

California High-speed Rail Project

Peer Review Report of Operation and Maintenance

**The Third Railway Survey and Design Institute Group Corporation
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Declaration:

At the invitation of California High Speed Rail Authority, this peer review report was compiled by experts from The Third Railway Survey & Design Institute Group Corporation and Shanghai Railway Administration, the list of experts is shown as below.

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Peer Review Report of Operation and Maintenance

1. Review Scope

Operation and maintenance design of Phase 1 and the full build-out of the California High-speed Rail network.

2. Review Basis

Operation and Maintenance Peer Review Introductory Material and following enclosures provided by California High-Speed Rail Authority:

- A. TM 4.2-Phase I Service Plan;
- B. TM 4.3-High-speed Train Service Plan Draft-Full Build Network with links to Sacramento and San Diego;
- C. TM 5.1-Terminal and Heavy Maintenance Facility Guideline;
- D. TM 5.3- Facilities Requirements Summary.

3. Review Principle

Give review comments and suggestions based on the practice in operation and maintenance of China High-speed Railway and with the reference of the international practice.

4. Major Comments

4.1 General evaluation

California High-speed Railway Program Management Team gives basic assumption and initial ideas to the operation and maintenance of the project based on international practice of High-speed Railway design and operation, in consideration of the actual requirements of California High-speed Railway. The general thoughts, methods and research achievements can meet the development process requirements of California High-speed Railway Project and better direct the design of next stage.

Meanwhile, California High-speed Railway Program Management Team considering the limits of current research achievements and future verification to assumptions proposes the works, research contents and problems to be solved in the next stage, thus indicating the spirit of objectivity, pragmatism and scientific work altitude.

4.2 Service plan

4.2.1 About the year on which is based for developing phase 1 and full-build network service plan

According to the Operations and Maintenance Peer Review Introductory Material, the phase 1 and full-build network service plan are developed based on passenger flow on typical busy weekday in the year 2035. However, in “TM 4.2 - Phase 1 Service Plan” and “TM4.3 - High-Speed Train Service Plan Draft – Full Build Network with Links to Sacramento and San Diego”, the service plans are developed based on the predicted passenger flow of the year 2030. This inconsistency will seriously influence the design of California High-speed Railway system, which shall be emphasized particularly. The year taking as the basis for railway project design and construction shall be selected rationally and kept consistent.

4.2. 2 About the terminal layover and turnaround time

The shortest time of the terminal layover and turnaround can be 20 minutes (including 4 minutes for passengers to leave the train, 6 minutes for preparing the train, 10 minutes for passengers to get on the train) according to the practice of China High-speed Railway. Such design can increase the circulating times of train set, reduce total train set number as well as improve the efficiency of station tracks.

4.2.3 About the all-stop service

The all-stop service can facilitate the communication of passenger flow between stations, in particular neighboring stations. However, due to the stop at each station, the time for start and stop will be increased greatly, the distance covered with the highest operating speed will be shortened greatly, and the time waiting for an express train passing by will be increased, thus resulting a low traffic speed. The operation of trains stopping at interval stations can meet the communication between stations. The training stopping at each station generally attracts the passengers between neighboring stations. However, it does not have an advantage over highway transportation characterized in door to door service.

At present, there is no all-stop service on China’s High-speed Railway. The trains running on Shanghai-Nanjing High-speed Railway stop for five to six stations in interval. Based on China’s actual practice, the high speed trains can stop at stations in interval to reduce overtaking.

4.2.4 About service and business process outsourcing

Service and business process outsourcing can meet the requirements of professionalized operation, guarantee safety and quality, avoid the excessive expansion of enterprise, reduce human resources and related facilities and equipment, reduce operating cost, improve management efficiency and customer satisfaction. We believe that the business of terminal and other stations, foods and drinks service, station and training cleaning, advertising can apply outsourcing service.

4.2.5 About the manpower staffing for passenger service

It is a very complicated problem to determine the manpower staffing for passenger service, involving railway enterprise management and service objective, enterprise's social responsibility, competitive condition, regional culture and tradition, social and economic development, quality of the public, etc. The manpower staffing for High-speed Railway shall be determined according to the situation of a country and operating features of High-speed Railway other than directly copying another country's mode. However, it is worthy to understand the manpower staffing for passenger service in other countries. Therefore, China's peers are willing to introduce the manpower staffing for High-speed Railway passenger service for your reference.

