Research on the interface solution with trains for ATP system stabilization

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ABSTRACT

The introduction of ATP (Automatic Train Protection) system which is being pursued recently can be a dramatic project upgrading the signaling section of railway rolling stock, by improving track capacity and safety, since we already realize that signaling facility now takes a great effect on not only infrastructure but also selecting car types of rolling stock and deciding system newly introduced.

This study examined the measure to acquire interface with ATP system in the system installation to achieve safety operation of railway rolling stock. Even if the onboard signaling system has been verified home and abroad and has superb quality, the optimal installation measure should be sought, considering the condition with peripheral devices so that the system can exhibit its required performance when it is installed in rolling stock. Especially, the interface measure with braking system to acquire safety, and level transition solution measure between ground system and onboard system following the mixed use of signaling system in ground-level section (ATC/ATP/ATS) should be perfectly presented, and the measure to collect and handle various information - speed detection, the measure to acknowledge insulation section, recording operation information, etc. - should be prepared.

To successfully settle down ATP system, the full verification on interface with ATP system shall be preceded even from the design stage of rolling stock, and in case of upgrade project for rolling stocks which have already been operated, train operator, system manufacturer, and railway policy decision-maker should proceed with a project after having fully understood and prepared a strategy on the system. Also, by preparing Korean Rail Traffic Management System (KRTMS) measures which are appropriate to local conditions, the countermeasure to prevent confusion in case of developing or introducing new signaling system for the future should be established.
1. Introduction

Since 2003, KORAIL has been driving a project to install ATP (Automatic Train Protection) system, for the purpose of increasing speed on conventional line and running train in safety. ATP system permits a running train to receive distance information with previous train and running condition information from wayside, in addition to track information, and then enlarges line capacity by on-line modification of running speed pattern, taking the related train's increase/decrease properties in consideration, by means of the distance-to-go control system that calculates a safety curve from onboard computer.

ATP system to be introduced in Korea shall satisfy level 1 of ERTMS/ETCS (European Rail Traffic Management System/ European Train Control System) and is likely to be upgraded to level 2 in the future. Existing system requirements apply functional / safety ones for ERTMS/ETCS.

There are not a few elements to consider, when it comes to the installation of other company's ATP system on control system of existing trains in operation (Korea Train Express, Electric Locomotive, Diesel Locomotive, Push-pull Multiple Car), stabilization of the system, and interface with environmental systems. In particular, regarding level transition between ATP, ATS and ATC section, the assurance of safety and reliability is considerably important for train operation. Besides, to prevent initial fault in advance, serve convenience in driving, and render inspection works efficient, an optimized selection of location, valid management measures of train and operation information, and efficient selection of braking system shall be done first of all:

- Interface with trains for stabilization of ATP system;
- Optimization of ATP braking;
- Favorable level change between signaling system;
- Interface with environmental systems.

Also, this research will contribute to the selection of signaling system proper to Korean situation and the stabilization of ATP system, and the selection of ATP likely to be compatible with the newly introduced train.

2. Characteristics of ATP system

2.1 ATP (Automatic Train Protection) system

ATP system recognizes track condition and driving information of corresponding train via Balise (or transponder or beacon). It permits, therefore, to shorten headway of train and augment track capacity, through ensuring a minimum braking distance. It is in most cases used
for train’s safe operation because it makes possible to control train by intermittent message transmission to improve running speed and to solve crowded driving. As of today, it is used under 220km/h.

Figure 1 indicates the speed control curve of ATP system. ATP system represents linear control curve, on the contrary to the conventional ATS system showing a tiered control curve; so ATP system shows ensuring driving efficiency as much as the slant-lined portion.

![Figure 1: Speed control curve graph for ATP & ATS](image)

### 2.2 Overseas present status for ATP system

In Europe, for cross-border train, there have been problems in running with several signaling systems (e.g. Sweden: EBICAB, France: KVB, and Germany: ZUB). Hence, a train operation system called ERTMS (European Rail Traffic Management System) has been conceived, which is possible to receive signal from several wayside systems, by unifying onboard equipment for the purpose of undertaking such complex and uneconomic points.

ERTMS system is subdivided as follows: level 1 which was developed at the beginning for incorporating signal systems of each country in Europe, level 2 which searched for change from information transmission by existing Balise to radio transmission, and level 3 which is aimed at ultimately controlling train without any wayside equipment (No Formal development of Level 3 is ongoing).

