Project Number: TA 4955-PRC
May 2010

PRC: Railway Emergency Management System Study

FINAL REPORT

Prepared by: IDOM Ingenieria Y Consultoria S.A.
Avda. Lehendakari Agirre, 3, 48014 Bilbao, Spain

In association with: China Academy of Railway Sciences
No. 2 Daliushulu, Haidian District, Beijing, PRC

Asian Development Bank

This consultant's report does not necessarily reflect the views of ADB or the Government concerned. ADB and the Government cannot be held liable for its contents. All views expressed herein may not be incorporated into the proposed project's design. The report is made publicly available in accordance with ADB's policy communications policy (2005).
# CONTENTS

1. **INTRODUCTION** .................................................................................................................................1  
   1.1 **BACKGROUND AND OBJECTIVES OF THE TECHNICAL ASSISTANCE** .............................1  
   1.2 **PROJECT METHODOLOGY** .............................................................................................................2  
   1.3 **SCOPE OF TECHNICAL ASSISTANCE** .............................................................................................2  
   1.4 **STRUCTURE OF THE FINAL REPORT** ...............................................................................................4  
   1.5 **ACKNOWLEDGEMENTS** ....................................................................................................................4  

2. **ANALYSIS OF REFERENCE COUNTRIES** .........................................................................................5  
   2.1 **LEGAL & REGULATORY** ....................................................................................................................5  
   2.2 **INSTITUTIONAL** ....................................................................................................................................7  
   2.3 **EMERGENCY MANAGEMENT** ...........................................................................................................12  
   2.4 **NETWORK COMMUNICATIONS AND INFORMATION SYSTEMS** ..................................................39  

3. **COMPARISON BETWEEN PRC AND REFERENCE COUNTRIES** ......................................................46  
   3.1 **LEGAL & REGULATORY** ...................................................................................................................46  
   3.2 **INSTITUTIONAL** ...................................................................................................................................47  
   3.3 **EMERGENCY MANAGEMENT** ..........................................................................................................49  
   3.4 **NETWORK COMMUNICATIONS AND INFORMATION SYSTEMS** ...............................................56  

4. **RECOMMENDATIONS** ..........................................................................................................................59  
   4.1 **RAILWAY EMERGENCY MANAGEMENT INFORMATION SYSTEM IMPLEMENTATION** ...............59  
   4.2 **EMERGENCY MANAGEMENT CENTRES (EMC)** ............................................................................70  
   4.3 **MOBILE EMERGENCY MANAGEMENT CENTRES (MEMC)** .......................................................73  
   4.4 **NETWORK COMMUNICATIONS** .......................................................................................................75  
   4.5 **TRANSMISSION OF VIDEO IMAGES TO THE EMC** ........................................................................77  
   4.6 **EARLY WARNING AND NATURAL DISASTER SAFETY SYSTEMS** .............................................79  
   4.7 **TECHNICAL RESOURCES, INVENTORIES** .....................................................................................81  
   4.8 **RISK ANALYSIS AND INCIDENT CLASSIFICATION** ......................................................................81  
   4.9 **EMERGENCY MANAGEMENT PLANS** .............................................................................................84  
   4.10 **EMERGENCY RESPONSE AND RECOVERY INDICATORS** ......................................................86  
   4.11 **EMERGENCY MANAGEMENT STAFF STRUCTURE** ......................................................................86  
   4.12 **TRAINING PROGRAM** ...................................................................................................................89  

5. **ACTION PLAN** ....................................................................................................................................92  

6. **ANNEXES** ........................................................................................................................................94  
   6.1 **ANNEX 1. RAILWAY EMERGENCY RESPONSE CASE STUDIES** ..............................................94  
   6.2 **ANNEX 2. SAFETY SYSTEMS** .........................................................................................................94  
   6.3 **ANNEX 3. EMERGENCY MANAGEMENT INFORMATION SYSTEMS** ......................................94  
   6.4 **ANNEX 4. INTERNATIONAL TRAINING REPORTS** ......................................................................94  
   6.5 **ANNEX 5. INFORMATION SOURCES** ............................................................................................94
Figure 15. Hybrid intervention vehicles based on road vehicles ................................................................. 31
Figure 16. EMIS windows presentation: event form, call assistance, resources and communication interface 63
Figure 17. EMIS windows presentation: event form, call assistance and communication interface ...........63
Figure 18. Call taker window ........................................................................................................................ 64
Figure 19. Dispatcher window ...................................................................................................................... 65
Figure 20. Description of TETRA based communication integration window .............................................66
Figure 21. Activity report presenting the response time .......................................................................... 66
Figure 22. Location of automatic vehicles based on GIS ........................................................................... 67
Figure 23. Integration of video management .............................................................................................. 68
Figure 24. Video-wall control screens administration window ................................................................. 69
Figure 25. EMC areas: operators room, Data Processing Centre and crisis room ................................. 71
Figure 26. Crisis room of a mobile emergency management centre installed on a truck .............................. 74
Figure 27. Truck transported container mobile hospital unit ...................................................................... 75
ABBREVIATIONS

AAR: Association of American Railroads
ADB: Asian Development Bank
ADIF: Spanish Administration of Railway Infrastructure (Administrador de Infraestructuras Ferroviarias)
AMTRAK: American national railroad Passenger Corporation
ARAIB: Aviation & Railway Accident Investigation Board of Korea
ARAIC: Railway Accidents Investigation Commission of Japan
ATM: Asynchronous transfer mode
AVL: Automatic Vehicle Location
BBK: Federal Office of Civil Protection and Disaster Assistance of Germany (Bundesamt für Bevölkerungsschutz und Katastrophenhilfe)
BEA-TT: Land transport accident investigation bureau
CARS: China Academy of Railway Sciences
CCTV: Closed Circuit Television
CIL: Incident Local Chief (Chief d’Incident Local)
CNO: National Operation Centre (Centre National des Operations)
CODIS: Provincial Centres of Fire and Rescue (Centre Opérationnel Départemental des services d’Incendie et de Séours)
CPE: Civil Protection and Emergencies Department
CTCS: Chinese Train Control System
DB: Deutsche Bahn
DPC: Data Processing Centre
DSC: Civil Security Department (Direction de la Sécurité Civile)
DXF: Drawing Exchange Format
EBA: Federal Railway Authority (Eisenbahn-Bundesamt)
ECT: Emergency Command Team
EMC: Emergency Management Centres
EMIS: Emergency Management Information Systems
EMO: Emergency Management Office in the General Office of the State Council of PRC
EMS: Emergency Management Systems
EPSF: French Railway Safety Authority
ETCS: European Train Control System
EU: European Union
FDMA: Fire and Disaster Management Agency
FEMA: Federal Emergency Management Agency (USA)
FRA: Federal Railway Administration (USA)
GIS: Geographical Information System
GSM: Global System for Mobile communications
GSM-R: Global System for Mobile Communications – Railway
GPRS: General packet radio service
ISDN: Integrated Services Digital Network
IT: Information Technologies
ITU: International Telecommunication Union
JMAIA: Japan Marine Accident Inquiry Agency
JR Group: Japan Rail Group
JTSB: Japan Transport Safety Board
JV: Joint Venture
KRRI: Korea Railway Research Institute
KTX: Korea Train eXpress
LAN: Local Area Networks
LMDS: Local Multipoint Distribution Service
LTE: Long Term Evolution
MCAF: Mission for Control of Railway Activities
MEMC: Mobile Emergency Management Centres
MLIT: Ministry of Land, Infrastructure, Transport and Tourism (Japan)
MLTM: Ministry of Land, Transport and Maritime Affairs of Korea
MOR: Ministry of Railway
NA: Not available
NELTRA: National Emergency Rescue Leadership Team for Railways Accidents
NEMA: National Emergency Management Agency (Korea)
NTSB: National Transportation Safety Board (USA)
P.I.S: Plan for Intervention and Safety in France
PABX: Private Automatic Branch Exchange
PDA: Digital mobile cellular network
PDC: Personal Digital Cellular / Pacific Digital Cellular
PMR: Analogue radio systems
PRC: People’s Republic of China
PSTN: Public Switched Telephone Network
RB: Railway Bureau
RENFÉ: Spanish public railway company (operator) (Red Nacional de Ferrocarriles Españoles)
RFF: French Railway Infrastructure Administration (Réseau Ferré de France)
RTRI: Railway Technical Research Institute (Japan)
SDH: Synchronous Digital Hierarchy
SNCF: French National Railway (Société Nationale des Chemins de fer français)
SOA: Service Oriented Architecture
SOP: Standard Operation Procedures
TA: Technical Assistance
TADS: Trackside Acoustics Diagnosis System
TCDS: Train Coach Running Diagnosis System
TCP/IP: Transmission Control Protocol/Internet Protocol
TERRA-S: Tokaido Shinkansen Earthquake Rapid Alarm System
TETRA: Trans European Trunked Radio
TFDS: Trouble of Freight Car Detection System
THDS: Trace Hot box Detection System
UHF/VHF: Ultra High Frequency/Very High Frequency
UMTS: Universal Mobile Telecommunications System
VCR: Voice Recording System
VSAT: Very Small Aperture Terminal (Satellite communications)
WAN: Wide Area Network
EXECUTIVE SUMMARY

PROJECT BACKGROUND AND REPORT STRUCTURE

(1) The Asian development Bank (ADB) has contracted a consortium led by IDOM Ingeniería y Consultoría S.A. (IDOM) in collaboration with China Academy of Railway Sciences (CARS) to conduct a Technical Assistance (TA) for the study of Railway Emergency Management Systems (EMS) in the People’s Republic of China (PRC) – TA 4955. The objective of the TA is to help PRC Railways in the preparation of a Plan for an efficient and effective Emergency Management System (EMS) for the PRC railways. Both companies (The Consultants) submit this Final Report according to the fourth milestone of the Technical Assistance.

(2) The Final Report is structured in four main chapters. After an introductory chapter, the report presents an analysis of the reference countries’ practices in four frameworks of activities (Legal & regulatory, Institutional, Emergency management and Network Communications & Information technologies.). The third chapter develops a comparative analysis between the practices in reference countries and current situation in the PRC for each framework. The fourth chapter presents a set of suggestions, observations and recommendations that would help PRC railways to obtain an efficient and effective EMS and finally the fifth chapter proposes an Action Plan to develop those recommendations.

(3) This report includes also the key findings of the international capacity building activities undertaken by MOR delegations according to the reports prepared by their officers.

(4) This consultant’s report does not necessarily reflect the views of ADB or the Government and the Ministry of Railways (MOR). Therefore, ADB and the Government cannot be held liable for its contents.

CONSULTANTS’ UNDERSTANDING OF THE SCOPE OF THE RAILWAY EMERGENCY AND MANAGEMENT CYCLE

(5) Within the railway emergency management framework, safety rules and recommendations focus on risk management, establishing systems (procedures, protocols, technical means, communication and information systems, others) to avoid incidents. However, accidents and crises are not likely to be stopped, but managed and solved in the most efficient and effective way using the available resources in the minimum time.

(6) Consequently, the scope of the Emergency Management System Study focus on accident and crisis situations in the railway sector, as shown in the exhibit below:

Exhibit 1. Scope of Railway Emergency Management.

Source: Consultants
(7) Emergency situations are usually managed through a four-step emergency management cycle:

- **Mitigation**: This phase involves all the safety measures (rules and recommendations) adopted by the railway authorities to prevent incidents. Although the safety field was initially out of the scope of the Technical Assistance, Consultants take into account some safety aspects in this Final Report as required by the PRC Railway Sector in the Interim meeting.

- **Preparedness**: At this stage, the railway authorities define capacities, maintain the resources (human and technical) and define the Emergency Plans and Organization to be prepared for an unlikely Emergency situation.

- **Response**: Once the Emergency occurs, the railway authorities coordinate with external organizations, perform the initial measures on the field, deploy staff on the site and define the need of technical means support. In this phase, the Emergency is usually solved by external organizations with the support of the railway authorities.

- **Recovery**: This phase begins once the Emergency is solved (usually the injured people have been treated, the site has been processed by all the organizations according to their duties and those external organizations have finished their main tasks). Here, the railway authorities take a leading position with their own resources (human and technical) in order to restore the railway service as soon as possible. The findings of the emergency (事故) investigation are the basis to create or modify the safety rules and recommendations. This is known as the 360º safety circle.

Exhibit 2. Emergency management cycle.

(8) The Emergency Management System to be improved in PRC Railways should be able to fulfil all those steps in order to manage accident and disaster situations in the most efficient and effective way, ensuring the most accurate resources allocation.

**ANALYSIS OF REFERENCE COUNTRIES**

(9) This Technical Assistance has conducted a research in the following countries: France, Germany, Spain, Japan, Korea and USA.

**Legal**

(10) National laws concerning Civil Protection are the basis for the country emergency management legal framework. Reference countries manage emergency situations through a unified set of laws and regulations that are mandatory to all sectors of activity of the country. The roles and responsibilities are
delegated (by further law development) to regional governments in some of them (Europe, USA) while
other maintain a single position on that (Korea).

(11) Regarding the legal framework that supports railway emergency management in reference
countries, as a common rule, the responsibility of these emergencies management is assigned to the
same organisations that manage any other type of emergency at local/provincial/federal government’s
level. Although most of these countries have national civil Protection Laws it is common to delegate the
responsibility of emergency management to the provinces/states that develop this function through the
governmental emergency management agencies.

(12) With regard to the railway legal framework, reference countries present complete railway
regulations with a similar scope including three main aspects:
• Rules concerning railway safety constraints, certifications, targets and reporting. As a common rule,
  these countries’ railway laws assign these safety related functions to a specific railway safety agency
  or authority.
• The responsibility of railway accidents investigation has been delegated by law to specific railway
  accident investigation agencies. Although attached to the corresponding transport ministries, these
  agencies maintain a certain level of autonomy in order to ensure that enquiries are objective and that
  they are able to develop their tasks without the influence of other agents.
• In most cases, railway regulations require railway companies or railway infrastructure administrations
to develop railway general emergency plans to ensure preparedness to railway incidents in their lines.

(13) On the other hand, European countries have laws to ensure the proper separation between the
Railway Infrastructure Administrator (who owns the tracks, stations, power installations …) and the
Railway operators (who perform the dispatching and transportation service to the customers), while in
other countries the operation involves both areas (USA, Japan). In both cases, Railway Safety laws are
strong enough to support the railway sector development.

Institutional

(14) Concerning the legal framework, the existence of a railway safety agency attached to the
Corresponding Ministry of Transport, is common to all countries. These agencies are in charge of the
definition of safety rules and safety constraints to be met by all railway companies, the issuance of railway
operation authorizations, definition of safety targets, analysis of railway companies’ annual safety reports
and capacity building through relations with international railway safety organisations.

(15) Other common aspect to all the reference countries is the railway accident investigation agency,
also attached to the corresponding Ministry of Transport but working autonomously to ensure objectivity
and the absence of external influence while analysing the causes of each railway accident and extracting
conclusions and defining corrective measures.

(16) Railway emergency management in the reference countries involves, on one hand, the Civil
Protection agencies attached to the Ministries of Home Affairs and the corresponding
local/provincial/federal authorities and, on the other hand, the railway companies and railway
infrastructure administrations attached to the Ministries of Transport of the countries.

(17) Generally, the railway infrastructure administrators and railway operator companies are
responsible for the management of incidents of a lower level of seriousness that can be solved internally
with their own resources.

(18) In case of emergencies, when external emergency agencies are necessary to develop fire
fighting and rescue and relief actions, the responsibility of emergency response relies on
national/provincial/local emergency agencies and the corresponding authorities. In this case, the railway
companies’ tasks during the response phase are limited to technical support, zone securing and internal
and external services coordination. The responsibility for the recovery phase rests with the railway
company.

(19) The collaboration protocols among railway companies and others agents (government, local
authorities, etc) involved in the emergency management are implemented through out the Emergency
Plans for each risk situation, where all the participants agree the collaboration method, the proper
coordination mechanisms, the available resources (human and technical) and the telecommunication and
information systems to be used. In reference countries, the governmental organizations in charge of
emergency management lead the preparation of multisectorial emergency plans involving others
agencies (including railway companies) and the involved sectors have to prepare their internal emergency plans to accomplish with the general requirements.

(20) Once an emergency has taken place, the proper Emergency Plan is activated by the Emergency Management governmental organization. All involved participants within this Plan have a mechanism to stay connected to the Government agency in charge of the emergency management. Coordination is performed in the Emergency Centres where a crisis room can be used for all participants to collaborate during the whole emergency process resolution. On the emergency site, the emergency manager takes the control of the situation and coordinates all possible participants.

(21) Once the emergency situation is solved on the site, the railway company has to deal with the recovery phase in order to restore the normal train operation condition. During this phase railway emergency management is in charge of coordination of the human and technical resources involved in that final period.

Emergency Management

(22) As a common rule, all the reference countries have developed an exhaustive railway emergency management system (EMS) according to the competences that the legal framework of each country assigns to the railway companies. The main element of the railway EMSs of these countries are the Emergency Management Centres (EMCs) (traffic or specific emergency management centres attached to the traffic centres) where railway personnel conduct the coordination of all agents involved. In European railway companies, the railway emergency management is conducted from regional centres in accordance with the emergency management principle that recommends to manage emergencies as close to the site as possible. In other countries like Korea, railway emergency management is not so regionalized but is based on a powerful system supported by a strong emergency classification and well-defined procedures and flowcharts.

(23) The analysed EMS involves different components including infrastructure, technology, organizational, management or human resources aspects among others. The common components of the railway EMS of the reference countries are:

- General and specific Emergency Management Plans defined by the railway companies and including indications, available own-resources, communication and coordination protocols and written agreements with external emergency agencies and authorities.
- Incident/Emergency classification and corresponding procedures/Emergency Plans, based on risk analysis and geographical location.
- Railway EMCs. Specific emergency management centres attached to the traffic control centres or traffic control centres developing emergency management functions.
- Emergency Management Software. Information systems for incident alarm dispatching and monitoring, which include information about the railway network, available in the centres to help railway companies’ staff to develop emergency coordination tasks in a more efficient manner.
- Qualified emergency management personnel in centres and on field.
- Proper updated technical resources for relief.
- Emergency management training composed of lectures and drills to ensure the qualification and preparedness of all of the internal and external agents involved in railway emergency management.
- Communication networks to connect on-field and centre personnel as well as authorities and external emergency agencies to ensure appropriate coordination of the emergency management. These communication networks are usually those used for normal operation.

(24) In the specific case of Natural Disasters, the procedure in the reference countries starts with the analysis of the risk, which identifies the risk of natural disaster in specific areas; continues with the identification of safety systems to predict such disasters and mitigate their effects and, once the disaster occurs, involves a coordinated emergency response with the governmental emergency management agencies. Potential identified risks in railways are heavy storms, earthquakes, typhoons (floods), stones drop into track, tunnels, bridges, heavy winds, animal crossing, hazardous goods transportation and terrorism. Each of these can have more than one Emergency Plan regarding different geographical locations (i.e. different tunnels) or combination of several risks.

(25) Japan and Korea, where natural disaster safety systems are specially considered, the early alert and safety systems found include meteorological stations, earthquake early alert systems, wind speed meters, windbreak fences or landslide or rock fall detection systems.
(26) In European countries, where these risks and therefore the corresponding safety systems are limited, as well as in countries where this kind of disasters is more usual, the protocols to develop the response are included in specific emergency management plans for natural disasters. The use of meteorological early warning systems is also included as well as other safety technologies for early detection in key tracks (i.e. drop detectors in high speed lines, fire and smoke tunnel detection...). Safety systems are developed in those countries according to each special railway line needs.

(27) All countries present a number of detailed Plans for these situations, where specific analysis, procedures, people affected and relief resources are clearly defined. As a common rule, these plans indicate the agents who shall participate in case of such disasters, and states the creation of a crisis cabinet where representatives of all these agencies should be present to coordinate actions.

(28) Analysis of several case studies in the reference countries have pointed out key lessons for Emergency Management:

- Emergency situations involving many organizations, training is necessary to ensure coordination and Emergency Plans execution.
- A clear command chain is necessary in the emergency site with good communications with the Emergency Centres.
- Lessons from Emergency situations should bring improvement in new Safety measures.

Network Communications and Information Systems

(29) Communication Networks and Information Systems are the basis for effective and efficient railway Safety and Emergency Management, nowadays. Thus, they enable on-site incident monitoring and facilitate clear and secure communication channels to ensure coordination among organizations involved in the emergency response phase (railway authorities and external agencies).

(30) The two main problems that are detected in an emergency situation are: a poor or intermittent path of communication with the emergency site and the lack of information compiled and adapted to facilitate the Emergency management. This report includes some Emergency cases in its annexes, in which this sort of problems are clearly arisen. Communication networks and Information Systems are the main tools to solve those problems.

(31) The software platform in charge of this management is the EMIS (Emergency Management Information System). The analysed EMIS in railway authorities of the reference countries are basic information tools used to identify, register and dispatch incidents and emergencies, which include information from other integrated tools such as Geographical Information System (GIS), technical resources inventories, railway network inventories, etc. The functionalities of these tools are in accordance with the responsibilities that the legal framework assigns to railway companies in case of emergency.

(32) Since a significant part of the railway emergency response is performed by the governmental emergency management agencies, it is important to stress that these organisations have complex Emergency Management Information Systems (EMIS). These are platforms that integrate emergency management information tools and communications within all the agents involved. EMIS are implemented in Emergency Management Centres (EMC), where the overall coordination of the emergency is managed. Extensive information on EMIS utilized by government agencies is included in this report. The main functions performed by an EMIS platform are: Incident reception, classification, communication with others, procedure or emergency plan activation, resource allocation and dispatching, on site data gathering, geographical positioning (GIS), emergency close, backup analysis, statistics module and general maintenance routines.

(33) Mobile networks are the key element for the railway sector to keep a direct contact with the emergency site, while gathering the needed information. European countries use their wireless networks for emergency purposes (i.e. GSM-R and ground to train communication system) as well as commercial mobile networks from operators. Similar systems are used in Japan and Korea.

(34) Emergency governmental agencies have their own wireless systems specifically oriented to manage big emergency situations. Those networks are mainly based in high security and highly reliable systems as the TETRA technology, which is basically deployed for emergency purposes.
(35) An important issue is to ensure the communication between the Railway EMC and the Governmental EMC. Consultants has found that voice communication is the main common way to implement it, using fixed telephone lines (Germany, Spain) or secure wireless systems (France-TETRA). Fax and Data communication are also used in those countries, being voice the main choice.

(36) To sum up, the following table shows the reference countries where the practices have been identified regarding the different areas of the frameworks analysed:

<table>
<thead>
<tr>
<th></th>
<th>France</th>
<th>Germany</th>
<th>Spain</th>
<th>Japan</th>
<th>Korea</th>
<th>USA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Legal and Institutional Frameworks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institutional Framework</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td><strong>Emergency Management</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency Plans</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Incident classification</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Natural Disasters Management</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Emergency Management Centres</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Training</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td><strong>Network communication and Information Systems</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency Management Information Systems (Vendors)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Mobile communications</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

Source: Consultants

**COMPARISON BETWEEN PRC AND THE REFERENCE COUNTRIES**

(37) In 2004, China’s State Council approved the “Mid and long term Railway Development Plan”, which proposed, by 2020, to reach an operational length of railways nationwide of 100,000 km and to construct more than 12,000 km of Passenger Dedicated Lines (PDL). In 2008, in accordance with national integrated transport systems needs, the State Council adjusted the “Mid and long term Railway Development Plan”, indicating that by 2020, the operational length of railways nationwide shall reach more than 120,000 km and that more than 16,000 km of Passenger Dedicated Lines shall be constructed.
(38) These PRC railways development plans bring new complexity and needs in safety and emergency management, which make crucial to adapt railway EMS to the incoming situation and to provide effective and efficient response to railway emergencies.

Exhibit 3. Main PRC railway lines

Legal & Institutional

(39) PRC regulation assigns railway emergency response responsibility to the Ministry of Railways while in reference countries the Ministry of Civil Affairs is in charge of the management of any type of emergency. PRC presents a sector oriented (vertical) approach in Emergency Management while reference countries present horizontal approaches (all sectors). Due to this characteristic, some of the recommendations or suggestions presented are based on the practices of governmental emergency agencies instead of those of railway administrations. So far, MOR and the Railway Bureaus (RBs) manage the response and recovery of emergencies through their own technical, rescue and relief resources, and sometimes with the collaboration of external emergency services.

(40) The railway legal framework in PRC has, as in the case of the reference countries, powerful regulations concerning safety and emergency management, defining scope, affected agents, roles and responsibilities. The main contents of the railway regulation of the reference countries (safety constraints, accident investigation and emergency plans definition) are also the scope of PRC railway laws.

(41) Consultants found that current legal framework in PRC is appropriated for Emergency management, but PRC could consider the legal & institutional framework of the researched countries for future development of the Emergency Management System.

(42) In case of railway emergencies, under the leadership of the State Council, the Ministry of Railways, the local government, the relevant departments of the State Council, the local railway supervision departments and the railway transport enterprise jointly carry out rescue and relief work. Meanwhile in reference countries, emergency management is responsibility of the Governmental Emergency Agencies, as delegates of the regional governments and Ministry of Civil Affairs.
(43) In case of extra large emergencies, the State Council or the investigation team, which is authorized by the State Council, is responsible for the investigation and handling; while the Ministry of Railways or the local railway supervision departments are responsible for the investigation of other emergencies. Reference countries trend is to create Safety and Incident Investigation Agencies professionalized and with certain autonomy from the ministry of transport, although under its umbrella.

**Emergency Management**

(44) In PRC, RBs, like the railway companies of the reference countries, are in charge of the definition of **Emergency Plans**. General emergency plans are useful to give general instructions to respond to any type of emergency and to provide a global vision of the resources and preparedness of the railway companies to emergencies.

(45) PRC railways considers an **Incident Classification** based on cause criteria, like many of the railway companies of the reference countries, and a level of severity classification based on quantitative consequences of the emergency. Despite the soundness of these classifications, both of them could be improved following the practices found in Korea in order to obtain a multicriteria incident classification that permits the definition of specific response procedures/emergency plans to be integrated in an Emergency Management Information System (EMIS).

(46) Considering reference countries practice, combined with PRC railway construction and development, Mobile Emergency Management Centres (MEMC) are suggested, which could facilitate the management of people, communications and information technology in site, and help staff to reach the site for command.

(47) PRC Railways have their own mechanism of communication and information gathering with governmental climate and seismological agencies, as seen in the reference countries. The deployment of **Early Warning and Safety Systems** in RBs, like in some reference countries, can boost the safety indicators along the whole railway lines. Especially for Climate and Natural Disaster, those systems have proven to be of key importance to operate trains in a more safety environment with less risk for human beings and properties.

(48) RB and MOR have emergency management **personnel** in the control centres, as is the case with most of the reference countries. They also have rescue and relief own-resources (rescue team) which perform on-field response to the emergency on their own when possible. Most like the reference countries, in the emergency site, the coordination tasks are performed, not by a single on-site incident manager like in the reference countries but by a coordination team, that is, the Emergency Command Team (ECT), which sets up emergency coordination groups to supervise the emergency response actions.

(49) PRC railways count with their own **technical resources** (e.g. rescue trains and crane trains) and external resources for rescue and relief. In reference countries, railway companies also have agreements with external companies to hire their technical resources when in an emergency situation. All those equipments are normally located using an inventory, which is located in a Data Base.

(50) PRC railways organise **training** lectures and drills at RB and MOR levels to prepare their personnel in how to perform the response and cooperate in case of an emergency.

**Network communication and information systems**

(51) An **Emergency Management Information System (EMIS)** is very important, if PRC railways strengthened the construction of such a system in their EMCs, it would become the basis of the EMS and a common platform for fixed and mobile, data and voice communications.

(52) In emergency situations, PRC railways use the same fixed and mobile communication systems that they use for normal operation: PABX telephone, scheduling telephone network and automatic telephone network, trackside telephones and train dispatching system.

(53) Nevertheless, a boost in **mobile communications** to cover all the potential risk areas would ensure communications between the emergency site and the Emergency Management Centre (EMC), as it cannot always be close to the incident.

(54) Regarding fixed communication systems, although internally MOR and the RB have good communication networks, the RBs should foster the communication with other external organisations.
involved in railway emergency management through the definition of communication protocols to be included in the emergency plans together with telephone and fax numbers inventories.

RECOMMENDATIONS

(55) As a result of the comparative analysis of the practices worldwide and the current situation of the railway EMS (Emergency Management System) in PRC, Consultants have presented a list of recommendations which have been defined with the aim of helping MOR to improve the current railway EMS. These recommendations have also been shared and discussed with MOR and ADB in workshop sessions, in order to better adapt them to the Chinese railway system needs. As output of this process, Consultants have defined the definitive list of twelve recommendations of this TA.