The manpower staffing for High-speed Railway passenger service in China is listed below:

1 The manpower staffing for the comprehensive dispatch center of High-speed Railway

It is determined according to the number of dispatching desk, fixed number of persons per shift for each dispatching desk and shift system applied. Presently, two persons per shift are arranged for each dispatch desk in China. Four shifts system is applied.

2 The manpower staffing for station (see the following table)

Table 1 Manpower staffing for station Unit: person

Station Type	Professional title	Designed fixed number		Remarks
		Fixed number	Shift system	
Ultra large, large stations	Station master	1	day	
	Deputy station master	1	day	
	Person on duty in Centralized signal building	1	2	
	Person on duty on platform	1/platform	3	
Medium-sized and small stations	Station master	1	day	
	Person on duty in Centralized signal building	1	2	
	Person on duty on platform	1/platform	3	

3 Service staff for train

Service staff per 8-car trainset: One train conductor, two train attendants, two shifts per day; calculate based on three shifts in consideration of holidays. The posts and

number of service staff for catering and cleaning can be determined by outsourcing companies.

4.2.6 About shared operation

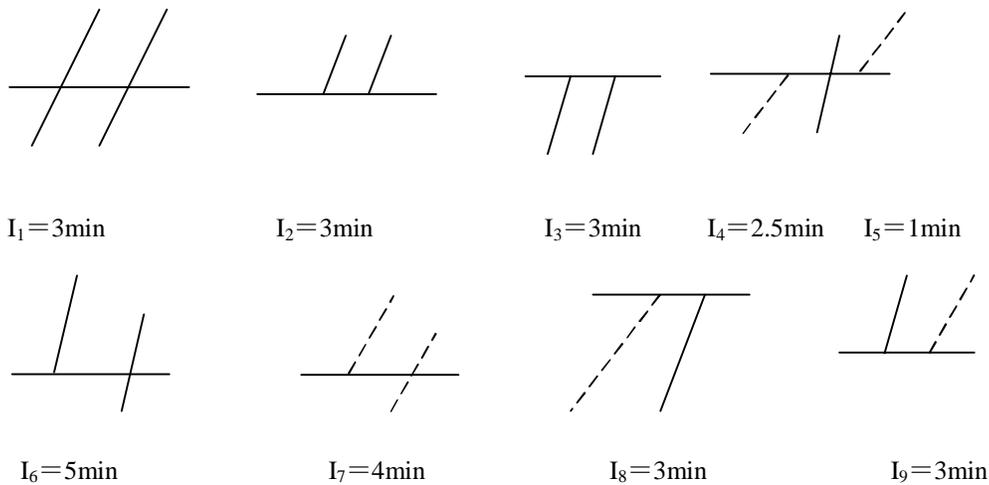
The shared operation shall take the following aspects into account: Firstly, the operating controls system shall meet the requirements on compatibility; secondly, the train width and platform gauge, door height and platform height shall match; thirdly, the high speed train, commuter and traditional train shall enter respective fixed lines and platforms to meet operating conditions.

4.2.7 About schedule recovery time or pad

It is necessary to arrange schedule recovery time or pad in train stringline diagrams for passenger flow fluctuation influencing the layover time of train, weather and other unpredictable factors and improving the on-time rate. The 5% recovery time proposed in report is proper.

4.2.8 About the time interval for tracing

The time interval for tracing train and different operations of train shall be calculated according to towing performance, train control method, arrival and departure tracks, turnouts, etc. The time intervals are recommended as below when one-off braking mode is applied by the train control system.



Note: The broken line is applied for trains with the speed of 200km/h or 250km/h. The real line is applied for the trains with the speed of 300km/h.

When the highest operating speed equals 350km/h, reaching time interval of trains is more than 3min and less than 4min, other factors are the same with that of 300km/h.

The involved parameters which are adopted to compute time interval mentioned are following:

- 1 The braking deceleration rate is not more than 0.75 m/s^2
- 2 The length of receiving and departing line is 650m.
- 3 The time from confirming signals of equipments on train by the driver to the braking of the system is 6s, and the time of comfortable steering is 10s.
- 4 The response time of receiving signals of equipment on train is 3.5s, the time form surpassing speed permitted to giving out instructions by the equipments is 2s, the time of unloading of equipments on train is 0.6s, the delaying time of starting braking system is 0.5s.
- 5 The preparing time of departing route or receiving route of a station is 8s.
- 6 The working time of performing train reaching and departing is 18s. (not including continuing route)
- 7 The running time of Air-brake in emergency is 3s, the running time of electricity & air-brake is 1.5s.
- 8 The length of the throat area of a station is 1000m.

