Shinkansen Technology for Export to Taiwan

By Nehashi Akira

Introduction

The history of Japan's technological cooperation in construction of *shinkansen* high-speed railway systems abroad started with the Northeast Corridor Improvement Project (NECIP) of the United States that lasted for 10 years from 1976 and the Tehran-Mashhad Shinkansen project of Iran which began in 1975. In the United States, NECIP started with the Ohio project in 1978, and was followed by the 1981 Los Angeles-San Diego and Tampa-Orlando-Miami high-speed railway projects. The United States highly evaluated Japan's shinkansen technology in terms of both safety and profitability and asked Japan to extend the shinkansen system as it is to the U.S. Japan supplied technological cooperation through Japan Railway Technical Service (JARTS) on a nonprofit basis under minutes of understanding and other notes signed between the now-defunct Japanese National Railways (JNR) and various countries or state government organizations. These projects failed because not enough funds were raised. As a result, Japan's export of shinkansen technology did not materialize.

For a long period of time, Japan was locked in a fierce competition with European countries in the field of high-speed train technology. A conclusion has yet to be reached regarding the advantages and disadvantages of Japanese and European technology, although Japan lost to Europe in South Korea's Seoul-Pusan project. As for the Taiwan high-speed rail project, a European team again was competing with Japan for this project. Finally, Taiwan High Speed Rail Corp. (THSRC), which acquired the right to operate the Taiwan high-speed rail system on a build-operate-transfer (BOT) basis, granted priority negotiation rights to a Japanese seven-firm consortium, called Taiwan Shinkansen Consortium (TSC), on December 28, 1999. In June 2000, THSRC and TSC concluded a Memorandum of Understanding (MOU) concerning a core system contract, with a formal contract signed on December 12, clearing the way for Japan to implement the much-awaited export of shinkansen technology.

Figure 1 **Plan of THSRC High-Speed Railway Line**

Outline of Project

The project calls for creating a 345-kilometer link between Taipei in the north of the island and Kaohsiung in the south. The number of stations was set at eight initially, and will be increased by three. The number will be increased further by two by the time projects to convert existing rail lines in the cities of Taipei and Kaohsiung to underground lines are completed. THSRC projects about 200,000 passengers to use daily the line scheduled to open in 2005 – about half that of Japan's Tokaido Shinkansen Line (one-third in terms of average transportation density).

The new Taiwan High-Speed Rail Line will reduce the Taipei-Kaohsiung run to less than 90 minutes with one stop at Taichung. Bullet trains can run at speeds of up to 300km per hour. THSRC plans to introduce 30 12-car train sets based upon the Shinkansen 700 series bullet trains when the service starts.

The acquisition of land lots has almost been completed, with almost all orders for engineering works in 12 sections of the main line placed (Japanese firms will help to build four of these sections).

The total construction cost is estimated at NT$431.6 billion (about ¥1.5 trillion, US$13 billion), of which 25% will be provided by Taiwan's Ministry of Transportation and Communications (for the acquisition of land lots and converting existing train lines in the Taipei area to underground lines). The remaining 75% will be funded by THSRC, the organization that signed a contract with the ministry to implement the project for 35 years from 1998 on a BOT basis. The organization will put up 30% in capital and 70% in borrowings to purchase cars, construct ground facilities, and manage and maintain related facilities after completion. (see Figure 1, Table 1&2)

Table 1 Outline of Stations of THSRC High-Speed Railway Line

Stations	Distance	Type of structure	Links with
Nankang (future plan)	–2.2 km	underground	existing lines (after going underground)
Taipei	6.5 km	underground	existing lines and Taipei MRT
Panchiao	13.4 km	underground (two layers)	existing lines
Taoyuan	42.3 km	underground	Taoyuan MRT (future plan)
Hsinchu	72.2 km	elevated	Hsinchu MRT (future plan)
Miaoli (to be added later)	105.0 km	elevated	
Taichung	165.8 km	elevated	existing lines (station to be relocated) and Taichung MRT (future plan)
Changhua (to be added later)	194.0 km	elevated	
Yunlin (to be added later)	218.0 km	elevated	
Chiayi	251.6 km	elevated	
Tainan	314.7 km	elevated	Tainan MRT (future plan)
Chiaotou Workshop	332.0 km		
Tsoying	346.0 km	underground	existing lines (station to be relocated) and Kaohsiung MRT (future plan)
Kaohsiung (future plan)	353.5 km	underground	existing lines (after going underground)

Taiwan's Transportation Ministry will be responsible for engineering works for the section up to 16.8 km. The 0.8 ~ 14.7 km section will be a TRUPO (Taipei Railway Underground Project Office) tunnel.