(56) The following exhibit shows the global set of recommendations proposed for the EMS (Emergency Management System) in PRC. The core of this set of recommendations is the deployment of the Emergency Management Centres (EMCs) and the Emergency Management Information Systems (EMIS) to be developed at these centres. The inputs that feed those EMIS and EMC are a multicriteria Incident Classification, the corresponding procedures and emergency plans, and the early warning safety systems. These three elements are the result of an initial risk analysis to be developed by Railway Bureaus (RB) and MOR. The output of the EMCs and EMIS is the mobilisation and coordination of the corresponding technical resources and the qualified and well-trained emergency management personnel who will manage these technical resources.

Exhibit 4. Summary of the set of recommendations to improve the current EMS of PRC railways

Exhibit 4. Summary of the set of recommendations to improve the current EMS of PRC railways

<table>
<thead>
<tr>
<th>Risk analysis and Safety measures</th>
<th>Incident &amp; Emergency Classification</th>
<th>EMIS (Emergency Management Information System)</th>
<th>EMC (Emergency Management Centre)</th>
<th>MEMC (Mobile Emergency Management Centres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training, exercise, fire practice, etc</td>
<td>Personnel</td>
<td>Rescue &amp; Relief technical resources</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source. Consultants analysis.

(57) The twelve proposed recommendations are classified according to the four frameworks of this TA (legal, institutional, emergency management and network communication and information systems), as shown in the following table. This set of recommendations has been defined taking into account specific characteristics of the Chinese railway system and their particularities and shall help MOR to improve the whole process of Railway Emergencies Management in the above-mentioned four frameworks.

Table 2. Table of Recommendations.

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Framework</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recommendation 1: PRC railways should optimize and perfect an EMIS (Emergency Management Information System) in order to help MOR and the RB in railway emergency management. The proposed EMIS should include integrated communications permitting the registering of all type of data-voice-images. This would constitute the platform for the coordination between MOR and the RBs, and for coordination with other local authorities, and external emergency organizations. In addition, it would make easier the data-gathering process, statistics and indicators</td>
<td>Network Communications and Information Systems - Institutional -</td>
</tr>
</tbody>
</table>
accounting, propaganda and general management functions. PRC railways should deploy a unified EMIS software based on a distributed Database (DDBB), for MOR and all the RBs. The central node would be at MOR and all RBs would roll out their own implementations of the EMS (risks, emergency plans, procedures, etc).

(59) **Recommendation 2**: EMIS should be installed in specific EMCs (Emergency Management Centres) where the overall coordination of the emergency would be performed. The Consultants propose to construct and perfect an EMC in each Railway Bureau connected with another EMC at MOR. Those EMCs at RB should be located next to the corresponding Station & Depot (traffic control centres).

(60) **Recommendation 3**: Mobile Emergency Management Centres (MEMC) are useful elements when the circumstances make necessary emergency management on the site of the emergency (when numerous resources need to be deployed, in case of complex emergencies or when emergencies are foreseen to last several days). MEMC platforms are basically intended to bring the management power of an EMC with its EMIS near to the emergency site. One of the learned lessons from other countries' case studies is that the lack of proper information from the field and the lack of a clear command chain on-site result in inefficient emergency responses. The Consultants recommend that, in accordance with each RB needs, multiple MEMC should be rationally allocated.

(61) **Recommendation 4**: In emergency situations it is crucial to have a permanent flow of data from the site of the incident to the EMCs as well as from those EMCs to other organizations involved in the emergency. A wireless communication network is the most suitable for the first case, considering that emergencies take place in different locations. Consultants recommend adopting wireless technology to perform the communication from the site to the EMC. Regarding communications between the EMC with other organizations, Consultants recommend defining and implementing at least secure and reliable voice networks, using the fixed or wireless technologies as available. Finally, all those technologies should be developed considering their interoperability.

(62) **Recommendation 5**: Availability of all types of information (data, voice and video) is an asset to perform effective emergency management. Video is becoming a key element in emergency management centres worldwide, as it provide lots of information to the emergency management personnel with a quick look, sparing them asking many questions to the on-field personnel. The available video sources in the RBs should also be available in the EMCs (especially station cameras images). Other sources of video can be made available from the emergency scene using satellite communication, considering local cameras on the ground or helicopter cameras. The Consultants recommend deploying the necessary networks and the necessary infrastructure in the EMCs in order to make video available at these centres.

(63) **Recommendation 6**: Natural disasters are one of the greatest challenges within Emergency Management. The complexity of these risks does not permit to define a procedure, but require specific emergency plans to deal with them. These specific emergency plans for natural disasters indicate not only the risk characteristics by type (earthquake, typhoon, sand storm, flood, etc) but also the geographical area where they are more likely to happen, in order to create the most concrete awareness in possible affected people, geographical areas and technical resources. Finally, these plans usually define the counterpart measures to predict them or mitigate their effects. Consultants recommend installing and perfecting appropriate early warnings and safety systems for natural disasters according to the outcome of the risk analysis by RB or geographical area.

(64) **Recommendation 7**: PRC railways should analyse the necessity of procuring new technical resources at RB level in order to ensure a good coverage of

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Subject Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Emergency Management</td>
</tr>
<tr>
<td>3</td>
<td>Emergency Management - Institutional - Legal</td>
</tr>
<tr>
<td>4</td>
<td>Network Communications and Information Systems</td>
</tr>
<tr>
<td>5</td>
<td>Network Communications and Information Systems - Emergency Management</td>
</tr>
<tr>
<td>6</td>
<td>Network Communications and Information Systems - Emergency Management - Legal</td>
</tr>
<tr>
<td>7</td>
<td>Emergency Management -</td>
</tr>
</tbody>
</table>
the entire railway network in case of emergency. One practice seen in all the reference countries to ensure this technical coverage in a cost effective way is to conclude agreements with external companies in order to hire technical resources to these companies when their own resources are not available, are insufficient or cannot ensure an acceptable time of response. Additionally, another good practice that should be considered by MOR is to develop technical resources inventories (including agreements with external companies) and integrate these in the EMIS of the RBs EMC in order to ensure a fast localization and mobilisation of these resources when needed in case of emergency.

(65) **Recommendation 8**: Current incident classification should be improved following the model of the Korean multicriteria incident classification in order to achieve a higher level of granularity. This would permit the definition of detailed procedures (for incidents) or detailed emergency plans (for emergency situations) and therefore the implementation of both the classification and the procedures, on an EMIS. Moreover, RBs should develop a proper risk analysis in their area of influence, which should be the basis for the mentioned incident classification, emergency plans and procedures.

(66) **Recommendation 9**: Although some specific emergency plans are developed at RB level, General Emergency Plans should also be defined by each RB and approved by MOR. These general plans should include the basis risk analysis for the whole of tracks and stations, the possible lines affected by those risks, early warning systems available, list of local governments, emergency organisations (public security bureau, fire fighters, ambulances, etc) and volunteer organizations involved and contact data, communications protocols and available resources of these external agents. Institutional coordination between the involved agents and organizations should be therefore based on the collaboration mechanisms, resources mobilized and training programs defined in these emergency plans. In addition to this General Emergency Plan, each identified risk situation should have a corresponding Specific Emergency Plan, which should developed the detailed approach to resolve those situations. It is advisable to have as many Specific Emergency Plans as possible in order to implement them in the EMIS.

(67) **Recommendation 10**: Railway companies in the countries subject to research do not manage recovery indicators; only some response indicators related to human and technical resources deployment are usually considered. However, governmental emergency agencies in those countries do manage response and recovery indicators. Considering that MOR and RB functions regarding railway emergencies are similar to those of the reference countries’ emergency agencies, Consultants recommend creating a set of indicators (and respective goals) to be analysed annually.

(68) **Recommendation 11**: According to the deployment of a new EMC, there is a need for new staff to be placed in charge of the operation, maintenance and management of those centres. In addition, the Consultants recommend the inclusion of an overall on-field official to ensure the single command principle and the single information flow towards the EMC.

(69) **Recommendation 12**: Regarding the training for PRC railway emergency management personnel, both MOR and the RBs should further improve training programs to ensure that the different agents involved in emergency response obtain appropriate skills to face an emergency situation according to their various tasks. The training programs should include initial and refreshing lectures with a common component regarding basic principles of emergency management and specific chapters corresponding to different department functions and tasks; rescue-relief exercises, drills or fire practices for internal training of the rescue and relief techniques and drills with external organizations focused on coordination procedures with local departments, fire fighters, public security bureau, health services, etc. The
proposed periodicities are two days per year for the refreshing lectures, one internal drill per year by RB, one internal drill per year at MOR with the collaboration of other RBs and one drill including external agencies and departments per year. EMIS training and simulation modules permit also to develop simulations of emergency management without deploying trains, personnel, resources, vehicles, etc. on field.

Source. Consultants analysis.

(70) These twelve recommendations, agreed in the mentioned process of discussion between all the agents of this TA, shall help MOR to achieve an efficient and effective Railway Emergency Management System (EMS) in PRC.

ACTION PLAN

(71) Finally, the agreed set of recommendations have been discussed by the participants in this Technical Assistance (TA) in order to define the main activities within each recommendation, to make the most appropriate prioritisation and to integrate them in a temporary framework. This has resulted in the following proposed Action Plan considering three time scenarios: ST, short term up to 1 year; MT, medium term 1-3 years; LT, long term, beyond 3 years.
<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Period</th>
<th>Main Activities</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> Implement an Emergency Management Information System (EMIS)</td>
<td>ST</td>
<td>• Study to define the final functions to be implemented. Procurement documents.</td>
<td>• A tool for the efficient and effective Emergency Management of resources in the most accurate way to deal with Emergency situations.</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Procurement of the EMIS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• First prototype implementation in one RB and at MOR offices.</td>
<td>• Record of every Emergency, off-line training and statistics analysis.</td>
</tr>
<tr>
<td></td>
<td>LT</td>
<td>• Deployment in the rest of the RBs</td>
<td></td>
</tr>
<tr>
<td><strong>2</strong> Develop Emergency Management Centres (EMC)</td>
<td>ST</td>
<td>• Definition of the definitive model of the EMC (emergency and traffic departments separation or integration)</td>
<td>• Define a general coordination and reference point for emergency management</td>
</tr>
<tr>
<td></td>
<td>ST</td>
<td>• EMC location and design by RB</td>
<td>• Integrate all the emergency management agents and functions</td>
</tr>
<tr>
<td></td>
<td>ST</td>
<td>• EMC personnel dimensioning based on the incident volume and background analysis of each RB.</td>
<td>• Allow interaction with other departments</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• EMCs deployment and systems integration</td>
<td></td>
</tr>
<tr>
<td><strong>3</strong> Mobile Emergency Management Centres (MEMC)</td>
<td>MT</td>
<td>• Final evaluation of needs. Document on MEMC assessment in PRC</td>
<td>• Improvement in on-site coordination</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Technical specifications documents</td>
<td>• Support to ECT and Incident coordination.</td>
</tr>
<tr>
<td></td>
<td>MT-LT</td>
<td>• Procurement documents</td>
<td>• Better data gathering to EMCs.</td>
</tr>
<tr>
<td></td>
<td>MT-LT</td>
<td>• Deployment of MEMC in RBs.</td>
<td></td>
</tr>
<tr>
<td>Recommendation</td>
<td>Period</td>
<td>Main Activities</td>
<td>Impact</td>
</tr>
<tr>
<td>----------------</td>
<td>--------</td>
<td>----------------</td>
<td>--------</td>
</tr>
<tr>
<td><strong>4 Mobile (wireless) network deployment</strong></td>
<td>MT</td>
<td>• GSM-R mobile extension for conventional railway sections.</td>
<td>• Ensure the communication between the emergency site and the EMC.</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• GSM terminal distribution for operation staff and maintenance brigades</td>
<td>• Improve communications facilities until the full implementation of a GSM-R or wireless system.</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Wireless system implementation as base for emergency response.</td>
<td>• Ensure the communication between the emergency site and the EMC.</td>
</tr>
<tr>
<td></td>
<td>LT</td>
<td>• Invest on satellite communications.</td>
<td>• Ensure continuity of communications in the case of a failure in the main route.</td>
</tr>
<tr>
<td><strong>5 Availability of video images at EMC</strong></td>
<td>MT</td>
<td>• Wireless access network installation.</td>
<td>• Permit video transmission from incident site to the EMC.</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Video images integration into EMIS.</td>
<td>• Ensure a complete EMIS implementation.</td>
</tr>
<tr>
<td></td>
<td>LT</td>
<td>• Airborne video supported by helicopters.</td>
<td>• Permit real time video from incident site in major accidents and crisis situations.</td>
</tr>
<tr>
<td><strong>6 Early warning and natural disaster safety systems</strong></td>
<td>ST</td>
<td>• Continue investing in signalling systems.</td>
<td>• Eliminate risks and improves safe train traffic.</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Define procedures and automatic communication links among MOR, railway companies, the climate Bureau and the seismological Bureau</td>
<td>• Ensure accurate and early information about natural and climate disasters forecast such as expected high rains and typhoons.</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Identify and classify risk areas where early warning and natural disaster safety system may be installed.</td>
<td>• Permit efficiency efforts in early warning and natural disaster safety system.</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Invest on early earthquake alarm systems.</td>
<td>• Ensure early warning.</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Invest on strong wind warning systems.</td>
<td>• Ensure effective use of early warning systems through the connection with signalling systems</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Invest on landslide and rock fall detecting systems.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Invest on rain observation systems.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LT</td>
<td>• Connect early alert system to the rail interlock signalling system.</td>
<td></td>
</tr>
<tr>
<td>Recommendation</td>
<td>Period</td>
<td>Main Activities</td>
<td>Impact</td>
</tr>
<tr>
<td>----------------</td>
<td>--------</td>
<td>----------------</td>
<td>--------</td>
</tr>
<tr>
<td>7 Procure or upgrade technical resources for people rescue and tracks and rolling stock relief</td>
<td>ST</td>
<td>• Definition of different technical resources response times goals</td>
<td>• Ensure achievement of acceptable response times in technical resources in case of emergency</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Analysis of technical resources response times goals achievement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Analysis of the necessity of procuring new technical resources where response time goals are not achieved</td>
<td></td>
</tr>
<tr>
<td>8 Adapt current incident/emergency classification</td>
<td>ST</td>
<td>• Review risk analysis development at MOR and RB levels</td>
<td>• Better define the incident classification, incident procedures and the specific emergency plans through the risk analysis</td>
</tr>
<tr>
<td></td>
<td>ST</td>
<td>• Incident classification redefinition considering several factors</td>
<td>• Make easier the procedure definition including the resources needed for each type of incident</td>
</tr>
<tr>
<td></td>
<td>ST</td>
<td>• Level of severity classification redefinition avoiding quantitative criteria</td>
<td>• Permit the computerization of incident classification and procedure assignment tasks</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Definition of specific procedures and flowcharts for each type of incident</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Implementation of classifications and procedures in an EMIS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Establishment of a fax based incident classification and notification procedure while the EMIS is being developed.</td>
<td></td>
</tr>
<tr>
<td>Recommendation</td>
<td>Period</td>
<td>Main Activities</td>
<td>Impact</td>
</tr>
<tr>
<td>----------------</td>
<td>--------</td>
<td>----------------</td>
<td>--------</td>
</tr>
<tr>
<td>9 Improve Emergency Plans</td>
<td>ST</td>
<td>• Exhaustive risk analysis development at MOR and RB levels</td>
<td>• Disseminate the general principles and guidelines in case of incident among all agents involved</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Definition of general instructions and principles regarding incident response and operation in case of incident</td>
<td>• Give MOR a global vision of the emergency preparedness of RBs</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Definition of the training program</td>
<td>• Define the responsibilities of all internal departments in case of emergency.</td>
</tr>
<tr>
<td></td>
<td>ST</td>
<td>• Human and technical resources inventories definition</td>
<td>• Define the responsibilities and coordination procedures and agreements between all of the agents.</td>
</tr>
<tr>
<td></td>
<td>ST</td>
<td>• Internal coordination protocols definition</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Definition of coordination and communication protocols and written agreements with external emergency organizations and with authorities</td>
<td></td>
</tr>
<tr>
<td>10 Response and Recovery indicators definition</td>
<td>ST</td>
<td>• Definition of response and recovery indicators and goals.</td>
<td>• Permit monitoring and analysis of response performance quality</td>
</tr>
<tr>
<td></td>
<td>ST</td>
<td>• Definition of the procedure for periodical reporting and reports format</td>
<td>• Permit improvements in response procedures and coordination protocols</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Definition of the procedures for analysis of the outcomes of the indicator reports and improvement measures definition at RB and MOR levels</td>
<td></td>
</tr>
<tr>
<td>11 Reinforce Human Resources</td>
<td>MT</td>
<td>• Definition of new professional profiles, qualifications and functions for on-field management</td>
<td>• Professionalize the emergency management personnel structure, permitting station and depot personnel to concentrate efforts in their tasks</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Definition of new professional profiles, qualifications and functions for EMC personnel</td>
<td>• Ensure a unique command profile on-field to coordinate different working groups</td>
</tr>
<tr>
<td>Recommendation</td>
<td>Period</td>
<td>Main Activities</td>
<td>Impact</td>
</tr>
<tr>
<td>----------------</td>
<td>--------</td>
<td>----------------</td>
<td>--------</td>
</tr>
</tbody>
</table>
| **12** Establish EMS training programs at MOR and RB levels | MT     | • Definition of hierarchy and coordination procedures between on-field and EMC personnel, other departments and RB or MOR officers | • Better define responsibilities and improve the unique coordination and command chain  
• Ensure the optimal performance of the future EMCs functions through specialized and qualified personnel |
|            | MT     | • New on-field staff selection and training |        |
|            | MT     | • New EMC staff selection and training |        |
|            | MT     | • Definition of initial lectures and theoretical training contents specific to each agent involved in emergency management: rescue and relief, on board, on-site coordination personnel and EMC personnel. Common to all RB and MOR. | • Ensure the best qualification and training of each profile to develop its specific tasks in case of emergency  
• Ensure a better knowledge of coordination procedures and avoids miss-coordination in case of emergency  
• Ensure a clear responsibilities assignment and avoids interference in case of a real emergency  
• Permit to analyze possible failures in emergency response procedures and systems and to correct them before a real emergency arises |
|            | MT     | • Definition of refresher theoretical training and lectures contents and periodicity. Common to all RB and MOR. |        |
|            | ST     | • Periodicity definition for drills and simulations. |        |
|            | ST     | • Definition of drill contents; periodically at RB level based on risk analysis outputs. |        |

Source: Consultants analysis.
1. INTRODUCTION

(72) This document is the Final Report of the Technical assistance TA 4955-PRC, a Study of the Railway Emergency Management Systems (EMS), which is financed by the Asian Development Bank (ADB) of which the Ministry of Railways (MOR) of the People’s Republic of China (PRC) is the beneficiary.

(73) IDOM Ingeniería y Consultoría (IDOM) in collaboration with the China Academy of Railway Sciences (CARS) submits this report.

1.1 BACKGROUND AND OBJECTIVES OF THE TECHNICAL ASSISTANCE

(74) The TA to the People’s Republic of China for a Railway Emergency Management Study is part of the “Railway Safety Enhancement Project” (The Project) which is the first stand-alone sector-wide intervention by the Asian Development Bank (ADB) for enhancing railway safety on a network basis.

(75) The aim of the Project is to promote railway safety through the introduction of safe, reliable, energy-efficient, and environment-friendly emergency rescue and restoration technologies; to provide capacity-building support through staff training; and to rationalise the location of the comprehensive emergency rescue and restoration centres; all of which will help to achieve higher standards of railway safety, staff productivity and line capacity. Specifically expected project outputs include:

- The project shall result in new technologies with higher capacities, which are consistent with the needs of the PRC railways. These technologies will ensure more advanced self-diagnostic systems and safety protection systems for lifting and operation, thus reducing rescue and restoration time for accidents and emergencies.
- Railway personnel will receive capacity building: The railway staff will be trained in dealing with accidents and emergencies and they will also know the use of the mentioned equipment. There will be the proper equipment (simulators, training models, technical literature…) in the emergency management centres to be deployed or equipped for this purpose.
- In order to achieve a high level of safety and security in railway transportation, the following principles have to be assumed: good governance, accountability, transparency and result-based programs. The setup of the Emergency Management System will promote this good governance.

(76) With the goal to promote railway safety, the Ministry of Railways of PRC has adopted the Regulation on Emergency Rescue, Investigation and Treatment of Railway Traffic Accident on September 2007. This regulation has reviewed the classification of railways accidents including other accident causes.

(77) The objective of the TA has been to help the PRC Railways in the preparation of a Plan for an efficient and effective Railway Emergency Management System (EMS).

Exhibit 5. TA 4955-PRC Background, objectives and scope.
1.2 PROJECT METHODOLOGY

(78) The TA has included the reviewing of current practices adopted by PRC railway sector for managing railway emergencies, researching the international practices in railway Emergency Management systems, and recommending actions for developing an efficient and effective railway Emergency Management system in the PRC.

(79) Furthermore, the TA has supported capacity building through international and domestic training programs and the transfer of knowledge. During the international training, two delegations of MOR officers travelled to some of the reference countries in Europe (France and Germany) and Asia (Japan and Korea) where they met the main railway operation, research and engineering companies of these countries in order to know about the best practices regarding railway emergency management in these countries. The Domestic Training held in Nanchang Railway Bureau permitted the Consultants to explain to the audience of PRC railway the main concepts analysed, the study research and the recommendations for PRC railways.

(80) The following exhibit describes the methodology followed during this TA.

Exhibit 6. Progress of the TA.

<table>
<thead>
<tr>
<th>Stages</th>
<th>Main Objectives</th>
<th>Milestones</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Initial activities</td>
<td>Kick off 03/23</td>
</tr>
<tr>
<td>II</td>
<td>Current EMS practices in PRC</td>
<td>Inception report 04/06</td>
</tr>
<tr>
<td>III</td>
<td>Benchmark in reference Countries</td>
<td>Interim report 08/10</td>
</tr>
<tr>
<td>IV</td>
<td>Recommendations for PRC Railways</td>
<td>Draft final report 10/26</td>
</tr>
<tr>
<td></td>
<td>Development set of recommendations for setting up Emergency management system for PRC Railways</td>
<td>Final Report 12/21</td>
</tr>
</tbody>
</table>

Source: Consultants analysis.

(81) Based on the findings of the TA this Final Report covers (1) the analysis of the practices found regarding emergency management systems in the reference countries (2) the comparative analysis between these systems in the reference countries (France, Germany Spain, Japan, Korea and USA) and in PRC and (3) the proposal of a list of recommendations and set of actions that should permit PRC Railways to improve some aspects of its railway emergency management system based on an analysis of the reference countries.

(82) The content and conclusions of this Final Report should help PRC railway sector in the process of improving its current system towards an efficient and effective Emergency Management System for PRC railways.

1.3 SCOPE OF TECHNICAL ASSISTANCE

(83) The scope of the Emergency Management System Study focuses on railway accident and emergency situations management, although safety aspects are also related to emergency management.
The railway sector has a long tradition in the definition of both safety and emergency constraints and rules. As shown in the exhibit below, within the railway emergency management scope, events or perturbations are classified in three types depending on the level of seriousness. The normal operation and incidents of lower level of seriousness are related with safety elements and are usually solved internally, by the railway companies or railway infrastructure administrations. Accidents and crises of a high level of severity are related with emergency management elements and are usually solved with the intervention, not only of the railway companies’ resources, but also of external resources.


<table>
<thead>
<tr>
<th>Situation seriousness</th>
<th>Normal</th>
<th>Incident</th>
<th>Accident</th>
<th>Crisis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Situation under control</td>
<td>Limited impact on traffic operation</td>
<td>Unexpected / unknown situation, threat for people, equipment</td>
<td>Traffic operation interrupted</td>
<td></td>
</tr>
<tr>
<td>Management</td>
<td>Internal</td>
<td>Internal &amp; external</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Focus</td>
<td>Safety</td>
<td>Emergency management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Risk reduction by an interactive process of risk analysis and prevention:</td>
<td>- Threats/ hazards identification</td>
<td>- Includes two processes: emergency response and recovery</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Continuous Risk assessment (identification, analysis and evaluation) considering probability and impact/ consequences</td>
<td>- Both must be planned and organized in advance in the emergency preparedness process</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Preventive measures definitions/ Safety procedures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Equipment maintenance &amp; monitoring</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Consultants analysis.

(84) The three types of perturbation of railway operations considered in the exhibit are defined as follows:

- **Incidents**: situations in which the normal use of railways is affected in terms of service to the client, and which has a main cause that is related to the technical means of the railway company (a collision, an electrical power failure, derailment, etc.). Incidents are likely to be resolved by the railway company using their own resources. The probable cause of appearance of incidents is internal to the railway companies.

- **Accidents**: incidents in which a variable number of people or assets (to stock, track, other installations or environment) are affected. Minor accidents are normally fairly good protocolised and can be resolved within hours, while significant accidents (that is, accidents resulting in at least one dead or seriously injured, or in significant damage to assets, or extensive disruptions to traffic) require the involvement of external parties during response (health assistance, fire brigades or the police department).

- **Crises**: situations that have a deep impact not only on the railway company but also on people or on other assets. Usually Emergency Management involves the participation of Governmental organisations and the railway company, and the origin can be external to the railway company (floods, earthquakes, typhoons, terrorism, etc.) or internal (great train crashes, fire in tunnel, etc.).
1.4 STRUCTURE OF THE FINAL REPORT

(85) Following the introductory chapter of the report (Chapter 1), the Final Report is structured in four main chapters. Chapter 2 summarises the remarkable information about the railway Emergency Management systems in reference countries according to the data collected while preparing the Interim Report. Chapter 3 is a comparison between practices mentioned in Chapter 2 and those of the PRC railways related to railway emergency management. Chapter 4 presents a list of recommendations that should guide the PRC Railway Sector in the task of achieving an efficient and effective emergency management system for PRC railways. The last Chapter, number 5, summarises the recommendations and associated actions into an Action Plan.

1.5 ACKNOWLEDGEMENTS

(86) The team is grateful to the officials of the MOR Emergency Management Office for their support in the stages of the project.

(87) The Consultants would also like to thank for their collaboration as well as for the information provided to consultants to the following organisations:

• SNCF
• Siemens AG
• ADIF
• Renfe
• INDRA
• FRA
• RTRI
• JR East
• KRRI
• Korail.
• Thales Group
• Indra Sistemas
• Siemens IT
2. ANALYSIS OF REFERENCE COUNTRIES

(88) The present chapter intends to summarise the international models of railway emergency management systems presented in the Interim Report regarding the different aspects of this study (legal and regulatory, institutional, emergency management procedures and network communications and information systems). Consultants bring out the most significant practices among all the practices presented in the Interim Report.

2.1 LEGAL & REGULATORY

(89) The Legal and regulatory framework regarding railway emergencies in the reference countries is classified into two areas; civil protection and railway sector at national and provincial levels, since railway emergency management is a shared responsibility by governments and state owned organisations as well as by railway companies.

(90) Civil protection laws rule the managing of any type of emergency (including those from railways); while railway sector laws include guidelines for establishing safety systems, investigation procedures and traffic interruption plans in compliance with general emergency plans.

2.1.1 CIVIL PROTECTION

(91) In the civil protection-field, all the countries have a general law that rules at national level and which includes principles for the physical protection of people and goods in risk events, guidelines for preparedness (e.g. training courses, rehearsing evacuation plans, etc.), responses in emergencies. In the case of Spain, Korea and Japan, there are specific laws concerning specific type of risks. For instance, Japan has 21 hazard-specific acts like the Act on Special Measures for Large-scale Earthquakes. Moreover, in some cases, the laws reach a level of detail that present content structures for emergency plans, like France, Spain and USA.

(92) As a general rule, the legislations establish that responsibility emergency management must be at provincial level due to the emergency management principle indicating that disasters should be managed as close as possible to the place where accidents have occurred. At provincial level, in general, emergency plans are developed and, depending on the case, implemented in compliance with national legislations.

(93) In terms of scope, civil protection regulations include, among others:

• Definition of roles and responsibilities (e.g. in France, mostly police and fire departments).
• Risk assessment for potential hazards.
• Definition of procedures for implementing emergency plans.
• Delimitation of operations scope by geographic areas.
• Standards to ensure interoperability of wireless communication networks.
• Creation of operation centres.

(94) In particular with emergency plans, these laws require governments or companies to develop general emergency plans or plans for different geographical areas, zones (e.g. maritime zones) or sectors (e.g. chemical industry, railway sector, dams), as well as emergency plans for specific risks. In some cases, it includes their basic content like in France, Spain and USA. In the case of Japan, The Central Disaster Management Council, directed by the Prime Minister, the Minister of State for Disaster Management and heads of relevant public corporations formulates The Disaster Management Basic Plan is the master plan and the basis for disaster reduction activities, which consists of several plans for each type of disaster. It contemplates countermeasures for natural disasters (earthquake, storm and flood, volcanic activities and snow) and accidents (maritime, aviation, railroad, road, nuclear, hazardous materials, large-scale fire and forest fire) with regard to the preparation, emergency response, recovery and reconstruction emergency phases. It also contemplates duties assigned to the government, public corporations and the local government for implementing disaster management measures.