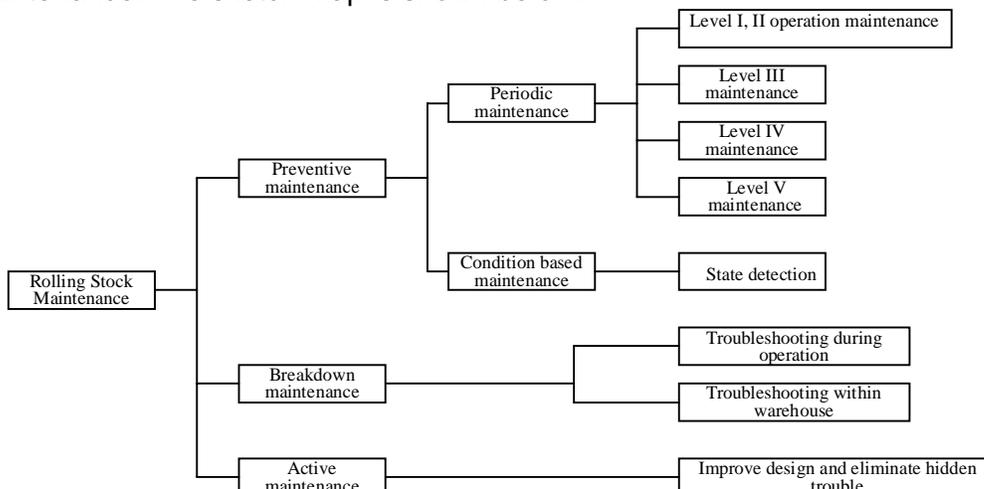
4.3 EMU storage and maintenance

Rolling stock storage and maintenance are related to EMU model. The following information is provided by the Chinese party based on the service plan and EMU configuration for California High-speed Railway Project and in consideration of the practices applied by China in EMU maintenance.

4.3.1 Maintenance program of EMU

The maintenance program of EMU shall be determined by the maintenance manual provided by manufacturer.

The maintenance program of high speed EMU can be divided into preventive maintenance, breakdown maintenance (or corrective maintenance) and active maintenance. The sketch map is shown below:



The overhaul of high speed train applies an effective method with the objective of greatly improving the safety and reliability of high speed train, greatly improve the efficiency of train, greatly reduce the time spent in overhaul, greatly improve the efficiency of overhaul and realize the manufacturing mode of overhaul. The overhaul of high speed train is based on parts life management system and applies advanced overhaul equipment, facilities and supporting overhaul service of parts manufacturer. It is divided into replacement overhaul, centralized overhaul, status overhaul, balance overhaul and overhaul nearby.

The maintenance program of CRH380A EMU is described as below:

Maintenance Level	Cycle
	CRH380A
Level I maintenance- <i>routine inspection</i>	4000 km or 48 h of operation
Level II maintenance- <i>emphasized inspection</i>	30,000 km or 30 days
Level III maintenance- <i>emphasized breakdown overhaul</i>	450,000 km or one year
Level IV maintenance- <i>system breakdown overhaul</i>	900,000 km or three years
Level V maintenance- <i>entre train breakdown overhaul</i>	1,800,000 km or six years

4.3.2 Task scope of EMU Facilities

Determine the task scope of EMU Facilities at each level; plan task scope of EMU equipment based on line condition and passenger train pairs, etc.

Maintenance Facilities for Chinese EMU includes:

EMU Depot: under takes level I to level V maintenance program, temporary maintenance, operation preparedness and storage of EMU. It is the application and overhaul base of EMU.

EMU Operation Depot: undertakes application preparedness, level I, II maintenance, storage and temporary maintenance of EMU. It is the application preparedness base of EMU.

EMU storage yard: is used for storing EMU. The application preparedness facilities can be provided according to demand.

4.3.3 Major design principles of EMU Facilities

1 EMU Facilities shall be implemented stage by stage based on railroad network planning, combination of recent and future works, unified arrangement.