Setup to Implement Project

THSRC is set to place orders for the new project in five packages of civil works, railroad tracks, stations, electric and machinery (E&M), and depots that are divided into several sections. Of these, the Japanese consortium will supply and maintain cars and electrical equipment and will also take charge of personnel training.

The Japanese consortium, TSC, is now making preparations to launch full-scale construction. JARTS is providing personnel and technological support behind TSC by deploying a large number of experienced technicians from Central Japan Railway Co. (JR Tokai), West Japan Railway Co. (JR West) and other entities, who had been engaged in the construction and management of the shinkansen since the JNR days.

There are many hurdles to clear in processes such as construction planning, construction, launch of service and maintenance. The Japanese consortium is in charge of cars and electrical equipment. Orders for civil engineering structures had already been placed in other packages, and orders for railroad tracks, stations and depots will be placed in separate packages. What is particularly important in construction of high-speed train lines such as the shinkansen is the integration of a system as a whole. If such integration is not secured, the system would not function properly and could cause safety problems. This is the first hurdle to clear.

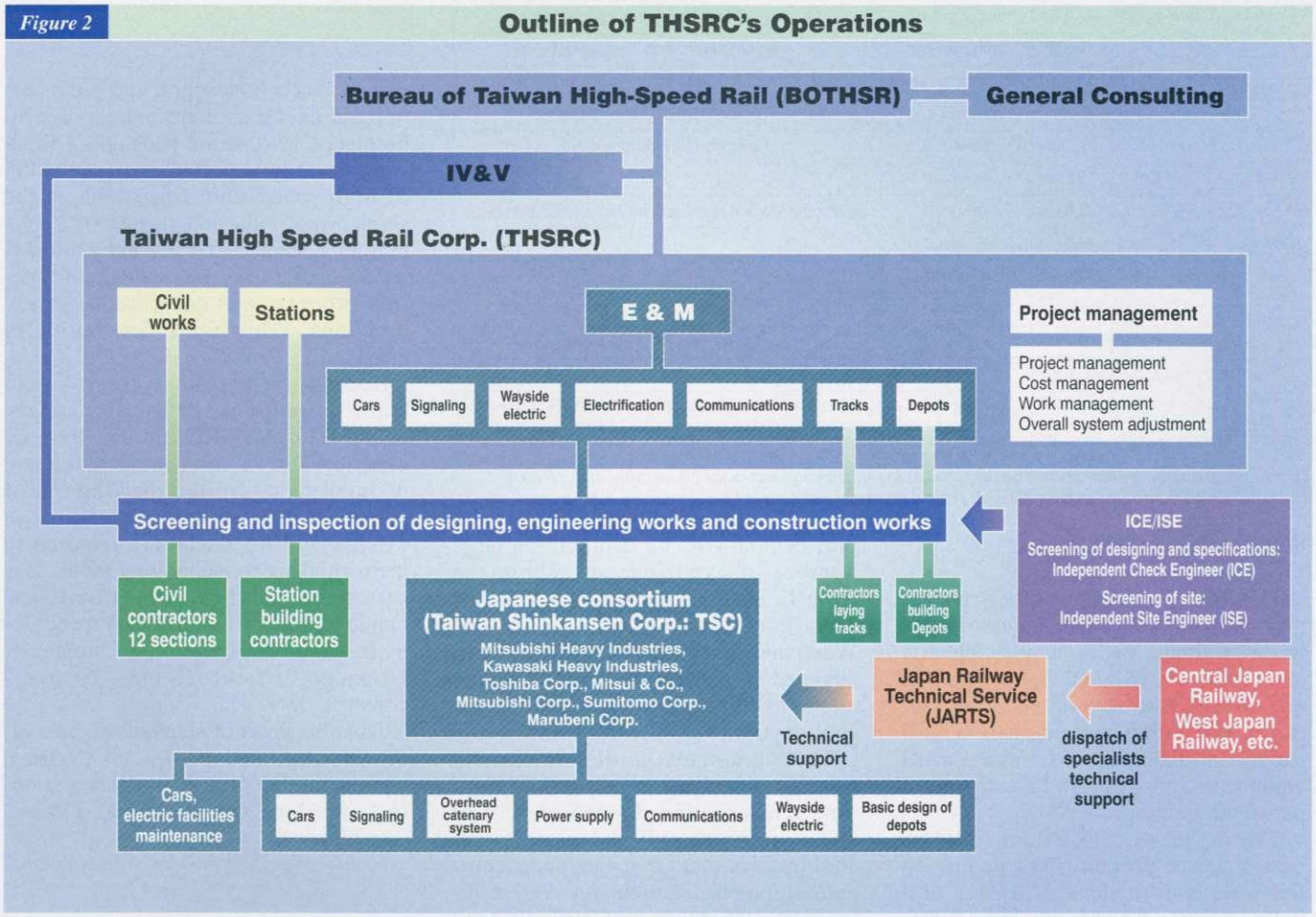
Second, the Japanese group has to train personnel, who are newly employed by THSRC and thus have no experience in shinkansen operation and maintenance. Unlike the training of personnel in Japan with experience in existing rail lines who are required to learn shinkansen technology alone, it is an extremely difficult job to have new employees master shinkansen technology in a short period of time. Moreover, language difficulties must be overcome.

