

# Operation Practice of Shanghai Maglev Demonstration Line

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**ABSTRACT:** Shanghai Maglev Demonstration Line is the first commercial application of high speed maglev transportation system in the world. The past 5 years witnessed its safe and punctual operation. None of the accidents, though occurred, caused passenger or operation staff casualties or interruption of the operation. It has also passed through the test of typhoon, rainstorm, heavy snow and other atrocious weather. The present paper summarizes the status of operation, failures and maintenance work on the line, showing safety and usability of high speed maglev system. It also puts forward some improvements, and last but not least describes Shanghai-Hangzhou Maglev Project.

## 1 GENERAL INFORMATION ABOUT SHANGHAI MAGLEV DEMONSTRATION LINE

Shanghai Maglev Demonstration Line is the first and so far the sole high speed maglev line in commercial service in the world. It is 30km long, connecting Shanghai Pudong International airport and Longyang Road Subway Station. On December 31, 2002 the trial run on single track succeeded. On May 1, 2004 it was put into trial commercial operation. Since then, the train has been running on the line with the highest speed of 430 km/h. Operation punctuality rate reaches 99.5% and 99.8% of the operation schedule is fulfilled.

Since the successful trial run on a single track on December 31, 2002, the maglev train has run for more than 2000 days in accumulative total and covered a mileage of over 5 million kilometer. No operation accidents that endangered the passengers or attendants on the train had happened.

During the past more than five-year operation, the maglev system has undergone such atrocious weather as heavy snow, gale and rain storm, but its operation schedule has never been changed due to weather changes, which demonstrates the system's availability of withstanding extreme weather.

## 2 OPERATION PRACTICE

### 2.1 Major events that occurred during operation

1) At the beginning of 2005, a tight-wire supporting the overhead cable across the maglev guideway hanged down and invaded into the vehicle dynamic clearance as the power maintenance workers violated the maintenance regulations while repairing the cable. The steel rope clashed the glass of the vehicle front window and slid through the vehicle top when the vehicle passed there at high speed, but only the antenna cover on the top was damaged. In spite of the accident, the maglev train still ran in accordance with the operation schedule.

2) In 2005 one guideway switch had a mechanical failure, resulting in one hour and 57 minutes delay of the normal operation. After occurrence of this failure, the design of the failed component was already improved.

3) In August, 2006, one section of the maglev train was found smoking in the station. After the passengers took off, the train ran away from the station and stopped in the designated point proper for putting out the fire. The section of the train was partly burned by the battery fire which was caused by the internal failure of one unit of battery cells and the operation schedule was disturbed by the accident, but

no personnel was injured. At present the burned vehicle is under repairing.

## 2.2 Operation in bad weather

1) At the end of 2004, Shanghai witnessed a heavy snow that reached 40 mm in thickness in Pudong area particularly in the place close to Pudong International Airport. In result, the highway connecting the city to other places was completely closed. But the maglev train still ran normally and was not affected (Figure 1).



Figure 1. The maglev train's running is not affected by the snow on the guideway.

2) In August ,2005, the typhoon "MATSA" made a direct attack on Shanghai and its speed on the ocean surface near Pudong International Airport reached 31.7 m/s. Both the airports and highway had to be closed. However, Shanghai Maglev Demonstration Line was still carrying the passengers normally.

3) In August, 2008, Shanghai was attacked by a torrential rain that reached 147mm of precipitation per hour and the highway traffic was completely blocked. However, the maglev train still ran punctually according to the operation schedule.

## 2.3 Statistic of system failures and system availability

Table 1 shows the statistic of subsystem failures that caused more than 2 min operation delay in the past five years. Table 2 lists the statistic of the rate of operation punctuality and schedule fulfillment.

Table 1. Statistic of subsystem failures that caused more than 2 min operation delay.

Sub-systems	Vehicle	Propulsion	OCS	Guide-way	Others
Number of failures	27	13	11	5	17

Table 2 Rate of operation punctuality and schedule fulfillment in the past years.