(95) In general, laws establish duties and responsibilities for the Ministries of Home Affairs, regional authorities, police and fire departments. For instance in Spain, the main functions of the ministry include elaboration of the basic law for civil protection, the national catalogue with the mobility resources for emergencies and intervention plans, supervision and coordination of the intervention plan executions and of the army and police departments intervention request when necessary.
Regarding the emergency management organisations, some countries present governmental agencies and non-governmental organisations specialised in these functions, such as the Academy of Emergency Planning and Civil Defence Private in Germany. In general, the government departments that lead development of emergency plans and supervise their implementation by province/local governments and services are organisations under Ministries of Home Affairs like:

- Civil Security Department (Direction de la Sécurité Civile, DSC) in France.
- Federal Office of Civil Protection and Disaster Assistance (Das Bundesamt für Bevölkerungsschutz und Katastrophenhilfe, BBK) in Germany.
- Civil Protection and Emergencies Department (CPE) in Spain.
- Fire and Disaster Management Agency (FDMA) in Japan.
- National Emergency Management Agency (NEMA) in Korea.
- Federal Emergency Management Agency (FEMA) in the USA.

### Railways

In the case of the railway sector, the scope of the laws covers safety requirements, investigation rules, traffic interruption plans as well as the establishment of an authoritative safety authority and investigation body. In particular they contemplate the following:

- **Safety targets**: safety levels that must at least be reached by different parts of the rail system (such as the conventional rail system, the high-speed rail system, long railway tunnels or lines solely used for freight transport) and by the system as a whole, expressed in risk acceptance criteria.
- **Safety indicators**: with the purpose to facilitate the assessment of the achieved safety targets and to support the monitoring of the development of railway safety. They can be related to:
  - Accidents (e.g. collisions of trains or fires in rolling stock), total and relative to train kilometres, number of persons injured and killed by type of accident.
  - Incidents (number of signals passed at danger).
  - Consequences of accidents (compensation for loss of or damage to property of passengers, staff or third parties).
  - Technical safety of infrastructure and its implementation (Percentage of level crossings with automatic or manual protection).
  - Management of safety (number of internal audits).
- **Safety certifications**: to grant access to railway infrastructure for railway companies that fulfil safety requirements.
- **Personnel qualifications standards**: for hiring railway personnel.
- **Accident/incidents rules and investigation procedures**: processes conducted for the purpose of accident and incident prevention; which includes the gathering and analysis of information, the drawing of conclusions, including the determination of causes and, when appropriate, the making of safety recommendations.
- **Requirements for safety management systems/plans**: which are the organisation and arrangements established by an infrastructure manager or a railway operator to ensure the safe management of its operations.
- **Railway emergency preparedness and response plans**: in case of traffic perturbation in compliance with generic emergency plans (i.e. to include activation of national/regional generic plans depending of the emergency level).
- **Reporting safety activities and achievements**: as well as accidents/incidents, investigation findings and safety recommendations.
- **Creation of a safety authority**: national body entrusted with the tasks regarding railway safety.
- **Creation of an investigation body**: responsible for the organisation, management and control of an investigation, working in an autonomous way.

In general, all countries’ legislations contemplate duties for a Ministry of Transport or Public Works and its railway departments and autonomous accident investigation bodies by regulating railway safety aspects and establishing guidelines for railway infrastructure administration, railway operators and other companies. For example in France, the law contemplates the creation of the National Safety Authority (Établissement Public de Sécurité Ferroviaire, EPSF) under the supervision of the Ministry of Transport and produces, among other functions, safety certifications for railway operators.

---

1 The railway legislation scope definitions based on examples of European railway legislations.
Regarding railway emergency plans for traffic perturbation, legislations contemplate their development and implementation by different organisations depending on the country’s legal system. For example, in France, the infrastructure administration has delegated this responsibility, among many others, to the main operator (SNCF). In Spain, the infrastructure administration is in charge of the plan definition with the ministry’s approval. In these two cases, railway companies shall collaborate with their own resources. In Korea and the USA, railway companies develop this duty with the railway authority’s approval. For instance in Korea, the Ministry of Land, Transport and Maritime Affairs (MLTM), who develops a Railway Safety Plan every 5 years, approves the definition of emergency response plans within the Safety Plan, supervises their implementations and evaluates the performances of drills submitted by operators, etc. In the USA, any railway company should have a written emergency plan approved by the Federal Railroad Administration (FRA).

Finally, regarding accident investigations, legislations contemplate guidelines for accident or incident survey techniques, accident research general procedures (i.e. implementing measures in the accident zone in order to begin investigations), definitions of accidents and incidents, the minimum content for reporting and the creation of investigation bodies. In general, there are investigation bodies (under ministries of transports supervision) which should preserve their autonomy in technical investigations of accidents. In the case of Japan and Korea, there is an authority in charge of investigating any type of accident. In Korea, The Act on The Investigation into Aviation and Railroad Accidents amended as of February 29th 2008, concerns aviation and railroad accidents investigation activities and procedures through the creation of the Aviation and Railroad Accidents Investigation Committee, which is supervised by the Ministry of Land, Transport and Maritime Affairs (The MLTM).

In general, railway emergency management is led in the civil protection-field while railway organisations coordinate and give support with their own resources.

### 2.2 INSTITUTIONAL

#### 2.2.1 REGULATING AGENCIES - SAFETY AND ACCIDENT INVESTIGATION

Different national and regional organizations collaborate in regulating and surveying the proper operation of the railway sector in each country, as shown in the table below. Although there may be some structural differences, the main tasks developed to ensure such proper operation of the railway industry are common to all of them:

- Legal regulation
- Operating authorisation
- Guarantee of diversity of supply
- Safety recommendations
- Accident investigation

The main institutional difference between Europe and the rest of the analysed countries is the regulation of non-discriminatory access of railway operators to the railway network infrastructures. European regulations impose the state-owned railway infrastructure administrations to allow every authorised railway company to operate their lines. National specific organizations are in charge of watching over the compliance of free competition laws. However, in the United States and Japan each company administrates and operates its own infrastructure and is not required to let other companies to operate rail transport on their tracks. In Korea, the railway sector has also been separated from the government, but today only one operator company monopolise the operation of the tracks of the national railway authority (another company is in charge of subway lines).

**Safety Bodies**

In France, the National Safety Authority (Établissement Public de Sécurité Ferroviaire, EPSF) acts on behalf of the Ministry of Transport, and within the framework of national regulations in line with European Directive 2004/49/EC. In creating EPSF, the French State satisfied the need for an organisation with the required rail safety competences that was also independent of railway operators. Its main functions are issuing and delivering safety certificates; publishing audit regulation and its agenda; creating a database for incidents and developing safety indicators; defining public technical conditions and rules related to railway safety and elaborating an annual report related to railway transport safety.
In Germany, the Federal Railway Authority (EBA) is responsible for the ‘supervision’ and ‘authorisation’ in the rail sector. Its main tasks focus on technical issues such as the responsibility for licensing railway companies, control of the safety of technical equipment or issues related to infrastructure planning and financing. As the state finances the railways infrastructure, the EBA grants and supervises the State contributions for infrastructure investment in infrastructure of railway infrastructure companies owned by the Federal Republic of Germany.

In Spain, the General Directorate of Railways is a management body under the Ministry of Public Works, which depends on the Secretariat of State for Infrastructure. It is responsible for preparation, monitoring, supervision and inspection of operational planning of railway infrastructure and the corresponding railway plans, validating safety methods and safety objectives and approving training centres for railway staff, among others.

In Japan, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) was established as part of the administrative reforms of January 6, 2001, which merged the Ministry of Transport, Ministry of Construction, Hokkaido Development Agency and the National Land Agency. It is in charge of Japanese railway legislation and safety supervision.

In Korea, the Ministry of Land, Transport and Maritime Affairs (MLTM) defines railway budgets, policies, targets, safety case policies, safety plans and standards concerning railway transportation. In terms of emergency management, the MLTM enact laws to operate in compliance with defined safety commitments such as the Railroad Safety Act, Disaster and Safety Management Act and Fire Act.

In the USA, the Federal Railroad Administration (FRA) was created by the U.S. Department of Transportation with the purpose, among others, of promulgating and enforcing rail safety regulations, administering railway assistance programs, conducting research and development for supporting improved railway safety and national rail transportation policy, and consolidating government support for rail transportation activities.

**Investigation bodies**

In France, The Land Transport Accident Investigation Bureau (Bureau d’Enquêtes sur les Accidents de Transport Terrestre, BEA-TT) is in charge of accident investigations. In the event of such accidents, a two-phased investigation approach is required: a judiciary inquiry to identify liabilities and, if necessary, to determine compensations for the victims, and a technical investigation to prevent similar occurrences.

In Germany, it is also EBA who ensures that the investigation of dangerous incidents is conducted objectively and autonomously of any internal or external organization. In this respect, it has been particularly useful for EBA to rely on its own team of trained specialists, which has eliminated the need to depend on railway employees’ assistance.

In Spain, the Committee for the Investigation of Railway Accidents is a specialised Professional Association affiliated to the Ministry of Public Works through the Secretariat of State for Infrastructure and is regulated by the Decree RD 810/2007. It performs its activities in a transparent, non-discriminatory manner, independently of the Directorate-General of Railways, ADIF, and any railway undertaking, notified or certifying body, or the Railway Regulating Committee. The Committee for the Investigation of Railway Accidents shall establish the scope and procedures to be followed in each railway accident investigation and carry out the investigations.

In Japan, the Japan Transport Safety Board was established by integrating the Japan Marine Accident Inquiry Agency (JMAIA) and the Aircraft and Railway Accidents Investigation Commission (ARAIC) on 01.10.2008, in order to enhance and combine investigation capacities for dealing with the causes of aircraft, marine and railway accidents/incidents and to prevent their recurrences. The JTSB conducts investigations to determine the causes of aircraft, marine and railway accidents, serious incidents and damage caused by them. Based on the findings of the investigations, the JTSB provides recommendations or opinions to relevant ministers or parties involved, concerning the measures to be taken to prevent accidents/incidents and to mitigate damage caused by accidents.

In Korea, the Aircraft and Railway Accidents Investigation Board (ARAIB) is part of the MLTM and is in charge of railway accidents investigation. It works in close cooperation with other national railway organisations to perform other functions like construction of preliminary traffic control centre for...
emergency response, establishment of security and terror response system and advertisement on emergency response.

(115) In the USA, the National Transportation Safety Board (NTSB) is a governmental investigative agency responsible for civil transportation accident investigation. In this role, the NTSB investigates and reports on aviation accidents and incidents, certain types of highway crashes, ship and marine accidents, pipeline incidents, railway and railway accidents when requested.

(116) All the organisations mentioned in this section are summarised in the following exhibit:

<table>
<thead>
<tr>
<th>Field</th>
<th>France</th>
<th>Germany</th>
<th>Spain</th>
<th>Japan</th>
<th>Korea</th>
<th>USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil protection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Legal Regulation</td>
<td>Ministry of Home Affairs</td>
<td>Federal Ministry of Home Affairs</td>
<td>Ministry of Home Affairs</td>
<td>Central Disaster Prevention Council including Minister of State for Disaster Management</td>
<td>Ministry of Public Administration and Security (MOPAS)</td>
<td>Department of Homeland Security</td>
</tr>
<tr>
<td>National emergency agency</td>
<td>DSC</td>
<td>BBK and THW</td>
<td>NA</td>
<td>FDMA</td>
<td>NEMA</td>
<td>FEMA</td>
</tr>
<tr>
<td>Railways</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating authorization</td>
<td>EPSF</td>
<td>EBA</td>
<td>Public Works Ministry</td>
<td>Ministry of Land, Infrastructure, Transport and Tourism (MLIT)</td>
<td>MLTM</td>
<td>FRA</td>
</tr>
<tr>
<td>Guarantee of diversity of transport service supply</td>
<td>MCAF</td>
<td>Cross-sectorial Regulatory Body and BKartA</td>
<td>Railway Regulation Committee</td>
<td>Information not available</td>
<td>Information not available</td>
<td>Not applies</td>
</tr>
<tr>
<td>Safety recommendations</td>
<td>EPSF</td>
<td>EBA</td>
<td>Railway Traffic Safety Advisory Committee</td>
<td>JTSB</td>
<td>KRRI</td>
<td>AAR</td>
</tr>
<tr>
<td>Accident investigation</td>
<td>BEA-TT</td>
<td>EBA</td>
<td>Committee for Investigation of Railway Accidents</td>
<td>JTSB</td>
<td>ARAIB</td>
<td>NTBS</td>
</tr>
</tbody>
</table>

Source: Consultants analysis.

2.2.2 COORDINATION WITH EXTERNAL AGENCIES. ROLES AND RESPONSIBILITIES.

(117) As a general rule in the countries of analysis, railway emergencies are solved by the same governmental emergency agencies that manage any type of emergencies. Although they try to manage the emergency by themselves when possible, the role of the railway companies during the response phase is usually to collaborate with these external agencies coordinating internal and external resources and providing support through track and rolling stock relief technical resources when necessary. These external emergency agencies are the fire brigades, the health services, the police, and other
governmental or volunteers’ organizations such as Red Cross, high mountain expert brigades, volunteer fire-fighters, etc. It is remarkable that volunteers in the reference countries (USA and Europe) are structured associations of qualified people, trained and organized in a similar way than official emergency agencies. The participation of all these agencies in railway emergency response is defined in the emergency plans, where the written agreements between the railway companies and the government in charge of these agencies and resources are defined. When an emergency is detected, the corresponding plan is activated, and therefore all the resources included in the emergency plan are ready to be mobilised. Usually, these emergency agencies have their own transport means, and the railway company has to transport them only in very specific situations (e.g. in a tunnel).

(118) Other organizations with which railway companies of the reference countries establish relationships regarding emergency management are climate agencies and insurance companies. As it is explained later in the 2.3.3 Natural Disaster Management chapter, during the preparedness phase, railway authorities establish written agreements with national climate agencies defining the protocols to receive periodic climate bulletins in normal situation and special bulletin during pre-alert or alert situations. Regarding the interaction with insurance companies, in the reference countries every train ticket (and in general any ticket of any mean of transport) involves a compulsory travel insurance. This insurance cost is included in the price of the ticket when the passengers acquire it and permit them to claim for compensations after incidents or accidents. Any passenger travelling without ticket will not have the right to be compensated after such type of situation.

(119) With regard to Europe, the emergency situations are basically managed by organizations depending on the national or provincial governments. The 112-emergency telephone number is the number used across Europe to communicate the event of an emergency, including the railway incidents. The 112 centres, usually at regional level, that receive the emergency call coordinate the deployment of the different rescue services involved.

(120) In the United States the main organizations for emergency management are the state or the county governments. They define their emergency plans in accordance with the railway company which operates within their geographical situation. There is a key emergency organization which is the one related to 911 emergency centres.

(121) In Japan and Korea, rescue and health services are managed from the 119 centres that receive and dispatch the emergency calls. Police can also be advised through 110/112 numbers respectively. The 119 organization provide emergency services at national level in both countries, but their centres can be provincial, or local.
Exhibit 8. Agents involved and roles during railway emergency response in the reference countries.

<table>
<thead>
<tr>
<th>Responsibility</th>
<th>France</th>
<th>Germany</th>
<th>Spain</th>
<th>Japan</th>
<th>Korea</th>
<th>USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall emergency management</td>
<td>Regional Centres of Fire and Rescue (CODIS)</td>
<td>The Mayor of the city or upper authority (länder or national) responsible of national rescue services</td>
<td>The provincial Authority responsible for the provincial rescue services (112 service)</td>
<td>The provincial Authority responsible for the provincial rescue services (119/110)</td>
<td>Korail or national/provincial/local authority responsible for the rescue services (119/112)</td>
<td>Railway company or national/state/local authority responsible of rescue services</td>
</tr>
<tr>
<td>Railway on-site responsible</td>
<td>Chief of local incident (CIL), appointed by SNCF.</td>
<td>Emergency Manager appointed by the Emergency Management Centre of the area</td>
<td>Delegate Chief who is already in the kilometic point, normally the driver</td>
<td>Director of the nearest main station</td>
<td>Korail staff placed in the kilometic point, normally the driver.</td>
<td>Incident Commander</td>
</tr>
<tr>
<td>Rescue &amp; medical relief actions</td>
<td>State fire, rescue and health services mobilized by the 112 service</td>
<td>State fire, rescue and health services mobilized by the 112 service</td>
<td>State fire, rescue and health services mobilized by the 112 service</td>
<td>State fire, rescue and health services mobilized by the 110 and 119 services</td>
<td>State fire, rescue and health services mobilized by the 112 and 119 services</td>
<td>State fire, rescue and health services mobilized by the 911 service</td>
</tr>
<tr>
<td>Track relief and zone securization</td>
<td>SNCF maintenance department</td>
<td>DB maintenance department. Fire brigades collaborate in power supply cut-off</td>
<td>ADIF maintenance in collaboration with Renfe</td>
<td>JR zone securization. For relief tasks and technical resource external companies are contracted</td>
<td>Korail technical resources</td>
<td>AMTRAK maintenance department</td>
</tr>
</tbody>
</table>

Source: railway companies’ web sites; meetings with companies.

(122) In general, in case of emergency, the coordination of railway companies or infrastructure administrations with governmental emergency agencies is made between the emergency management centres (EMC) of these agencies (usually regional 112/911/119 centres) and the regional railway centres (specific emergency centres of traffic control centres) of the railway authorities. These centres are the common platform from which different emergency agencies or services are coordinated to solve the emergency. Sometimes, when the railway emergency involves several railway regional centres or when it exceeds capabilities of these regional centres, they may be supported by the national railway centre. Through this coordination, the emergency agency obtains all the information needed from the railway authorities to decide the type and number of resources to mobilise including fire brigades, police and ambulances among others. Both centres exchange information related to other actions to coordinate, such as the zone securing, catenary earthing, technical resources mobilisation, etc. All EMCs count with crisis cabinets or crisis rooms where, in case of emergency, the representatives from each agency or railway department must be present, as stated in the emergency plan. When agencies or departments that are not included in the common platform of the EMCs are required, the responsible for the crisis cabinet is in charge of contacting and coordinating with these agencies.

(123) The responsibility of the emergency management or response has been, as general rule, delegated by the corresponding ministries in charge, to the regional authorities. These develop the emergency management through the mentioned EMC of their emergency agencies. The communication between the emergency managers of the agencies with the local authorities, governments and ministries is made from the EMCs.

(124) Both railway and governmental emergency centres obtain information about the situation on the place of the incident from their respective staff mobilised on field. The in situ railway companies’ incident manager is in charge of the railway technical and human resources. This person coordinates them in order to secure the zone and to give all the support that the external rescue and relief resources may need to perform their activities easily and in a safe way. The external emergency services have also own command figures (fire brigade major, police officer, etc.) to coordinate their respective resources. These persons command their resources but also coordinate with the railway companies’ on-field incident
manager. On field, there is usually a meeting and operation point from where the incident manager develops all its tasks and where any group of external resources can meet the on-field incident manager when they arrive. In some cases, this is just a tent, with a visible element such as a balloon with the “Incident Manager” indication on it. It is important that any resource arriving to the place of the emergency knows who the overall coordinator is; as well as it is important that the on-field incident manager knows any new resource that gets there. The Incident Manager has usually a vehicle to move through the incident area, equipped with communication technology, which permits to maintain the communication with the rest of the agents.

(125) In general, the Incident Manager should coordinate the following actions developed by different groups of work:
- Medical assistance
- Rescue and relief
- Communications
- On-field signalling
- Access control to the zone
- Train technical relief actions
- Data gathering for propaganda and media

(126) The on field responsible is also supposed to report all the information about emergency situation and response progress to their respective superior officer in the corresponding centre.

(127) Finally, in case of serious emergencies, the railway companies are usually in charge to inform about it to the Ministry of Transports while the emergency agencies’ centres are usually attached to the Ministries of Home Affairs of the different countries, to which they report information about the railway emergency resolution. Commonly, these and other ministries that may be involved, such as the Environmental Ministry, the Health Ministry, etc. are also informed.

(128) The coordination protocols of the reference countries concerning communication between railway companies and external emergency services and authorities correspond with the following scheme:

Source: Consultants analysis.

2.3 EMERGENCY MANAGEMENT

(129) This section reviews the main elements of emergency management in reference countries, analysing existing policies, organization, capacities and procedures present in the emergency management cycle: mitigation, preparedness, response and recovery. The emergency management
cycle starts with the preparedness phase, which involves adapting the organization in order to prepare it to give an efficient response to emergencies and to achieve fast and effective restoration. The preparedness phase includes the definition of emergency plans, emergency management organization, capacities (personnel, centres, technical resources) and training programs.

(130) The response phase involves the response procedures followed by the railway organizations when an emergency occurs. In the reference countries, these procedures, described in the emergency plans, consist on collaborating with the rescue and relief services and ensuring these services to work in safe conditions.

(131) Recovery phase begins once rescue and relief services have finished their works, and the emergency is solved. In this phase, the railway organizations of the reference countries develop traffic restoration and infrastructure recovery works. Also at this stage, the emergency is analysed by the railway emergency investigation bodies to understand the causes of the emergency and to obtain feedback that may permit to revise the preparedness and safety measures if necessary.

Exhibit 10. Phases of the emergency management

Source: Consultants analysis.

2.3.1 RISK ANALYSIS. INCIDENT CLASSIFICATION

(132) As explained in the legal chapter, governments entitle railway companies (as they do with other industrial sectors) to develop general emergency plans which define procedures and protocols common to all type of railway emergencies. However, railway companies also develop special emergency plans for specific risks of different lines or geographical regions and procedures for incidents of lower severity. While procedures describe how to solve incidents by following a detailed list of indications (generally internally), general emergency plans give global indications and considerations and specific plans describe, with more level of detail, the procedures to be followed in certain type of incidents including the coordination agreements with external agencies.

(133) In order to define these specific emergency procedures, railway companies of the reference countries develop an analysis of the specific sectorial or sector-geographical risks that menace railway operation. Based on previous emergency experiences, their consequences, periodicity and other factors, railway companies identify and typify the probable local risks that usually result in railway emergencies in determined lines or areas or in the whole railway network. As shown in the following exhibit, this risk analysis becomes not only the basis for the different incident classification and corresponding specific procedures or plans managed by the railway companies, but also determine the safety systems to be developed in different lines or areas of the network in order to face up these risks and their possible consequences.

(134) When a risk is identified, the first step is to set safety systems to avoid that the risk becomes a real event. Sometimes safety systems are not enough to avoid this event (e.g.: in case of risk of heavy rainfalls, or in case of risk of earthquake); in these cases, the objective of safety systems is to try that the event results in an incident (which can be easily solved internally by the railway company) instead of resulting in an emergency (when probably external emergency resources will be needed).
The Incident classification obtained as result of the risk analysis is the basis to determine specific emergency response procedures and resources and personnel mobilisation requirements and protocols. Classification criteria vary from country to country. While some countries consider immediate consequences, on-field conditions and seriousness, others consider the cause and origin of the incident and some others combine both types of classification. The most accurate incident classification in found in Korea, where a more complex and exhaustive classification, including cause, seriousness, type of traffic and location, is considered. The classification results in a series of codes for each type of emergency that can apply to each type of railway line.

Most of the studied railway companies complement this Incident Classification with a classification of levels of severity. Levels of severity indicate the extent of the emergency and give an idea of the resources that will be needed to solve it. Incidents of low levels are easily solved internally while incidents of high severity generally need to be solved in coordination with external emergency agencies. The criteria used to assign the level of severity also vary in different countries. In Spain for example, it is based on the combination of 5 risks, that result in 9 levels of severity:

- S1: Risk for people’s lives. When the incident has caused or may cause casualties.
- S2: Environmental risks. When the incident has resulted or may result in damage to the environment.
- S3: Risk for goods
- S4: Risk of train delays
- S5: Information about incident without specific risk

In Korea the level of severity is associated with the personnel required to solve the incident or emergency:

- The lower levels should correspond with those incidents that can be solved by passengers, by staff at the station or by the driver.
- An intermediate level of seriousness may correspond with emergencies that require the intervention of railway companies' own emergency resources such as own fire brigades or rescue personnel.
- Higher levels would correspond to emergencies that require a national management at MOR level with the coordination of other ministries, hospitals, etc.

To summarise, a good incident classification is based on a previous risk analysis and should contemplate the combination of several aspects of the railway emergency, which involve a more accurate classification that considers different circumstances and permits to assign more specific and appropriate procedures to solve it instead of using general ones. In addition, this incident classification is usually complemented with a level of seriousness classification, which indicates if the incident can be solved with internal railway companies’ resources or if external emergency resources are needed.
2.3.2 EMERGENCY PLANS

(139) Emergency plans are a key element of the preparedness phase of the emergency management cycle. In the reference countries, these plans, which describe how to solve any emergency that may affect the railway traffic, are distributed between all people and departments concerned of the railway companies or infrastructure administration, to fix common procedures and coordination protocols to face emergencies. The main objectives of the railway emergency plans are:

- Minimization of incident consequences
- Restoration of operating conditions
- Identification of risks in railway traffic operation
- Control of technical resources
- Definition of procedures for each type of incident

(140) In France, the order dated August 12, 2008 in application of the decree no 2006-1279 on National Railway Security defines the general contents and the updating requirements of the Intervention and Security Plans, which should be defined at Prefecture Level and updated every 5 years if any specific modification need is not detected before. SNCF, the French delegate infrastructure administration, should define these plans at a regional level with the collaboration of the railway administration (RFF) and the corresponding Prefecture (regional administration). It is also the Prefecture who validates the plans.

(141) In Germany, the General Railways Law (Allgemeines Eisenbahngesetz) requires railway infrastructure administrations and railway companies to construct and operate in a secure manner, prevent risks, participate in emergency response and investigate incidents when they occur. With this aim, the infrastructure administrator Deutsche Bahn (DB) defines emergency plans, which include the guidelines, roles and coordination protocols to be considered in case of emergency. DB develops these plans by itself, however the emergency services or the Bundesländer (states) are taken into account during the development of such plans.

(142) The Spanish Railway Sector Law of 2003 states that the Railway Infrastructure Administration (ADIF) should define an Emergency Plan at national level to determine the measures to be taken in case of railway emergency. ADIF takes into account the coordination with the railway operators (especially with RENFE) and with the national emergency services. This plan, which should be updated every 2 years, should be approved by the Ministry of Public Works.

(143) Japanese government does not specify requirements to railway authorities with respect to emergency plan definition, as long as they ensure a safe railway operation. However, JR Group does define manuals that contain groups of guidelines to be followed in case of railway emergency. The national/regional police, fire brigades and medical services are considered during the definition of these manuals, in order to include into these guidelines the coordination protocols with these agencies in case of emergency. Since these manuals are not requested by law, they do not need to be approved by any governmental body, and no periodicity is either fixed regarding their updating.

(144) In the case of Korea, the Ministry of Land Transport and Maritime Affairs (MLTM) is especially involved in the supervision of railway emergency plans’ approval and implementation. Complying with the Railway Safety Act of 2004, the MLTM (in collaboration with the railway companies, the infrastructure administration, and other Korean railway agencies) defines a Railway Safety Plan every 5 years, which should be implemented by the railway operators. The implementation of this safety plan by the railway operators includes the definition of emergency plans, training programs and standard operation procedures (SOP) among others and it is supervised annually by the MLTM.