### 2.3 Present status of ATP system installed in Korea

ATP system installed in Korea is as the following table 1:

<table>
<thead>
<tr>
<th>Kind of trains</th>
<th>Installed trainsets</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>KTX</td>
<td>92</td>
<td>Being installed</td>
</tr>
<tr>
<td>Diesel locomotive</td>
<td>218</td>
<td>Being installed</td>
</tr>
<tr>
<td>Diesel motor car</td>
<td>102</td>
<td>Being installed</td>
</tr>
<tr>
<td>EL</td>
<td>57</td>
<td>Being installed</td>
</tr>
<tr>
<td>KTX-II</td>
<td>38</td>
<td>On progress(introducing after installation)</td>
</tr>
<tr>
<td>Busan subway</td>
<td>-</td>
<td>In operation</td>
</tr>
<tr>
<td>Incheon subway</td>
<td>-</td>
<td>In operation</td>
</tr>
</tbody>
</table>

Table 1. ATP system installed in Korea
3. Interface

3.1 Stabilization of voltage

KORAIL’s trains use different control voltages according to the train. Table 2 implies control voltages per train.

<table>
<thead>
<tr>
<th>Types of trains</th>
<th>Voltage</th>
<th>Control voltage</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>KTX</td>
<td>AC 25,000V</td>
<td>72V</td>
<td></td>
</tr>
<tr>
<td>Diesel locomotive</td>
<td>AC 25,000V</td>
<td>110V</td>
<td>“</td>
</tr>
<tr>
<td>Diesel motor car</td>
<td>DC 600V</td>
<td>74V</td>
<td>“</td>
</tr>
<tr>
<td>Electric locomotive</td>
<td>DC 440V</td>
<td>24V</td>
<td>“</td>
</tr>
</tbody>
</table>

Table 2. Control voltages per train

It is possible to use ATP system in common in the manner to replace power module per each kind of trains. Stabilized voltage by onboard filter is provided to train. In case of diesel locomotive, however, the equipment is subject to be damaged due to 469V (pkpk) of surge voltage entered at the moment of moving or stopping train. So, in effect, system damage arising from abnormal voltage has been prevented by installing a surge protection (protection level 700V) on power entrance part.

![Analyzing graph on surge voltage](image)

3.2 Braking system

3.2.1 Interface with braking system

ATP system has been designed to automatically authorize train to brake if it considers that driver does exceed predefined speed or it is not a safe condition. For giving train authorization to brake, first of all not only the interface measures shall be considered between ATP system and train, but also how to interrupt notch and traction shall be considered. As a result of tests for various measures for interface with train, for KTX and diesel electric locomotives it was designed and manufactured newly 'pneumatic braking interface equipment for ATP', for electric
locomotive, ‘braking signal convert equipment for ATP’ have been installed for compatibility with existing braking system, and for diesel motor car, existing braking magnetic valve was exploited. Also, safety aspect is improved by authorizing train operation provided that it was proved no abnormality in performance through braking test every 35 hours to determine whether a brake works well or not.

3.2.2 SB(Service Braking)

3.2.2.1 Precondition of ATP service braking command

(1) In case of logic of maximum speed monitoring
- Braking command in case of exceeding 5km/h compared to allowed speed
- Possible to release braking command if reduced at allowed speed

(2) In case of logic of targeted speed monitoring
- Alert in case of exceeding 1 second, and command an service braking in case of exceeding 2 seconds within allowed speed curves

3.2.2.2 Reduced speed required for service braking

As mentioned above, braking value has been derived from a variety of tests and calculations to determine a proper braking value according to the kinds of train. This document will explain how to calculate the result values for service braking of KTX train.

The appropriate braking value for KTX train was determined after establishing a global braking plan considering margin time up to emergency braking for possible malfunctioning, and calculating braking power. The following table 3 & 4 indicate essential data for KTX braking.