Year	Rate of operation punctuality	Rate of schedule fulfillment
2004	98.48	99.43
2005	99.94	99.95
2006	99.74	99.86
2007	99.97	99.98

Note: Punctuality is defined that the operation delay does not exceed 2min.

## 2.4 Maintenance work

Shanghai Maglev Demonstration Line is configured with 3 trains each consisting of 5 sections, 2 propulsion substations, one operation control center and one maintenance base. Generally speaking, the maintenance workload of maglev transportation system is not big and the majority of it is scheduled inspection, the reason of which is that the large numbers of the electric components are structurally modularized for easy on site replacement. According to the statistic, scheduled maintenance work time makes up 76% of the total maintenance work time.

# 3 TECHNICAL IMPROVEMENT

## 3.1 Noise inside vehicle

The present noise inside the carriage of the maglev train running on Shanghai Maglev Demonstration Line is on the high side in regard to long distance passenger transportation. On the basis of the tests and analysis of the characteristics of the sound source and sound spreading inside the vehicle, the modification solutions are made and planned to be used on the newly designed reference train.

## 3.2 Vehicle air conditioning system

As the vehicle's air conditioning system on Shanghai Maglev Demonstration Line was designed according to the climate condition in Germany, The vehicle's air conditioning system can not adapt well to the summer climate in Shanghai featuring in high temperature and high humidity. In the season of midsummer, it can not attain the expected temperature. In addition, it is discovered that the compressor's ventilation volume drops markedly, resulting from the wind effect when the train runs at high speed. We have studied solutions to improve the refrigeration capacity of the air conditioning system and increase its fresh air volume and planned to use them in the new reference train.

### 3.3 Battery

The original vehicle battery used on Shanghai Maglev Demonstration Line had the potential risk of such failures as locally over heating, short circuit, and burning, which are hard to be discovered by the monitoring and diagnostic system beforehand. After the vehicle burning accident caused by the battery failure, the technicians from both the German and Chinese side have made careful analysis about the cause and brought forward such measures as reinforcing insulation, improving temperature monitoring, adding voltage monitoring and improving charging management. These measures have been used in the trains running on Shanghai Maglev Demonstration and the new reference train under developing.

## 4 PLANNING FOR NEW MAGLEV PROJECT

To further verify the usability and economic efficiency of high speed maglev transportation in medium and long distance line with multi-stations and multi-sections, in March 2006, the Chinese government approved the project proposal for Shanghai-Hangzhou Maglev Project proposal; at present the engineering feasibility study for the project is being carried out. The line of Shanghai-Hangzhou Maglev Project will be 191km long in total (Figure 2) including the following new built stations: Shanghai South Station , Hongqiao Station, Jiaxing Station and Hangzhou East Station. It also includes the 31 km new-built airport link in Shanghai. Its highest speed for commercial operation will be 450km/h and the highest demonstration speed 500km/h.

At present the main obstacle in the project feasibility study rests with the economic efficiency of the project in particular the high unit price of the system equipment. The possible reasons for the high price are that the equipments are produced in small quantities and can not create scale effects. It is also possible that the suppliers are impatient to get the returns of the development cost from the limited order of the initial project. All parties participating in the project need to show great foresight to jointly solve this problem. I believe that the fundamental way for continuous application of high speed maglev transportation is to make breakthrough in its economic effects.

## 5 CONCLUSIONS

The over five-year operation practice of Shanghai Maglev Demonstration Line verifies that conventional conductive high speed maglev technology is generally safe and usable.

In comparison with car and airplane that are powered by oil, high speed maglev transportation system has noticeable advantages in energy saving and environment protection and therefore is more suited to the conditions of China with large population, vast territory and not rich in oil resources.

The decision of cancelling Munich Maglev Project the German government made has not shaken the confidence of the Chinese government in developing application of maglev technology. Preparations for Shanghai-Hangzhou Maglev Project are being carried forward as planning approval procedure.



Figure 2. Layout of Shanghai-Hangzhou Maglev Line