Consulate General of the Republic of Korea
San Francisco

RECEIVED
DEC 0 7 2010
BY:

December 3, 2010

Mr. Roelof van Ark
Chief Executive Officer
California High-Speed Rail Authority
9255 L Street, Suite 1425
Sacramento, CA 95814

Re: "Peer Review" of your Operations and Maintenance concepts and procedures of California High Speed Rail

Dear Mr. Ark,

I am pleased to forward you the attached "Peer Review" that I received from the Ministry of Land, Transport and Maritime Affairs of the Republic of Korea.

My hope is that the review will be a great asset for you to build the most advanced and safest High-Speed Rail in the state of California. In addition, as I mentioned in my previous letter dated September 17, 2010, I hope that the Republic of Korea will be able to participate in the project.

Taking this opportunity, I would like to request a meeting with you and your officials working for the project to exchange our views on the High-Speed Rail system at your earliest convenience.

Sincerely,

Jeong Gwan Lee
Consul General

Enclosure: "Peer Review" from the Ministry of Land, Transport and Maritime Affairs of the Republic of Korea.

3500 Clay Street, San Francisco, CA 94118
Tel:(415)921-2251 • Fax:(415)921-5946 • Email:consularsf@mofat.go.kr

- California High speed Train Project -

Operations & Maintenance
Peer Review

Ministry of Land, Transport and Maritime Affairs

Republic of Korea

1 Review on Inquiry & Issue

1. Train Operation Frequency & Stopping Pattern

✓ Accurate demand forecast is required to establish the train operation frequency and the stopping pattern.

- It is important to determine the necessary number of train sets and the operation frequency by forecasting the demands by the section and the maximum section demand(the number of on-board passengers1)) to prevent oversupply, even though the frequent train operation is required to accommodate the demand.

❍ The plan is only for the peak and off-peak periods. It is recommended to make the additional plans for week day and weekend to alter the frequency by the demand.

❍ It is agreed that the fixed train departure times stated in this plan is good to improve the service quality and convenience for the users.

- It is, however, difficult to make the train operation plan considering the operation conditions such as stopping time and the frequency on peak/off-peak period by route and train class on the intermediate stations.

2. Provision of Combined Service with Various Train Classes & Stopping Patterns

- The train service is classified into the express, limited-stop and all-stop services on the plan, and the priority is given by the order of express, limited-stop, and all-stop service in terms of the siding. It is not desirable to provide the differentiated services in the high speed rail(HSR) system considering the characteristics of HSR such as the fast and safe travel.

- It is recommended to apply the skip-stop2) method which classifies the service into the express(non-stop) or major station stopping service' and 'limited station stopping service'.

- The Korean HSR does not adopt the siding schedule. The fare should be adjusted by the train class in case of the siding operation.

3. Recovery of Delay

- An allowance time varies by the number of stations and the accelerating/decelerating performance of the train. One percent of the allowance time may be short to recover to the normal operation condition in the case of unexpected incident. It is then recommended to provide the longer allowance time.

  - The Korean HSR service provides 2 ~ 3% of the allowance time for the on-time service.

- It is concerned that the operating time plan based only on the result of the simulation without test run may result in the lack of the operating time by the crew's operation ability or the other conditions which are not considered in the simulation.

  - The Korean HSR determines the operating time considering the performance of the rolling stock, acceleration/deceleration performance, and the track conditions, and the operating time is verified by the test running.

<Reference 1> Comparison on On-Time Operation Rates by High-Speed Rail Systems (Delayed less than 15 minutes on the Terminal Station)

4. Actual Train Headway & Distance to Siding Station

- This plan does not contain the data required to determine the carrying capacity (frequency, and etc.). The headway and the carrying capacity were reviewed independently.

<Reference 2>Comparison on Carrying Capacity and Train Frequency by Headway

- The reduction of the number of operations is required when assumed one-way operations.

- When the number of operations increases by the increased demand, the reduction of the headway is required but the safety limits should be considered.

- Five minute departing headway results in less than 3 minute headway with the following train when the train stops. The verification of 3 minute headway should be required by the simulation considering the various expected or actual stopping patterns (skip-stop, and etc.).

- Three class services(express, limited-stop, and all-stop) may limit the maximum number of train operations by the interferences by each other.

- The Korean HSR is considering various train operation patterns. The minimum headway is assumed 3 minutes theoretically, but the practical headway is 4 minutes and the waiting for another train is not necessary.

<Reference 3> Example of Siding by Headway

- The service length of Korean HSR is 423.8 with 9 sections, and the distance to the siding station is 47km in average. The distance of 48 km in this plan is similar to the Korean experience.

- The distance to the siding station is determined with the schedule speeds of passing and passed trains. The distances are 59.8 and 79.9 km in the first phase and the completion respectively, and it is regarded to be acceptable according to the result of calculation by the Korean criteria and the siding station determination method.

※ The result is for the Korean HSR, so other conditions should be considered.
<Reference 4> Calculation of Distance between Siding Stations

5. Train overtakes

- It is regarded to be appropriate.

6. Storage yard facilities

- It is regarded to be appropriate.

7. Track Sharing

- When the high speed track is shared with the conventional train, the difference in the schedule speeds causes the interference, and the operating speed of HSR should be reduced. It reduces the carrying capacity consequently.

- It is possible to share the track as long as both trains use the same gauge, the optimal condition of rail section should be kept between the high speed & conventional trains and rail.

  - The specifications vary by high speed train and conventional train, the rail section contacting directly should be considered.

- It may be inefficient to share the high speed track with the conventional train considering the influences to the high speed train in terms of the carrying capacity and the case of incident. When it is shared, it is recommended to increase the speed of the conventional train.

8. Terminal station

- It is regarded to be appropriate.

9. High-Speed Train Service Time & Maintenance Time Operation

- The night train service may be considered to accommodate the special demands (weekend travel, Monday demand for commuting, and the peak season (Christmas, and etc.)). The periodic maintenance should be postponed and the maintenance time should be secured during the period except those.

- Korean HSR sets the time for maintenance of inspection for an hour (11 ~ 12 am) during a weekday in which the demand is little.

- An appropriate maintenance time may vary by the structure of track.

  - A ballast track bed relaxes by the train operation, and the track defect may occur, then the periodic tamping is required. The transport of maintenance equipments (maintenance depot-site) and the minimum work time should be considered.

  - A concrete track does not require a routine maintenance and repair.

10. Train Operation Type

- It is determined to be a suitable plan.

1> The Number of On-Board Passengers: It is the number of train passengers on board. This number changes by section since the passengers boarding/alighting at the stations.

2>skip-stop method: It improves the schedule speed by stopping at every other station. It may cause the reverse-transfer.