<table>
<thead>
<tr>
<th>Types of braking</th>
<th>Super high speed (km/h)</th>
<th>Braking distance(m)</th>
<th>Average reduced speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency for 300 km/h</td>
<td>300</td>
<td>3,300</td>
<td>1.0522 3.79</td>
</tr>
<tr>
<td>Service for 300 km/h</td>
<td>300</td>
<td>6,600</td>
<td>0.5261 1.89</td>
</tr>
</tbody>
</table>

Table 3. Braking distance for KTX

<table>
<thead>
<tr>
<th>Types of braking</th>
<th>Super high speed (km/h)</th>
<th>Braking distance(m)</th>
<th>Average reduced speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Command for emergency push button 300</td>
<td>3,500</td>
<td>0.9921 3.57</td>
<td></td>
</tr>
<tr>
<td>Command for emergency push button 270</td>
<td>2,750</td>
<td>1.0227 3.68</td>
<td></td>
</tr>
<tr>
<td>Command for emergency push button 170</td>
<td>1,100</td>
<td>1.0136 3.65</td>
<td></td>
</tr>
<tr>
<td>Reduce speed of brake controller 270 --&gt; 230</td>
<td>1,050</td>
<td>0.7300 2.63</td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Test value for braking
As seen above, for emergency braking, its reduced braking speed differs according to the speed, however average reduced braking speed is about 3.6~3.8 km/h/s. For service braking, it is about 1.9 km/h/s; this one indicates around a half of emergency braking value. Service reduced speed to be considered shall be determined about 50~75% of emergency reduced speed. Also, the next consideration after defining service reduced value shall be a validation of braking force and how to brake. KTX can not satisfy required braking force exclusively by braking force (electric + pneumatic) of motor bogie, so it can not help using passenger car’s power together. Combination of passenger car’s pneumatic braking force with motor car’s electric/pneumatic braking is to be applied in a same way as maneuvering a main braking controller.

For other types of cars, it has been confirmed that, in case of service braking, 50% of emergency braking is correct braking value through value calculations and tests. Based on this confirmation design and manufacturing have been implemented.

![Reducing test by ATP service braking of Diesel Locomotive](chart)

**Figure 3. Jerk curve in case of reducing by ATP service braking after accelerating to 130km/h (unit: m/s³)**

In case of service braking test, detection of pressure in brake pipe generates feed back signal. However, unless the pressure falls under a predefined reduced speed (80%) within 10 sec, it is considered as abnormal in braking performance and consequently it constrains train’s operation.

Figure 4 indicates air flow chart of brake system for ATP service braking in diesel electric locomotives.
Table 5. Brake method in relation to kind of trains

<table>
<thead>
<tr>
<th>Types of trains</th>
<th>Basic Braking</th>
<th>ATP service braking</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>KTX</td>
<td>Electric brake system</td>
<td>Cross-Blending brake System</td>
<td>Pneumatic braking interface system for ATP</td>
</tr>
<tr>
<td>Diesel locomotive</td>
<td>Pneumatic brake system</td>
<td>Pneumatic brake system</td>
<td>Pneumatic braking interface system for ATP</td>
</tr>
<tr>
<td>Diesel motor car</td>
<td>Electric-Pneumatic brake system</td>
<td>Electric-Pneumatic brake system</td>
<td>Apply existing brake magnetic valve</td>
</tr>
<tr>
<td>Electric locomotive</td>
<td>Electric brake system</td>
<td>Electric brake system</td>
<td>Brake signal conversion system for ATP</td>
</tr>
</tbody>
</table>

3.2.3 Emergency braking

In the event that train speed exceeds a limited speed during running on ATP area, ATP onboard system commands a service braking unless a driver intervenes even with alarm for a certain period of time. It will command an emergency braking if speed arrives at emergency braking profile curve without being reduced under service braking profile curve.

When ATP commands EB (Emergency Braking), EB relay is closed, power of EB train line and emergency solenoid valve is interrupted, and it is open to discharge BP pressure outside (consequently vent valves in train brake system are triggered in turn). EBMV are controlled via ATP SB, EB and RB relays. Each command causes exclusively a complete emergency braking.

Emergency braking signal is directly related to the safety. Thus, a circuit consists so that “a” contact point can be connected to the input stage of ATP emergency brake valve, by using VDX (Vital Digital I/O Unit) of ATP system (same or similar method as emergency braking of existing signal system).
Moreover, status information of pressure switch shall be feed-backed to ATP system to verify whether or not emergency braking is triggered. Pressure switch functions at air pressure less than 2.5 bars. Emergency braking feedback toward ATP through pressure switch is quite different from being feed-backed from emergency braking of existing ATC and ATS. However, since an emergency braking uses air pressure brake receiving feed-back signal in pressure, switch of emergency brake will be more sure method in safety aspect.

