

The topic of this speech is train control system, which is divided into four parts: introduction of Chinese high-speed railway, general situation of Chinese train control system, CTCS-2, and CTCS-3.

The first part introduces Chinese high-speed Railway, Chinese high-speed railway includes 4 parts: passenger dedicated line、intercity transport system、updated conventional railways、new lines for improving railway network. According to the plan, by 2020, there will have been more than 120,000km railway, in which double track and electrified account respectively for over 50% and 60%. The main busy line will have realized separation of passenger and freight traffic, main technical equipment shall have reached or gotten close to international advanced level, and transport capacity shall have met the need of economic and social development.

The second part is the overview of Chinese Railway Train Control System, Learning from Europe Train Control System (ETCS) development and foreign experience in high-speed rail control system, combining with Chinese railway transportation characteristics, and following the principle of unified planning the whole railway, Chinese Ministry of Railway (MoR) determined to build Chinese Train Control System (CTCS). The target of CTCS is to improve safety function and Efficiency of transport, satisfy interchange operation, regulating the system design and system classification to adapt to the demand of development.

CTCS is divided into 5 ranks:

CTCS-0 is applied to existing lines, Wayside Equipments content domestic track circuit, On-board equipments include universal cab signal, monitoring and recording devices (Ordinary) . This system adopt fixed block system.

CTCS-1 Wayside Equipments content domestic track circuit of ZPW-2000, On-board Equipments include the main cab signal and LKJ-2000, This system adopt fixed block system

CTCS-2 has been used in current 200-250km/h railway, its Wayside Equipments content Balise and ZPW-2000A track circuit, The On-board Equipments include ATP and LKJ-2000 which is based-on vital computer. This system adopt fixed block system.

CTCS-3 is based on wireless communication, applied to 300-350km/h line. Its wayside equipments content Radio Block Center (RBC), GSM-R wireless train-to-wayside communication module. ZPW-2000A track circuit realizes the occupation inspection. The on-board equipments include ATP which is based on vital computer. The locomotive driver takes the cab signal as evidence. This system adopt fixed block system.

CTCS-4 is the tendency of development in the future. Its wayside equipments content RBC, GSM-R wireless train-to-wayside communication module. The on-board equipments include ATP which is based on vital computer. It cancel section track circuit and can accomplish virtual /moving block system.

The third part emphasize on CTCS-2. CTCS-2, which is based on the

transferring of movement authority information between track circuit and balise, uses the target range continuous speed control mode to monitor the safe operation.

The main equipments of CTCS-2 content Track Circuit (TC), Balise, Train Control Center (TCC), and On-board equipments. The main structure is that Centralized Traffic Center (CTC) exchange information with Train Control Center (TCC) and Interlock, TCC receives the information from track circuit and balise, and Interlock control signals and switches.

On-board equipments of CTCS-2 content Vital Computer (VC), Track Circuit Reader (TCR) and its antenna, Balise transmission module (BTM) and its antenna, Driver - machine interface (DMI) and Speed sensor.

The function of every part of CTCS-2:

Track Circuit checks section occupied and provides the number of free block section in front of the train.

Active Balise is used to provide temporary speed restriction and route information.

Fixed Balise is used to provide line information, permitted speed and length of block section fixed information.

The main function of on-board equipments is to integrate track circuit, balise information and EMU parameters, to generate a continuous speed control mode curve automatically, real-time monitor the safe operation.

Now let me introduce the Operation principle of CTCS-2: Centralized Traffic Control (CTC) send the operation diagram to CTC station extension, the CTC extension send route command to the Station Interlocking, and at the same time send temporary speed limit information to the Train Control Center(TCC). Station interlock collects the information of section occupation from track circuit, and the information of switch positions. After proceeding, interlock provides the route setting and controls the signals and switches in accordance with the commands from CTC. Then interlock sends the route information to TCC, TCC generates track circuit code and message of the balise according to the route information and the temporary speed restriction information which is generated by itself. The track circuit code sends to the track circuit and message of the balise sends to Balise. On-board unit receive all the information from track circuit and balise and then generate speed control curve to monitor the safe operation.

The Wayside Equipment of CTCS-2 include active Balise and fixed Balise. There is the Balise arrangement of CTCS-2:

1. In / out points:

Use active Balise and fixed Balise in order to provide the information of temporary speed limit and lateral line routes.

2. Section Interval

Set single fixed Balise to provide line data, each Balise contains the information of 10 track section in front of it.

3. Grade of the border

Set fixed Balise group to provide the information of grade forecast, grade conversion command.

The fourth part introduces the CTCS-3 system, CTCS-3 system is based on GSM-R wireless communicate to achieve bi-directional communication between the train and wayside. The Radio Block Center (RBC) generates Movement Authority, and the Track Circuit is used to inspect section occupation. Balise is used to locate train position, and has the features of CTCS-2.

The main facilities of CTCS-3 include RBC, GSM-R net, Track Circuit, Balise, TCC, on-board equipment, etc.