11. Operation Service Plan

- No comments or recommendations

12. Dwell Times at Intermediate Station & Turnaround Times at Terminal

- A high-level platform is desirable for reducing the boarding and alighting time as well as for the convenience of the disabled.
- As stated in the plan, it is evaluated that the terminal turnaround times of 30~40 minutes are appropriate.
- If reviewing the train platform size based on the terminal turnaround times of 30 minutes (2 trains per hour) and the train operation times of 19 hours:
  - One-way 152 trains can be operated at 2 platforms with 4 tracks
  - One-way 228 trains can be operated at 3 platforms with 6 tracks
- If reviewing the train platform size based on the turnaround times of 40 minutes (1.5 trains per hour) and the train operation times of 19 hours:
  - One-way 114 trains can be operated at 2 platforms with 4 tracks
  - One-way 171 trains can be operated at 3 platforms with 6 tracks
- Since this plan has a lack of the basic data(curve, grade, stop station & etc) required to calculate the train operation time, it is difficult to evaluate on the operation time of phase 1 section taking for 2 hours and 57 minutes with the speed of 745km/h (schedule speed of 252.5 km/h).

- It is advantageous in terms of operation flexibility to operate 200m long single train set for off-peak period and operate a doubled train sets during the peak hours.

- In addition to the operation based on peak and off-peak periods, it is necessary to consider operating the doubled train sets only at a section with many on-board passengers and splitting the doubled train sets to two single sets heading toward two different final destinations.

  - Operating the doubled train sets at San Francisco to LA section and splitting into two operations, one for LA to Anaheim and the other for LA to San Diego.

- However, it is required a suitable guidance prior to the boarding for the passengers to be seated in the appropriate train set by their final destinations since they cannot move back and forth to the each train set while under the operation.

14. Size of Crew Plan

❍ It is operated 2 types of high-speed trains in Korea and the number of crews on-board is shown below.

- KTX-Sancheon(201m, 10 cars)
- 1 train captain, 1 train team manager, 1 crew and 1 on-board sales person
- KTX (388m, 20 cars)
- 1 train captain, 2 train team manager, 2 crews and 1 on-board sales person

※ At the initial stage of train opening, 1 additional rolling stock maintenance technician could be on board for the safety reasons.

15. Ticket Issuing & Fare Collection

- It is necessary to check the tickets on board to prevent users from on-boarding without paying for a fare. To do so, it is required to set a plan to supply crews with PDA (personal digital assistant) equipped with functions to check the ticketing status and calculate the fare, and to utilize smart phones.

- In terms of services, it is necessary to operate an information center not only to inform the users with the railroad information but also to provide overall local sightseeing and travel information in connection with the local government.

- KORAIL Ticket Reservation and Issuing System

  - It is a system to provide users with various services in real time so that they can reserve and issue tickets for 24 hours. The services including not only the ticket reservation/issuing but also various travel packages are offered via various media such as ticket offices at stations, travel agencies, call centers, on-board PDA(personal digital assistant), Internet, ATIM(automatic ticket issuing machine), cell phones and so forth.

- Providing Various Channels to Use Tickets

  - 548 installed ticketing terminals at stations, 537 ticket sale stores and 428 automatic ticketing vending machines nationwide
  - 73 installed and 17 portable ticketing terminals at main banks and post offices
  - 933 wireless portable ticketing terminals used at trains under operation
  - Ticket reservation/issuing services via Internet homepage (www.korail.com), cell phones(2G) and smart phones

<Reference 5 > KORAIL Ticket Types & History

16. Railroad Passenger Security at Stations

- Railroad terrorism is in the increase worldwide requiring measures to improve the security equipments and facilities of the railroad and to strengthen the drills to prevent and be fully-prepared for terrorism

- KORAIL is building an improved security system by forming a team to manage terrorism within the Head Office and Regional Headquarter and reinforcing the protective equipments/facilities.

<Reference 6> Organization Chart on Railroad Terrorism Protection Team at Head Office and Regional Headquarter

17. Handling Traveler's Baggage

- If the standard rolling stock is based on 200m in length with 500 seats as assumed in the plan, a review for the customer service should be considered.
  - If 500 seats provided in a 200m long train set, the size of carry-on baggage should be limited in order to secure the minimum space between seats.
  - Required to consider the environmental conditions of a coach room such as an increase of CO2 concentration per additional passenger
  - KORAIL is complying with the UIC standard, setting the load per passenger as 75kg, yet taking into account the figure of Westerners it is required to secure broader seat spaces than ones in KTX

<Reference 7> Comparison on Human Body Size and Weight of Easterners Westerners

18. Handling Bicycles

- KORAIL is currently operating high-speed trains that do not allow bicycles on board, but a theme train which is the one of conventional non high-speed trains is being operated providing a space for bicycle loadings considering the characteristic of a bicycle as leisure.

<Reference 8> Theme Train: Bicycle Train

19. Conventional Train Boarding/Alighting Procedure

- It is determined to be a suitable plan

20. Train Boarding/Alighting Procedure at Intermediate Station

- It is determined to be a suitable plan

21. Passenger Boarding Process, Terminal Stations

- It is determined to be a suitable plan

22. Passenger Access to Platforms

- In Korea, separate platforms for maintenance personnel are not installed at terminal and intermediate stations. The installations of separate platforms cause acquisitions of land and construction cost increases. Also their economic efficiency is low.

- The train maintenance is performed at the rolling stock depot and the preparation for train operation is executed at the terminal stations basically. Therefore, we judge that the installations of separate platforms at terminal and intermediate stations aren't useful except for inevitable cases.

23. Access to Platforms served by High-Speed & Non- High-Speed Trains

- It is not easy to distinguish the passengers using high-speed trains and Conventional trains at the shared platform so it is reasonable to consider plans to strengthen the ticket checking and fare collection on-board the vehicle.

- A single railroad operating company (KORAIL) adopts the same platforms and station facilities for the high-speed trains and conventional trains in South Korea, resolving the operational issues.

- As reviewed in the plan, if the other railroad management companies share the platforms and gauges with different fare systems and passenger service procedures, it requires providing different train using routes and transfer facilities resulting in complicated platform and station facility plans. Moreover, the construction cost is expected to rise owing to the overlapping investment on facilities.

- The specification of rolling stock is a critical factor that influences the platform installation standard, so it requires a standardized specification to share the platforms.

- In Korea, the specifications of KTX and conventional trains are similar, adopting low-level platforms. It is desirable to review the rolling stock specification so that the low-level platform can be used when selecting the high-speed trains in the future. This will reduce the construction cost at the construction stage and be beneficial during the train operation.