2 EMU Facilities shall be provided based on existing EMU equipment or EMU equipment of neighboring lines and overhaul capacity. The new EMU Facilities shall be provided based on the previous design, construction and operation experiences,

with the utilization of existing facilities and sharing of overhaul resource.

3 EMU Facilities scale shall be determined according to EMU model, number, overhaul cycle and overhaul time.

4 Rescue Facilities shall be provided based on railroad network planning.

4.3.4 Positions standard of facility site

1 Conform to the general planning of railroad network, match with surrounding environment and scenery.

2 Be provided with good conditions for connecting tracks and facilitating operating management.

3 Be long and wide enough for meet functional and use requirement and be expandable.

4 Be easy for connecting power supply, water supply and drainage pipelines.

5 Be provided with good natural drainage conditions.

4.3.5 General plan of EMU facility

Scientific arrange the application, overhaul, auxiliary facility functional zones based on EMU application and overhaul demand; realize the effective operation of EMU section with independent as well as organically combined functional zones.

The general plan shall meet the requirements on smooth application and overhaul of EMU. The position of each facility shall be arranged closely related to overhaul contents, operation method and requirements, working sequence, working time, etc. Determine the implementation plan based on fully consideration of section site landform, land acquisition, investment control, etc.

4.3.6 Major maintenance facility and equipment

1 Operation maintenance facility

Facility functions include: EMU management function, EMU technical inspection and preparedness function, EMU passenger transportation preparedness function, EMU storage function.

Level I, II overhaul facilities include: inspection warehouse, under-floor wheel lathe and temporary maintenance warehouse, motor train unit washing warehouse, storage yard, etc.

2 preventive maintenance facility

The major function of overhaul plate is to undertake the level III, IV and V maintenance of EMU, including major parts overhaul and maintenance of train-carried equipment, perform breakdown overhaul for entire motor train unit, update parts in a

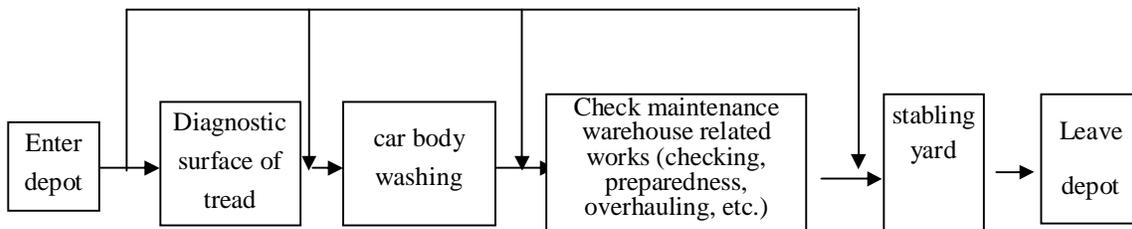
large scope, including supplementary painting or painting to car body.

preventive maintenance facility include: level III, IV maintenance and overhaul warehouse, bogie overhaul workshop, level V maintenance and overhaul warehouse, traverse table, train body surface treatment workshop, materials warehouse and EMU testing line, etc.

3 Maintenance process and equipment

Maintenance process and equipment characterized in high efficiency shall be provided: Determine the overhaul process of motor train unit taking high efficiency as the basis; apply advanced equipment to realize modern overhaul process.

Basic process of EMU in depot is shown as below.



Major equipment for level I, II Operation maintenance include: rail bridge and three-layer working platform , ground power, traveling part troubleshooting device, under-floor wheel lathe, bogie and wheel pair replacement device, car body washing machine , vacuum sewage discharge facility, hollow axle detection equipment, part storage and distribution system, safety monitoring and informatization system, storage facility, etc.

Level III-level V overhaul facilities mainly include: car lifter, bridge crane, bogie overhaul line, wheel pair overhaul line, etc.

4.3.7 Designed manpower staffing for EMU application and overhaul

The manpower staffing for EMU application and overhaul is determined based on EMU maintenance program and matching EMU number. If the matching number changes, the fixed number of persons for overhaul will also be adjusted. According to Chinese High-speed Railway EMU maintenance program and application and overhaul practice, the fixed number of persons for CRH380A motor train unit application and overhaul is set below for reference:

1 Level I maintenance operation staff

Level I maintenance operation staff will work for eight hours each day. Each group is arranged with four persons. Three trains can be overhauled by each shift. Eight persons are arranged for long train and four persons are arranged for short train. Three-shift system is applied. The standby rate of fixed number of persons is 1.07. In

level I maintenance, the maintenance will be performed after each operation.