Japan's export of shinkansen technology is not limited to cars and electrical equipment, but also maintenance, training, interface and system knowhow. (see Figure 2)

Table 2 Outline of Taiwan's High-Speed Railway Line (planned by THSRC)

Distance	345 km between Taipei and Kaohsiung	Gauge	1435 mm
Number of stations	13 (eight at the time of opening)	Characteristics of mainline	Maximum gradient 35 % Minimum radius 6,250 m Tunnels (including the underground section in urban Taipei) account for 17 % of the total distance
Maximum speed	300 km/h (315 km/h in test runs) (350 km/h in structural design)		
Traveling time	Less than 90 minutes (stopping at one station)	Engineering structures	Design axle load: 25.5 t Length of sub-tracks at stations: about 800 m ~ 1,300 m Distance of track center: 4.5 m Width of formation: 13 m² Inside cross section of tunnels: about 90 m²
Estimated number of passengers	171,000 daily at the time of opening in 2005 361,000 in 2033		
Headways	3 minutes		
Capacity of one train	More than 900 persons	Type of electrification	AC 25 kV 60 Hz
Type of carriages	One train consists of 12 cars (based on Japanese shinkansen series 700) 30 trains will run daily at the time of opening	Type of electric and communications systems	Japanese shinkansen systems to be adapted

Figure 2 **Outline of THSRC's Operations**



Afterword

Taiwan's decision to adopt Japan's shinkansen technology for its high-speed rail system was apparently due to the high credibility of the Japanese technology that has been amassed for more than 36 years since the 1964 Tokyo Olympic Games, ultra-high safety as exemplified by the fact that no casualties have been reported among shinkansen passengers in accidents, strict environmental standards, and similarity in meteorological and social conditions between Japan and Taiwan such as earthquakes, typhoons and other natural disasters, and limits to the establishment of railroad stations. Taiwan's decision to adopt the Japanese technology may also have developed from the Nagano Shinkansen Line, which started service in October 1997, steady construction and extension of shinkansen lines in various parts of Japan and the September 1999 great Taiwan earthquake.

Taiwan and Japan have greater similarity in various areas than with the United States and European nations, but differ in language and culture. In order to construct and operate the shinkansen system in Taiwan steadily, a broad range of communications between the Japanese and Taiwanese people involved is essential, ranging from top management to end-users. People in Taiwan say that they do not want to establish completely the same shinkansen system as Japan's. They are seeking the world's highest performance based on Japan's proven technology. They are also persistently cost-conscious and want the project completed on schedule.

The Japanese side needs to make all-out efforts to succeed in completing the new Taiwan High-Speed Rail system, the first shinkansen to be run abroad. It will be the first Japanese project that involves trading houses, makers and JR companies and requires their close coordination. It will be a great pleasure for us if we can achieve a good job amid mounting interest in the high-speed railroad project not only among people in Taiwan but in the whole world. JJTI

Reference
http://www.hsr.gov.tw
http://www.thsrc.com.tw

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