24. Service Access to Platforms

- Cleaning works of passenger cars and toilets, for the train operations, preparations for various fixtures and loading of goods, foods for shops or dining cars are performed at High Speed Rail terminal Stations. Accordingly, in addition to the pathways used by passengers, a separate working corridors and elevators or ramps which make it possible to deliver equipments and materials should be planned.

- Seoul, Yong-San terminal station of Korea High Speed Rail have been installed and operated with elevators that can deliver freights.

25. Dwell Times at Intermediate Stations

- It is determined to be a suitable plan

26. 10% Spare Ratio

- It is required to calculate an efficient spare ratio by considering the following matters:

  - Until the stabilization phase from the opening, the maintenance standard of the rolling stock can be established on both mileage (kilometers) and period basis.

  - At the initial opening stage, the spare ratio is required to take into account of the inexperienced and unskilled maintenance workers who are not able to respond to the possible contingencies properly.

  - Trains cannot run for a long time when a heavy maintenance time comes. In this case, the spare ratio could be increased according to the heavy maintenance plans.

  - Based on how the maintenance system of the rolling stock is executed, the weekday and weekend spare ratios may be adjusted and it is advised to review the maximum dispatch of rolling stocks during the peak time on weekends.

  ※ A plan that reduces the spare ratio of weekends through the low maintenance on weekdays.

- You may refer to the spare ratio of rolling stock in other companies' or overseas cases. But it is essential to determine the spare ratio in light of the operating condition of CAHSR Authority such as the number of train sets and train routes you have.

27. Infrastructure Maintenance & Asset Management System

- An integrated information system is required to manage the assets such as the facility history, spare parts and equipments as well as the facility inspection records. This is ideal to connect to the documentation management system that is able to manage the facility design drawings, photos and so on.

- Kovis, ERP system of korail, has the function of the asset management that enables to manage the facility information and history and to calculate the additional manpower, parts and cost.

- On track inspection, KORAIL operates a track geometry inspection car, a track patrol inspection car, and a rail ultra sonic car in order to identify the condition closely related to train operation.

  - The inspection and measurement can be carried out by the engineers of KORAIL as well. Because most inspection cars run slower than operating trains, they cannot run for the operating hour. So, inspection cars are carrying out the maintenance during the nighttime.

    ※ generally, inspection cars are operated twice a month.

- For an efficient management of the asset and maintenance, it is requested to build an IT-based track management system. This track management system manages various monitoring data and maintenance history as well as the available resources (equipment and manpower), various maintenance materials, maintenance time, cost and so forth.

  ※ KORAIL Track Maintenance System : KTMSYS
  (Korea high speed Track Maintenance decision supporting SYStem)

28. Maintenance HR Management

- The layout of maintenance resources (manpower & equipments) should be considered to take actions promptly in case of an emergency. In addition, it should be considered the optimal movable distances during the routine maintenance.
  - Especially, the station compound where multiple turnouts that are vulnerable in terms of security are installed is determined to be the most appropriate maintenance depot for a swift motor car trip time and a stable equipment management.
- To respond properly to exceptional cases, it is most significant to arrive at the emergency spot as fast as possible. So, when organizing a facility maintenance team, the motor car trip time should be precisely reviewed along with the labor productivity.
  - For example, if the distance from the maintenance center is 100km or more, an equipment(motor car) and rehabilitation materials should be allocated at the intermediate track turnout in order to reduce the time required to transport the heavy materials, resulting in an efficient management.

29. Outsourcing

- It is reasonable to reduce the cost by outsourcing simple, repetitive works and it is not easy to replace the regular task with outsourcing once the operation begins, so it is necessary to select the outsourcing targets before starting the opening.

- The outsourcing of facility maintenance shall be done mainly for simple, repetitive and general works.

  ※ For example, Alignment on defects of the ballast track, maintaining cracks of the concrete track and etc.

- You may consider the fact that outsourcing does not guarantee cost reduction and quality assurance without question, and it should be implemented regarding the safe train operations, customer services and so forth.

2 Other Matters Reviewed

1. Consideration on Transport Safety

❍ Operational Aspect

- When the rolling stock at the high speed line is out of order, a rescue locomotive will be dispatched to remove the stopped rolling stock

※ In Korea, there are **4 diesel locomotives under operation at the high speed line**. At normal times, they are operated as the shunting locomotives at the main stations and dispatched to the high speed line at an emergency to remove the stopped rolling stock. (Removed twice)

- Implement a routine accident response action
- Introduce and operate accident rehabilitation equipments
- Prepare for an emergency action manual

※ Systematic management including actions taken for each emergency type and for each duty, high-speed train access instruction & order systems, rehabilitation equipments and etc

- Work manual for maintenance related workers based on the introduction of new technology

❍ Facility Aspect

- A facility protection system that can recognize the intrusion of rolling stock from outside (elevated bridge)
- A facility protection system that can recognize the intrusion within the track including the falling rocks
- A rail temperature detector that can detect the rise of rail temperature during summer

- A sensor that can detect the rolling stock maintenance error or the rolling stock dragging
- A system that measures the outside air conditions including rainfall, snowfall, strong wind and seismic monitoring
- A CCTV system that monitors the intrusion of outsiders to the tunnel, bridge and etc
- Fences are installed at all sections of the high speed line to prevent people and animals from entering
- Equipments/facilities that enable siding of trains at the tunnel and bridge (slope tunnel, vertical shaft and etc)

❍ Rolling Stock Aspect

- A temperature detector that detects the fire at locomotives and coaches (main distribution panels)
- A Hot-Box Detector(HBD) that detects the temperature rise of axle during the train operation
- Detecting the axle temperature by installing a sensor at the track
- A train protecting device based on no-voltage by detecting the catenary voltage
- A passenger alarm system that enables an emergency call among passengers, drivers and crews
- A system that measures the outside air conditions including rainfall, snowfall, strong wind and seismic monitoring

2. Maintenance Method & Equipments (Electricity)

- Based on this plan, the distance (radius) required to get to the maintenance location is 75 miles (120km) and it appears that 60miles/h (96km/h) maintenance equipments are used for the facility equipment maintenance. In this case, the motor car trip time shall be maximum 1 hour 25 minutes (two-way: 2 hours 50 minutes) and when including the work preparation time, it will sum up to be 3 hours 30 minutes, resulting in 1 hour and 30 minutes for the actual maintenance work. This will be too short for the longest radius of coverage maintenance.

- Considering the maintenance cycle and details of catenary for each UIC 799-R train speed, it is determined that it will contribute to the facility stabilization and safe train operations if the motor car trip time to the work area is set as 1 hour 20 minutes (two-way) and the remaining time is allocated for the maintenance time. It is appropriate to set the work radius as 50 km and the motor car operation speed should be limited to 80km/h or less to secure the safety of facilities and workers.