3.3 Interface with peripheral systems

3.3.1 Record on driving information

Existing trains including KTX have a recording system to record driving information such as train speed etc. According to the addition of ATP system on existing train, now it is necessary to record additionally information induced from ATP, and an appropriate record method per types of trains has been acquired without being against ERTMS regulations.

<table>
<thead>
<tr>
<th>Types of trains</th>
<th>Before</th>
<th>After</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>KTX</td>
<td>ATESS Electronic</td>
<td>ATESS</td>
<td>Accept ATP information</td>
</tr>
<tr>
<td>Diesel locomotive</td>
<td>Speed recorder Electronic</td>
<td>RU/JRU</td>
<td>Accept existing information</td>
</tr>
<tr>
<td>Diesel motor car</td>
<td>Speed recorder Electric</td>
<td>RU/JRU</td>
<td>Accept existing information</td>
</tr>
<tr>
<td>Electric locomotive</td>
<td>Speed recorder Electronic</td>
<td>RU/JRU</td>
<td>Accept existing information</td>
</tr>
</tbody>
</table>

Table 6. Method to record driving information per each kind of train

As shown in table 6, KTX was determined to additionally record ATP information on ATESS recording ATC and ATS information, and other trains were modified to record both ATP information and information being recorded on existing speed recorder by installing RU/JRU (Recorder Unit/Juridical Recorder Unit) instead of removing existing speed recorder.

RU and JRU have respectively 32 M byte of memories and consist of followings.

- Memory
  .STM(Short Term Memory): 9.6M Byte (1.11K Byte/km)
  .LTM(Long Term Memory): 22.4 M Byte (0.76 K Byte/km)

- Input
  .Digital input: 16ch
  .Analog input: 4ch

3.3.2 Detection of speed

ATP system detects and calculates train operation speed by using tachometer and Doppler radar sensor. KTX is designed to calculate train speed when using ATP system by installing additionally company D’s product in addition to company F’s Tachometer. For other trains,
company D’s products have been installed after dismantling existing speed generator (Tacho Generator).

Nevertheless, for diesel motor car, its circuit is constituted to control notch control range by using SDM (Speed Detect Module) device in order to limit excessive traction force at the moment of depart of train by detecting train speed from existing speed generator. To solve this problem caused by modification (Generator to Pulse), the pulse was converted to DC voltage in a newly manufactured SDM through withdrawing pulse from Tachometer CH4.

- Less than 23km/h: limited at maximum 6 notch
- More than 23km/h ~ less than 45km/h: limited at maximum 7 notch
- More than 45km/h: Full notch

<table>
<thead>
<tr>
<th>Number</th>
<th>Division</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>OFF</td>
<td>More than 23 km/h = 133 rpm (283 Hz)</td>
</tr>
<tr>
<td>V2</td>
<td>OFF</td>
<td>More than 28 km/h = 162 rpm (345 Hz)</td>
</tr>
<tr>
<td>V3</td>
<td>OFF</td>
<td>More than 45 km/h = 261 rpm (557 Hz)</td>
</tr>
</tbody>
</table>

Table 7. Speed monitoring module

3.3.3 Insulated section

When passing the insulated section on conventional line, ATS (Automatic Train Stop) system permits driver to recognize that train is fronted toward insulated section with 68Hz of frequency emitted on train via Balise. The following explains how to recognize and pass the insulated section for KTX and electric locomotive that has been changed with introduction of ATP system.

- Main circuit interrupter display OFF (4km ahead of coasting display)
- Traction interrupted
- Rear pantograph main circuit interrupter display OFF after 5 seconds of traction interruption
- Rear pantograph main circuit interrupter display ON after certain distance after passing neutral section.
- Main circuit interrupter ON, after 3 sec train traction

4. ATS/ ATP/ ATC level transition

4.1 ATS/ATP level transition

Level transition from ATS to ATP section, a method using Balise was applied. For KTX, ATC (Automatic Train Control) and ATS system have been integrated, so it does not correspond to ATS/ATP level transition. Other trains, however, shall apply this level transition:
- Alerting a level transition from previous warning Balise: display MMI
- Sending level transition information from warning Balise
- Request for driver’s confirmation
- Keeping on running under modified mode

In case of level transition, it is required to verify for driver to recognize. If the driver verified level transition, train can keep on running without stopping.