2 Level II maintenance operation staff

The level II maintenance team is composed of 10 persons. Level II overhaul operation staff will work for eight hours each day. Each group is arranged with 10 persons. Three trains can be overhauled by each shift. Three-shift system is applied. The standby rate of fixed number of persons is 1.07.

Level II maintenance will be performed after operating for 30,000 km or monthly.

3 Quality inspector

One quality inspector is arranged for each two motor train units.

4 Other staff for level I, II maintenance

Management staff and technician of each application site (including superintendent, deputy superintendent, technician) and auxiliary staff including (scheduling staff, odd job men). It is calculated based on 20% of above staff.

5 Level III, IV and V overhaul operation staff

In 2009, China started to perform level III overhaul of EMU. Level IV and V overhaul has not been performed within EMU depot. The developed overhaul operation and staff arrangement are still under exploration. According to investigation, the design fixed number of persons for EMU depot will be 17 for each EMU (16-unit group).

6 EMU driver

One driver will be arranged for single or recombined EMU. The total number will be determined according to driving time. 1.07 standby rate is determined.

7 Engineman for the train

One engineman is arranged for each EMU. Three-shift system is applied. 1.07 standby rate is determined.

4.3.8 Standby EMU

At present, the designed EMU standby rate of Chinese High-speed Railway is 10%.

4.4 Maintenance of way

4.4.1 Function of MOW

The comprehensive maintenance will arrange maintenance facilities and sites for engineering, power supply, communication, signal, water supply, drainage, etc. collectively. The maintenance equipment will be provided in unification. The maintenance mechanism and maintenance staff will be managed and scheduled in unification. Such design is characterized in improved efficiency of resource utilization and maintenance. Therefore, it is necessary to apply comprehensive maintenance for

California high speed rail.

4.4.2 MOW facility site and configuration

The description of conditions for selecting infrastructures maintenance site is relatively complete in the TM 5.3, namely: the site for each MOW facility must be located immediately adjacent to main line of the HSR and be arranged with tracks connecting to main line; the site for each MOW facility must be connected with highway network nearby and be easy to connect municipal water, power, gas, sewage pipeline and communication facility; internal roads should be built in the site.

The governing mileage of maintenance site (workshop) is determined by workload of infrastructures maintenance, maintenance skylight time, efficiency of heavy maintenance machinery, operating method of confirming vehicle, etc. Therefore, the governing mileage of maintenance site (workshop) shall be determined according to the condition of station after above factors are fixed.

4.4.3 Manpower staffing of MOW

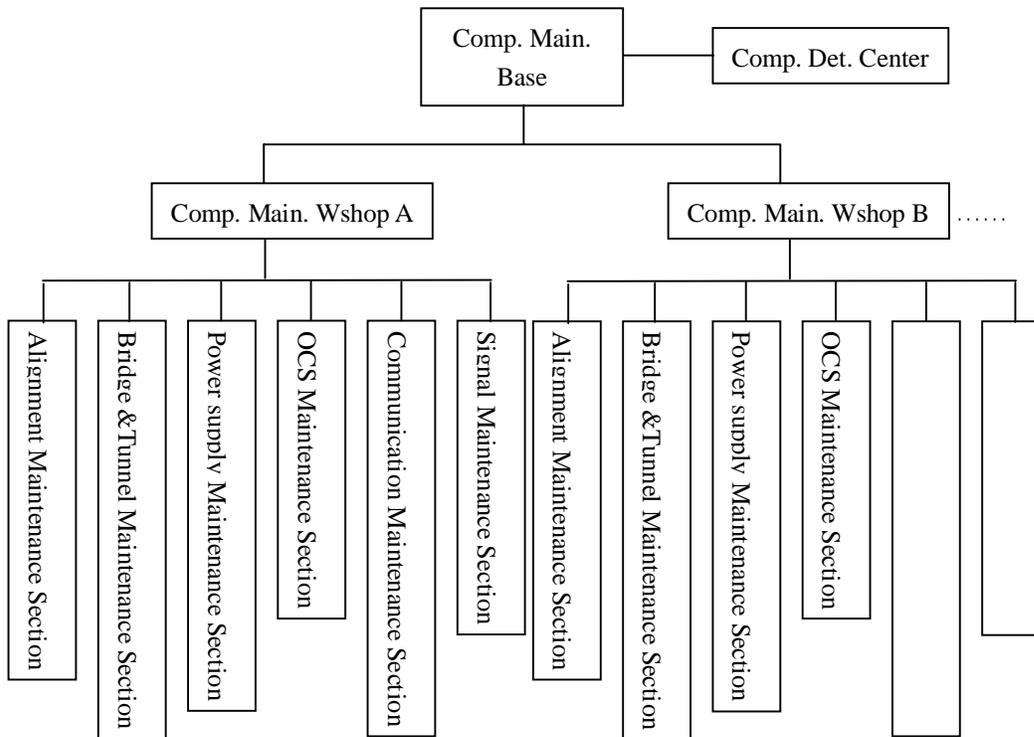
The manpower staffing is closely related to organization structure, line length, track type, turnout quantity and outsourcing of maintenance, etc.