(145) In the United States, the 49 code of the Federal Regulation 239.101 of October 2008 establishes the minimum content of the emergency plans that the railway operators should define, adopt and implement. The contents of the North American railway emergency plans are similar to the ones identified in the rest of the studied countries and coordination with fire services, emergency medical services and police is also considered in their definition. These plans are revised by the Federal Railroad Administration (FRA) for their approval.
The following exhibit summarises the railway emergency plans developed in the reference countries, the parties responsible for their development and approval, the periodicity and the related regulation:

Exhibit 12. Definition of Parties involved in emergency plans

<table>
<thead>
<tr>
<th>Country</th>
<th>Regulatory environment</th>
<th>Railway entities</th>
<th>Other entities</th>
<th>Validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>• Order August 12, 2008 applying Decree nº 2006-1279 on National Railway Security (Ministry of Transport) defines content and updating requirements of Intervention and security plans (PIS)</td>
<td>• Infrastructure manager (railway, stations)</td>
<td>Federal I Regional government</td>
<td>5 years</td>
</tr>
<tr>
<td></td>
<td>• SNCF defines emergency plans at prefecture level</td>
<td>• RFF collaborates in emergency plan definition</td>
<td>• Prefectures collaborate in emergency plan definition</td>
<td>5 years</td>
</tr>
<tr>
<td>Germany</td>
<td>• Civil Defence Act of 1997 civil defence law delegates emergency planning and operational preparation in peace time entirely to the Länder and their structures</td>
<td>DB AG Defines emergency plan</td>
<td>Bundesländer collaborates with DB in definition, procedures, responsibilities</td>
<td>NA</td>
</tr>
<tr>
<td>Spain</td>
<td>• Royal Decree 2387/2004 develops Law 39/2003 of Railway sector Regulation, by defining that Railway Infr. Manager will develop Contingency Plan</td>
<td>• ADIF defines emergency plan</td>
<td>RENFE collaborates</td>
<td>2 years</td>
</tr>
<tr>
<td>Japan</td>
<td>• Railway safety act 2004 defined by Ministry of Transport (MLTM), states that a comprehensive safety plan shall be defined every 5 years and annually implemented</td>
<td>Japan Railways (East, West, North South Railways) collaborate in the emergency plan</td>
<td>• The MLTM defines the Railway safety plan</td>
<td>5 years</td>
</tr>
<tr>
<td>Korea</td>
<td>• Does not participate</td>
<td>• Safety plan implementation</td>
<td></td>
<td>1 year</td>
</tr>
<tr>
<td>USA</td>
<td>• 49 code of Federal Regulations 239 sets up the obligation to Railway players of adopting and implementing an EMS</td>
<td>AMTRAK Defines emergency plan</td>
<td>• Federal Railway Administration</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Department of Transportation</td>
<td></td>
</tr>
</tbody>
</table>

Source: Railway organisations web sites and interviews.

As a general rule in the reference countries, railway companies or railway infrastructure administrations are required by governmental bodies to define railway emergency response procedures and coordination protocols through railway emergency plans. Usually these governmental bodies, at national or provincial level, are also in charge of the approval of the plans. While some governments, like in Germany or in Japan, only require railway companies to ensure a safe operation without other specific constraints, others participate more actively in the emergency plans preparation indicating the contents to be included (in France) or validating the plans (France, Spain, Germany, and Korea). The best practice is found in Korea, where the MLTM, supported by other railway organizations such as KRRI, not only requires and surveys the emergency plan definition, but also develops a whole Railway Safety Plan that should be implemented by railway companies through preparing emergency plans and defining training programs among others. The close collaboration of the government in the definition of railway emergency plan results in a more elaborated model and better defined response procedures and ensures that the railway companies fulfil the desirable emergency preparedness constraints.

As explained before, these plans are based on the sectorial or sector-geographical risk analysis developed by the railway companies. As shown in the following exhibit, the risks analysis provides the incident classification, but permits also to define the following aspects of the contents of the emergency plans:

- Who will be susceptible of being affected by such risks.
- How these risks could be avoided through preventive methods.
- Which agents will be in charge of solving the incident/emergency.
- When the risk becomes real.
- Which would be the resources used by these agents.
(149) These are the basic contents of the emergency plans, although other issues are also considered in reference countries’ railway emergency plans such as training programs, prudent operation common indications, alternative traffic plan development, level of seriousness classification, basic measures for zone securing, technical resources inventory, compensation policies, etc.

(150) External emergency agents, such as national/provincial emergency and rescue resources, which are often involved in the response to certain railway emergencies, are commonly taken into account during the preparation of the plans. Plans include written agreements with governments and governmental agencies, which ensure that, in case of emergency, these agencies’ resources will be mobilised to participate in the response. The close cooperation with the national/provincial governments like in the case of Korea or France (where the Prefectures collaborate with SNCF in the plans definition), may also facilitate the definition of the coordination protocols with the national/provincial emergency agencies.

(151) As mentioned previously, general emergency plans should be completed with plans and procedures for specific risks such as natural disasters, hazardous goods transportation, terror attacks, etc. As a general rule in the studied countries, railway emergency plans are developed at a national level; however, in France, SNCF plans are defined by region, which permits to make a more accurate risk analysis considering local circumstances and infrastructure characteristics while in the countries where emergency plans are developed at national level the railway companies must take into account risks of the whole railway network to develop the specific emergency plans.

(152) Despite the fact that in some countries like Japan the validity of these documents is not defined, all the countries consider revising the plans anytime a failure in the procedures is detected, during a drill or after the occurrence of a real emergency. Among the countries where a periodic updating is considered, Spain is the most restrictive since the Ministry of Publics Works requires the infrastructure administration to revise the National Railway Emergency Plan every two years which ensures the quality and efficacy of the plan.

2.3.3 NATURAL DISASTERS MANAGEMENT

(153) In natural disaster management, railway companies consider actions mainly to stop or reduce the consequences of these Emergencies. In mitigation phase, a risk analysis is conducted to identify the geographical areas with identified risks. The preparedness phase includes two mains actions: First, the deployment of early warning and safety systems and second, climate information systems. The safety systems are mainly oriented to stop or modify the train operation procedures, if a climate alert is detected. (Response phase).
Climate information systems

(154) Once the local and specific climate risks associated with the corresponding geographical areas are identified, railway authorities, as well as governmental emergency agencies by region, must daily monitor and survey the climate conditions. It is usual to manage certain thresholds for rainfalls, snowfalls and winds, above which exists a real risk of having problems. These thresholds are normally defined by the Civil Protection or emergency agencies based on previous experiences.

(155) Some railway authorities, as well as the governmental emergency agencies, receive climate conditions reports from the national climate agencies through defined information protocols. In some cases, like SNCF, ADIF or the 112 centres in Spain, in normal conditions, the climate agencies send a daily climate report every morning usually by electronic mail or fax. This information is also available in the website of the climate agencies and can be consulted at any time by railway companies and emergency centres. When the possibility of suffering an adverse phenomenon is detected, climate agencies also report pre-alert or vigilance bulletins to the railway companies and emergency centres, through an information protocol defined for such cases. This protocol establishes the format of the information, the periodicity, the channels of information, the levels of alert, etc. In these cases, it is usual to receive the information every 10 hours.

(156) In addition, railway authorities often have their own climate information sources. For instance, ADIF, SNCF and Korail have deployed their own weather stations along their railway networks and SNCF have even earthquake detection systems in the Mediterranean area. Such systems may be considered safety systems and are therefore mentioned in the following section.

Early alert and safety systems

(157) Railway authorities are making investments to equip their infrastructures with early alert and safety systems that permit a rapid detection when a natural risk has become real. In Japan, strenuous efforts have been made to predict earthquakes, typhoons and other natural disasters as early as possible with the principle objective of ensuring the complete safety of railways, for example, by limiting train speeds or even stopping them. On the other hand, safety high-speed lines in Europe and Korea have incorporated meteorological equipment. The most remarkable early alert systems implemented are:

- Meteorological stations including anemometers and snowfall detectors.
- Wind speed meters.
- Wind break fences.
- Strong wind prediction by the Doppler radar.
- Landslide and rock falls detecting systems.
- Practical precipitation index analysis system for rain observation in Japan Railways.
- The Tokaido Shinkansen Earthquake Rapid Alarm System (TERRA-S).
- The Disaster Alarm System (PreDAS) in Japan Railways.
(158) **Meteorological stations including anemometers and snowfall detectors** are installed trackside in some high-speed lines in Europe and Japan.

Figure 1. Meteorological station including anemometer and snowfall detector in a high-speed line in Spain.

Source: Consultant.

(159) Korail have ten gale detectors, ten rainfall detectors and three snowfall detectors, which send automatic speed reduction or stop signals to the Korea Train eXpress (KTX) when thresholds are trespassed.

Figure 2. Korail gale detector.

Source: Korail.

(160) **Wind speed meters** are installed close to both tunnel entrances and exits and high viaducts in order to limit train speed in case wind speed exceed the defined secure limits.
In Japan Railways, anemometer data is transmitted to the Disaster Alarm System (PreDAS) which is later described in this chapter. If the wind speed measured by the anemometers along the lines reaches 25 m/s, Japan Railways normal regulation order to reduce the train speed; moreover, train operation is stopped when wind speed reaches 30 m/s. Furthermore, there are some sections defined as "early regulation" where train service is completely stopped in case wind speed is 25m/s. The next table shows speed regulation according to wind velocity.

<table>
<thead>
<tr>
<th>Wind velocity</th>
<th>Normal regulation</th>
<th>Early regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducing train speed</td>
<td>25 m/s to 30 m/s</td>
<td>20 m/s to 25 m/s</td>
</tr>
<tr>
<td>Stopping train operation</td>
<td>30 m/s or more</td>
<td>25 m/s or more</td>
</tr>
</tbody>
</table>

Wind break fences have been installed by Japan Railways in order to reduce the wind force on trains. A section where wind break fences have been installed becomes a "normal regulation section" although it is located at a zone of strong winds risk.

Strong wind prediction by the Doppler radar and its practical use for operation control have been developed by Japan Railway to observe extremely strong local wings that occur over small areas for short periods of time that are difficult to observe with conventional observation equipment such as anemometers. Therefore, the prediction of the local strong wind is based on the meteorological information and data from a local Doppler radar. Japan railways have set up several operation restriction zones based on strong wind hazard maps.
Landslide and rock falls detecting systems, developed in Japanese and Korean railways, are based on slant sensors supported by wires or fences. The first system adopted the combination of a slant sensor and a disconnection detection mechanism that detects the falling of a terminal. The second system adopted a disconnection detection method, using a cable with a weak part.

In Japan Railways, the disaster warning detected by the just previously described systems is transmitted to a driver via the Disaster Alarm System (PreDAS) which is later described in this chapter, or directly by special signal indicators at the spot.
The practical precipitation index analysis system for rain observation is used to evaluate the water in the ground that changes by seeping and flowing out as time goes in order to dispose a more appropriate train regulation due to rain. Three kinds of practical precipitation are considerate based on geological features, topography at the track or neighbouring place, and past disaster histories. Comparing with the former index, the hours of train operation stopped decreased to about 80% while the protection against disasters is the same. The following figure shows three practical precipitation and running regulation.

Figure 7. Three practical precipitation and running regulation.

Source: East Japan Railway Company.

The Tokaido Shinkansen Earthquake Rapid Alarm System (TERRA-S) is an effective system for providing early warning against earthquakes. This system has seismographs installed at both sides of the track and in the coastal areas along the line to detect the primary and secondary waves of an earthquake. Based on the information depending to the earthquake scale, the substation device transmits a signal to cut the power off, causing an application of the train emergency brakes. It allows train operation to be suspended immediately when earthquake is detected or occurs.


Source: Enhancement of Functions of Tokaido Shinkansen Earthquake Disaster Prevention System report.

The Disaster Alarm System (PreDAS) is an effective network system that brings together all the information from early alert and safety systems located along the track and the climate information that it
is obtained from weather companies. This whole system permits to receive, analyze and operate the train according to the present situation of the safety systems and doing prediction on the climate situation for section of the track where climate risks has been identified. Therefore, it applies restrictions to the train operation as previously described. The following figure shows the system architecture.

Figure 8. Disaster Alarm System (PreDAS) system architecture.

(169) In case of natural disasters, and as a common rule in emergencies of any type, the preparedness actions are as important or even more than the response activities. Railway authorities of the reference countries not only consider safety systems a key part of emergency cycle, but also in some cases like Japan give much more importance to the deployment of early alert and safety systems in order to avoid the necessity of performing a response to an emergency. Although some emergencies are unavoidable, these systems guarantee certain level of safety through the early warning or techniques of train operation control in degraded situation, which permits to minimize effects of the natural disaster and to face up the emergency in safer conditions for the emergency services.
Construction measures against natural disaster

(170) Japan Railways facilities design and construction consider natural disasters protection elements such as sand stopper fences to prevent the inflow from natural slopes, concrete lattice frames and restraint stakes to prevent landslides at embankment and cut sections, drainage for rainfall and cover of the tunnel entrance and exit.

Figure 9. Stopper fences, concrete lattice frames, drainage for rainfall and cover of the tunnel entrance installations.

Source: East Japan Railway Company.

(171) Japan Railways have developed systems to prevent deviation from the track in the event of an earthquake while a derailment occurs. The L-shaped car guide equipment on bogies prevents the car from moving far from the rail after the derailment. The following figure shows a L-shaped car guide equipment installation.

Figure 10. L-shaped car guide equipment installation.

Source: East Japan Railway Company.

(172) Additionally, Japan Railways are improving rail glued-insulated joint design in order to changing their shape so that a derailed wheel does not give a shock directly to bolts of the joint bar, and therefore will not break the bolt. The following figure shows a rail glued-insulated joint designed to minimize derailed wheel effect
Coordination with authorities and governmental emergency agencies

(173) Once a natural disaster has become a real railway emergency, railway authorities of the reference countries do not perform the response management by themselves. As explained previously, when the emergency requires the intervention of rescue and relief resources (as in the case of natural disaster), railway authorities play just a role of technical support for the governmental emergency agencies which do perform the response from a civil protection and medical point of view and with which railway companies shall coordinate.

(174) Firstly, railway companies coordinate efforts in natural disaster response with the governmental emergency agencies at a regional level, usually through the governmental emergency management centres. Railway authorities, as well as governmental emergency agencies report information about the incident and its resolution to the local or regional government who will transmit all this information to the national authorities only for information purposes.

(175) However, when the geographical extension is affected or the strength of the natural disaster exceeds the capabilities of the regional emergency services, these transfer the responsibility of the emergency response to national level emergency services, such as the National Emergency Management Agency (NEMA) in Korea, the Fire & Disaster Management Agency in Japan, the Civil Security Department (Direction de la Sécurité Civile, DSC) in France or the Civil Protection and Emergencies Department (CPE) in Spain. In these cases, railway companies should coordinate the emergency response with national level emergency services. However, railway companies’ functions in both cases are similar: securing the zone, stopping the train if necessary and offering technical support to the external emergency services.

(176) Both railway authorities and emergency services are responsible to inform authorities from a local to a national level. In case of such great disaster, it is common to have direct communication between the railway authorities’ emergency centres crisis rooms and the corresponding regional or national authority, which is in most cases connected through a videoconference. In addition, the emergency service centre responsible is in charge of the communication of the situation and disaster evolution to the authorities.

(177) To sum up, in accordance with the principle of solving the emergency at a location as near to the place of the incident as possible, emergency agencies always try to give firstly an efficient response to the emergency at a regional level. This involves a wider knowledge about the area affected, about the specific risks or characteristics of the zone, etc. Only in those cases of greatest disasters, where the regional emergency services cannot provide an adequate emergency response, shall these emergency services require the intervention of national emergency agencies, such as NEMA, FDMA, DSC or CPE.

2.3.4 Emergency response in difficult access zones

(178) Concerning emergency response in difficult access zones, such as tunnel, bridges or high mountain lines, the railway companies of the reference countries develop incident response procedures and specific plans for emergencies in such places. These plans and procedures are defined based on a sector-geographical risk analysis of those zones. More specifically, in the case of tunnels, different safety
systems are usually implemented to prevent that risks become real incidents and to avoid incidents become emergencies.

(179) These procedures and plans have not been provided by the railway companies of the reference countries. However, some case studies of real emergencies solved in difficult access zones are available in Annex 6.1 Railway Emergency response case studies.

(180) Regarding the equipment used in emergency response in such areas, reference countries railway companies explain that the equipment is the standard one used in any other part of the line. No specific rescue process or equipment is used for emergency response in difficult access zones.

2.3.5 ORGANISATION

(181) Concerning the internal organisation of the railway infrastructure manager or railway companies of the studied countries, it should be emphasised that several departments are always involved in emergency management. These are the traffic operation department, the maintenance and rolling stock departments, and customer service or corporate communication departments.

(182) First of all, as mentioned before, in most of the studied countries, rescue and relief actions in case of railway emergency are usually performed by national or regional emergency services and in most cases, such as in France, Japan, Korea or USA, railway companies do not consider specific departments for emergency management. In these countries, the coordination with external emergency agencies is made by the traffic operation department through the personnel in charge of the operation of the trains affected (usually through the 911/112/110 numbers). Only in some cases like Spain or Germany, railway authorities (infrastructure administrations/railway operators) have emergency management departments in charge of the coordination with external emergency agencies, but they do not perform the rescue activities by themselves either. In the case of ADIF in Spain, this department is also in charge of security and surveillance of the railway infrastructures.

(183) The rest of departments involved in the emergency management process are common to all the reference countries. Traffic or operation departments collaborate during the response phase through the traffic control centres managing the special traffic circulation (through the alternative traffic plans), ensuring the most possible level of operation is conducted in a safe mode while the rescue actions are performed by the emergency services. During the recovery phase, these departments progressively adapt traffic in order to restore normal circulation.

(184) The maintenance and rolling stock departments of the railway companies/infrastructure administrations also participate in the response and recovery phases, providing technical support and collaborating in track and access relief actions to facilitate rescue services work at the response stage and normal traffic restoration at the recovery stage.

(185) As a general rule, the railway authorities of the reference countries also have customer service departments or corporate communication departments in charge to provide accurate and updated information to passengers, victims, families and media about the causes and the solving process of the incident.

(186) To sum up, in the reference countries, the main responsibilities of railway authorities in emergency management are limited to provide technical support to external emergency services that perform the rescue actions coordinating them with internal resources, to ensure safety during these services’ intervention and to restore traffic circulation once the rescue and medical relief actions have been performed. The difference between the v models is that some of them assign a specific department for the coordination of the emergency professionalizing the emergency management and avoiding the operation departments to interrupt their tasks to manage the emergency.

2.3.6 EMERGENCY MANAGEMENT CENTRES

Railway Centres

(187) Concerning the railway companies and infrastructure administrations capacities, and closely related to the previously analysed emergency management-involved departments, in most of the reference countries as France, Korea, or Japan, the railway authorities do the coordination task from the
traffic control centres, while only some of them (Germany, Spain) have specific railway emergency management centres.

(188) In France, Korea or Japan, the incidents are detected and managed from the same control centres that manage traffic operation. These centres combine traffic control and incident management tasks. In case of emergency, they are in charge of alerting the external emergency services (112/911/119/110), coordinating internal and external resources and operating traffic in a safe way in the affected tracks. In the USA, the railway company Amtrak also manages the incidents from traffic control centres. However, since it has its own police, controlled from an internal police station, this one may also collaborate with the traffic centres in emergency management when necessary.

(189) In Germany and Spain, the railway network administrations DB and ADIF count with specific Emergency Management Centres (EMC) that are usually adjacent to the traffic ones in order to achieve a good coordination with the operation departments. These centres, which shall coordinate the internal resources and the external emergency services, have specific information tools for emergency management. They are also equipped with video-walls and work posts with several screens that show information about the site of the incidents such as route maps, accesses, bridges, tunnels, video, etc.

(190) The advantage of having specific centres for coordination with external emergency services is that the traffic operation personnel do not have to develop this task and can concentrate efforts in securing measures and traffic alternatives. On the other hand, the existence of emergency centres also involves more links in the information and coordination chain, which may result in less efficient information flow and decision making; to avoid this, it is important to have well-defined coordination protocols.

**Governmental Emergency Centres**

(191) It is also important to take into account the emergency management centres of the governmental emergency services from which any type of emergencies, including railway ones, are managed. As mentioned before, the governmental emergency agencies of the reference countries play an important role in railway emergency management since they are in charge of the rescue and relief actions of emergencies exceeding railway authorities' capabilities. In these countries, the emergency agencies tend to coordinate their work from emergency centres that integrate different emergency services (fire services, medical services, police, etc,) and mobilise, coordinate and monitor the necessary resources of the different services in each case.

(192) When a railway emergency occurs, these centres can be alerted by the railway centres (control or emergency centres depending on the country), by passengers or by other witnesses, and they are in charge of mobilising the rescue and medical relief resources needed to solve the emergency. No matter who alerts the emergency agency centre, once a railway emergency is identified, it should work in coordination with the railway company’s centre in order to ensure that the zone has been secured and that the emergency services on field can intervene in safe conditions. The emergency agencies’ centres are specialised in mobilising the appropriate resources, in tracking them and monitoring the response to the emergency from a civil protection point of view, which results in a more efficient management of the resources that the railway companies cannot provide. Usually these functions are developed through an Emergency Management Information System that permits to computerize all processes, procedures and communications.

(193) Concerning backup of these centres, some public emergency organisations have implemented back-up replicated emergency centres, which are fully equipped with hardware systems, communications infrastructure, and dispatcher workstations, far away from the main emergency centre location. A continuous on-line replication of application data and configuration from the main centre to the back-up centre exits. Additionally, some back-up centres dispose of video-wall with video connection as in the main emergency centre. The back-up centres are ready to be used in case of downfall of the main centre due to major disaster or terrorism. Some back-up centres have been designed to operate simultaneously as an extension of the main centre in order to dispose additional operators if required.

(194) In addition, governmental emergency agencies have mobile units or Mobile Emergency Management Centres (MEMC) on board of trucks or buses that are deployed on-field in case of complex emergencies, when numerous resources have been mobilised or when the emergency is likely to last

---

2 Consultants have not identified mobile centres ready to be air transported, or mobile centres ready to drive by both road and railways, though some solutions are based on containers ready to be ground transported.
several days. They are also used for preventive reasons in case of important events, when crowds are expected. MEMCs are used to carry out on field the same functions than the EMCs in order to manage the emergency locally. They have the same EMIS software and facilities, and usually have even a space for establishing a crisis cabinet. Once on field, they should be connected to the common platform of the EMC and emergency services through wireless communications; therefore, the connection availability on field is also a crucial factor to decide if it is worth to deploy it. The following figure presents the warm room of a mobile emergency management centre installed on a bus:

Figure 12. Warm room of a mobile emergency management centre installed on a bus.

Source: Mobile emergency centre on a Madrid Council (Spain) bus. Indra Sistemas, S.A.

2.3.7 EMERGENCY MANAGEMENT PERSONNEL

**Railway Emergency Personnel**

(195) Since rescue and relief actions in railway emergencies of the studied countries are carried out by the national rescue and emergency services, railway operators or infrastructure administrations do not have specific rescue and relief personnel. The railway authorities of these countries have only security brigades that protect their facilities and, in the case of the USA, the main operator has its own police, but these personnel do not solve emergencies. Railway personnel who collaborate in emergency response and recovery are control and emergency centres staff and maintenance department staff. As mentioned before, it is also common to all the reference countries to assign a person to coordinate actions at the location of the emergency and to transmit on-field information to the centres. In order to ensure the availability of all these personnel, railway companies usually enlist periodically on-duty staff. These lists include the contact data of the people on duty on that period that shall be required when an incident occurs.

(196) In those countries like France, Japan or Korea where railway emergencies are managed from traffic control centres, the staff in charge of the coordination with internal and external emergency resources is composed of dispatchers, operation and maintenance staff. In countries like Spain or Germany where specific railway emergency management centres have been deployed separated from those of traffic operation, there is specific emergency management staff responsible for this coordination between departments and external agencies in case of emergency.

(197) In addition, as a general rule in all the reference countries, one person is always appointed as responsible for the coordination on-field becoming counterpart with on-field rescue and relief services and compiles incident data to transmit it to the corresponding emergency or control centres:

- In France, this person is the Incident Local Chief (CIL), a qualified person, designated by the regional control centre, who moves to the kilometric point of the emergency in less that one hour.
- In Germany, the Emergency Manager is also a qualified person in railway techniques and emergency management who should arrive on field within 30 minutes and report information to the corresponding Emergency Centre.
- In Spain, the traffic control centre appoints the figure of the Delegate Chief as coordinator on field and counterpart with the centre. Usually it is the train driver, if not affected by the incident, who becomes Delegate Chief. If so, the control centre selects another person among ADIF/RENFE on-field staff.
- In Japan, it is usually the deputy station master of the nearer station or the facilities manager there who goes to the kilometric point to coordinate emergency response on field.
In Korea, like in Spain, it is usually the driver (if in good conditions) who develops this task on field.

Finally, in the USA, the main responsible on field is the Incident Commander who can be a worker of the railway company if the emergency can be solved internally or a person of the 911 services depending on the seriousness of the emergency.

(198) To sum up, besides the personnel of the centre in charge of the coordination with external resources, it is crucial to have on field a technical profile with knowledge on railway infrastructures and preferably qualified in emergency management. Figures like the CIL in France or the Emergency Manager in Germany shall not only have train operation, railway infrastructure and track securing knowledge but they also provide benefits as emergency management qualification and skills in emergency resources coordination, which train drivers or stations deputies may not always have. This is important when coordinating with the external emergency resources on field and when reporting information to the railway centres which are in contact with governmental emergency agencies.

Governmental Emergency Centres Personnel

(199) Regarding the previously mentioned governmental emergency centres, there are currently different models for personnel arrangement and tasks allocation in these centres as they are designed ad hoc considering specific characteristics of each case. However, the international common practice goes towards the following structure:

- **Call Centre staff.** These people are in charge of receiving the phone call and of gathering the basic information to decide if it is actually an emergency (rejecting false calls or redundant alerts) in order to dispatch it, in the minimum delay, to the corresponding qualified emergency manager who will treat it. This staff does not need to be qualified in emergency management as their task is limited to filtering calls and classifying them in a basic way to determine which type of emergency manager should treat each of them. Afterwards, they do not contribute in the emergency response. This is why, in some cases, the call centre staff is being subcontracted to teleoperator companies.

- **Qualified emergency managers or operators.** Each centre usually congregate managers from the different governmental emergency services such as fire-fighters, police or medical services staff. Sometimes there are also general emergency operators that manage all type of emergencies in coordination with these specialized profiles. This way, the call centre personnel dispatch the phone calls to the general emergency managers (or to one specialized manager) which mobilise and coordinate the necessary resources on their own or in cooperation with other specialized managers depending on the nature of the emergency. The emergency managers use the Emergency Management Information System to mobilise, coordinate, track, monitor resources and communicate with them and with other agents involved. These personnel should be qualified not only in their field but also in emergency management and coordination in general.

- **Qualified operators’ supervisor.** This figure, which may be a single supervisor for all the managers or one supervisor for group of specialized managers, only participates at the closure of the emergencies checking that it has been properly managed or if there is any problem during the response to an emergency.

- **Room chief or centre chief.** It is the main person responsible for the emergency management centre and is usually in charge of the overall management of the centre, the institutional communications, the reporting to authorities, etc.

- **Technical support personnel.** These personnel ensure the correct working of the equipments and communications of the centre and is usually staff who may be in the centre by shifts or on duty out of it, but being able to arrive there within a period of time (15 minutes usually) to solve any technical failure that may arise.

(200) It is also remarkable that although that personnel is organized hierarchically, emergency managers have full authorization to take decisions concerning the number of resources needed and to mobilise and coordinate them without asking for permission to their superior officers. The supervisors and the room chief only intervene in specific situations or when emergencies become too complex.

(201) The personnel of these centres is dimensioned based on the number of calls and in the number of emergencies received by centre, taking into account that these centres are operative 24/24 and 7/7 and that personnel shall therefore work in shifts.

(202) It is important to emphasise the fact that most of the personnel of these centres should be emergency management qualified people or even experts in determined fields (e.g.: fire fighting, rescue and relief, medical relief). The general emergency managers are specialized in coordination of emergency resources and in emergency situations and should be trained in the use of the information tool.
of the emergency centre (EMIS). The specialized emergency managers are experts in a specific emergency management field such as rescue, fire fighting, medical relief, etc. and usually belong to specific public emergency agencies such as fire brigades, medical services, police, civil protection, etc.

2.3.8 TECHNICAL RESOURCES

(203) Since railway authorities do not perform rescue and relief actions, they do not usually have specific technical emergency resources (ambulances, fire tracks, etc) for these situations. Technical resources used in emergency response and recovery are the ones used for maintenance operations. The most important technical resources common to all the reference countries are:

- **Relief trains.** These convoys are prepared to develop accident recovery work in the place of the incident when this is foreseen to take several days. Usually, the first wagon of the convoy is a railway crane, this way it becomes the first resource available when the train arrives to the place of the incident. The following part is usually the traction machine. Then there is a series of normal passenger wagons transformed into different work zones that house other material, work zones and accommodation for the rescue train brigade so they can stay there for several days.

Figure 13. Relief train.


- **Railway cranes.** These cranes are used on railways for one of three primary uses: freight handling in goods yards, permanent way maintenance, and accident recovery work. Although the design differs according to the type of work, the basic configuration is similar in all cases: a rotating crane body is mounted on a sturdy chassis fitted with flanged wheels. The body supports the jib and provides all the lifting and operating mechanisms. On larger cranes, an operator's cabin is usually provided. The chassis is fitted with buffing and coupling gear to allow the crane to be moved by a locomotive, although many are also self-propelled to allow limited movement about a work site. For cranes with a jib that extends beyond the length of the chassis, a match wagon is provided to protect the jib and to allow the crane to be coupled within a train. The match wagon is usually a long, flat wagon that provides a means of securing the jib for transportation; storage areas for special equipment or supplies are usually fitted too.