4.2 ATC/ATP level transition

ATC/ATP level transition corresponds exclusively to KTX. As mentioned above, assuming it is impossible to remove onboard ATS in that ATS onboard system of KTX is totally integrated with ATC(TVM430). Ultimately, a direct level transition between ATC and ATP has to be implemented; however it consisted of the level transition via ATS due to various problems.

4.2.1 Transition between ATC and ATS on KTX train (Figure 6. Current system)

Figure 6. Transition system between high speed line and conventional line (Current system)
- R-NL-01 : relay for high speed line
- AR : ATC(TVM430) Point information to start ATC(TVM430), BSP loop signal
- DE : ATC(TVM430) Point information to end ATC(TVM430), BSP loop signal
- KAR : ATC(TVM430) Information to control ATC(TVM430), ATS Balise(same as “R” signal)
- QBAL : Balise relay (bistable)
- DKAR : Information to control closing of ATC(TVM430) operation, ATS Balise(same as “G” signal)
- QKARM : Relay for reconfirming operation start

The above time chart shows a transition procedure for KTX between ATC and ATS at the boundary between high speed line and conventional line.

4.2.2 To install ATP Balise on Seoul-Busan and Honam line on which KTX runs.

4.2.2.1 Condition for signal transition control
- ATP system controlling signal between ATP and ATC, ATS and ATP
- For ATP ↔ ATS section, control in a same way as existing control system
- In case of ATP ↔ ATC transition, withdraw KAR, DKAR Balise to control ATS
- ATP system keeping waiting status in ATC/ATS section
- ATC/ATS system keeping waiting status in ATP section
- ATP system monitoring and controlling the status of arming and disarming ATC/ATS

4.2.2.2 Transition from ATC section to ATP section (figure 7)
- ATS disconnect at the moment of passing boundary Balise
- ATP arming at the moment of passing boundary Balise
- Verify ATP arming and generate ATC disarming signal.
- ATC disarmed by receiving ATC disarming signal

![Figure 7. Transition from ATC to ATP section](image-url)
4.2.2.3 Transition from ATP to ATC section (figure 8)

- ATC(TVM) arming by ATP controller before passing boundary Balise.
- ATP disarming after verifying ATC(TVM) arming

There are KAR and DKAR which are ATS Balise in transition section between high speed and conventional line. If we assume that such Balise does not intervene in ATS Arming and Disarming, a transition between ATC and ATP will be performed separately without any necessity of ATS. For this approach, it is required assuming that absence of KAR and DKAR will not interfere in ATC arming and disarming.

Besides, a strategic approach is needed to operate KTX after ATP installation on all of KTX operation area except high speed line.

5. KRTMS(Korean Railroad Traffic Management System)

Developing or securing an original railroad-related technology is extremely difficult due to small land and short track lines in Korean conditions. Railroad signal technology is up-to-date day by day; the most advanced train operation and control technologies such as from ATS to ATC, ATP, or MBS are being introduced. In fact, it is infeasible to develop all of these technologies in the country. It is considered that how harmonize introduced technologies in conformity to national condition is the most important. For this, ‘Railroad car traffic operation system’ standard plan, that is compatible to Korean conditions, shall be prepared and defined to establish guidebook for integrating technology. The basic preconditions for technical standard plan are as follows:

5.1 Definition of onboard signal system level
Signaling system in operation in Korea has been in a state of flux by contractor’s technology level or direction without a definite standard for structure and safety level per equipment at the moment of introduction from abroad. Consequently, the signaling system sometimes differs according to the kind of car or system. Recently in Korea also, some basic requirements for onboard signaling system were defined by ‘Rules for railroad car safety standard’ of ‘Railroad Safety Code’. However, each introduction of new system would bring dispute due to absence of clear standard. Thus, if it is systemized and defined by train operation condition (i.e. high speed, normal, or fret) and system requirements (train control, driver to complete, or minimum safety to ensure); it will help a driver raise efficiency of work and prepare the system standardization plan in case of introduction of new equipment.