- In addition, maintenance equipments should be kept at the turnouts in between the neighboring maintenance locations. Before the track is blocked, workers should move to the maintenance location so as to reduce the trip time.

- It is reasonable to carry out the maintenance strategy by classifying into 6 stages for the safe operation of high-speed trains.

  - Conditional maintenance
  - Predictive maintenance
  - Programmed maintenance
  - Corrective maintenance
  - Temporary maintenance
  - Curative corrective maintenance

3. Review on California Rolling Stock Depot Plan

- The accessibility to the rolling stock depot shall be allocated in substitution based on diverse variables under the train operation or it shall be considered with importance in order to secure the rolling stock maintenance time for the safe train operation. If the rolling stock depot is not near the terminal station, the work coverage should be set so that the work can be processed at the repatriation station and stand-by depot.

- Review on California Rolling Stock Depot Trip Distance

  - An inspection shed and a spare part warehouse are planned to be allocated leaving a space for the hold track in between which results in an inconvenience of crossing the track to deliver the spare parts and a longer trip time. So, it is required to reexamine a plan to reallocate the spare part warehouse near the inspection shed in order to reduce the distance for spare parts delivery.

  - Since the distance between the employee parking lot and the rolling stock depot is about 1km (25-minute walk) which is too far from each other, it is expected that the employees will unlikely to use the parking lot. Along with this matter, a plan to minimize the distance between the employee parking lot and the inspection shed should be reexamined.

<Reference 9> California Rolling Stock Depot Plan

- Review on Allocating Facilities in the California Rolling Stock Depot

  - The location of the washing station and that of the automatic wheel inspection workshop should be exchanged.

  - Difficult to obtain accurate data from the rolling stock with water

- The water on the rolling stock may quicken the corrosion and deterioration of equipments when it drops on the automatic wheel inspection workshop

- Since it is difficult for the high-speed trains to approach the track during the maintenance of washing station and automatic wheel inspection workshop, it is necessary to establish a plan to prepare for a separate detour line.

<Reference 10> Location of Washing Station at the Rolling Stock Depot Approaching Line

- It is required to examine a test track, a wheel cutting track and a wheel ultrasonic inspection device that should be taken into account when selecting the site of rolling stock depot and arranging the facilities.

<Reference 11> Track Facilities Requires for Rolling Stock Depot

4. Operation & Maintenance Workers Management

- P.26

- The number of operation & Maintenance workers and the working hours are calculated based on the USA Labor Standard Act to organize the work system.

- It is assumed that the work will be carried out in three shifts or 5 groups 3 shifts which means that 3 people should be assigned for each substation, communication and signal team and 4 people should be assigned for each catenary system·power distribution team. As shown in the table, it is short of employees when dispatching them to each maintenance center (3 centers) and by working hours (shift, daily service).

<Reference 12> Electricity Communication Field. Phase 1 Manpower Staffing

- If there is an outsourcing for the inspection and maintenance and there is no plan that assigns only the managers, it is necessary to assign more employees so as to accomplish the maintenance strategies that include the predictive maintenance.

<Reference 13> Comparison on Working Hours & Holidays among KORAIL Shift Systems

3 Introduction on KORAIL System

1. IT (Information Technology)

❍ MTIT (Mobile Ticket Issuing Terminal)

- Major Functions

  · Inspect passengers' tickets and inform the train's time-table.
  (Holding amount: 933)

  · Change tickets (class, member, origin-destination, etc.) of passengers on board by utilizing the information on train operation/ticket issuing.

- Since the ticket inspecting procedure is not carried out, the passengers can enjoy the travel time without any interruption. It is one of the best IT-based services that can maximize the customer satisfaction.

❍ Information Security Management System

Type	Functions & Roles
IPS (Intrusion Prevention System) Fire Wall	• Monitoring the traffic among networks • Blocks the bad traffic and allows the normal traffic
WAF (Web Application Firewall)	• Protect from the attack on the web's weak point
Intrusion Detection System	• Detect/Report unwanted system operations in the network - Fake, abnormal access, known back-door access, etc.
PC Anti-Virus System	• A protection system that monitors and treats the malicious codes of PC(personal computer) for work in real time - Malicious Codes: Virus, Worm, Spyware, Adware
ESM (Enterprise Security Management)	• A system that monitors the security performance and the operation status of the internal/external network in real time
V/W (Virus-Wall)	• A hardware that detects and protects from malicious codes including viruses

Server Security System (Secure O/S)	• An agent-type security system to limit the server access and to log the access
Vulnerability Scanner	• A scanner tool to detect vulnerabilities of the system under operation - Opened service port, detectable back-door, etc.
Source Code Analysis	• An automated tool to detect the security vulnerabilities of the program source code when developing and changing the software
DB Security System	• A system to control the access of users and developers to the DB table
Identity Management	• A system to control and log the access to the user's login of SUN OS server
Storage Device Clearing	• An equipment to disapprove data recovery by eradicating the magnetic properties of auxiliary memory in PC
Iris Scanner	• Authorized users can access the system based on the unique iris scan of each person

❍ Railroad Operating Information System

Railroad Operating Information System
1. Plan
• Marketing System • Transport Planning System • Train Operation Planning System • Rolling Stock Operation Planning System • Crew Management & Planning System • Transport Capacity Control System
❍ Marketing System ✓ Based on the data analysis including the market information, sales and transport performances, annual and monthly(of the following year) sales demands are predicted via a demand forecasting model to support the

sales plans. The passenger-freight demand for each origin/destination group is forecasted and its result is sent to the transport planning system.

- Transport Planning System

  - ✓ The profitability and practicability of the train operation are verified in advance and based on the results; an efficient transport plan can be established.

- Train Operation Planning System

  - ✓ It is to ensure an on-time operation and safety on the integrated operation of high-speed trains and conventional trains, and to establish flexible operation plans based on changes of the transport demand.

- Rolling Stock Operation Planning System

  - ✓ For an efficient use of rolling stocks, this system can help the operating rolling stock plans should be created including editing and ordering

- Crew Management & Planning System

  - ✓ Considering the on-board regulations and working conditions, it provides plan management and editing functions for each project period and offers efficient management plan on train/locomotive crews

- Transport Capacity Control System

  - ✓ By using the information on the ticket issuing status, the transport performance and the train with high-demand, it provides a transport capacity control service that can promptly respond to the short-term transport demand

Railroad Operating Information System

2 Operation/Sales

- Train Operation Control System
- Train Operation Management System
- Crew Operation System
- Ticket Issuing System
- Freight Transport System
- Metropolitan Subway Management System
- KTX-OIS
- KTX-RCM

❍ Train Operation Control System

❍ Train Operation Management System

✓ It manages all station status information and the assignments related to the train operation including a locomotive allocation, a rolling stock arrangement, a coach allocation, and switching.