Railway companies usually have railway cranes with different transport capacity, for medium (75-90 tons) and heavy weights (120-160 tons).

- **Electrification track cars.** These are self-propelled vehicles that have a tower that permits easy access to the catenary. Old track cars had fixed towers; however, nowadays they are mobile and capable to do lateral movement or rotation. In some cases, these vehicles are equipped with contact wire wear measure systems, and wires heights measure systems. They are often accompanied by coil carts; these are small platforms designed for the contact wire coils transportation from which the wire can be easily unrolled for installation work, renovation or repair. Some track cars, however, have the coil cart integrated in its own platform.
2.3.9 TRAINING

(206) Due to the fact that railway authorities’ role in emergency management consists mainly of coordination tasks, internally and with external parties (rescue and relief services, passengers, media), training programmes seek to enhance cooperation routines to ensure the efficiency of emergency management process. In this sense, drills (and fire practices) are the most common training and coordination methods applied by railway companies in the reference countries. Additionally, railway
authorities may offer lectures and other training methods for internal personnel as well as for rescue and relief services.

Theory training and lectures

(207) As a general rule, all the railway emergency management training programs of the reference countries involve initial theory training and lectures for the personnel when they are hired. This initial training usually include information about the railway network, accesses, substations, security rules and concepts and explanation of restoring manoeuvres and techniques. Then, refreshing training is periodically provided to staff in order to remind the concepts of the initial training and to instruct them in new material manage or in new restoring techniques. Although different periodicities are considered for the refreshing training in each country (one day per year in France or one day every 3 years in Germany and USA), the most remarkable one is the case of Korea, where Korail gives 2 hours of theory training per month to their staff.

(208) In Germany, DB is also involved in external training, providing courses to the fire brigades about rolling stock rescue/extrication techniques, earthing and mobile training for hazardous goods. This helps the fire brigades to familiarise with the railway environment and gives them basic knowledge about techniques, which can be very useful on field in case of emergency, especially in Germany, where fire brigades are authorised to participate actively in zone securing activities such as power cut-down or catenary earthing.

Drills

(209) Drills are considered to be the key element of the training programs of the railway companies analysed. The objective of these drills is to practice emergency response to specific and identified risks and usually involve not only railway emergency and operation personnel but also external emergency services such as fire brigades, police and ambulances in order to ensure that all coordination protocols are practiced. SNCF develops eight drills per year, each one of them involving the participation of 2 or 3 regional centres (there are 23 regional centres). JR East develops one drill per year for 9 of its 12 branches and Korail organises also one drill per year for 6 of its 17 agencies. These mean that as a general rule, each railway control centre or branch of these railway authorities participates in one drill per year or every 2 years.

Simulations

(210) Other alternatives to drills are the emergency simulations, which permit agents involved in emergency management to practice the procedures of emergency response and coordination without deploying the whole scenario with tracks, vehicles and rolling stock on field. DB, for instance, has developed virtual reality simulation packages that are already being used for training purposes. Korail, has a simulation control centre where simulations of real accidents and emergencies occurred on Korail lines are performed. As a part of Korail’s training program, personnel goes to this training centre one every 6 months to practice with one of these simulations.

Education for passengers

(211) Besides the described staff training, and complying with the Railway Safety Plan, Korail considers education for passengers. A safety Guide Map brochure for passengers including information about safety elements in Korail trains can be found on seats. In addition to this brochure, an emergency response guide for passengers, educational videos, drill videos and other material are also available in the web site.

(212) To sum up, all the railway authorities studied develop emergency management related training activities. In addition to the initial and refreshing theory training, railway operators give great importance to periodical drills and simulations that allow staff to practice emergency protocols performing specific response procedures in order to be prepared when a real emergency occurs.

(213) In some cases, like the USA or Korea, the training programs contents are part of the emergency management constraints imposed by the railway governmental bodies. In the USA, the Federal Railway Association (FRA), according to the USA legislation, proposes to develop training programs with contents adapted to the different positions of the staff (emergency and rescue personnel, on board personnel, control centre personnel...), and including initial and periodical theory training and drills. Based on these recommendations railway authorities define their training programs. In Korea the Railway Safety Plan of
the Ministry of Land, Transport and Maritime Affairs (MLTM) requires the railway companies to develop an Education and Training Program including both passenger education and staff training.

(214) Better defined training programs are found in the USA and Korea. In both cases, governmental bodies require the railway companies (FRA through the Code of Federal Regulations and MLTM through the Railway Safety Plan) to define an exhaustive training program, describing the training activities (lectures, drills, simulations) for the different agents involved (emergency and rescue personnel, on board personnel, control centre personnel…) and specifying the contents and periodicity for each activity and group of agents.

2.3.10 RESPONSE INDICATORS

(215) In accordance with the fact that railway companies of the reference countries do not develop emergency response actions by themselves, they do not measure indicators corresponding with the performance of this response, since it depends to a large extent on external emergency service resources and their efficiency. However, the governmental emergency agencies that do develop rescue and relief actions during railway emergencies, usually manage this type of indicators, which can be easily obtained from the emergency management information systems (EMIS) of their emergency centres.

Railway authorities emergency response indicators

(216) As a general rule, when asked about emergency response or recovery performance indicators, railway authorities of the reference countries explain they do not actually measure or analyse this type of indicators.

(217) Only Korail from Korea manages a list of qualitative indicators to be followed during the drills and practices. These indicators are measured using different checklists that are updated every year. It is important to emphasise that the measurement of these indicators does not apply in case of real emergency. The indicators are:

- Adequate drill goal and scenarios
- Status of step by step implementation of emergency response
- Status of the role by the response body
- Status of the accident notice, emergency contact performance
- Status of report, response and recovery of emergency
- Status of search & rescue of people, fire distinguishing, emergent medical services
- Performance of prevention of pollution, access control, preservation of order, etc.
- Effective cooperation with the rescue & support organization

(218) The rest of the railway companies analysed only consider some response times goals concerning the time of arrival of their resources to the kilometric point during the response phase. These are only technical and track relief resources (such as relief trains, railway cranes, etc.) and on-field emergency coordinators (when this figure is not already present at the moment of the emergency).

(219) Regarding the technical resources, the railway companies usually decide their location based on response time goals. SNCF resources are supposed to arrive to the kilometric point of the incident within 2 hours and a half, while in Germany DB's re-railing vehicles are expected to be at the kilometric point in 90 minutes, 75t cranes in 3 hours and 160t cranes in 6 hours.

(220) Concerning the on-site coordinator, in Germany the Emergency Manager is supposed to arrive to the place of the incident within 30 minutes from the notification to the centre. In France the CIL should arrive to the kilometric point in less than an hour. Statistics confirm that this goal is accomplished in most cases, as they arrive in 45 minutes on average. The DNO should also arrive to the CNO, if needed, within 30 minutes. This involves that when appointed, there is a location constraint associated to these figures.

Emergency response indicators of governmental emergency services

(221) The EMIS of the governmental agencies’ emergency management centres can usually generate statistics regarding response times of different aspects of the emergency response, permitting not only the general process evaluation but also an emergency response chain weaknesses analysis. This analysis may result on the application of corrective measures for the improvement of the global emergency response weaker points.
(222) In these global emergency centres, where this applies for all type of emergency, the most commonly studied indicators are:

- Nº of incidents
- Nº incidents by location
- Nº of calls
- Nº of emergency agencies involved
- Nº of interventions by resource
- Effectiveness in protocols management
- Average call response time (also maximum and minimum times)
- Average time to dispatch resources (also maximum and minimum times)
- Average time of resources arrival to the site of the emergency (also maximum and minimum times)
- Average time to dispatch additional resources when the first ones result insufficient (also maximum and minimum times)
- Average time of incident resolution and closure (also maximum and minimum times)

(223) Emergency response indicators permit to evaluate the degree of efficiency and efficacy of the emergency services as well as to fix goals for these indicators, forcing emergency agents to provide the best response possible in order to achieve them. This indicator analysis also permits to detect the weak points of the chain of response and fails in procedures or in protocol routines, which can therefore be improved in order to get a more efficient global response.

2.3.11 INCIDENT COMPENSATION PRACTICES

(224) In case of incident, railway authorities of the reference countries define different indemnity policies for passengers and freight clients in order to compensate damages, freight damages or loss, delays, etc. Depending on numerous factors, these compensation practices are vast and complex, and railway companies do not make them public.

(225) However, concerning the natural disasters, when the scale of damaged people and property is big and a wide geographic area is affected, the railway passengers and clients are considered victims of the disaster and it is usually the national government who compensates them through the national funds for natural disasters. The European Union itself has an international fund of this type called the European Solidarity Fund from which all the member countries of the EU (among them Germany, France and Spain) can beneficiate in order to compensate their citizens in case of natural calamity. Railway authorities of other countries of reference, such as Korail, are also supported by this type of funds to compensate their passengers and clients in case of great disaster.

2.3.12 EMERGENCY MANAGEMENT CASE STUDIES

(226) As a result of the research work, Consultants have also obtained the following case study reports:

- Review of the Express Railway Disaster in Amagasaki (Japan) in 2005. It describes the response to the derailment of the express train in the urban area of Amagasaki, which was the worst rail disaster in 40 years in Japan.
- Channel Tunnel Fire (France/United Kingdom) in 1996 occurred on a train carrying heavy goods vehicles through the Channel Tunnel from France to Great Britain.
- Eschede Train Disaster (Germany) in 1998. The high-speed train accident occurred near the village of Eschede in the Celle district of Lower Saxony, Germany, caused by a single fatigue crack in one wheel which, when it finally failed, caused the train to derail at a set of points.
- Daegu Subway Station Fire (Korea) in 2003. Caused by an arsonist who set fire in a train stopped at the Jungangno Station of the Daegu Metropolitan Subway in Daegu, South Korea.
- I-35 W Mississippi River Bridge Collapse in 2007. The bridge, which was Minnesota's fifth busiest, carrying 140,000 vehicles daily, collapsed into the river and onto the riverbanks beneath.

(227) Although all these case studies are attached in Annex 1, the two most interesting case studies (Channel Tunnel Fire and Schede Train Disaster) are analysed next in order to extract and present the more useful lessons learned in each case.
CHANNEL TUNNEL FIRE

**Typology:** Fire

**Location:** Channel Tunnel from France to United Kingdom

**Date:** 1996

**Type of train:** Freight (heavy goods vehicles – HGVs)

**Casualties:**
- No killed people.
- Seven minor injured people (smoke inhalation)

**Summary**

(228) The Channel Tunnel fire of 18 November 1996 occurred on a train carrying heavy goods vehicles (HGVs) and their drivers through the Channel Tunnel from France to Great Britain.

(229) The fire began after the train had loaded and was travelling through the French terminal to the tunnel portal. Security guards noticed the flames shortly before the train went underground. Although they raised the alarm, the train was well into the tunnel by the time the driver was advised that his train might be on fire. He attempted to drive the train to the other end, but an unrelated fault forced the train to make a controlled stop in the tunnel. Due to radio systems failure the driver and the staff in the amenity coach could not communicate with each other. Although the amenity coach was stopped in front of a cross-passage, nor the driver, neither the personnel in the amenity coach where able to see the numeration of the cross-passages due to the smoke in the tunnel. After approximately twenty minutes of exposure to smoke-laden air, the passengers and crew were evacuated into the adjacent service tunnel.

(230) No one was killed during the fire, although seven people were taken to hospital suffering from smoke inhalation. The fire destroyed a locomotive and ten HGVs, caused major damage to approximately one kilometre of tunnel infrastructure and severely tested the abilities of fire brigades from both France and the UK.

**Emergency services involved**

(231) Fire Brigades from France and Great Britain participated in the rescue and relief tasks. The presence of hundred of fire-fighters along half a kilometre of service tunnel caused great logistical problems.

**The accident minute by minute**

<table>
<thead>
<tr>
<th>Time</th>
<th>Fire Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>21:48 (French time)</td>
<td>• The train entered the South Running Tunnel.</td>
</tr>
<tr>
<td></td>
<td>• A 1–2 m fire flame was seen beneath a lorry abroad the train by some security guards and reported to the Terminal Control Centre in the French terminal.</td>
</tr>
<tr>
<td>21:49</td>
<td>• The Terminal Control Centre informed the Rail Control Centre.</td>
</tr>
<tr>
<td></td>
<td>• Tunnel fire detection system gave first “unconfirmed” alarm.</td>
</tr>
<tr>
<td>21:50–21:52</td>
<td>• Four further “unconfirmed” alarms.</td>
</tr>
<tr>
<td></td>
<td>• The Rail Control Centre informed the train driver of the possible onboard fire and the train would be diverted to the emergency siding in the UK terminal.</td>
</tr>
<tr>
<td></td>
<td>• The onboard fire alarm system warned the driver of a fire in the rear locomotive.</td>
</tr>
</tbody>
</table>
• A fire on the rear locomotive was confirmed by both onboard and tunnel fire detection systems.
• The train had travelled 10 km into the tunnel.

21:56
• The French First Line of Response (FLOR) team comprising 8 fire-fighters left the French Emergency Centre.

21:58
• The train stopped adjacent to the cross-passage at PK 4131.

22:01
• The train driver was trapped in his cab and the passengers could not be evacuated due to dense smoke.

22:02
• The French FLOR team entered the Service Tunnel. One minute later, the UK FLOR team also entered the Service Tunnel.

22:22
• Supplementary Ventilation System had been reconfigured to move smoke along the South Running Tunnel towards France.
• The train passengers were evacuated.

22:28
• The French FLOR team arrived at cross-passage 4131 and saw the evacuated passengers.
• The train driver was later rescued from his cab.

22:53
• The UK FLOR team entered the South Running Tunnel to inspect the exact location and extent of the fire.
• It was found that the fixed tunnel equipment had been damaged and five wagons were involved in the fire at the rear rake of the train.

23:39
• Fire was confirmed between cross-passage doors 4163 and 4201.
• In the following 5 hours, the fire was attacked by the combined force of the French and UK firefighters.

05:00
• The centre of the fire was extinguished. Minor fires were extinguished during the early morning.
• Smouldering debris continued to be dealt with until 03:00 on 20 Nov.

Problems and lessons learned

As a result of an analysis of the main problems found during the fire and the response phase, and of the consequent improvements considered in the Channel Tunnel Fire emergency elements, facilities and procedures, Consultants have extracted the following lessons learned.

<table>
<thead>
<tr>
<th>Area</th>
<th>Problem found</th>
<th>Lesson learned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management from the Control Centre</td>
<td>Too many duties carried out by the Rail Control Centre.</td>
<td>Need of additional staff dedicated to fire alarms management permanently on duty.</td>
</tr>
<tr>
<td></td>
<td>The supplementary ventilation systems (SVS) only run when activated by a controller. In this case, the commander of French emergency services had to request SVS activation to the Rail Control Centre, and the SVS did not work properly until 20 minutes after this request.</td>
<td>Procedures for operating the ventilation system have been simplified.</td>
</tr>
</tbody>
</table>
### Operating procedures in case of fire

In case of fire, trains were allowed to continue running in prudent mode. One of them had a propping loop failure alarm and stopped after the French crossover.

Policies of attempting to drive trains in case of on board fire and uncoupling the locomotive and amenity coach have been abandoned.

**New policies:**
- Trains immediately brought to a controlled stop.
- Occupants evacuated into the service tunnel

### Facilities

Due to the smoke in the tunnel, the driver could not see the number of the cross-passage he had stopped at. Neither could the staff in the amenity wagon.

Illumination of cross-passage markers has been improved and on board staff provided with powerful torches.

### Railway staff roles

The driver and the staff in the amenity wagon (where the passengers were) could not communicate with each other due to a failure in the radio system.

Evacuation responsibility shifted from the driver to the Train Chief.

### Railway staff and emergency services training

Passengers and crew inhaled smoke that got into the amenity wagon and also when evacuating.

More train staff receive now first aid training.

Hundreds of fire-fighters spread along half a kilometre of service tunnel caused huge logistical problems with supplies of BA sets, water and sanitation from both end of the tunnels.

Relationships between emergency services have been revamped. Including now joint practices between British and French fire brigades.

### SCHEDE TRAIN DISASTER

**Typology:** High Speed train derailment and crash with a highway overpass

**Location:** Eschede (Germany)

**Date:** 1998

**Type of train:** Passenger

**Casualties:**
- 101 killed people
- 108 critically injured people (smoke inhalation)

**Summary**

(233) On June 3rd, 1998 a high-speed ICE train derailed and collided with a highway overpass in Eschede, northern Germany. The train consisting on two electric powered locomotives (one at the front, one at the end) and 12 passenger cars (each with capacity for 750 people) run at a speed of 120mph.

(234) About 3 miles prior to the crash site, a rear wheel of the first passenger car failed. However, there was no monitoring system to alert the engineer about the wheel failure and the train continued travelling 3 miles with the damaged wheel until a turnout, where the broken wheel rim collided with a guide rail and rear left wheels of passenger car no. 1 derailed. One hundred and twenty yards later the derailed truck hit the next turnout switch. Passenger car no. 1 went straight through the switch, followed by car no. 2. The front wheels of car no. 3 followed as well, but the rear wheels diverted to the sliding track and derailed. The trailing end of passenger car no. 3 hit the concrete bridge and knocked out the support columns.
making the 300-ton overpass collapse. Car no. 3 and 4 were able to go through the falling bridge. The middle of car no. 5 was crushed by the collapsing bridge and torn apart. The rear end was buried under the 300 tons of concrete debris. Passenger car No. 6 turned sideways across the track in front of the barrier. The following six passenger cars no. 7 through 12, including the rear end locomotive, hit with full force (still 120 miles per hour) into the blockade. Passenger cars no. 6 and 7 were partially buried and crushed by the bridge debris. Sometime during the accident sequence, the front engine separated from the rest of the train, only 2 miles ahead of the accident site, when the locomotive was initiated by an automatic emergency braking system did the engineer realize the situation. Car no. 1, 2 and 3 derailed and skidded along the tracks but did not fall over. Car no. 4 slid from the railroad embankment into a wooded area and fell on its side. Car no. 5 was torn up in the middle; the first part passed the overpass, while the rear part was buried under the debris.

(235) As a result of the collision and derailment 101 people were killed, another 108 people were mostly critically injured, and only 5 survived unhurt.

Emergency services involved

(236) 1,889 emergency workers with 400 vehicles and 39 helicopters responded in the first hours to the accident site in the remote town of 6,000 citizens. The initial dispatch at 11:03 consisted of 5 ALS and 3 BLS ambulances, 1 emergency physician squad and 2 ambulance helicopters stationed in other counties.

(237) EMS helicopters, volunteer organizations like the Red Cross, German and British military physicians and EMTs, and volunteer medical squads rushed to the scene when heard about the catastrophe.

The response minute by minute

<table>
<thead>
<tr>
<th>Time</th>
<th>Fire Development</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wednesday 11:01</strong></td>
<td>Fire and police county dispatchers received the first calls reporting the accident and dispatched the volunteer fire department of Eschede and the local ambulances.</td>
</tr>
<tr>
<td><strong>Wednesday 11:07</strong></td>
<td>First units arrived and county fire dispatcher received the first radio message describing the magnitude of the ICE-train crash.</td>
</tr>
<tr>
<td><strong>Wednesday 11:19</strong></td>
<td>The medical director of the county emergency medical services arrived on scene and assumed command as Medical Leader and organized all medical activities.</td>
</tr>
<tr>
<td><strong>Wednesday 12:05</strong></td>
<td>Helicopters began to evacuate the most critically injured.</td>
</tr>
<tr>
<td><strong>Wednesday 13:45</strong></td>
<td>All extricated people were en route to hospitals by ambulances and helicopters.</td>
</tr>
<tr>
<td><strong>Wednesday 14:00</strong></td>
<td>Between 800 and 1,000 first responders were at the accident site.</td>
</tr>
<tr>
<td><strong>Wednesday 15:00 –</strong></td>
<td>Secondary search operations; logistics; body recovery; first press-conference; replacement of first responders; registration of fatalities, injured and uninjured train occupants; taking care of relatives and starting on-site stress debriefings</td>
</tr>
<tr>
<td><strong>Thursday 12: 00</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Thursday 12: 00 –</strong></td>
<td>Body recovery; accident investigation; public relations, logistics; collection of private baggage; salvage of the wreckage; and the search for body-parts.</td>
</tr>
<tr>
<td><strong>Saturday 7:00</strong></td>
<td>Command of the accident scene was transferred from fire-brigades to police</td>
</tr>
</tbody>
</table>
Problems and lessons learned

(238) As a result of an analysis of the main problems found during the response phase in the Eschede train disaster, Consultants have extracted the following lesson learned and recommendations related with these problems.

<table>
<thead>
<tr>
<th>Area</th>
<th>Problem found</th>
<th>Lesson learned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical rescue</td>
<td>Unbreakable windows and lack of information about materials of modern High Speed trains.</td>
<td>Emergency services must receive training to become familiar with trains and railway material in their jurisdiction</td>
</tr>
<tr>
<td></td>
<td>Sections of the collapsed bridge buried cars. Some parts of the debris weighted over 150 tons.</td>
<td>Emergency services must have adequate equipment to meet the hazards (in this case heavy weight cranes were requested from private companies)</td>
</tr>
<tr>
<td>Command chain</td>
<td>Several medical services' physicians wore clothed with “Leader” identification, as they had this role in their jurisdiction. The same happened with Fire Chiefs. It was difficult for arriving units to identify and report to the Incident Commander.</td>
<td>It must be ensured that command staff is easily recognizable and locatable. The command post should be well marked. new identification waistcoats must be available in the site of the emergency</td>
</tr>
<tr>
<td>Medical relief activities</td>
<td>Numerous medical relief helicopters, volunteer, ambulances and trauma teams rushed to the scene.</td>
<td>Coordinating medical services units within a larger incident command structure is a difficult task that requires training.</td>
</tr>
<tr>
<td>Casualties documentation</td>
<td>Families could not find their surviving relatives due to the lack of track of the patients' names or destinations.</td>
<td>Names of the injured and hospital destinations must be documented from the very beginning by police or administrative personnel if emergency services are too busy.</td>
</tr>
<tr>
<td>Media/Press relations</td>
<td>Nearly 250 media representatives and camera teams came to the place of the incident immediately after the news spread.</td>
<td>A public information officer, trained in dealing with a bulk of media representatives, has to be assigned as soon as possible.</td>
</tr>
</tbody>
</table>

2.4 NETWORK COMMUNICATIONS AND INFORMATION SYSTEMS

(239) Today, technological means are the support for safety and emergency management. Network communications are the basis for all the information systems that a modern railway authority needs for the management of all the processes related with its business. Moreover, safety and emergency situations are critical due to the need of information, quick response time, and accurate data management. Therefore, fixed and mobile network communications identified in the studied countries for voice, data and video transmission purposes are analysed in the following sections.

(240) The implementation of safety systems is the base to avoid or mitigate incidents. Therefore, safety information systems, including signalling control and railway auxiliary safety systems, identified in the reference countries are summarized.

(241) In the studied countries, railway authorities and governmental emergencies organizations use Emergency Management Information Systems (EMIS) to manage emergency response. These EMIS are usually custom-made for each organization. Governmental emergency management agencies are implementing EMIS worldwide. Railway authorities implement EMIS to assist in the emergency management, but they are simple systems compared with the ones of governmental bodies due to the fact that railway emergencies involving external agencies (fire brigades, medical services or police) are managed by governmental emergency centres.
2.4.1 FIXED NETWORK COMMUNICATIONS

(242) Railway companies' voice-fixed communications are supported on telephone systems worldwide. European, Japanese and Korean railway systems use PABX as main telephone system among headquarters, control centres and stations. On the other hand, United States railway systems use PSTN as the main telephone system.

(243) PSTN supports communication between railway systems and government emergency management systems or other external agencies and suppliers. In European railways, PABX are connected to PSTN networks by ISDN links. Japan Railways staff communications are supported by both PABX and telecommunication operator terminals, which results in two phone numbers per person.

(244) In conventional and high-speed lines in Japan and Korea, there are specific railway operation telephony systems based on track telephones that continue under service; in Europe however, this technology has been considered in conventional lines but not in high-speed projects. In Japan, when digital mobile cellular network (PDA), used as main system, fails or collapses due to an incident, then trackside telephones are used as a replacement communications system.

(245) PABX, PSTN and track telephone are used for both operation and emergency communications purposes during the response and recovery phases.

(246) Currently, data transmission worldwide is supported by Ethernet connections based on different link speed interfaces mainly connected by optical fibre as physical infrastructure. Nevertheless, Japan railway communications installed twenty years ago continue on service supported by copper wires. Optical fibre infrastructure is more developed in Spain due to the fact that the telecommunication market used railroads infrastructures first, instead of road infrastructure, to extent backbone networks. Therefore, ADIF is a telecommunication carrier offering 14,000 km of dark optical fibre. Both in conventional and high-speed lines, ADIF optical fibre backbone network has alternatives routes of redundancy to connect sites. There are also 550 km of optical fibre cable in Korean rail lines.

(247) In the past, analogue systems supported by optical fibres were used to enable video communications between stations and control centres. Additionally, some video transmission digital systems were implemented too. Nowadays, TCP/IP based video systems supported by Ethernet are implemented. IP cameras technology is widely extended in railways and continues growing as projects to remove oldest analogue systems are planned. Railway authorities are migrating existing low speed Ethernet links to Gigabit Ethernet. In the case of Spain, video transmission from ADIF cameras to the emergency management centres is based on Ethernet links supported by the fixed network communications. Normally, video is transmitted to traffic, safety and security and other departments. However, when an incident occurs, video images from safety and security departments are screened before being transmitted to traffic or other ADIF departments.

(248) There are no significant differences among the access and backbone equipment that supports PABX and data connections. The standards for all these technologies are defined by the International Telecommunication Union (ITU) in ITU-T recommendations. The equipment of European countries is based on European standards. Additionally, new high-speed lines in Korea, which have been developed by European companies, are based on European standards. On the other hand, Japanese equipment follows Japanese developments.

2.4.2 MOBILE NETWORK COMMUNICATIONS

(249) Usually, fixed communications previously summarized are not accessible from the place of the railway incident. Therefore, mobile communications are the basis for voice, data and video transmission from the site of the incident to the railway centres during emergency management in the response phase.

(250) On the one hand, communications between the control traffic centre and the train is supported by train-to-ground radio system that is always a proprietary system not depending on external mobile cellular providers. Nowadays analogue radio systems continue under operation on conventional lines in France, Germany and Spain. Nevertheless, as it is mandatory in Europe, GSM-R will be the platform for voice and data communication between control centres and railway operational staff, including drivers, dispatchers, shunting team members and maintenance brigades, train engineers, station controllers and surveillance brigades. GSM-R technology is bound to replace the different existing radio communication railway networks based on walky-talkies and PMR analogical systems that present limitations of interoperability.
and service implementation. GSM-R is already implemented in some track sections in Spain (high-speed lines are GSM-R operated), France, United Kingdom, Germany, Netherlands, Belgium, Switzerland, Sweden, Norway, Finland, etc. and it has been introduced in other non-European countries as Korea. There are projects to implement GSM-R mobile communication system in French railways in incoming years. There is a section from Belgium to Germany operated by GSM-R. ADIF is replacing existing train dispatching system technology based on PMR by GSM-R in all conventional line sections. Therefore, GSM-R will soon be the only mobile communication system under operation both in ADIF high-speed and conventional. Therefore, GSM-R is a valid technology in the medium term.

(251) On the other hand, mobile communications for headquarters personnel is based on mobile cellular systems of each country: GSM in European countries or PDC in Japan. The mobile public networks could not provide the level of resilience and capacity in case of incident, since usually the system is blocked by the huge volume of calls generated at or near the scene when people try to contact the emergency services, friends or relatives. Mobile public networks are useful in the mitigation and the preparedness phases but they are not totally reliable in the response phase. Therefore, control traffic staff in European countries and Korea, where GSM-R networks are implemented, use GSM-R terminals.

(252) The most common radio systems installed by governmental emergency management agencies are PMR, TETRA and TETRAPOL systems. PMR technology has been discontinued. TETRAPOL systems will be replaced by TETRA in the incoming years. TETRA is widely implemented in Spain, France, Germany and Korea. Additionally, some projects have tried to integrate such systems with fire brigades, police and emergency medical services in the area. TETRA is the standard communication system for emergency situations, because the bands used are not among the bands inhibited for security in some emergency situations.

(253) After the migration from UHF/VHF mobile communication systems to trunked mobile communication systems done in France, Germany, Spain, Korea and the United States, efforts go on to dispose interoperable communications systems among the emergency agencies involved in incidents response. On the other hand, Japan railways operation staff and maintenance brigades, which do not dispose of terminals of train dispatching system, use mobile terminals supported by Personal Digital Cellular (PDC) technology implemented in Japan, as mobile communication system for normal operation and emergencies as long as this public mobile network does not collapse due to emergency excess of traffic.