<table>
<thead>
<tr>
<th>Onboard signaling system</th>
<th>Structure</th>
<th>Applied train</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATC</td>
<td>Dual</td>
<td>KTX</td>
<td></td>
</tr>
<tr>
<td>ATP</td>
<td>Ansaldo</td>
<td>Dual</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>BT</td>
<td>Single</td>
<td>Diesel, electric locomotive</td>
</tr>
<tr>
<td></td>
<td>Siemens</td>
<td>Single</td>
<td>Partial dual (cold standby)</td>
</tr>
<tr>
<td>ATS</td>
<td>Single</td>
<td>All Trains</td>
<td></td>
</tr>
</tbody>
</table>

Table 8. Structure by onboard signaling system

5.2 Preparation of real-time management plan

Since onboard signaling system introduced recently builds the system based on program, accuracy of time information is highly important issue in case of recording and analyzing events. Setting time of system and recording device and recording each kind of events through proper store time being managed by system will generate time error in case of analyzing information due to the error of equipment in itself, finally it will deteriorate the reliability of data. This problem can be solved by building a real-time management system through GPS information when developing or introducing new system.

5.3 Integration of driver information device

There are sometimes cases to install various onboard signaling systems such as ATS, ATC on one single trainset owing to an unavoidable situation. In this case, driver information device (e.g. MMI) is installed each time; so, driver is forced to use different screen every signaling section. However, the above problem could be solved by forcing the proponent to submit and implement a plan to integrated driver information device when purchasing a signaling system based on KRTMS.

5.4 Efficient maintenance plan

There is tendency to estimate only focusing on performance and driving convenience when introducing existing or new signaling system; but, this might bring large loss in the aspect of
maintenance from long-term point of view. As shown in ATP system, only raising track efficiency and safety level was an important determination standard, while maintenance aspect was missed. We need to add the measure to lessen long-term costs by estimating whether it is possible to perform an efficient maintenance in case of considering the introduction of system which will be appropriate in Korea.

5.5 Interface with peripheral devices such as OBCS(On Board Computer System)

The train to be controlled with computerized system is being increased and this method will become a general tendency. It converts driver’s driving handling contents, and starts, protects, monitors and controls, and implements information processing and controlling by interface with OBCS and train control system for KTX and CCU(Central Control Unit) for new type electric locomotive. Also, any failure or fault during driving is recorded on driving information recorder (e.g. ATESS, Speed recorder). The recorded data are utile for maintenance depot to acquire failure information and exploited as RAMS and failure statistics data. In order that ATP shows its function as signal system, not as a separate independent system in a train, interface with train controlling system such as OBCS is indispensable. Consequently, the interface with existing train’s controlling system shall be considered from the design phase. Otherwise, it is expected a difficulty to modify software in the future.

6. Results

ATP system introduction being driven recently will be a breakthrough project to upgrade signaling domain in railroad car one step forward. It is true to feel rather a little late in introducing and installing in Korea. Because we have realized the signaling system has definite influence on introduction and exploitation of future train as well as infrastructure. Accordingly, optimized interface measures should be supplied to secure train safety operation as above-mentioned for clearing off any initial difficulty in introducing the system and showing its functions as train system.

This research reviewed how to assure an interface between train and ATP system in installing it for safe operation of train. Even though it is tested internally and externally and proved excellent in performance, an optimized installation plan has to be presented considering peripheral devices for displaying its given performance on train. Moreover, if mixing different signaling systems, the solution for level transition between wayside system and onboard system should be completely proposed. Also, for train, brake processing plan and interface with recorder should be secured. Since onboard computer device supports globally driving and maintenance through onboard computer device, the interface problem between ATP system and onboard computer system must be solved. If it is an obstacle in driving and maintenance for operator in
the future, indeed it is not desirable for train exploitation in spite of excellent advantages of ATP system. We will be able to introduce appropriate system in Korea in the future by deriving optimized measures from joint research between industry and science for the purpose of introducing KRTMS suitable to Korean conditions. At least it will be used as a great guide for preparing suitable alternatives per equipment.

We need to validate sufficiently the interface with ATP system from design phase to settle ATP system successfully, and realize a system combining the theory and reality. In particular, in case of improvement project for already running train, the importance of interface between train and ATP shall be recognized as a new problem of ATP project to a train operator, ATP manufacturer, and railroad policy direction and so on. They need to approach in a more precise way, thinking that it is system operator to be damaged if they don’t pay attention to it.

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