The preconditions such as the type and length of track, the outsourcing items and quantity of higher level maintenance and etc., were not given in the Introductory Material, so it is difficult for us to assess the manpower staffing of MOW. According to the maintenance experience of Chinese HSR, the manpower staffing of MOW provided in table 10 in the Introductory Material can basically meet the requirements of daily inspection, maintenance and temporary repair, however, that will be not enough for completing the higher level maintenance work.

4.4.4 Setting of maintenance system for Chinese HSR infrastructures

1 Maintenance mode and organization structure

The maintenance of Chinese HSR infrastructures applies comprehensive maintenance mode. The comprehensive maintenance business can be divided into detection and maintenance. The complete maintenance organization of Chinese HSR is composed of the comprehensive detection center and comprehensive maintenance base. Along with the increase of HSR operating mileage and increasing demand of comprehensive detection, the comprehensive detection center may be combined into the comprehensive maintenance base. The comprehensive maintenance base is composed of the comprehensive maintenance workshop, comprehensive maintenance workshop dividing into alignment, bridge, communication, signal, power supply and transformation, contact line maintenance sections, etc. The Chinese HSR maintenance organization structure is shown as below:



2 Comprehensive detection

To a certain extent, the comprehensive detection technology is developed along with the development of High-speed Rail. It is characterized in multiple detection items, fast detection speed, high detection accuracy, real time detection, fast data processing and easy storage, being able to contain into the operation plan and comprehensive detection train being able to run at the highest speed during detection,

The comprehensive detection refers to the detection of track geometry status, acceleration, wheel/track force, contact line, communication, signal, train control system and derailment coefficient, rate of wheel load reduction and axle lateral force, etc. and video monitoring of environment with high speed comprehensive detection train in a certain cycle based on the time specified by operation chart and normal running speed on such line. The detection and patrol result will be analyzed and reported to related maintenance and management departments and archived in the same time. The assessment and management criteria in regard to the detection items were formulated by Ministry of Railways of China.

The high speed comprehensive detection train is vital facility for realizing the comprehensive detection. It is composed of accurate professional detection, analysis, patrol inspection instrument and computer, etc. on an EMU operating on HSR, so as to guarantee the working condition of detection is consistent with the actual condition of operation and obtain correct and real time detection data. The high speed

comprehensive detection train independently developed by China is provided with above functions and it takes the lead in the world on performance and technical indicators.

In order to guarantee the successful implementation of comprehensive and special detection, a special organization-comprehensive detection center is established, with the objective of managing and supporting the comprehensive detection train, track detection train, etc., and preparedness, maintenance of overhaul and detection facilities, and the overhaul and detection, data processing, etc.

A special comprehensive maintenance information system shall be provided to realize the continuity, analysis, storage and transportation of comprehensive detection, track detection and related facilities information, etc., and then correctly master the real time quality status of infrastructures detected, analyze and predict the potential disease trend, and on such basis, to provide correct and detailed guidance for related maintenance and evaluate the maintenance quality.