❍ Crew Operation System

✓ It handles the information based on the crew's working details and supports tasks including the creation, transmission and reception of operation orders that are generated during the train operation such as train operation limit, train management and passenger service.

❍ Ticket Issuing System

✓ This system enables reservation and issuing of train tickets through various media including the ticket office at the station, Internet, travel agencies and customer centers(Refer to page 1)

❍ Freight Transport System

✓ Based on the contract management and freight transport plan, it manages the reservation, consignment, delivery, freight-to-collect and

freight transport performances. This system also supports the logistical assignments using the logistic information system and CY (Container Yard)'s information services, etc.

- Metropolitan Subway Management System

  - ✓ This system collects the data of MS and traffic card system, generates the subway inspection data and manages the fare settlement in connection with other institutes.

- KTX-OIS (KTX-Operating Information System)

  - ✓ In interface with the KTX-related systems, it improves the overall performance of the KTX operating system and supports the safety and on-time performance of the rolling stocks

- KTX-RCM (KTX-Reliability Centered Maintenance)

  - ✓ This system can help to determine the inspection policy and to build a maintenance system that is suitable for the operating environment

Railroad Operating Information System
3. Business Administration (ERP system)
• Financial Accounting/ Controlling Accounting • Material Management/Asset Accounting • HR Management • Equipment/ Design Drawing Management • Safety & Environment Management • Executive Information System

- Strategy Enterprise Management System (SEM)

  ✓ In connection with the strategy target - management planning - KPI - budget, this system strengthens the performance system and improves the quick decision-making.

- Financial Accounting System (FI)

  ✓ Based on the financial accounting system that includes the whole company's integrated budget, revenue, expenditure, tax and settlement, it secures a real-time accounting transaction with other departments such as HR and maintenance departments, and reduces the settlement lead time.

- Controlling Accounting System (CO)

  ✓ This system provides detailed information on each department's activities, cost calculation and consignment cost, prepares the basis for a reliable PSO compensation and an appropriate fare calculation and offers data on specific goods such as the delivery cost, incidental expenses and consignment cost.

- Asset Accounting System (AA)

  ✓ In connection with the PS (Project System), this system reduces the calculation duration for the assets under construction and implements the real estate master management, which in result improves the efficiency and accuracy of the asset acquisitions.

- Material Management System (MM)

  ✓ This system calculates the required quantity based on the goods requirements in connection with the maintenance, secures the visibility of the warehouse inventory, simplifies the tasks related to electronic contracts and tax invoices and improves the material quality through an integrated inspection management.

- HR Management System (HR)

  - ✓ Based on the interconnection processes among organization/HR/payroll, this system integrates and manages the data related to personnel administration, wages, attendance/absence, benefits, training, etc. and improves the employee satisfaction by simplifying the certificate application/issuance.

- Project System & Plant Maintenance System (PS & PM)

  - ✓ This system ensures the integrity of project/budget/material supply, standardizes the work list for each vehicle type/inspection type, builds the integrated facility system and manages the systematic maintenance strategy.

- Environment, Health and Safety Management System (EH&S)

  - ✓ This system includes safety inspections, safety goods, accident investigations, statistical management, industrial accident prevention, resources/equipments management, accident management, health management, working environment safety management, low-carbon management, environmental performance management and assessment, environmental activities and etc.

- Executive Information System

  - ✓ This system collects and manages information on various management activities that are generated during the railway operation, suggests the analysis results and supports the optimal decision-making promptly and appropriately.

Railroad Operating Information System
4. Infrastructure
• Network • Information Security • Server & Middleware • Database • Enterprise Architecture

❍ Network

✓ Based on the network center and the communication node, nationwide railway agencies are linked by TCP/IP based network. Real-time decision-making is supported and the passenger and freight information is sent by the internal network. It enables an operation of the Internet ticket issuing system via the Internet, a sharing of information services related to nationwide railway and a management of data communication infrastructure for value maximization.

❍ Information Security

✓ With an intention to manage safe and reliable train operations, an integrated security control is implemented in real time with no interruptions so as to control and protect the information assets effectively. Based on the predefined security policies that are reviewed and established, it blocks the bad traffic, diagnoses and treats the malicious codes and prevents illegal data modulation/data loss.

❍ Server & Middleware

✓ 72 systems specialized for the railway tasks are allocated effectively to the server resources considering their functions and performances so that they can be structured allowing flexible system expansions and changes without an additional cost even under the business condition changes. Hardware and middleware architectures should be operated to mutually support the heterogeneous applications and

data formats.

- Database

  - ✓ Based on the database schema optimized for requirements of customers who use the railway information system and the data design appropriate for each work process, a high-performance data I/O structure of the application and DB is realized. This will secure the timeliness based on the data integrity, which in result contribute to providing an improved and reliable level of information services.

- Enterprise Architecture

  - ✓ This is the software architecture that complies with the external regulations and laws, supports the operating application changes for an immediate business and customer responses and delivers the executive business requirements as much as possible.

2. High speed Rail Safety Equipment Example

Type		Installation Qty		Purpose	Remarks
		Phase 1	Phase 2		
HBD (Hot-Box Detector)		14	10	Promote the safety of passengers through a slow train operation owing to the heat generated from the axle * Install at every 30km	Rolling Stock Security Device
ID (Intrusion Detector)		135	71	Detects the interferences at the track including the falling rocks, earth and sand from the mountain slope, KTX crossing roads and service roads in order to prevent accidents	
DD (Dragging Equipment Detector)		11	4	Detects the rolling stock that is operating with the damaged or deserted spare parts dragging under the train so as to protect various facilities installed between tracks	
METEO (Meteorological Detector)	Rainfall · Strong Wind Sensor	10	5	Detects the weather conditions including strong wind, heavy rainfall and snowfall in advance in order to slow down or stop the trains to prevent the accidents from happening	
	Snowfall Sensor	3	1		
Rail Temperature Detector		12	6	Measures the rail temperature of specific section to prevent rail defects due to a sudden temperature rise and to take appropriate measures such as controlling the train operation or performing the maintenance	Facility Protection
Turnout Heating Device		80	33	It is likely that the turnout will not operate properly when it freezes under the heavy snowfall or temperature drop so an electrical heater is installed for a smooth operation of the device	
Tunnel Alarm		62	53	When the train approaches the tunnel while the maintenance worker is on duty, the alarm lamp and alarm will be turned on so that the worker can safely evacuate	Worker Protection
Pedestrian Staff Crossing (PSC)		77	22	When the maintenance worker has to cross the track at the designated location, PSC is used to safely cross the track after checking whether any train is approaching or not	
Protection Switch	Track Side ZEP Switches (TZEP)	209	117	When a risk factor is detected from the train operation at the track side, the authorized person will operate the safety switches to stop the train and secure the safety of passengers. Also, it is to ensure the safety of maintenance workers on duty at the track (Install at platforms and in stations)	
	Block Section Protection Switches (CPT)	1,257	766	Install in stations and at block sign column	
Seismic Monitoring System		21	14	Seismic data received from the high-speed railroad track seismic measurement equipments is displayed at the central monitoring unit at the control room and it is a system that displays the alarm or warning depending on its size to secure a safe train operation	

3. Emergency Response Measure & Drill

- Measures to rescue stopped trains owing to an accident or failure.
  - To rescue the stopped train due to an emergency, a diesel locomotive is waiting at all times at main stations so that the stopped train can be transferred to neighboring station
- Operating an accident recovery team
  - Accident recovery equipments (Unimog, jack kit and etc) and staff should be allocated at main stations to recover the accidents including the derailed trains.
- It is advised to carry out recovery drill once in a while for a prompt action in real situation.