(254) Satellite communications as well as TETRA and mobile cellular systems are used by mobile emergency management centres described in the Emergency information systems chapter. Therefore, satellite communications are limited to connect mobile centres with control centres. Control centres have satellite interfaces, which reduce the operation cost, as this is lower in case the origin and destination are both satellite terminals of the same supplier.

(255) Besides, some emergency management agencies have wireless networks technologies operating in cities to transmit video from incident site cameras to emergency management centres. These solutions are under operation on reduced areas compared with long track distance of a railway authority. Wireless access network has not been identified in railway companies of the studied countries related to emergency management.

(256) Live video download from helicopter is developed in some public emergency management information systems. Both in Europe and the United States, usually police helicopters, equipped to transmit live video images, support and transmit airborne video to the emergency management centres. Airborne video has not been identified in railway companies of the studied countries.

---

3 The Integrated Centre for Security and Emergencies operating in Madrid (Spain), that is the emergency management centre of the city, receives live video images from the incident site which are supported by a wireless access network extended on the city.
2.4.3 Safety Information Systems

(257) Safety systems are those that are directly related to track rail operation: signalling control, power supply control, stations control and supervision. Additionally, there are some railway auxiliary systems related to the track and train supervision that are regarded as safety systems. The following exhibit shows how the four types of safety systems feed the traffic control centres with the necessary data for traffic operation:

Exhibit 15. Safety information systems.

Source: Consultants analysis.

(258) Signalling control is essential in the mitigation phase in order to avoid incidents due to human failures in railways. There are different signalling control system solutions implemented due to the fact that industrial, commercial and national interests worldwide are incompatible. Nowadays, in some European and Korean high-speed lines, the signalling systems have been standardized based on ETCS technology. On the other hand, Japan proprietary systems continue in service at Japanese railways. H-ATS is the Japan high-speed signalling systems.

(259) In addition, there are several railway auxiliary safety systems that involve different technologies and functionalities operating as early alert systems. Those systems, related with natural disasters and climate risks control, have been previously described in section 2.3.3 Natural Disasters Management. Additionally, there are other technologies which are implemented to improve operation safety and technical performance that are the following:

- **Falling object detectors** have been installed on flyover crossings on high-speed lines in Europe based on wire electrical continuity or infrared sensors. In Japan, Shinkansen is protected from falling objects with fences, so that no active detection system is required.
- **Falling object detectors** are installed in platform borders in some Japan railways to stop incoming trains in case a person falls from the platform to the track level.
- **Laser radar obstacle detectors**. Japan railways have incorporated dimensional laser radar obstacle detecting devices which accurately detect obstacles on existing crossings in conventional lines.
- **Tunnel fire and overheat detection systems**. Currently the installation of these systems inside railway tunnels is not mandatory in Europe\(^4\). Nevertheless, some tunnels in France and high-speed line tunnels in Spain are equipped with fire and overheat detection systems based on optical fibre sensor wires. These systems are being implemented worldwide together with the evacuation facilities, the tunnel ventilation systems and water supply inside tunnel installations based on the experience got in accidents.
- **Hot bearing/hot wheel detectors** are installed in France, Germany, Spain and Korean high-speed lines as other sections in France, Germany, Spain and United States. Some hot wheel detectors are installed at the entrance of long or major tunnels.
- **Dragging equipment detectors** are installed in France, Germany, Spain and Korean high-speed lines and in some lines of the United States.
- **Train wheel defect detection systems** are installed in high-speed lines in Europe.
- **Pantograph dynamic monitoring systems** which supervise the mechanic relation between the train and the catenary are installed in high-speed lines in Spain.

\(^4\) It is mandatory that European road tunnels must be equipped with a continuous fire and overheat detection system before 2014 based on continuous sensor system.
When asked about annual investment in safety systems, some railway authorities declare this information cannot be made public. Korail and JR East and Central companies, however, have provided the following information:

Table 5. Korail, JR East and JR Central investment in safety during the last 3 years

<table>
<thead>
<tr>
<th>Year</th>
<th>Korail (million USD)</th>
<th>JR East</th>
<th>JR Central</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>6,732</td>
<td>1,317</td>
<td>771</td>
</tr>
<tr>
<td>2007</td>
<td>4,231</td>
<td>1,701</td>
<td>1,439</td>
</tr>
<tr>
<td>2008</td>
<td>4,099</td>
<td>1,747</td>
<td>1,895</td>
</tr>
</tbody>
</table>

Source: Korail, JR East and JR Central companies’ interviews and annual reports

JR East has even analysed the relation between railway safety investments and accident decrease. The following picture shows how the increase of investments in safety systems and techniques has resulted in a clear reduction of accidents in the last 20 years:

Table 6. Analysis of the relation between railway safety investments and accident decrease at JR East

2.4.4 EMERGENCY INFORMATION SYSTEMS

(262) As previously indicated, railway authorities of the reference countries have Emergency Management Information System (EMIS) to help in the emergency management. These systems are not as complex as those of the governmental emergency agencies' centres in Europe, Japan, Korea and the United States and do not integrate communication with external agents. Usually the EMIS of the railway authorities performs alert dispatching, integrates information of the railway network, integrates GIS applications, registers the actions carried out during the emergency and permits to obtain reports about all the actions carried out from the railway authorities.

(263) On the other hand, governmental emergency management centres have developed strong EMIS that integrate different modules permitting internal/external communications, call centre functions, resources mobilisation, graphical information system (GIS), voice recording and data mining, among other functions.

Exhibit 16. Systems of an EMIS.

Exhibit 16. Systems of an EMIS.

Source: Consultants analysis.

(264) The components of this EMIS are:

- **Call centres.** As previously indicated, some call centres function is limited to filter incoming calls. Therefore, some implementations dispose different rooms or sites for call centre and emergency management functions operated by different operators. Although, the best solution is the one where the same software supports both the call centre and emergency management in order to integrate the information, consultants have identified that some call centres are not integrated to the emergency management centre and the information is required to be computed twice. On the other hand, the best integrated solutions are those which are based on the same software that assigns different roles to call centre staff, managers or operators, operator supervisors and room chief. Nowadays, railway emergency centres are not database integrated to the public emergency centres in the referenced countries.

- **The EMIS platform** which integrates other systems around it. Although commercial software products exits, the best technical solutions are based on customer-made solutions of parametrical and flexible software developed by vendor companies which offer integrated solutions supported on hardware and software components provided by different manufactures.

- **The incident dispatcher,** which drive the emergency manager or operator during the response phase as well as tools which provide additional information to the operator and connect to external databases. Every action related with the incident is registered in the trouble ticket which is assigned to each incident in order to monitor the process of the incident management.

---

5 Siemens (Germany), Thales (France) and Indra Sistemas (Spain) which are EMIS developer companies worldwide have provided information to Consultants. The commercial brochures received by Consultants are attached as Annex 6.3 Emergency Management Information Systems.
- The geographical information system (GIS) that supports both graphical information\(^6\) and emergency resources position on the maps based on automatic vehicle location (AVL). There are several companies worldwide developing commercial GIS software as ESRI, Intergraph Corporation, AED SICAD, GMV, etc. which is integrated in the EMIS by the EMIS developer company.
- The front-end communication systems which include PABX connection with telephone, call centre functions, voice recording system (VCR) and communications with external services as meteorological agencies.

(265) In general, the EMIS meet the following basic requirements: windows environment, oracle database, total integration of applications and modules, scalability and easy adaptation to changes, fault tolerance availability. Consultants have not identified complex system developments based on workstations or UNIX operating system as it is common in railway traffic control centres. Until now, EMIS are generally based on client-server architecture although some developers have started to offer EMIS based on Service Oriented Architecture (SOA) which is based on operation concept\(^7\) and best fits database integration among different services and agencies.

(266) In general, EMIS implementation projects for governmental emergency agencies' centres involve three different phases as summarized next. About one to two years are usually needed before starting an EMIS operation service in an EMC:
- First, a detailed study and analysis of previous situation is done to identify the services and operation particularities of agencies involved in emergency management. Next, the expected operation is specified in order to determine changes required in services and links among the agencies and services. Afterward, the best architecture, hardware and software requirements for the EMIS implementation are selected.
- Simultaneously the software is developed and implemented based on commercial products integrated by the developer company; communication links among services are developed too.
- Usually there is a maintenance period to confirm operation and update procedures by the developer company.

---

\(^6\) Standard formats used by GIS system are DXF, MrSid, ESRI Shape and Tiff.

\(^7\) Mexico City where 22 million people live has developed a public management information system based on SOA architecture which supports 80,000 personnel by one main centre and five regional centres integrating emergency agencies.
3. COMPARISON BETWEEN PRC AND REFERENCE COUNTRIES

(267) This chapter reviews current practices adopted in the People’s Republic of China (PRC) for managing railway emergencies and compares them with the practices of the analysed countries in order to identify challenges and possible feasible alternatives for the improvement of the railway Emergency Management System in the PRC railway network.

3.1 LEGAL & REGULATORY

(268) The People’s Republic of China (PRC) legal framework for emergencies contemplates several laws that regulate railway fields.

(269) For railway emergencies in PRC, specific regulations from railway sector rule over this subject while in the references countries, as it is mentioned above, civil protection-field leads the management of all type of emergencies including those from railways in which railway legislation encourage and support it. Thus, in PRC for general emergencies the State Council is the supreme administration while for railway emergencies it is the Ministry of Railways (MOR) that is responsible.

3.1.1 LAWS AND REGULATIONS

(270) Like in reference countries, in China there is a general law for emergency response and there are others for specific hazards like floods, earthquakes and fires. Additionally, there are other laws related with specific subjects as reporting production accident and work safety.

(271) China establishes emergency management responsibility at provincial level, as well as in reference countries, like for example to develop and implement emergency plans, personnel training plans for departments with responsibility of managing emergency events, etc.

(272) In general, relevant laws provide principles for emergency response, prevention and emergency preparedness; for monitoring warning, emergency response, rescue, and reconstruction; for reporting, investigating and managing the production safety accidents. In addition, they mandate to elaborate emergency plans and to assure work safety in production and business operations.

(273) In particular with emergency plans, there is in PRC a specific regulation that stipulates a general emergency plan. The Master Plan in PRC, similar to reference countries, contemplates organisation structure, procedures and mechanisms to resolve any type of incidents/accidents (flood, epidemics of infectious diseases, traffic accidents, etc.). The State Council is the supreme administration for the emergency management of public incidents. Besides emergency plans for public disasters, also communities and business organisations shall formulate their own emergency rescue plans.

(274) Regarding duties and responsibilities, legislation includes the State Council and counties, governments’ authorities, relevant experts and organisations engaged in production management activities in PRC.

(275) Moreover, similar to reference countries, in PRC there is an organisation which performs duties regarding emergencies, information collection and overall coordination, the Emergency Management Office in the General Office of the State Council.

3.1.2 RAILWAYS

(276) Like in reference countries, railway sector regulations covers principally, plans for traffic accidents, safety requirements and accident investigation rules and intervention.

(277) In terms of emergency plans for railway traffic accidents, and similar to the practice seen in the reference countries, PRC railway laws require RBs to develop and implement, under the guidance of MOR, emergency plans covering organisation procedures, roles and responsibilities, definitions of emergency response levels and corresponding response actions, training and drills. Thus in PRC, by including specific emergency plans for railway sector and by assigning the whole responsibility to railway departments, railway organisations perform an active role in managing their urgency situations. In this case, they shall plan, implement and coordinate their own resources while in reference countries railway agents collaborate with government authorities who lead emergencies resolution.
Due to the fact that, PRC laws transfer railway emergencies responsibility to the Ministry of Railways, while in reference countries this is a responsibility of the Ministry of Home Affairs, PRC railway legislation attaches special importance to emergency issues in addition to safety ones; while in reference countries, railway legislations are focused in safety matters.

Following this trend, PRC railway regulations challenge should be related with safety constraints, reinforcing regulation related with safety targets, annual reports, certifications, etc.

Finally, regarding accidents investigations, legislation in PRC contemplates definitions of accidents and incidents and reporting procedures. For example, for tremendous accidents (100 or more seriously injured people and 30 or more deaths including missing), PRC Railways shall report to the State Council and inform National Safety Supervision and Management departments. In addition, in case of accidents with killed and injured people, on-site rescue team (Site Command) shall inform county or higher government authorities.

3.2 INSTITUTIONAL

3.2.1 REGULATING AGENCIES. SAFETY AND ACCIDENT INVESTIGATION

In the People’s Republic of China (PRC), there are three levels of management in the national railway system:

- Ministry of Railways, part of the State Council of the People's Republic of China.
- Railway Administration (Railway Bureaus and Railway Group Companies).
- Railway Stations.

While in reference countries ministries of transports or ministries of public works are in charge of railway sector business development and safety managing, in PRC there is a specific ministry for the railway sector: The Ministry of Railways (MOR) is the leading organisation with regard to railways that regulates all railway sector aspects: safety/security systems recommendations, certifications, accident investigation, etc. Under MOR there are eighteen Railway Bureaus (companies).

Regarding safety agencies, the Safety Supervision Department of MOR is a specific agency like in reference countries (France, Germany, Spain and USA.), where agencies subscribed to the ministries of transports or public works are specialised in railway safety issues with competency, for example, in promulgating and enforcing rail safety regulations, in conducting research and development in support of improved railroad safety, in supervising and issuing authorisations and certifications, etc. This would ensure that railway organisations comply with safety requirements and targets.

<table>
<thead>
<tr>
<th>Task</th>
<th>China</th>
<th>France</th>
<th>Germany</th>
<th>Spain</th>
<th>Japan</th>
<th>Korea</th>
<th>USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legal regulation</td>
<td>MOR Ministry of Transport</td>
<td>Federal Ministry of Transport, Building and Urban Affairs</td>
<td>Ministry of Public Works</td>
<td>MLIT</td>
<td>MLTM</td>
<td>FRA</td>
<td></td>
</tr>
<tr>
<td>Operating authorization</td>
<td>MOR EPSF</td>
<td>EBA Federal Railway Authority</td>
<td>Ministry of Public Works</td>
<td>MLIT</td>
<td>MLTM</td>
<td>FRA</td>
<td></td>
</tr>
<tr>
<td>Guarantee of diversity of transport service supply</td>
<td>MOR MCAF</td>
<td>Cross-sectoral Regulatory Body and BKartA</td>
<td>Railway Regulation Committee</td>
<td>NA</td>
<td>NA</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Safety recommendations</td>
<td>MOR EPSF</td>
<td>EBA Federal Railway Authority</td>
<td>Railway Traffic Safety Advisory Committee</td>
<td>JTSB</td>
<td>KRRRI</td>
<td>AAR</td>
<td></td>
</tr>
<tr>
<td>Accident investigation</td>
<td>MOR BEA-TT</td>
<td>EBA Land Transport Accident Investigation Bureau</td>
<td>Committee for Investigation of Railway Accidents</td>
<td>JTSB</td>
<td>AARAB</td>
<td>NTBS</td>
<td></td>
</tr>
</tbody>
</table>

Notes: MOR: Ministry of Railways; EPSF: French Railway Safety Authority; MCAF: Mission for Control of Railway Activities; BEA-TT: Land Transport Accident Investigation Bureau; EBA: Federal Railway Authority; MLIT: Ministry of Land, Infrastructure, Transport and...
3.2.2 COORDINATION WITH EXTERNAL AGENCIES. ROLES AND RESPONSIBILITIES.

(284) The following diagram reflects the current emergency management and settlement (organisational chart), roles and responsibilities of personnel within MOR, railway bureaus, stations and other related emergency management departments. The legend shows the basic meanings of the connection lines.


Source: Consultants analysis.

(285) In case of emergency of any level, an Emergency Command Team (ECT) for railway accidents should travel to the site and set up emergency coordination groups to supervise the emergency response actions. ECT shall also report information about the railway incident to MOR, during and after the emergency management.

(286) Under ECT there is the Emergency Management Office for Railway Accidents, which helps leaders of MOR in managing railway accidents and disasters, collects information, coordinates response actions and informs MOR. The Emergency Office is responsible for the integrated management of unexpected railway incidents and the coordination with the national emergency management department.

(287) Other agents of MOR involved in emergency management are:
- The Emergency Leadership Team of MOR is the supreme leading organisation for managing unexpected railway incidents.
• The Emergency Command Centre is the command organisation for managing railway emergencies, and is responsible for the organisation, coordination and command of emergency rescue of the national railway system. It also accepts relevant business guidance from the National Work Safety Emergency Rescue Command Centre at the same time.

• The Site Command Team takes charge of the real-time command and is dispatched to the rescue site, while the Site Rescue Team is the organisation responsible for rescue implementation. It consists of professionals related to emergency rescue in the fields of locomotive, rolling stock, electricity, civil engineering, public security and medical service.

(288) The provincial government of the location of the railway accident should establish a field rescue headquarters responsible for evacuating and quartering the people on-site, commanding social rescue forces and providing logistics.

(289) Railway Bureaus are allowed to directly contact local government to perform coordination in case of an emergency. If necessary, MOR is also needed to help coordinate with local government, local medical resources, etc. There is a list of telephones or faxes of local government to be contacted by RBs in case of emergencies.

(290) In the event that a railway accident of Level I (e.g. tremendous accident) and sometimes Level II (e.g. serious accident) railway emergency response occurs, the central and local governments will lead, coordinate and participate into emergency rescue.

(291) In case of railway incident of level III or IV, the corresponding RB becomes the main responsible for the response and, if necessary, contacts with the local government to perform coordinated actions. Most of the responses to incidents in PRC railways are managed by railway departments. The main difference in comparison with the reference countries is that PRC railway bureaus provide great part of the human resources that perform the response and that MOR directly organizes emergency response; while in the reference countries the emergency management is the responsibility of the governmental agencies, as delegates of the regional governments and Ministries of Home Affairs.

3.3 EMERGENCY MANAGEMENT

3.3.1 EMERGENCY PLANS

(292) In PRC, like in the reference countries, railway emergency management plans are developed based on the Safe Production Law of the PRC, the Railway Law and the Regulation on the Emergency Rescue, Investigation and Managing of railway traffic accidents among others. They have a well defined structure including not only the definition of the organization, responsibilities, alerting and response procedures during the response phase, but also elements of the recovery phase such as post-disposal and indemnities policies; propaganda, training and drills, updating constraints of the emergency plan, etc.

(293) These plans shall be developed specifically for determined risks, such as traffic accidents, natural disasters, mass incidents or dangerous chemical goods transportation.

(294) As in the case of the studied countries, the emergency plans defined by the RBs are supervised by a governmental body. The Ministry of Railways, in this case, guides the RBs during the development of these plans and once defined, they are reported to MOR for the record. And they are updated in a timely manner as indicated in the supplementary provisions of each plan.

3.3.2 RISK ANALYSIS. INCIDENT CLASSIFICATION

(295) As previously explained, this risks analyses are the basis for the development of specific railway emergency plans, for the definition of incident classifications and the corresponding procedures and for the identification of the safety systems to deploy.
Incident classification of PRC railways is classified as four main groups, as shown in the following exhibit:

Exhibit 19. PRC railways incident classification

<table>
<thead>
<tr>
<th>Category</th>
<th>Incident Typology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Disasters</td>
<td>• Earthquake, flood, Landslide, mudslide, storm, snowstorm, etc. Which causing disruption of railway traffic incidents.</td>
</tr>
<tr>
<td>Railway Traffic Accident</td>
<td>• Derailed, subversion, collision, fire, explosion, etc., which causing personal injury or property damage event.</td>
</tr>
</tbody>
</table>
| Social Security Incidents     | • Bombing, gun, homicide, robbery, major theft and other crimes against the safety of railway transportation security incident  
|                               | • The impact of railways, blocking trains, mob looting railway transport materials, and other mass incidents. |
| Public Health Incidents       | • Epidemics of infectious diseases, Group of unknown causes diseases, caused or may cause serious damage to social and public health, and may spread by means of railway accidents  
|                               | • In the railway station or the train, 3 or more people affected or causing the death of collective food poisoning incidents  
|                               | • In the internal railway units, occurred 3 or more people collective occupational poisoning, food poisoning, infectious diseases outbreak events |

Source. CARS analysis.

This is a solid incident classification which, as most of the reference countries’ incident classifications, is related to the cause of the incident.
In case of incident or emergency, the incident is classified at the station & depot according to this incident classification and it is also given a level of severity based on the quantification of immediate consequences. Incidents of level I and II are managed at MOR level, while incidents of levels III and IV are managed at RB level. The level of severity classification is shown in the following exhibit.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Incident scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Tremendous Accident</td>
<td>A Causing death of more than 30 persons or serious injury of more than 100 persons (including acute industrial poisoning, the same below), or a direct economic loss of more than RMB 100 million</td>
</tr>
<tr>
<td></td>
<td>B Over 18 passenger trains are derailed on arterial railways and the traffic is interrupted for more than 48 hours</td>
</tr>
<tr>
<td></td>
<td>C Over 60 freight trains are derailed on arterial railways and the traffic is interrupted for more than 48 hours</td>
</tr>
<tr>
<td></td>
<td>A Causing death of 10-30 persons or serious injury of 50-100 persons, or a direct economic loss of more than RMB 50-100 million</td>
</tr>
<tr>
<td></td>
<td>B More than 18 passenger trains are derailed</td>
</tr>
<tr>
<td></td>
<td>C More than 60 freight trains are derailed</td>
</tr>
<tr>
<td></td>
<td>D 2-18 passenger trains are derailed and the traffic of busy arterial railways is interrupted for more than 24 hours, of the other railways for more than 48 hours</td>
</tr>
<tr>
<td></td>
<td>E 6-60 freight trains are derailed and the traffic of busy arterial railways is interrupted for more than 24 hours, or the other railways for more than 48 hours;</td>
</tr>
<tr>
<td>• Serious Accident</td>
<td>A Causing the death of 3-10 persons or the serious injury of 10-50 persons, or a direct economic loss of more than RMB 10-50 million</td>
</tr>
<tr>
<td></td>
<td>B 2-18 passenger trains are derailed</td>
</tr>
<tr>
<td></td>
<td>C 6-60 freight trains are derailed</td>
</tr>
<tr>
<td></td>
<td>D Busy arterial railways are interrupted for more than 6 hours</td>
</tr>
<tr>
<td></td>
<td>E Other railways are interrupted for more than 10 hours</td>
</tr>
<tr>
<td>• Considerable Accident</td>
<td>A Causes the death of less than 3 persons</td>
</tr>
<tr>
<td></td>
<td>B The serious injury of less than 10 persons</td>
</tr>
<tr>
<td></td>
<td>C A direct economic loss of less than RMB 10 million</td>
</tr>
</tbody>
</table>

Source. CARS analysis

The factors considered for this level of severity classification are the number of dead or injured people, the number of people evacuated, the economic loss or the time of traffic interruption. The reference countries do not usually consider such type of quantitative classification since it is difficult to evaluate consequences in a detailed manner in the early moments of the accident/emergency. Sometimes, based on the information provided by the person who alerts from field, it is possible to foresee that the traffic will be interrupted for a long period of time or to suspect about the possibility of finding death or injured people in the train or its surroundings, like the level of severity classification of ADIF which is also based on consequences but in an intuitive manner. However, it is not realistic to do a quantitative evaluation of this type of damages in the first moments. That is why other railway companies such as Korail consider basing the level of severity classification on the resources needed to solve it, which is also an intuitive criterion. In all cases (PRC and the reference countries) due to these intuitive components of the level of severity classification, the level of severity assigned to an event can vary during the emergency response.

The definition of a multicriteria incident classification in PRC railways, as that seen in Korea, would permit a more accurate definition of the corresponding procedures and the implementation of both the classification and the procedures in an EMIS software. The first step to define such type of incident classification would be the development of an appropriate Risk Analysis.
3.3.3 NATURAL DISASTERS MANAGEMENT

(301) Concerning natural disaster management, as in reference countries, PRC railways develop actions in both the preparedness and response phase of the emergency. PRC railways obtain climate and earthquake risk information from other governmental bureaus, to be alerted about risks that may become emergencies. Once the climate or earthquake risk has become real, PRC railways perform the response to the natural disaster at the corresponding levels.

Climate risk management

(302) The China Seismological Bureau is responsible for the earthquake prediction; the bureau of meteorology is responsible for the climate forecast.

(303) The China Seismological Bureau is responsible for the collection of earthquake quick reports.

(304) Office of Disaster Reduction Committee works with the National Coordination Office for disaster relief to summarize early warnings of various types of disaster and forecast information timely, and to report the information to the member units and the local government.

Coordination with authorities and governments

(305) Once a natural disaster has become a real railway emergency, PRC railways perform the response in the railway environment by themselves while PRC authorities manage the response in a general way for all sectors affected.

(306) Ministry of Civil Affairs participates in the overall coordination of disaster recovery. This Ministry, in conjunction with the provincial civil affairs departments, organizes related experts to go to disaster area to carry out assessments and verify the situation about the victims living in difficult conditions. According to the provinces, autonomous regions and municipalities to consult the State Department in seeking funds, combined with the disaster assessment situation, the Ministry of Civil Affairs and the Ministry of Finance allocate serious natural disaster relief grants and earmark for victims. Development and reform, finance, agriculture and other departments implement work-relief policies, food department work to ensure food supplies. When the disaster situation has stabilized, the county civil affairs department immediately organizes disaster assessment. Within 10 days after the disaster situation has stabilized, the provincial civil affairs departments should report the disasters situation such as the collapse of the province's housing to the Ministry of Civil Affairs.

(307) Ministry of Health takes full charge of post-disaster disease prevention and epidemic monitoring work. In addition, they are responsible for organizing medical and health personnel go in-depth disaster area, providing medical and health services, promoting health and disease prevention knowledge, guiding the masses to improve environmental sanitation, implementing water and food hygiene supervision, achieving no major epidemic after the disaster.

(308) The disaster relief work is based on local government. When disaster occurred, township, county, prefecture-level, provincial people's governments and relevant departments should start the emergency plans of the relevant departments according to the disaster situation and the management at different levels, arrange the victims emergency transfer work and living work, do disaster relief work, do a good job of disaster monitoring, disaster investigation, assessment and reporting, minimize the loss of people's lives and property.

(309) To sum up, in PRC like in the reference countries, natural disasters involve such a high level of seriousness that they are not considered like railway emergencies managed exclusively from the railway sector, but they are managed in coordination with the Ministry of Civil Affairs and many other governmental departments. MOR maintains the leadership in the response actions in the railway field, and should help the Ministry of Civil Affairs in any requirement it may have such as transportation of resources, material, etc.

(310) Since PRC railways, just like the reference railway companies, have already procedures to obtain information about climate and earthquake forecasts; the main challenge for PRC railways would be to optimize and perfect an early alarm and safety system, according with the risk analysis by zones and based on the international practices, the appropriate early alert and safety systems that would permit to minimize the consequences of this type of unavoidable risks.
3.3.4 ORGANIZATION

(311) Like in Spain or Germany, PRC railways have a specific department for emergency management at RB and at MOR level (which will intervene depending on the seriousness of the emergency). However, unlike all the studied countries, PRC railways have several specific departments for rescue and relief actions such as the Public Security Bureau and the Labour & Health Department. In the response phase, the Public Security Bureau coordinates internal and external agents involved in emergency response and is responsible for the safety of passenger and masses, managing public order and ensuring passenger and personnel security during the emergency actions. The Labour & Health Department is in charge of the specific coordination of health services, coordinating medical care experts, medicines and medical equipment and preventing epidemics on field.

(312) On the other hand, the rest of departments involved in emergency response and recovery (maintenance and rolling stock, traffic operation and customer service departments) are similar to those analysed in the reference countries. The Departments of Equipment Division develop track and access relief actions to permit normal traffic restoration and the Traffic Dispatching Centre adapts the alternative traffic plan towards normal circulation. The Freight Transport Department and the Passenger Transport Department are responsible for information to passenger, claims and settlement of prices of the casualties and property loss. However, the information release to media is the direct responsibility of MOR or the authorized RB.

(313) To summarise, PRC railways emergency management organization’s main difference and strong point in comparison with the reference countries is that the emergency services in charge of rescue and relief actions and main responsibilities are attached to internal departments of the Ministry of Railways or of the Railway Bureaus.

3.3.5 EMERGENCY MANAGEMENT CENTRES

(314) As in most reference countries like France, Japan, Korea or USA, in case of emergency, the traffic dispatching centres develop emergency management functions in addition to dispatch train, maintenance, planning and scheduling for passenger and cargo trains.

(315) Differing from the references countries, since most of the information are internal to MOR or the RB, so most part of the information can be shared internally to enable the station and depot to coordinate the rescue and relief services.

(316) In case of emergency, PRC railways send special emergency management human power to the site, and usually officials including the RB director itself also move there.