3 Comprehensive maintenance

1) Comprehensive maintenance workshop

The comprehensive maintenance workshop is liable for daily curing, maintenance, temporary maintenance of the governing infrastructures, rechecking the area with problems found during the comprehensive detection, correct determining and positioning, cooperating the curing and maintenance of heavy maintenance machine in such area, acceptance of its quality, and managing the comprehensive watching point. Therefore, the comprehensive maintenance workshop is divided into maintenance sections such as alignment, bridge and tunnel, communication, signal, power supply and transformation, contact line, etc. The density of maintenance workshop is about one site/150-200km, which is considered based on related shifts, operation and contact line working vehicle application requirement in consideration of station arrangement and saving of investment.

In addition, the station without comprehensive maintenance section is arranged with the comprehensive watch point (including alignment, power supply, communication signal speciality, etc. in general) subject to corresponding comprehensive maintenance workshop. The comprehensive watch point is liable for monitoring and maintaining the infrastructures of station where it is located in. The large maintenance program will be performed by the comprehensive maintenance workshop.

However, the application of heavy maintenance machine for the comprehensive maintenance workshop with density of one site/200km will affect the efficiency because of the long travel distance and increase the maintenance cost. Therefore, it is required to set side line for stopping heavy maintenance machine between comprehensive maintenance workshops with the density of about one site/50km.

Based on the above function of the comprehensive maintenance workshop and comprehensive watch point and apart from the public traffic, transport, hoisting, maintenance, curing facilities, each professional shift shall be provided with corresponding detection and maintenance machinery. In particular, the alignment shift shall be provided with necessary static detection and small railroad maintenance tools, and process the business information as well as input into the above comprehensive maintenance information system.

The comprehensive maintenance workshop is provided with tracks for heavy maintenance machine, motor-trolley, contact line vehicle, etc., and garages and office buildings for vehicle maintenance, curing and work area management and operation. Beside above factors, the site shall be located in the station in the area with developed economy and culture, so as to make it easy to use maintenance tools and equipment from social resource and provided convenience to employees.

2) Comprehensive maintenance base

The infrastructures comprehensive maintenance bases for HSR (in Beijing, Shanghai, Guangzhou, Wuhan) are the top organization for comprehensive maintenance system. They can be regarded as the headquarters and will be set in proper position of railroad network. The comprehensive maintenance base is the main body in organization structure for the “management, overhaul and maintenance” of fixed equipment for HSR. It is completely responsible for the technical status of governing fixed equipment and providing fixed equipment with good conditions, in order to guarantee the “safe, comfortable and on-time” operation of train. The functions of comprehensive maintenance base can be divided into following six aspects:

- Unify the management of infrastructures maintenance of HSR within the governing area, including the management of equipment status and data, maintenance plan and budget preparation, allocated maintenance cost, unify the dispatching of maintenance resources within the governing area, provide technical support to important professional technical problems, check, supervise and accept the maintenance of full line.
- Accept the orders from dispatch center as a dispatch point of the comprehensive dispatch and comprehensive maintenance dispatch subsystem, so as to exchange information with Beijing Dispatch Center.
- Take charge of infrastructures detection for all HSR lines within the governing area, download and save detected information and data, perform analysis and process to guide the maintenance. Detect the maintenance results to provide technical basis for future acceptance.
- Directly take charge of rush for repair of HSR line within rational work scope and some maintenance works, manage the related comprehensive maintenance workshops and maintain the maintenance equipment involved.

- Take charge of the application of heavy maintenance machines and track based vehicles for HSR line and the complete maintenance of above vehicles.

5. Suggestions

1. Build intelligent passenger transportation service system. Set passenger transportation service system control platform in the operation and control center. Control the guidance, broadcasting, monitoring, clock, inquiry, help and deposit system of each station by platform operator through remote control technology, so as to realize the informatized, automatic and intelligent passenger service.
2. The senior overhaul facilities for EMU shall be set in concentration; the low level overhaul facilities shall be set dispersedly according to the departing and arriving motor train units at station to meet the application requirements of motor train unit.
3. The comprehensive detection is a functional subsystem vital for high speed railway infrastructures status monitoring, maintenance guidance and quality supervision and should be taken into consideration in California High Speed Rail.
4. Set a comprehensive watch point for engineering, power supply, communication, signal works to take charge the infrastructures maintenance and temporary maintenance of each station. The watch point is subject to related workshop management.
5. The station space between Merced and Gilroy, Bakersfield and Palmdale is too large. It is recommended to set branch lines between them for stopping maintenance vehicles.