Diesel Locomotive for Rescue

Unimog for Accident Recovery

Accident Recovery Drill

References

<Reference 1> Comparison On-Time performance of High-Speed Trains (Delayed less than 15 minutes based on the terminal station)

Country	Korea(Converted)	Spain('07)	France	Belgium	Italy
(Company Name)	(KORAIL)	(ADIF)	(SNCF)	(SNCB/NMBS)	(FS)
On-Time performance (%)	100	100	93	91	83

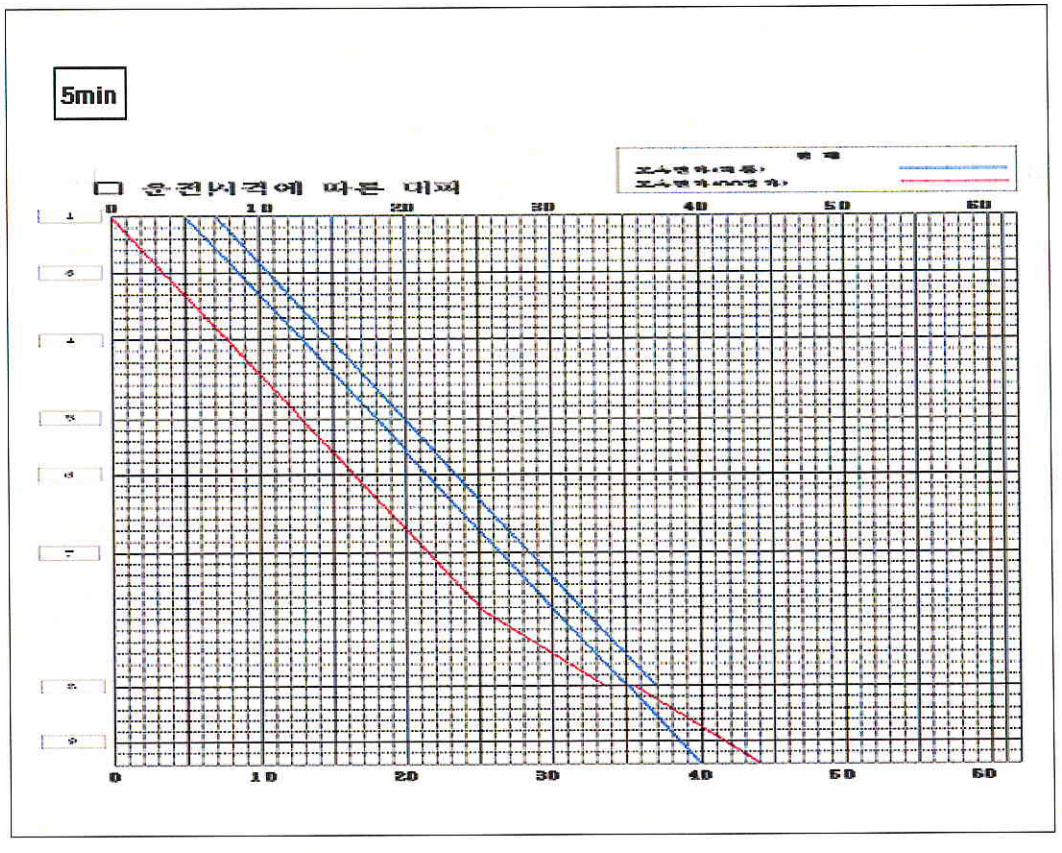
※ Data Source: 2008 UIC World Railway Statistics Yearbook

<Reference 2> Comparison on track Capacity and Train Frequency based on the Headway

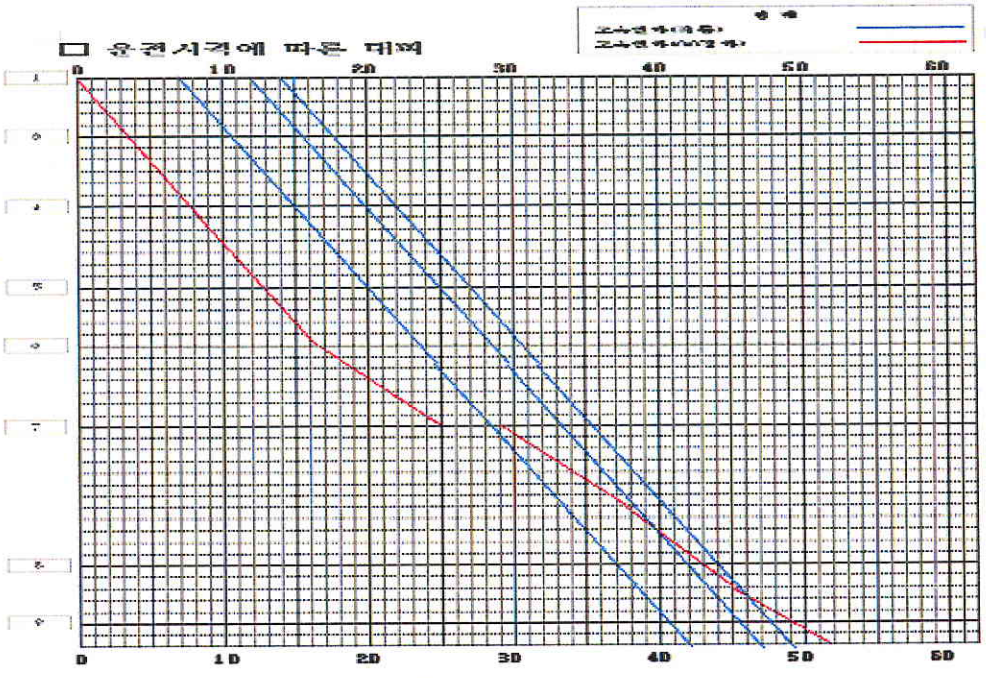
Type		Capacity (A)	Train Frequency(day)		Difference	
			Phase 1(B)	Completion(C)	A-B	A-C
3min	19h	288	260	339	28	-51
5min		172	260	339	-88	-167
6min		144	260	339	-116	-195

- ✓ The train frequency stated above is based on the one-way train.
- ✓ In case of two-way trains, the formula applied will be carrying capacity*2 so the carrying capacity is within the limit. It is significant to set a clear standard on one-way. two-way trains.