(317) The emergency management centres in PRC railways possesses professional emergency management capabilities and resources coordination functions, it would permit station and depot dispatchers concentrate in traffic tasks and would provide emergency management staff better facilities and technical resources to develop their functions.

(318) In addition, when the complexity of the emergency requires it and if the circumstances permit it, the deployment of an MEMC would help the on-site personnel and coordinators to perform their tasks, making all the information and communication resources of the normal EMC available on-site and permitting to coordinate the emergency where it takes place.

3.3.6 EMERGENCY MANAGEMENT PERSONNEL

(319) In PRC, related with the fact that rescue and relief actions are mainly developed by internal departments, there is emergency management personnel not found in the railway companies of the studied countries. This staff is not limited to coordination but they participate actively during the response phase through rescue and relief actions. They are the Emergency Command Team, the rescue squad, the rescue team and the security monitoring team who may be supported in determined situations by governmental emergency resources like ambulances or external fire brigades.

- The Emergency Command Team (ECT) travels to the site and sets up emergency coordination groups to supervise the emergency response actions. ECT also reports information about the railway incident to MOR or the RB, during and after the emergency management.
• **The rescue squad** selects staff with rescue experience from stations where the rescue train is located, in order to assist the rescue train.

• **The rescue team** can tackle ordinary derailment and can single-handedly recover traffic without the use of a rescue train. This team is responsible for rescue implementation and it consists of professionals related to emergency rescue in the fields of locomotive, rolling stock, electricity, civil engineering, public security and medical service.

• **The security monitoring team** is responsible for video, the collection of evidence for investigations and the surveying of the rail traffic’s compliance with security constraints. It will also report the related information to the security-monitoring department of the RB.

(320) Concerning on-field command of the response, the ECT establishes groups to coordinate and supervise different activities performed by the rescue team and other personnel. The single overall responsible figure necessary to provide an efficient coordination and a unique command line is ensured by the RB director that usually goes to the place of the incident to supervise the actions coordinated by the ECT. However, the main difference between this profile and the on-field emergency coordinators seen in the reference countries is the RB director provides an institutional profile (which results really helpful in the communication with local/regional governments, media, etc.); while the CIL, the Emergency Manager, the Delegate chief and other on-field parties responsible for the reference countries are technicians who combine emergency management skills with railway infrastructure, maintenance and operation knowledge.

(321) In comparison with the studied countries, where most of the railway authorities have no specific personnel for emergency response and rescue, PRC railways have an important number of human resources not only for emergency coordination but also for intervention and rescue.

(322) Due to the great number of internal human resources that PRC railways own for emergency management, it should be convenient to reinforce the structure and hierarchy of these resources to ensure a well defined responsibilities assignment, a more fluent coordination and a more effective response to emergencies.

### 3.3.7 Technical Resources

(323) As the reference railway companies, PRC railways are nowadays equipped with large number of technical resources for emergency situations, such as relief trains, railway cranes, electrification vehicles as well as other emergency and rescue resources located in each rescue centre along the railway network. This ensures technical support nowadays in case of incident or emergency.

(324) Taking into account the mentioned incoming expansion of PRC railways network in the next years, China Railways shall ensure that each RB has the number of resources needed to face up emergencies along all its lines with acceptable response time.

### 3.3.8 Training

(325) According to the principle of tiered management, pre-tasks training at different levels for the personnel of all emergency response institutions and professional rescue teams, and regular professional trainings concerning rescue knowledge should be given to improve their rescue skills.

(326) The Railway Bureaus carry out individual and comprehensive practices and drills for emergency management. Individual practices for emergencies of level III and IV are mainly organized by the Railway Bureaus, as these types of emergencies are managed at RB level. A comprehensive practice for emergencies of levels I and II involve RBs, as well as some relevant competent departments of MOR.

(327) The challenge regarding emergency training for PRC railways would be to further optimize an elaborated training program taking into account specific contents for the different groups of professionals involved, detailing the training organization periodicity. Further optimization of the coordination with external agencies may require the development of shared training activities with these agencies.

### 3.3.9 Response Indicators

(328) As in some reference countries, PRC railways have defined some response time goals in order to ensure an efficient response to railway emergencies by the emergency agents who intervene at this stage. The response time goals defined by PRC railways are:
• When a railway traffic accident happens, the associated personnel should immediately report it to MOR, no later than 2 hours after; inform the members of the emergency command team of MOR according to the emergency plan’s request.

• During the emergency rescue phase, relief train shall depart within 30 minutes after they receive the dispatching order. When the relief train arrives at the site of the accident, the head of the relief train should immediately determine the specific emergency response rescue plan. When this specific rescue plan is approved by the on-site chief commander, then the relief train shall immediately start to carry out the lifting works.

• When the emergency rescue need communication, the communication department should start using the ‘117’ emergency communication manual attendant panel according to the needs when they receive the notice and should organize the emergency communication system put into operation.

• If the accident occurs at the station, the telephone should be opened within 30 minutes; the static image transmission equipment should be opened within 1 hour. If the accident occurs at the track section, the telephone should be opened within 1 hour; the static image transmission equipment should be opened within 2 hours.

(329) Considering the fact that PRC railways are in charge of the whole emergency management, including rescue and relief resources dispatch and actions, the monitoring of response and recovery indicators would make more sense in PRC than in the other countries analysed and would permit the PRC railway sector to evaluate the efficiency of the emergency response and of the emergency management system.

3.3.10 INCIDENT COMPENSATION PRACTICES

(330) In accordance with the railway passenger and freight transport management rules and regulations, Railway Bureaus compensate or indemnify the affected passengers, freight owners, the masses and their families. The Freight Transport Department and the Passenger Transport Department are responsible for claims and settlement prices of the casualties and property loss.

(331) As mentioned before, the insurance and compensation practices of the railway companies of the reference countries are not public, so no comparison is possible in this regard.

Compensation measures:

(332) Based on the "Regulations for Railway Freight Transport protocols" of March 1991, issued by the Ministry of Railways, the limit amount for loss of compensation for loss or damage of goods in railway transport are as follows:

• In the case of loss of not insured transport goods, if the compensation is not related to the number of goods carriages but only to the weight, the maximum compensation amount is 100 RMB/ton. If the transport of goods compensation is not only related to the number but also to the weight of goods carriages, the maximum compensation amount is 2000 RMB/ton.

• For individual consignment of moving goods, the maximum compensation is 30 RMB each 10 kg. If the actual loss is under the above-mentioned compensation limits, the compensation should be in accordance with to the real damages.

• If the goods loss due to the carrier's intentional acts or gross negligence, the above mentioned compensation requirements do not apply, and compensation should be in accordance with the real damages.

• If during the transportation, passengers are injured or goods lost or damaged, the maximum compensation is 40,000 RMB per person injured and 800 RMB for goods.

• Accident compensation standards regarding luggage are that in case of total lost of insured goods, the compensation should be in accordance with the real damages, without exceeding the declared price of the goods. If goods are partially lost, the compensation should be proportional to the part lost.

• In the case of non-insured goods, the compensation should be in accordance to the real price of damages, without exceeding 15 RMB/Kg.
Insurance measures:

(333) The insurance measures are clearly defined in the domestic seaway, railway cargo transportation insurance policy issued by the Chinese People's Insurance Company on Oct the 1st, 1986.

(334) The insurance is divided into two types: basic insurance and comprehensive insurance.

- **Basic insurance:**
  1. The loss caused by fire, explosion, lightning, hail, storms, heavy rain, floods, earthquakes, tsunamis, subsidence, cliff collapse, landslides, mud-rock flows.
  2. The loss caused by transport tools collision, stranding, grounding, capsizing, sinking, derailment or tunnels, piers collapsing.
  3. During the loading, unloading, or reproduction period, the loss caused by factors other than the poor quality of the packaging or breach of operational rules by handling personnel.
  4. According to state regulations or the general practice of general average share of the costs.
  5. In the event of such disasters, accidents, because of confusion goods may be lost and as a result of rescue or protection of the goods, the direct and reasonable costs are paid.

- **Comprehensive insurance:** This insurance not only includes the basic liability insurance, but also the insurer is responsible for compensation.
  1. The loss of goods due to vibration, impact, compression which caused crushing, bending, concave shrivelled, broken, cracked or ruptured the packaging of goods.
  2. The loss of liquid cargo due to vibration, impact or compression which caused damage in the used containers (including sealing) and leakage losses; or in liquid preserved goods, as the fluid leakage caused the loss of preserved goods or spoil them.
  3. The loss caused by theft or loss of the whole delivery of goods.
  4. Provisions of the safe transport are obeyed, but loss happened due to rain.

3.4 **NETWORK COMMUNICATIONS AND INFORMATION SYSTEMS**

(335) In emergency situations, PRC railways use the same fixed and mobile communication systems that are used for normal operation:

- PABX telephone.
- Scheduling telephone network\(^8\).
- Automatic telephone network.
- Trackside telephones and train dispatching system.

(336) The previously indicated systems are independent from other external communication systems used by people not related with railway operation or emergency, this guarantees communication continuity during the emergency response phase.

(337) As in the studied countries, PRC railways have both signalling and safety-related information systems. PRC railways have developed and continue developing its own signalling systems standards.

---

\(^8\) Scheduling telephone network is referenced as the selective telephony system in other countries.
3.4.1 FIXED NETWORK COMMUNICATIONS

(338) Fixed voice and data communications between MOR and all RBs headquarters are based on optical fibre and SDH connections fully extended from Beijing to all China. As in European and Korean high-speed lines, communications between the station and depot and the two stations of the high-speed line Beijing - Tianjing are based on two optical fibres supported SDH connections. In addition, meanwhile in these reference countries the backup networks are also based on optical fibre, the Beijing - Tianjing has a frame-relay backup network. In conventional lines, however, each RB headquarters is connected to the Stations and Depots by digital or analogue lines based on copper wires. The connection between the station and depots to signalling equipment on track and track telephones is based on copper wires too, while in the reference countries several technologies (copper wires or optical fibre) have been used for this purpose.

(339) Regarding fixed telephony systems, PRC railways have a PABX supported telephone system connected to the public switched telephone network (PSTN) at MOR, RB headquarters and stations. PSTN is the network used to communicate MOR and the RBs with external agents.

(340) As in the reference countries, the railway voice communication network is composed of the scheduling telephone network and the automatic telephone network:
- The scheduling telephone network, which connects the station and depots with stations and trackside telephones, is used for train dispatching and passenger and cargo scheduling.
- The automatic telephone network, which connects stations, depots and other facilities, is supported by the program-controlled switching network.

(341) Additionally, as in conventional lines of the reference countries, there is a trackside telephone system, with terminals every 1.5 km along the track connected to terminals in the stations, in the RBs and at MOR. Therefore, this trackside telephony system is almost a nationwide railway voice communication system.

(342) The network that connects MOR, the RBs and the stations is a Local Area Network (LAN) based on Fast Ethernet, which is a common practice also in the studied countries. For railway data communications, the LANs are connected by a Wide Area Network (WAN).

(343) The emergency communication network should be a very important part of PRC railways EMS. Although the current fixed communication systems between MOR and RB are satisfactory, RBs should increase the communication links with other external agents involved in railway emergencies response.

3.4.2 MOBILE NETWORK COMMUNICATIONS

(344) Traffic control mobile communications for RBs’ personnel at headquarters or at stations are supported by GSM-R or by the train dispatching system used as radio train to ground system. On the other hand, radio communications for headquarters staff not related with traffic control are supported by GSM. Messaging communication services are transmitted by GSM-R or the train dispatching system.

(345) GSM-R technology, which is a European standard and also used in Korea, was selected by PRC railways as the main mobile communication system for both high-speed and conventional new railways line sections in China. Additionally, GSM-R has been selected for new high-speed lines from Zhengzhou to Xi’an and from Wuhan to New Guangzhou. Where operating, GSM-R is used for all radio communications, supports Chinese Train Control System (CTCS) signalling system and provides wireless network coverage along the track.

(346) Therefore mobile communications in case of emergency between on-field personnel and EMCs are similar to those of the European countries, since it is supported by GSM-R where available or by the train dispatching radio system (from the trains).

(347) GSM is the mobile system used by PRC railways officers to communicate with authorities or external agencies. In order to ensure the voice communication between the emergency site and the Emergency Management Centre (EMC) PRC railways need a mobile (wireless or similar) communications system to guarantee the full coverage of the potential risk areas.
3.4.3 SAFETY INFORMATION SYSTEMS

(348) At present, all stations in PRC railways have installed computer-based interlocking equipment jointly with an continuous improvement in automation. China Railways have adopted Chinese Train Control System (CTCS), similar to European ETCS, as main signalling system.

(349) PRC’s railways have developed a safety-related monitoring system oriented to identity unsuitable train operation that is referenced in short as the 5T System: Trace Hot box Detection System (THDS), Trouble of Freight Car Detection System (TFDS), Trackside Acoustics Diagnosis System (TADS), Track Performance Detection System (TPDS) and Train Coach Running Diagnosis System (TCDS).

3.4.4 EMERGENCY INFORMATION SYSTEMS

(350) A software tool for emergency management in the EMCs, would help MOR and RBs emergency management personnel in the incident classification, corresponding procedures performance, resources mobilisation and coordination and other emergency management functions.
4. RECOMMENDATIONS

(351) Based on the contents analyzed in the previous chapters, this chapter presents the new situation faced by PRC Railways Emergency and proposes a series of suggestions. Consultants consider PRC railways shall further enhance Emergency Management System (EMS) to obtain an efficient and effective emergency system.

(352) The following exhibit presents the global set of a EMS based on experiences of reference countries. The core of this system is the deployment of the Emergency Management Centres (EMCs) and the Emergency Management Information Systems (EMIS) to be developed at these centres. Input of them is the multi-criteria incident classification, including incident/emergency classification, procedure/emergency plan and meteorological early warning system, which are derived from the results of incident risk analysis from MOR. While the output of EMIS and EMC is a mobile site, emergency technical resources, as well as the professional and trained emergency management personnel who master such emergency technical resource.

Exhibit 21. Summary of the set of recommendations to strengthen PRC railways EMS

Source. Consultants analysis.

4.1 RAILWAY EMERGENCY MANAGEMENT INFORMATION SYSTEM IMPLEMENTATION

Recommendation

(353) PRC railways should consider implementing an more effective and efficient emergency technological platform depending on EMS on the basis of current emergency platform. Emergency Management Information System (EMIS) shall provide functions of information collection, resource positioning and control, and has effective cooperation with MOR, railway authorities and local governments.

Rationale

(354) Railway Companies of the reference countries make use of some current emergency platforms to construct a more efficient EMIS. In addition, governmental emergency agencies in the reference countries participate in the procedures of railway emergency treatment, which improves the efficiency of EMIS and realizes more effective cost control.

(355) Emergency response is a process that needs proper coordination and previous preparation and deployment to be managed in a successful and orderly way. Through the analysis of the case studies presented in Annex 6.1 Railway Emergency response case studies, Consultants have identified that the main problems that may result in an inefficient emergency response are:

- Lack of emergency information from the emergency site.
- Absence of proper resources (Human and technical) management tools.
- Failures in coordination with other organizations involved.
• Lack of a reliable communication system between the site and the Emergency Management Centres.
• No properly defined and trained rescue and relief techniques.
• Lack of clear and well defined Emergency Plans or Procedures.
• Response coordination problems within railway participants.

(356) EMIS is able to realize precise incident position identification on the basis of graph management functions of a GIS. Driven by this tool, the emergency management personnel or operators are able to acquire incident-related information rapidly and make quick response. Based on these information, EMIS could integrate emergency-related information effectively, so as to ensure the emergency personnel to cope with emergency management in a more effective way.

(357) Generally speaking, whether the EMC could implement effective emergency management response is closely related to the response time of emergency. Undoubtedly, an EMIS could shorten incident response time and resource dispatching capability effectively.

(358) Incident database in EMIS could provide in-time and accurate incident-related information to the media, victims, relatives and the public.

(359) EMIS could provide MOR and relevant railway agencies a plenty of information about the incident to such as incident type, occurrence area and the number of fatalities. These information would facilitate effectively relevant departments to start incident assessment, and help to reduce the occurrence and lost of accidents.

(360) This unified platform for emergency command and rescue was also highlighted in the European travel report.

Description

(361) EMIS is a unified management platform based on different technologies, ensuring efficient, effective and cost-effective implementation of the whole emergency response. EMIS is a comprehensive software system that integrates functions of transmission, monitoring, management, recording and analysis, it could ensure effective and efficient implementation of emergency response according to the digital Emergency Plans and Procedures.

(362) Consultants recommend that the EMIS shall not be used only for daily management of MOR and RBs, but play the due role in emergency management and response.

(363) EMIS supports the emergency management from the moment an emergency call is received until the closure of emergency response after emergency management agency treating the incident. The stages of this process are:

• Each Emergency is received through the communication systems (voice or data) or in automated way from the operative systems of the RBs (Signalling, traffic control, Power, communications, etc.)
• A new Emergency control sheet is created in the EMIS and relevant information is gathered from reports of relevant departments.
• According to the gathered information, the incident/emergency is classified.
• According to this classification a Procedure (for Incidents) or and Emergency Plan (Emergencies) is assigned and the emergency response is developed.
• According to the information about emergency resource allocation acquired through EMIS, all internal (to the railway sector) and external (Local governments, fire brigade, etc) emergency resources are dispatched and departments involved are coordinated to deal with emergencies effectively.
• During the whole process of emergency response, the EMIS maintains continuously real-time communication between relevant agents and the site (if video is available, then it is presented in the video-wall of PC screens).
• All the information about the progress of the emergency is recorded in the EMIS (automatically and or manually).

(364) All this process is quite often named as “trouble ticket” technology, meaning that every emergency creates a trouble ticket (a white sheet) where the information received, the process of emergency response according to relevant emergency plans and the final results achieved are recorded and can be used for to ensure the most efficient and effective implementation of emergency management. The following exhibit shows the described process:
EMIS may be designed as a modular system including relevant services and functions:

- **Core system module** that is developed on the basis of EMIS with capabilities of call taking and management, dispatch management, incident management and trouble ticket assignment. These independent capabilities allow emergency management agents assign a unique trouble ticket to each incident and coordinate and manage the ticket. Meanwhile, a unified EMIS could integrate warning information of the same type of incidents and combine warnings about one incident.

- **Operational modules** are developed for each type of emergency including functions of full multi-agency emergency management: fire brigades, medical emergency services and police, etc.

- **Functionality modules** are developed on the basis of GIS, reporting and statistics functions to manage mobile location and response and supply training and simulation based on synthetic environment for daily emergency management.

- **Communication integration modules** which are the low level common functions that are used by all of the functional modules for communication. All the communications are recorded for later analysis.

- **Integration modules** support system security, database and computer telephony integration components. The technology for VoIP may also be supported. The functionality required for specific services such as fire extinction and rescue, ambulance, police etc. is delivered in special operational modules to realize the integration of the different system components and general functions such as reporting and administration of the system.

- Finally, additional **data mining, training and access control modules** provide those additional functionalities.

The following exhibit presents an example of a general modular architecture of EMIS. The four core modules are in the center and the rest of modules are integrated on this core.
The base of EMIS hardware may be realized equipping relevant servers and data centres in conjunction with workstations. Usually, the EMIS software meets the following basic requirements: Windows® environment, total integration of applications and modules, scalability and easy adaptation to changes, fault tolerance availability. The software is based on Java®, .NET® or XML languages. The relational database management system is generally based on Structured Query Language (SQL) supported by Oracle® database, and Microsoft® database solutions is also compatible. Open platforms for communications integration and emergency management, which support both analogue and digital telephones, voice over IP and digital radio interfaces, are used as GEMYC®. There are different GIS integration developments based on GIS server and client solutions depending on GIS supplier technology. Consultants have not identified EMIS as complex system developments based on workstations or UNIX operating system as it is common in railway traffic control centres. Nevertheless, the EMIS shall have high redundancy and backup solutions.

As previously described, EMIS are modular software and hardware developments. The applications and modules requirements for an emergency management information system may allow easy installation, easy sharing and communication between parameterization module of call taking and other sub-modules. High level of integration of EMIS modules ensures a smooth and secure transfer of information and at the same time leads to a balanced relation of system efficiency and costs. Additionally, it is required for easy integration of any geographical information system or other external information systems such as SAP Enterprise Resource Planning (ERP), data analysis system related to office automation. And text connection is also provided for EMIS in case of emergency to open usage of the information about emergency response. Meanwhile, interface of EMIS is user friendly and easy-to-use for emergency staff.

Java® is a programming language originally developed by Sun Microsystems®. The language derives much of its syntax from C and C++ but has a simpler object model and fewer low-level facilities. Java applications are typically compiled to byte code (class file) that can run on any Java Virtual Machine (JVM) regardless of computer architecture.

.NET is a software framework that can be installed on computers running Microsoft Windows® operating systems. It includes a virtual machine that manages the execution of programs written specifically for the framework.

GEMYC® is the Communication and Emergency Management System supported by Fedetec company installed by some vendors.
Consultants have identified that available and involved resources, communications and GIS are presented by an EMIS in three monitors:

- A left monitor dedicated to events
- A central monitor dedicated to resources and communications
- A right monitor dedicated to GIS.

The following figures show two cases of windows presentation to the EMIS.

Figure 16. EMIS windows presentation: event form, call assistance, resources and communication interface.


Figure 17. EMIS windows presentation: event form, call assistance and communication interface.

Source. Airport solution. Siemens.

The main modules of these EMIS are calls management, dispatching, supervision and control, statistics and reports, geographical information, video management, data administration and staff management which are described in the following paragraphs and shown in the following exhibit.
(372) **Calls management** is the process of collecting information and assisting information acquisition based on pre-established procedures. The process includes the answer of call, information gathering and analysis of the first call, asking the caller information about the incident, and defining position of the incident. If the incident has a high severity level, the call may be transferred to the management personnel or other decision-makers. The functions supported are: integrated telephone functions, integrated radio functions, automatic call distribution to operators following defined algorithms, automatic localization identification, mobile services location, receptions alerts from alarm devices, false call registry, related calls management, validation of address, assignment related to medical service zones, fire-fighters zones and police area of influence. The following figure shows a case of call centre window.

**Figure 18. Call taker window.**

Source. **SITREM® Real-time Emergency Management Solution. Siemens.**
(373) **Dispatching module** includes alarming, resource dispatching, communications after activation of emergency response procedure, mobile site management, supporting, monitoring and coordination of the different teams, groups and operating units dispatched for an incident. It can also include information gathering about victims and damages for the records. The incident dispatching is designed to continue the communication even in cases of a total failure of the information system. The next figure shows a dispatcher window:

Figure 19. Dispatcher window.

![Dispatcher window](image)


(374) **Supervision and control module** is used, before specific decision made by EMIS, for using historical information stored in the system to coordinate incidents involving more than one emergency agency managing crisis situation, including broadcasting of mass messages to the population, information offered to the press and reporting to the authorities.
Communication integration module allows control of all telephone and radio systems in the same way supported by voice matrix and specific hardware. The following figure shows a TETRA based communication integrated in an EMIS:

Figure 20. Description of TETRA based communication integration window

Statistics and reports module allows selection of information on events, provides EMIS with services of report and statistics. Information about events includes: incident details, response types, victims, compensation, etc. This information is useful for later analysis. The following figure shows an activity report presenting the response time:

Figure 21. Activity report presenting the response time.
The geographical information module allows precise positioning of resource available for emergency response based on GIS related to events. The functions include: positioning of incidents, display of available resource. Normally, the graphic window displays and integrates information about emergency management, being supplemented by text explanation. GIS supports an extensive resource database that contains a variety of geographic layers that can be accessed to visualize various data such as infrastructures, hospitals, government facilities, roads and other rail transportation and transit systems around. Additionally GIS includes conventional and high-speed railway lines and stations and depots, bridges, dams, rivers, street, road and highway names, blocks, places of interest (schools, banks, police stations, parks, museums, stadiums, gas stations, shopping malls, fire stations, health facilities, tourist attractions, etc.). Meanwhile, information from many organizations and agencies which would be part of the response effort is shown in the module. The following figure shows a EMIS integration based on a GIS, resources involved in the emergency response and vehicle automatic location in a government EMC:

![Location of automatic vehicles based on GIS.](image)


The training module allows management agents to meet management requirements in the future, such as simulated procedure completion under direct supervision, communication integration or other emergency management information system facilities.

The simulation module based on synthetic environment offers power modelling tool for training and mission rehearsal in complete urban or field area mission. It can quickly reproduce the whole process of large-scale emergency response by using available data.
Video management module allows local display of events controlled by video cameras. This module is more developed in railway emergency management information system as railway systems dispose of own cameras in stations and depots. The following figure shows a video management integration which integrates cameras from buildings in the EMIS based on a vendor specific solution:

Figure 23. Integration of video management

Source. Video SATHI. Thales.
(381) **The data administration module** refers to the storage and maintenance of information that is stored in the tables of the database, which refers to basic system data and parameters. System data includes, emergency call codes, resource / service proposal for each call type. The following figure shows the video-wall control screens administration window in a concrete EMIS solution:

Figure 24. Video-wall control screens administration window.


(382) **Staff management module** gives accurate forecast demand and schedule. Key functionality includes for example working calendar, free time (vacations, sick days), overtime management, the staff assignment to shifts, category changes, disciplinary actions, skills - training given and received, quadrant management, performance management, etc.

(383) The integration with other emergency services when exists, is based on voice and data. Previously agreements to define how to send and receive information with the external agencies are required. Consequently, all external agencies telephone and fax numbers which would be involved in emergency management are stored by the EMIS as internal data. When EMIS needs to use pre-defined telephone numbers, it can be done only by inquiry in the system. Consultants have identified that the coordination among agencies involved in government emergency management are main based on voice and data, so integrated communication protocols need to be defined in advance.

(384) Each procedure in the emergency response should be incorporated to the EMIS

(385) The best practice recommended is EMIS based on commercial hardware and software products that vendors integrate in a customer-made solution which requires additional specific software development.
Options

(386) Each RB should establish gradually an EMC and deploy at least one EMIS considering different risks and situations to be faced, so as to achieve the system adaptation to the geographical area, lines, emergency plans, procedures and specific RB organisation. All EMC in RBs should be coordinated by MOR, thus, various structures may be used to provide supports for all EMIS running in MOR and RBs:

- On the one hand, a centralized system supported by one main server in MOR to which every RB is connected is possible. This architecture simplifies the existence of a back-up data centre although requires secure and robust communications between MOR and RBs. Nevertheless, if particular configurations are done for RB as previously indicated then a distributed solution presents easier to develop.

- On the other hand, a distributed system based on a distributed database supported by both RBs and MOR EMCs, with MOR EMIS as point of centralization is also possible. Therefore, EMIS implemented in each RB are interconnected. This option requires qualified technical staff at RB centres which ensures EMIS operation in a 365x24 basis. MOR EMC would be configured as back-up of the RBs EMCS. Additionally, a full equipped back-up data for MOR EMC and some Mobile Emergency Management Centres (MEMC) equipped with the same EMIS software running in the EMCS are also required. Actually, distributed database solutions exist worldwide as basis for continue operating systems in case of systems failure due to natural disasters, terrorism, power supply cut off, etc.

(387) As previously indicated, EMIS are generally based on client-server architecture although some developers have started to offer EMIS based on service oriented architecture (SOA). In order to better integrate different services and agencies, SOA architecture is recommended.

(388) PRC railways should consider a phased installation for EMIS implementation instead of a simultaneously installation in all RBs. The pilot project would represent about 70% of the analysis and consultancy results in the global project. As a common rule in the studied countries, MOR should consider a maintenance period up to six months for RBs’ adaptation to the update of EMIS.

(389) Nowadays, all governments in the reference countries are equipped with EMIS. EMIS in the studied countries support integration with other agencies based on voice integration in simple systems or both on voice and data integration including trouble ticket sharing in more integrated systems. The functionalities to dispose a wide integration with external agencies have been easily incorporated due to EMIS modular architecture. Therefore, the first MOR EMIS development would consider only voice integration with external agencies and afterwards data integration including trouble ticket sharing. EMIS are commonly implemented simultaneously with other emergency services own EMIS development so that different integration phases may be defined to ensure integration with EMIS in local emergency agents.

(390) Emergency management operators would be focused on emergency management when an incident happens. Consequently, emergency management operators often neglect coordination with the traffic dispatching system during the emergency response. Train operation and power control should be done by the train dispatching operator. The integration between emergency management operators and traffic and energy power control operators is required based on voice communications or data-based urgent messages that should be recorded. Although emergency management operators do not need integration with traffic, Consultants propose that emergency management operators should visualize train traffic and energy power situation. The integration should consider only a limited access to visualize traffic tools or a deeper integration such as permit communications with trains depending on the agreements with department of railway traffic control:

- On the one hand, an integration based on an additional monitor is possible.
- On the other hand, an integration based on a window presented in the EMIS system should be possible.
- Finally, the most integrated solution is that the EMIS system accesses to the traffic database.