RBC generates the Movement Authority according to the track circuit, interlocking route and other information, and transmits the Movement Authority, line parameters, temporary speed restriction to the On-board equipment via GSM-R wireless communication system. It also receives information such as the location and the data of the train which is sent from on-board equipment by GSM-R wireless communication system.

#### GSM-R

GSM-R is used to achieve continuous, bi-directional, large capacity of information communication between the on-board equipment and wayside equipment.

#### Balise

Balise is used to transmit information of location and grade conversion to on-board equipment. It also sends line parameters and temporary speed restriction.etc to the on-board equipment to meet the needs of the standby system.

#### On-board equipment

On-board equipment is used to generate dynamic velocity curves which are base on the movement authority, line parameters, temporary speed restriction, train parameters provided by wayside equipment, according to the distance and the continuous speed control mode. The On-board equipment monitor the safety operation of trains.

#### Track circuit

The function of track circuit is to achieve inspection of section occupation, and send the state information of block section to meet the needs of standby systems.

Compared with CTCS-2, the wayside equipment of CTCS-3 adds Radio Block Center(RBC), GSM-R wireless communication network, the on-board equipment, GSM-R wireless communication unit and antenna. CTCS-3 system using RBC provide MA to the train, and achieve continuous, bi-directional, large capacity of information communication between the on-board equipment and wayside equipment.

The main working principle of CTCS-3: According to the information of section occupation from track circuit , Station interlocking authorized by the information signal sent to the speed limit, the CTC will be sent temporary speed limit

information to RBC, vehicle will be sent to the location and other information send to RBC, and RBC according to statistics, generate driving license will be generated and it sent to the vehicle, the vehicle in accordance with the device speed and using information permission to build a speed of the monitoring of the train.

1. Based on the GSM-R to achieve continuous large capacity information transmission, the system can provide as far as 320km of the target distance, line permitted speed and other information.

2. The System can meet operational requirements of different level railways.

3. CTCS-3 system, through integrating the message of CTCS-2 in Balise, meet the needs of 200 ~ 250km. At the same time, the CTCS-2 serves as a standby system of the CTCS-3.

4. Bi-directional information transmission between on-board and wayside equipment. The wayside equipment can control train speed, location, work state and other information in real-time, and can display all the information in the CTC system.

5. The system can set the temporary speed restriction flexibility, it also can achieve temporary speed restrictions setting in arbitrary location, length and number.

6. RBC can be centralized setting and also scattered setting.

7. RBC sends information of neutral zone to the train which is equipped with CTCS-3 and Balise sends information of neutral zone to train which equipment with CTCS-2, achieve to automatically over neutral zone .

The 9 kinds of Operation Mode of wayside equipment in CTCS-3 include: Full Supervision Mode(FS), On-Sight Mode(OS), Call-On Mode(CO), Shunt Mode(SH), Isolation Mode(IS), Standby Mode(SB), Sleep Mode(SL), Partial Supervision(PS), Cab-Signal Mode(CS). Among these, the mode of Part Supervision and Cab Signal only suit to CTCS-2.

The 14 kinds of Primary Operating Scene in CTCS-3 include: Registration and start, Enter and exit the segment of EMU, Grade conversion, Movement Authority, RBC switch, Automatic over Neutral zone, Multiple & disconnection, Temporary speed restriction, Case of degradation, Disaster protection, Parking and End of Mission, Shunting, Artificial unlock route, Special route.

GSM-R uses a single network interleave redundant coverage scheme. As long as the adjacent base stations don't fail at the same time, it will not affect the GSM-R network coverage.

Systematic evaluation of the system implementation throughout the whole process is divided into 4 phases:

System design phase

Product realization phase

Test checking phase

Acceptance confirmation phase

High speed railway has already been finished by the end of 2010:

1. 300km/h-350km/h new high speed line:

Jing Jin intercity high speed railway: Beijing to Tianjin

Jing Guang high speed railway(Wuhan to Guangzhou): Wuhan Xianning Yueyang Changsha Zhuzhou Hengyang Chenzhou Shaoguan Qingyuan Guangzhou.

Xv Lan high speed railway(Zhengzhou to Xian ): Xian Weinan Sanmenxia Luoyang Zhengzhou

Hu Ning city high speed railway: Nanjing Zhenjiang Changzhou Wuxi Suzhou Shanghai.

Hu Hang high speed railway (2010 10.1) : Shanghai Jiaying Hangzhou

Guang Shen high speed railway (2010.12.28): Guangzhou Dongguan Shenzhen.

2. 200km/h-250km/h new high speed line:

He Ning high speed railway: Hefei to Nanjing.

He Wu high speed railway: Wuhan Liuan Hefei.

Yong Tai Wen high speed railway :Ningbo Taizhou Wenzhou

Fu Xia high speed railway: Fuzhou Putian Quanzhou Xiamen.

Jiao Ji high speed railway: Jinan Zibo Weifang Qingdao.

Shi Tai high speed railway: Shijiazhuang Yangquan Taiyuan.

Shen Fu intercity high speed railway: Shenyang Fushun

JiuChang intercity high speed railway(2010.08.30): Jiujiang Nanchang

ChangJi intercity high speed railway(2010.12.01):Changchun Jilin