<Reference 3 > Example on Siding based on Headway



7min



<Reference 4 > Calculation of Distance between Siding Stations

Phase 1 : $S = \frac{300 \times 252.5}{300 - 252.5} \times \frac{2.25}{60} - 0.2 = 59.8(km)$

After Completion : $S = \frac{300 \times 262.6}{300 - 262.6} \times \frac{2.25}{60} - 0.2 = 79.9(km)$

○ Formula for Calculation of Distance between Siding Stations

$S = \frac{V_1 \times V_2}{V_1 - V_2} \times \frac{i}{60} - L = S(km)$, $i = \frac{1.5 \times 7 + 0.2}{285 km/h} \times 60 = 2.25$

V_1 : High-Speed Train Schedule Speed(km/h),
V_2 : Low-Speed Train Schedule Speed(km/h)
i : Minimum Headway(min),
L : Train Length(km),
S : Distance between siding stations(km)

<Reference 5 > KORAIL Ticket Types & History

❍ Self-Ticket

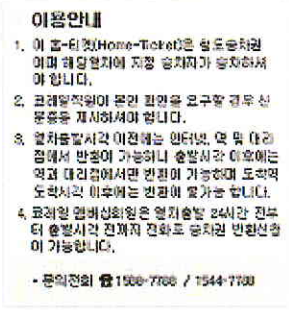
Home Ticket	➡	SMS Ticket	➡	Mobile Ticket	➡	**Smart Phone Ticket**
2005.04		2006.09		2009.01, KT 2009.04, SKT-LGT		2010.11

❍ Home Ticket

✓ After the ticket reservation/payment via Internet, it can be printed at home/office

Internet Reservation (All Citizens)	➜	Payment (Credit Card, Point, Account Transfer)	➜	Home Ticket Issuance (Personal Printer)	➜	Use it at a train (Own Ticket)

※Ticket



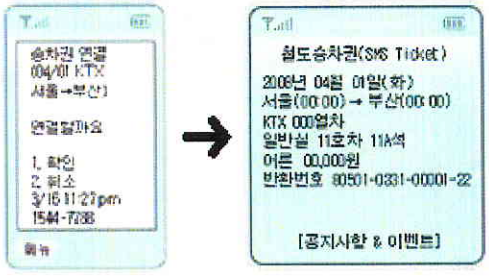
❍ Mobile Phone SMS Ticket

✓ After the ticket reservation/payment via Internet, the ticket is sent to the mobile phone (Maximized the use of portable tickets).

Internet Reservation (All Citizens) → Payment (Credit Card, Point, Account Transfer) →

Select SMS Ticket → Mobile Phone Verification → Send Ticket → Use it at a train

※ Ticket



❍ Mobile Ticket

✓ Without an Internet connection, the ticket can be inquired/purchased at anytime, anywhere

Download an exclusive-use program(initially) → Subscribe to the service and set PIN number(initially) →

Run the program → Search/Pay for the ticket → Send/Save the ticket → Use it at a train

※ Ticket

○ Smart Phone Ticket

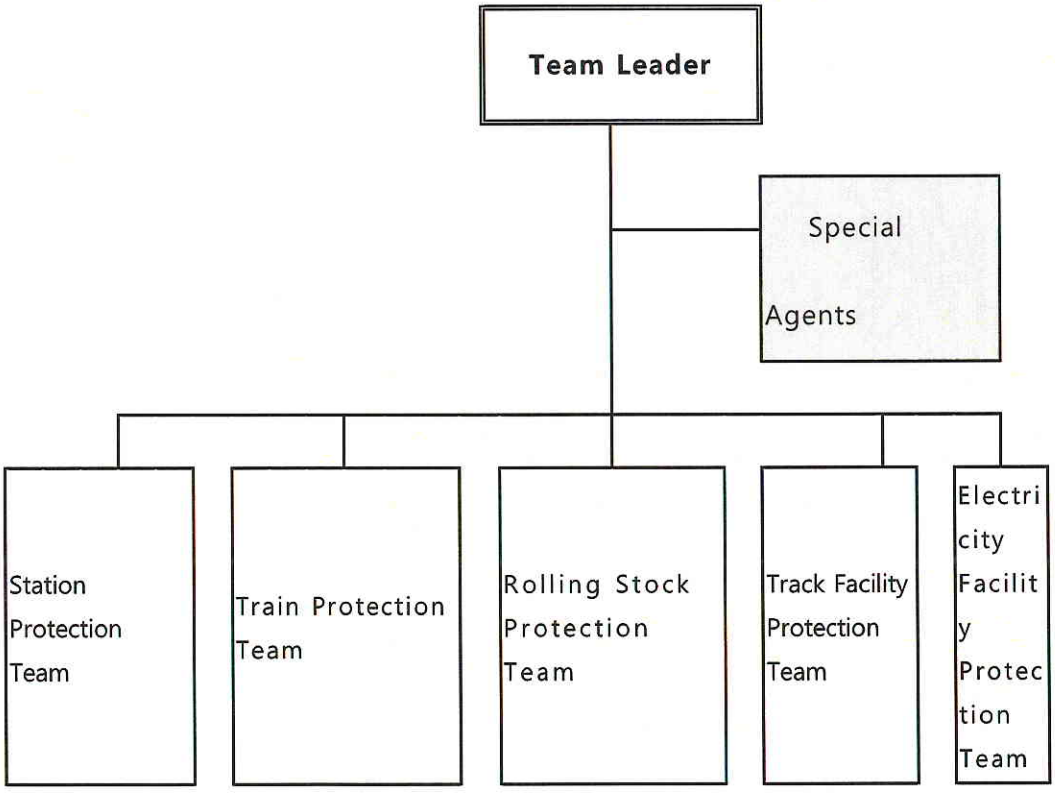
- ✓ In respond to the cell phone market change
- ✓ The focus of cell phones is moved to smart phones
- ✓ Released various OS-based smart phones
- ✓ Various services including the flat rate, expansion of wireless LAN (Wi-Fi) area and etc

