speed Commuter Trains to Tokyo

- 16-car double-decker trains (8-cars + 8-cars)

- Seating capacity for 1,634 passengers
  = The largest capacity for high speed trains in the world!

- Maximum speed: 150 mph
Commuter Ridership

Transitions in transport volume for morning commuter hours (average per day)

(index % = 1987 level is 100.)

- For Tohoku
- Joetsu and Nagano
- Tohoku index
- Joetsu and Nagano index

(Passenger)
Reducing Travel Times to Regional Cities

Through operation of Shinkansen trains onto conventional lines has shortened travel time.
Reducing Travel Times to Regional Cities

- **<Morioka-Akita>**
  - Conventional line
  - Operating speed: 81mph

- **<Tokyo-Morioka>**
  - High-speed dedicated line
  - Operating speed: 171mph

Time reduction: 47 minutes! (Before: 4 hrs 37 mins  >  Now: 3 hrs 50 mins!)

[Diagram showing train routes and speeds]
Efficiency of Operation

Tokyo Station has only 4 tracks (2 platforms) for JR East Shinkansen service. These tracks handle 300 trains per day, departing and arriving.

Track occupancy at Tokyo station for a typical hour
Efficiency of Operation

Turn-around time and cleaning at Tokyo Station

1. Crew welcomes arriving train
2. Thank you to de-boarding passengers
3. Cleaning up before passengers board.
4. Done cleaning, the crew welcomes passengers on board.
5. Seeing off the train with pride in a job well done.

E2 series: 10 cars • Seating capacity: 1,152
Cleaning force: 22 person crew
Efficiency of Operation
Number of Trains Operating Daily

Arriving at / departing from Tokyo station: 300 trains daily
The Key: Risk Management for High-Speed

High-speed rail operation is very different from freight rail, heavy rail and commuter rail with regard to guaranteeing safety.

The key to operating high-speed rail is risk management.

Shinkansen: Zero Fatalities Since 1964 (46 years)

- **Control center management with integrated system**
  The Control Center is supported by the Integrated Intelligent Transport Management System (COSMOS) to provide safety.

- **Safety design and safety management for high-speed**
  Shinkansen system is designed based on the concept of high-speed safety. Shinkansen system requires specialized safety management.

- **Improvements in reliability**
  We are implementing measures to improve reliability for the Shinkansen system.
Control Center Management

- **One Command from the Chief**
  When we anticipate a possible accident, the chief of the Control Center stops all high-speed trains until he makes sure that it is safe to resume operations.

- **Collection of Information from All Sections**
  In case of a possible accident, it is the responsibility of the chief of the Control Center to collect accurate information from all sections including the site.

- **Support from Planning Staff**
  If we have an accident, the planning staff will support the front-line staff 24/7.
Control Center Management

- Transportation Section
- Passenger Section
- Rolling Stock Section
- Driver/Conductor Section
- Track Section
- Power Supply Section
- Signal/Telecommunication Section
- System Section
Integrated Intelligent Transport Management System

COSMOS: Computerized Safety, Maintenance and Operation Systems of Shinkansen

- Facilities Control
- Transport Planning
- Operation Control
- Power System
- CMS (Centralized Monitoring System)
- Maintenance Work Control
- Station Yard Control
- Rolling Stock Control
Integrated Transport Management System

- Display of forecast diagram
- Dispatch Center of the Shinkansen Operation Headquarters
- Train operation display
- Central system
- Station system: 33 stations 5 depots
- Hand-held terminal
- High-speed digital bus
- 6 branches: Information terminals, Crew offices (10 offices), Maintenance office (69 offices)
- Wind, rain and height of river surface
- Substation control
- Display of operational conditions
- Maintenance work
- Rolling stop depot shunting control

International Practicum on Implementing High-Speed Rail in the United States
Design Concepts for High-Speed Safety Systems

Fail-Safe Design
Ex. ATC detection of broken rails

Early Detection
Ex. Detection of earthquakes

Elimination of Human Error
Ex. ATC prevention of signal violations

Redundancy System
Ex. Prevention of system failure (COSMOS)

Isolation of Maintenance Work
Ex. Maintenance work scheduled for 1am to 5am

Checking Obstacles
Ex. Detection of obstacles left by maintenance work

No Grade Crossings in Entire System
First Quick Response: Stop All Trains
When the train crew reported the incident to the Control Center, the Control Center ordered all train crews to stop their trains to prevent a second disaster.

Safety Check from All Sections
The Control Center ordered all sections to check safety. It collected all necessary information from these sections.

Decision to run a pilot train and then regular trains
The chief of the Control Center decided to run a first pilot train at restricted speed 18mph. He ordered the track and car equipment specialists on board the pilot train to reconfirm safety. After he received the safety report, he authorized operation of regular trains.
Punctuality

Average Delay time: 0.3-0.5 min. /train

"Average delay time": total "delay time" of all trains/ total train number, and the "delay time" is counted if it is larger than 1 minute.
Improvements in Reliability and Reduction in Downtime

- Quality control of maintenance for rolling stock and facilities
  Ex. Certification of ISO 9001 in depot

- Monitoring for possible trouble
  Ex. Remote monitoring for ATC facilities

- Preparation for replacement
  Ex. Distribution of door unit equipment

- Deployment of first-aid staff for rolling stock
  Ex. Stand by at the main station

- Training to take immediate action to prevent additional problems
  Ex. Field Training
  Concentration in Training Center by train simulator every year
Reliability of Rolling Stock

Fluctuation in rolling stock failures (Data of JR East)
(Number of failures per 1 million kilometers, 621,371miles, between 1987~2000)

*Definition of rolling stock failure
Failure in rolling stock that causes driving accidents and obstruction that result in passenger trains being suspended or delayed by 10 minutes or more or non-passenger trains being delayed by 30 minutes or more.
Summary

The Key to Operation: Risk Management for High-Speed

- Control center management with integrated system
- Safety design and safety management for high-speed
- Improvement in reliability
Thank you very much for your attention