※ Ticket

<Reference 6 > Organization Chart on Anti-terrorism team of KORAIL

<H.Q >

<Regional H,Q>

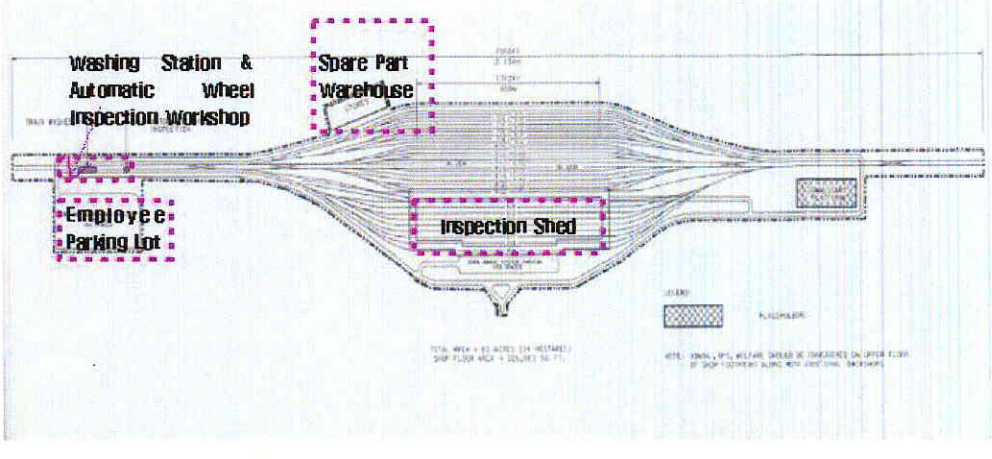


<Reference 7 > Comparison on Human Body Size and Weight of Easterners. Westerners ('06 Korean Agency for Technology and Standards)

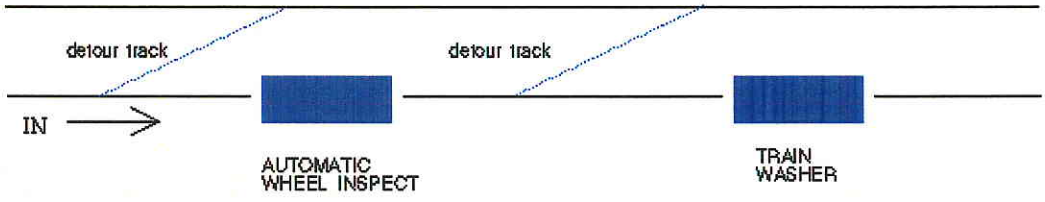
	Korean						American					
	Male			Female			Male			Female		
	18~25	26~35	36~45	18~25	26~35	36~45	18~25	26~35	36~45	18~25	26~35	36~45
Height_cm	173.14	170.793	169.144	160.3	159.1	157.5	175.061	174.277	174.114	163.09	163.25	163.09
Weight_kg	68.318	70.011	70.605	54.1	55.4	57	78.0435	84.041	85.1132	64.69	70.75	73.58
Bust	92.033	95.077	96.290	85.6	88.1	90.5	103.103	108.513	109.811	98.36	98.68	105.84
Hips	95.096	96.015	96.004	93.3	93.5	94.1	102.714	105.802	105.875	104.65	99.5	111.55

<Reference 8 > Bicycle Train

<Reference 9 > California Rolling Stock Depot Plan



<Reference 10> Location of Washing Station at the Rolling Stock Depot Approaching Line



<Reference 11 > Track Facilities Required at Rolling Stock Depot

Track Name	Track Function
Test Track	A track for trial run test after the main parts of the high-speed rolling stock are replaced
Wheel Cutting Track	A track to install and operate a wheel cutting board in order to cut the wheel tread
Wheel Ultrasonic Inspection Device Track	A track to install and operate a wheel ultrasonic inspection device

<Reference 12 > Phase 1 Manpower Staffing for Electricity. Communication Field

REQUIRED MANPOWER STAFFING – MAINTENANCE OF WAY AND INFRASTRUCTURE

Phase 1 Network

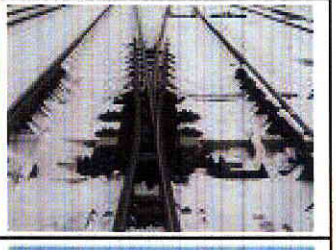
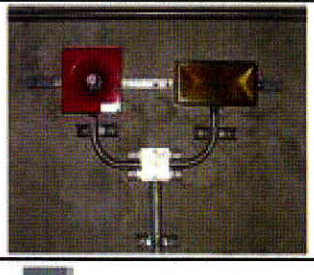
Element	Baseline	Upper Range
Track	195	234
Traction Power / OCS	150	180
Signal/Train Control	40	48
Communications	35	42
Bridges & Structures	25	30
Material Control	35	42
System Support	94	113
G&A, Supervision	60	72
Total	634	761

<Reference 13> Comparison on Working Hours & Holidays among KORAIL Shift Systems

Type	Work Cycle	Work Start/End Time	Monthly Working Hours (30days)		Number of Holidays
3Group 2Shift (Current)	D-D-N-N-O-H (6-day cyde)	Daytime : 09:00~19:00 Nighttime : 19:00~09:00	163.8		O · H: 12 days (O 10days, Designated H 2 days)
5Group 2Shift (Daytime)	D-D-N-O-H (5-day cyde)	Daytime I : 09:00~19:00 Daytime II : 09:00~19:00 Nighttime : 19:00~09:00	163.6		O · H: 12 days (O/H : 12days, No designated H)
5Group 2Shift (Nighttime)	D-N-N-O-H (5-day cyde)	Daytime : 09:00~19:00 Nighttime I : 19:00~09:00 Nighttime II : 19:00~09:00	163.6		O · H: 12 days (O/H : 12days, No designated H)
3Group 2Shift (Combined)	DDDDDDD NONONON ONONONO (21-day cyde)	Daytime : 09:00~18:00 Nighttime : 18:00~09:00	Group 1	164.3	O · H: 12 days (O 8days, Designated H 4 days)
			Group 2	165.8	O · H: 13 days (O 11days, Designated H 2 days)
			Group 3	162.8	O · H: 13 days (O 11days, Designated H 2 days)
			Average	163.5	O · H: 13 days (O 10days, Designated H 3 days)

* D: Daytime, N: Nighttime, O: Off-Duty, H: Holiday

<Reference 14> Photos on Safety Equipments at High Speed Train

HBD (Hot-Box Detector)		ID (Intrusion Detector)	
DD (Dragging Equipment Detector)		METEO (Meteorological Detector)	
Rail Temperature Detector		Turnout Heating Device	
Tunnel Alarm		PSC (Pedestrian Staff Crossing)	
Track Side ZEP Switches (TZEP)		Block Section Protection Switches (CPT)	
Seismic Monitoring System		Integrated Monitoring System (CCTV)	