4.2 EMERGENCY MANAGEMENT CENTRES (EMC)

Recommendation

(391) PRC railways should consider developing specific Emergency Management Centres (EMC), adjacent to traffic control centres of MOR and the RB, so emergency management personnel can develop their tasks with autonomy but co-ordinately with other departments’ staff.
Rationale

(392) In China, RB and MOR functions and responsibilities in emergency management are wider than in other countries. Besides, these additional functions in the reference countries are developed by external emergency agencies which count with specific emergency centres to develop their tasks, so these agencies’ centres should be the model for MOR’s and RB’s EMCs.

Description

(393) In those countries where there are emergency management centres as well as traffic control centres (as in Spain or Germany), the emergency management centres are placed next to those of traffic control or even in the same buildings. This allows sharing information among different in case of emergency maintaining their work autonomy in normal situation. Based on this practice, MOR’s and RB’s specific personnel of emergency management could be located in an adjacent room next to the one for traffic operators in other to maintain their independence but permit a close cooperation with the traffic operation personnel in case of emergency.

Figure 25. EMC areas: operators room, Data Processing Centre and crisis room


(394) As previously explained MOR’s and RB’s responsibilities and functions in emergency management are similar to the ones developed by the governmental emergency agencies in the reference countries. This functions should be therefore carried out from the PRC railway EMCS, mostly through the EMIS installed in such centres, and are the following ones:

- Emergency call/notification reception
- Emergency classification
- Procedure assignment based on the incident classification
- Internal and external resources assignment
- Coordination with external agencies
- Corresponding response procedure monitoring
- Incident closure registration

(395) In the case of MOR and RBs, the volume of incidents per EMC may be so low that, if its functions are limited to emergency response and recovery, the centre risks having sometimes a low workload. To avoid this, the EMC could, for instance, develop additional functions such as climate and natural disasters risk management and monitoring of early alert systems face to natural disasters, etc..

(396) Other important aspects of the EMCS are their internal structure, personnel and equipment management. Recommendations regarding equipment and IT tools can be found in the corresponding
Regarding the internal structure of the centres, and attending at the layouts seen in governmental emergency centres of the reference countries, the Railway Bureaus and MOR should consider optimizing their EMCs allocation as indicated in the exhibit:

- An operator's area, including the work posts of traffic dispatchers and other railway operation personnel.
- A video wall face to the operator's area where relevant images collected from railway company's CCTVs.
- A separated Crisis Room where the members of the Crisis Cabinet and emergency management department officers can discuss between them and take coordinated decisions. This Crisis Room should be common to both EMC and traffic centres.
- A Data Closed Room, next to the operator's room, housing video racks, communication racks and other auxiliary devices.
- A Data Processing Centre (DPC) housing all the equipment that supports the communications and the information systems used by the centre operators. The DPC do not need to be next to the operators’ area, it can be separated, in the same building of the EMC or even in a near building.
- Officers’ bureaus.
- Resting areas.

Exhibit 25. Layout of the parts of an EMC

As mentioned, the personnel dimensioning criteria for these centres are, as a general rule, the number of calls and the number of emergencies received by centre, taking into account that these centres are operative 24/24 and 7/7 and that personnel shall therefore work in shifts. These criteria may not apply in the case of a railway EMC because the volume of phone calls will be reduced in comparison to the governmental emergency centres. However, MOR and the RBs shall consider to place in each centre the appropriate number of operators to ensure they are prepared to manage a serious emergency 7/7 and 24/24.

PRC railways should optimize gradually installation and allocation of these EMCs next to each station & depot of each RB. Taking into account the foreseen expansion of PRC railways in the following years, the construction of EMCs should also be optimized when designing the station & depot in the future. EMCs of the RB should be in charge of the management of emergencies occurred in their area,

\[12\] Information related to IT tools in EMCS can be found in section 4.1 Railway Emergency Management Information System Implementation. Information related to EMC personnel can be found in section 4.6 Emergency Management Staff Structure.
while MOR EMC should only be activated in case the emergency affects more than one RB or in case an emergency exceeds capabilities of one RB.

Options

(399) When optimizing the EMCs, PRC railways could consider two options: to develop these EMCs adjacent to the station & depots or to develop EMCs inside the station & depots. In this case, traffic and emergency management department would share all the facilities of the station and depot (crisis room, video wall, etc) including the operators room, where both traffic and emergency dispatcher would work.

(400) The first option would involve a bigger investment to deploy additional facilities for the emergency operators. However, it would permit emergency and traffic personnel to maintain their autonomy during the performance of their respective tasks and each department would be able to manage their own information and decide which part of if make available for the rest.

(401) On the other hand, the second alternative of EMC allocation plan would reduce the necessary investment and not only facilities would be shared by the different departments but also information and technical resources. In addition, due to the proximity between both departments, emergency personnel would manage reliable and accurate information about the state of the tracks when performing the response to the emergency.

4.3 MOBILE EMERGENCY MANAGEMENT CENTRES (MEMC)

Recommendation

(402) PRC railways should consider installing and optimizing some mobile emergency management centres (MEMC) equipped with the same EMIS software running in the EMCs and connected by mobile network communications to the corresponding EMC and RB departments or external agencies involved in the response phase.

Rationale

(403) As mentioned before, one of the basic emergency Management principles is to solve the emergencies as close as possible to the place where they occur. Following this principle, in PRC railways, MOR and RB officers, as well as the Emergency Command Team, which coordinates actions on field, move to the place of the emergency. MEMCs would help these personnel in charge of on-field coordination to develop their functions through the same platform that the one used in the EMC and would foster communications between on field and EMC personnel.

Description

(404) MEMC is a mobile command unit which moves to the emergency site in order to coordinate the activity of the emergency resources deployed supporting the emergency control centre functions. As seen in the reference countries, this type of mobile units are only deployed in specific situations: serious emergencies which are foreseen to last several days, emergencies where a significant number of internal and external resources are needed and incidents that involve special complexity (such as hazardous goods incidents, terror attacks, etc). Following this criteria, in the case of PCR, MEMC should be moved to the incident site at least for level I and II emergencies. Even in these cases, the location of the incident should be taken into account before moving the MEMC taking into account the necessary network connection. The objective to be considered by PRC railways would be to dispose a MEMC on-site in the 24 hours from the notification of the incident. The number of MEMC required depends on the MEMC distribution criteria which should consider both distance distribution and transportation facilities in China: railway, road and airborne, in order to arrive to site incident. The Consultants recommend that, in accordance with each RB needs, multiple MEMC should be rationally allocated when an incident happens.
Figure 26. Crisis room of a mobile emergency management centre installed on a truck.

Source: Siemens.

(405) Regarding the MEMC installations, these mobile centres are equipped with autonomous electric power supply, air-conditioning, folded mast antenna, etc. and are designed to operate continuously during 48 hours without refuelling. Additionally, external solar supply may be available.

(406) The MEMCs connect with EMS supported by different communications depending on the technologies used by the government emergency agency: TETRA, GSM/GPRS/UMTS/LMDS, city wireless system, satellite communications, etc. Therefore, EMC databases are available on MEMCs. Consultants have identified the best practice is a specific development for remote MEMC in order to operate with a narrow bandwidth for the communications. Additionally, specific developments have been done to support different video quality depending on available bandwidth.

Options

(407) MEMC can be installed on a trailer, lorry, 4x4 vehicles or bus. Additionally, containers solutions have been identified although Consultants have not identified MEMC designs to be railway or airborne transported in the studied countries as previously indicated in this Report. If an airborne solution were considered then a specific fix furniture design would be necessary.

(408) The MEMC disposes only an open area, otherwise it is divided in two or three different rooms: crisis room (which supports leader requirements as video, access to emergency applications and communications), operator’s room (connected to applications running on emergency centre depending on the developed integration) and equipment room (electric and electronic systems).

(409) Nowadays, there are several vendors offering MEMCs solutions worldwide in Europe, Japan, Korea and the United States. Nevertheless, the final equipment incorporated to the MEMCs has been determined by the integration company that has developed the EMIS solution. Commercial information regarding MEMCs facilitated by Indra Sistemas, S.A. is attached in Annex 6.3 Emergency Management Information Systems.
4.4 NETWORK COMMUNICATIONS

**Recommendation**

(410) Emergency Communication Network of Railway Bureaus (RB), as a part of the Emergency Management System, should be able to fully cover the potential risk areas. Meanwhile, a mobile (wireless or similar) system shall be equipped.

**Rationale**

(411) Voice communications are the basis for emergency management. Additionally, data and video communications are useful in emergency management. Video images transmission is useful for emergency purposes as detailed in the following recommendation\(^\text{13}\). Therefore, it is absolutely required to ensure communications between the emergency site incident and the EMC through available, efficient, effective and redundant network communications. Due the site incident may be located on a non-fixed communications available area therefore especially efforts on wireless communications may be done.

(412) Optical fibre backbone between MOR and the RBs headquarters and copper wires among rail company headquarters and station and depots as main physical infrastructures support coordination during emergency response. Additionally, extension of redundant optical fibre backbone among the conventional rail company headquarters and the stations and depots should be analysed.

**Description**

(413) PRC railways should consider utilising the same private communication systems that would support communication form site incident when an emergency happens, for both normal operation and emergency situations.

\(^\text{13}\) Recommendation nº 14 proposes video images transmission from incident site to the EMC.
(414) On the one hand, PRC railways should consider planning the GSM-R extension for conventional railway sections where it is not under operation. MOR should consider allowing interoperable communications among the GSM-R railway system and the specific emergency mobile communication systems operated by the external emergency agencies that would participate in the incident response. Also, PRC railways should consider GSM terminal distribution only as low cost mobile communication system for operation staff and maintenance brigades for operation purposes until GSM-R system is implemented along the track but not as mobile communication system reliable for response phase in an emergency situation.

(415) A real optical fibre backup should be necessary based on alternative wires as solutions based on different optical fibres supported by the same wire would not guaranty backup in case the wire results damaged. Optical transmission equipment backup should be based on both different equipment and electronic components redundancy. Optical fibre and equipment configurations based on ring architectures result the best practice for communication continuity in case some equipment failure happens or the optical fibre wires are damaged. Optical fibre wires installed inside conduits result in safety against animals and other attacks.

(416) Fixed network communications support large video volume transmission, both based on Ethernet links or specific optical fibre analogue equipment in the studied countries. However, video supported by Ethernet is growing worldwide and replacing both analogue equipment using dedicated optical fibre or copper wires and ATM video distribution solutions. MOR should consider designing fixed network communications to support video transmission in both the existing railway sections and the newest passenger dedicated lines that will be built. Video transmission should be secured from the origin to the destination due to confidentiality requirements to avoid images to be leaked unauthorized.

(417) The trackside telephone system is a secure communication system based on fixed network communications, usually copper wires extended along the track. Consultants have identified the best practice in Japan railways where personnel use trackside telephone as alternative voice communications system as previously indicated in this Report. On the other hand, trackside telephones in European railways are non maintained years ago as train dispatching system has replaced on ground previously communications systems between train and control centres. Trackside telephone installation is not considered in newest European high-speed lines. MOR should consider continuing to support scheduling telephone network and telephone trackside where it exists in order to dispose a replacement communication system in conventional lines.

(418) PRC railways should consider expanding scale of satellite communications to link personnel at the incident site or the mobile centre to the EMC. Satellite communications are required for rural and mountainous areas where no mobile communication system is available. Consultants have identified the best practice to be the government emergency management both for communication personnel at the incident site and the mobile emergency centres in Spain and the United States supported by satellite communications as alternative communication where other technological means are not available.

Options

(419) The mobile communication system used for normal operation may be useful to dispose mobile communications on incident site when an incident happens. But, only using an own private mobile communication system guarantees communication continuity when an incident happens due mobile communications based on public operators are not reliable as previously indicated in this Report.

(420) GSM-R radio is a private mobile communication system used for railways and therefore independent with respect to the mobile public operators. Therefore, GSM-R guarantees communication continuity in case an incident happens. Small size commercial GSM-R terminals to be used by headquarters staff, operation staff and maintenance brigades are available from 88 g weight. Although GSM-R is a private mobile communication system that guarantees communication continuity in case an incident happens, it may be affected in special circumstances by jammers. Likewise, GSM frequency bands are affected by jammers.

(421) GSM is useful in the mitigation and the preparedness phases but it is not totally reliable in the response phase as previously indicated due public networks result sometimes collapsed.

(422) Government emergency organizations in Europe, Korea and some government emergency organizations in the United States have adopted TETRA as main emergency mobile communication system as previously indicated in this Report. TETRA system operates in defined frequency bands that
are reserved in order not to be affected by jammers. Therefore, two different separate mobile communication systems are under operation on railway emergencies: GSM-R used by railways and TETRA used by emergency agencies. Nevertheless, as government manages the emergency, TETRA is the main communication system that continues under operation even the police activates jammers due a bomb alarm situation.

(423) The following exhibit shows the comparison among the mobile communications systems:

Table 7. Comparison of communications systems

<table>
<thead>
<tr>
<th>Technology</th>
<th>Analogue</th>
<th>Digital</th>
<th>Emergency</th>
<th>Groups</th>
<th>Mobility</th>
<th>Security</th>
<th>Available</th>
<th>Voice</th>
<th>Data</th>
<th>Standard</th>
<th>Flexibility</th>
<th>Bandwidth</th>
<th>Investment</th>
<th>Service cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSM-R</td>
<td>Digital</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Ground to train</td>
<td>Analogue</td>
<td>X</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>communication system</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Track-side</td>
<td>Analogue</td>
<td>✓</td>
<td>X</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>telephone</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobile cellular</td>
<td>Digital</td>
<td>X</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>High</td>
<td>High</td>
<td>-</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>Wifi</td>
<td>Digital</td>
<td>X</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>High</td>
<td>Very high</td>
<td>High</td>
<td>High cost</td>
<td></td>
</tr>
<tr>
<td>Winmax</td>
<td>Digital</td>
<td>X</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>TETRA</td>
<td>Digital</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Satellite</td>
<td>Digital</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Satellite operator</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>X(d)</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
</tr>
</tbody>
</table>

(a) Satellite mobile telephone is considered an emergency system. Nevertheless, VSAT services may not be considered as emergency systems due to communication delays and bandwidth capacity.
(b) Wifi 802.11n® mobile standard has just been completely approved.
(c) Nevertheless, free bands would not guaranty network security.
(d) Different standards are defined for diverse services.

Source: Consultants analysis.

(424) PRC railways should consider analysing available railway routes that would constitute communication ring architectures as well as both trackside installations for alternative optical fibre wires. Detailed plans for optical fibre connections have been made in European railways projects.

4.5 TRANSMISSION OF VIDEO IMAGES TO THE EMC

Recommendation

(425) On one hand, PRC railways should consider transmitting video images from stations to the EMC. On the other hand, PRC railways should consider analysing wireless communication system installation along the track to transmit live video images from incident site to the EMC or to the fixed network communication that would distribute the images to the EMC. Additionally, incorporation of airborne video supported by helicopters should also be considered to record and transmit images from incident site in major accidents and crisis situations to the EMC. Moreover, satellite communications are a valid alternative for this purpose and also to connect the Mobile Emergency Management Centres with the EMCs.

Rationale

(426) Although not wide bandwidth is disposed, live video images transmission from the incident site to the emergency management control centre and subsequently to emergency services assists in the incident management and coordination of major incidents and provides track and stations real time

---

IEEE has ratified the IEEE 802.11n® amendment which defines mechanisms that provide significantly improved data rates and ranges for wireless local area networks, on 14th September 2009. Publication of the amendment is scheduled for mid-October.
information to help in mitigating the impact on the citizens. Additionally, these images are useful for medical purposes when people are injured. Finally, real time video is sometimes useful for informing citizens.

(427) Usually, video walls are installed as EMC equipment, both for computer images, maps and video presentation purposes. Therefore, video transmission from the incident site to the emergency management centre is required.

Description

(428) European, Japan and Korean railways have installed video transmission systems that support the connections between stations and control centres both for cameras used for operation and security purposes. Additionally, some railway installations dispose cameras inside and outside the technical buildings, antenna towers, track accesses and flyover crossings along the track connected to stations or the control centres. When an emergency happens, operation and security video is transmitted to emergency management personnel. On the other hand, if it is required then security personnel receive operation cameras.

(429) In the studied countries, governmental EMCs have been equipped to receive and manage video images from incident site as main information source that completes the voice messages and explanations from people on-site. On the one hand, the governmental EMIS integrates the video sources from cameras on road crossing and along the roads, cameras installed by local authorities, video from building security systems, etc. On the other hand, the mobile emergency management centres are equipped with cameras to record what happens on the incident site to transmit the images to the EMC. Additionally, as video communications are available in the mobile emergency management centres, videoconference is available to communicate local leaders in the incident side with the emergency centres.

Options

(430) The video signal transmission among the stations and the EMC would be based on the fixed network communication. Therefore, an optical fibre supported fixed network communication may be required to dispose video transmission to EMC\(^\text{15}\). Nowadays, analogue video transmission systems based on optical fibre, video transmission based on ATM and video TCP/IP based on Ethernet and Gigabit Ethernet equipment solutions support video transmission in the studied countries although IP solutions are the best practice with actual technology state.

(431) The video along the track transmission absolutely requires a wireless system supported by an external public operator or specific railway installations. On the one hand, Public operators alternatives supported on 3G mobile cellular, UMTS and LTE systems may be considered to transmit images form site incident to EMC although these networks are not reliable in case a crisis happens. Satellite communication solutions may be considered although the required bandwidth for video purposes significantly affects the system cost. On the other hand, Wimax technology extension by railway companies may be considered to support wireless communications although no reference has been identified for emergency purposes in the studied countries. Public emergency agencies in the studied countries have incorporate video transmission to the EMCs where images are presented both to operators and video-wall system, based on wireless solutions as previously presented in this Report.

(432) On one hand, airborne video technologies are worldwide extended based on helicopters which transmit video signals to the on ground antennas that are connected to the fixed network communication or other alternative communication networks as satellite links. Technology selection may consider both the distance between the ground equipment position and the possible incident site and the image quality required. On the other hand, it depends on real time or elapsed video requirements. The best practice is the real time video from helicopters that government emergency agencies are implementing worldwide which is broadcast to the citizens in crisis cases for information purposes.

(433) In addition, Satellite communication is a state of the art choice for video transmission. Although it is an expensive service according to the researched countries, this alternative provides full flexibility to connect distant geographical locations.

\(^{15}\) Recommendation no\(^\circ\) 13 proposes improve fixed network communication.
4.6 EARLY WARNING AND NATURAL DISASTER SAFETY SYSTEMS

Recommendation

(434) PRC railways should consider continuing investing on safety-related monitoring systems against natural disasters: such as earthquakes, strong winds and heavy rains, as well as defining procedures and automatic communication links between MOR-RB and, the climate and seismological bureaus in order to ensure accurate and early information about the natural and climate disasters forecasts.

Rationale

(435) Climate disasters have a great impact on the railway lines. Those climate problems are usually linked to specific geographical areas where there are most likely to happen. A proper risk assessment on those areas is the basis to define the proper early warning systems to be implemented. On the other hand, there are special areas of the track where the potential risks are much higher. I.e. tunnels and bridges also need a case by case risk analysis linked to a specific emergency plan.

(436) Safety systems are implemented in the mitigation phase in order to eliminate the risks or reduce the effects that unavoidable situations may cause to the railway network. Signalling systems are oriented to safety traffic operation worldwide.

(437) Unavoidable emergencies due to natural disasters should be the subject of geographical risk analysis by the RBs and therefore the subject of specific emergency management plans. However, before activating the corresponding emergency plans, railway administrations could manage such type of disasters through predictive and preventive measures. These measures are the early alert and safety systems which, in general, are deployed to avoid incidents in case of natural disasters and can also reduce the impact.

(438) Consultants have found that Japan has a strong implementation of those technologies for early warning regarding different climate risk, jointly with very up-to-date technologies to control the operation of trains. Besides, the Japan and Korea travel report (as well as the European) pointed out this same issue, focussing in prevention while investing in safety technologies.

Description

(439) Based on the RBs risk analysis, PRC railways should consider strengthening the installation of natural disaster related early alert and safety systems. The main systems to be taken into consideration\(^{16}\) are:

- **Early earthquake alarm system.** PRC railways should consider installing systems to detect earthquakes that occur both away or near the railway network. When the earthquake is far from the railway track, this type of systems estimates the earthquake epicentre and magnitude using the P-wave and send information. With the information from the remote seismograph, the need of issuing and alarm is evaluated. If the alarm is necessary, a signal is transmitted to action the train emergency brakes. When the earthquake occurs near the railway network, the seismograph detects it before the P-wave arrives and depending on the level of seismograph acceleration the train may be stopped.

- **Strong wind warning system.** Strong winds related safety systems involve anemometers along the lines to know if the wind velocity exceeds the threshold of traffic cancellation. The installation of wind fences would reduce wind force on railway cars, permitting PRC trains to run in normal conditions even in case of strong winds. In addition, prediction systems should also be considered. Some prediction systems are based on statistics to predict wind velocity, other are based on weather information such as the passage of cold fronts, height of clouds and other information obtained from weather bulletins or weather radars. Finally, wind prediction systems based on Doppler radar should also be considered.

- **Rain observation system** that monitors the volume of the precipitations and permits to regulate traffic operation based on the results of the continuous monitoring.

- **Landslide and rock fall detecting system.** Landslide and rock falls are usually consequences of heavy rains, which can affect normal train circulation. For the detection of these events, PRC railways can consider systems based on slant sensors or based on fences with cables that disconnect when a

\(^{16}\) Systems described are based on those studied in Japan railways. More information can be found in the Annex 2.
great volume of land falls over them. Sensors would detect the weight of the land or the cable disconnection and send the information to the EMCs or to the station and depot.

Exhibit 26. The Shinkansen landslide system.

Exhibit 27. The Shinkansen wayside safety devices.

(440) The following exhibit shows all the wayside safety devices found in the Shinkansen:

(441) Once installed, these natural disasters related early alert safety systems should be connected to the rail interlock signalling system to allow remote train control and to the power supply control system to allow power disconnection, in case of reception of an early alert in areas of high natural disaster risk.
(442) On the other hand, PRC railways should keep constant connection with the climate and seismological bureaus in order to receive valuable information for early warning in case of possible climate disasters (i.e.: Typhoons, high rains, floods, …). This data transfer should be stated on a day by day basis (i.e.: Every day a climate and seismological report is received in MOR and RBs at agreed timetable and at least 2 times a day) and while in a climate emergency should be on a demand basis from MOR or RBs. It is necessary to consider an access through out Internet (or direct connections) to the bureaus web page to consult the current climate and seismological information available.

4.7 TECHNICAL RESOURCES. INVENTORIES

**Recommendation**

(443) PRC railways should consider analysing the necessity of procuring new technical resources for people rescue and tracks and rolling stock relief at RB level in order to ensure a good coverage of the entire railway network in case of emergency.

**Rationale**

(444) RBs should ensure availability and efficient response times of the train and track relief technical resources in the future railway framework.

**Description**

(445) RBs should consider having the technical resources needed to ensure optimal technical support coverage along their respective networks. The list of these technical resources, which should be inventoried in the railway emergency management plan of each RB, should be revised by MOR to ensure the RB can provide efficient technical response in case of emergency. Each RB should analyse if it is feasible or convenient to maintain by itself all these technical resources. Another good method would be to arrange agreements with different external companies for hiring cranes, electrification vehicles or road relief vehicles in case of emergency. Through these agreements, PRC railways would have the possibility of using these external resources when own ones are not available, are insufficient or cannot provide an acceptable time of response due to their geographical location.

(446) It is important that MOR and the Railway Bureaus develop technical resources inventories in order to ensure a fast localization and mobilisation of these resources when needed in case of emergency. Knowing the number of resources and their exact location permits to perform efficient technical interventions during the response and recovery phases.

(447) Moreover, once the inventories are developed, they should be registered in the EMIS of the Railway Bureaus so the personnel who operate EMCs can easily identify the most appropriate technical resources to be mobilised. Each RB should have its own technical and rescue resources inventory, and MOR should have the inventories of all the Railways Bureaus. In case an emergency occurs near the border between RBs, attending to these geographical inventories, MOR should consider the possibility of mobilising resources of neighbour Railway Bureaus in order to obtain a better response time.

(448) Since the technical resources are used in special situations and are not constantly mobilised, the inventories do not need to be continuously updated. However, it is important to ensure that they contain accurate information about the resources location. With this aim, they should be periodically updated (for instance once a year) and, after the closure of an emergency situation, the Railway Bureaus should check that the mobilised technical resources return to their corresponding rescue centres.

4.8 RISK ANALYSIS AND INCIDENT CLASSIFICATION

**Recommendation**

(449) Risk analysis should be develop at RB and MOR level, as risk identification is the first stage to identify different type of incidents in a specific sector or line. In addition, PRC railways should also consider the implementation of the resulting classification in an information system to make easier the emergency classification in the early moments of the emergency.
Rationale

(450) PRC railways should consider adopting a new Incident Classification based on different aspects, and adapting the level of severity classification to base it on intuitive factors, easy to identify in the first minutes of the emergency, avoiding a quantitative evaluation of the consequences, which may result inaccurate.

Description

(451) As mentioned before, first of all, PRC railways should consider establishing a formal procedure to develop risk analysis by geographical areas in order to define later an incident classification, the corresponding procedures and emergency plans and safety and early warning systems to deploy. Although there are several methods for the development of risk analysis, the basic process of risk analysis is summarised in the following exhibit.

Exhibit 28. Risk analysis process

Source: Consultants Analysis.

(452) PRC railways incident classification should be based on the combination of at several aspects such as the cause, the place of the railway network where the incident take place, the type of railway transport affected, the level of severity and other typified characteristics. In addition, the level of seriousness currently considered by PRC railways should permit to assign responsibilities for the whole emergency management and to avoid miss-coordination. Current best practice is found in Korea where the KRRI proposes an Incident Classification based on the aspects shown in the following exhibit. The classification results in a series of codes for each type of emergency that can apply to each type of railway line.
Exhibit 29. KRRI proposed incident classification.

<table>
<thead>
<tr>
<th>Class</th>
<th>Pattern</th>
<th>Object</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collision (C)</td>
<td>1. Head-on Collision</td>
<td>1. Passenger(P) Train</td>
<td>1. Station</td>
</tr>
<tr>
<td></td>
<td>2. Read Collision</td>
<td>2. Freight(F) Train</td>
<td>2. General Station</td>
</tr>
<tr>
<td></td>
<td>4. Train Window Breakage</td>
<td>4. P-F Trains</td>
<td>4. Tunnel</td>
</tr>
<tr>
<td>Derailment (D)</td>
<td>1. Train Derailment</td>
<td>5. P-H Trains</td>
<td>5. Level crossing</td>
</tr>
<tr>
<td>Fire (F)</td>
<td>1. Train Fire</td>
<td>7. Others</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Rolling Stocks Fire</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Building Fire</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Facility Fire</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Possible accidents:
- Urban subway: 185 cases
- General line: 407 cases
- High speed line: 185 cases

Example:
F114: Passenger train Fire in a tunnel

Source: KRRI meeting.

(453) KRRI proposes a level of severity classification related with the resources required to solve the incident or emergency:
- The lower levels should correspond with those incidents that can be solved by passengers, by staff at the station or by the driver.
- An intermediate level of seriousness may correspond with emergencies that require the intervention of Railway Bureaus own emergency resources such as own fire brigades or rescue personnel.
- Higher levels would correspond with emergencies that require a national management at MOR level with the coordination of other ministries, hospitals, etc.

(454) PRC railways should adapt the current level of severity classification to one based on circumstances observation and not in quantitative consequences. The first information received from field is critical to determine the level of severity.

(455) This complex classification, where hundreds of types arise, is not manageable if not implemented in an information system. In addition, once integrated in an IT tool, it will be easy for the railway staff who receives the incident notification to collect the relevant information that will permit to classify the incident and start an efficient emergency response procedure. This information gathering should be guided by the information system that shall indicate the relevant questions and information required to classify the incident or emergency in type and in level of severity.

(456) However, while this implementation work is done, current classification based on causes and circumstances can be used. In order to classify incidents with the current classification a simple typifying questionnaire should be defined. This questionnaire, filled in and registered in paper format, is still used in some of the reference countries such as Germany, where these questionnaires are written by Deutsche Bahn (DB) emergency management personnel and transmitted by fax to the civil protection regional or national agencies (112) who will manage the emergency. This measure could be very useful to formalize the communications among MOR’s emergency departments, the RBs, the railway joint ventures and other agents, as well as to inform about the incident and its circumstances to the Authorities. Defining classification questionnaires and other communication forms on paper would permit a more efficient and formal communication protocol than the verbal one while the information system solution is being implemented.
PRC railways should consider defining response plans through the combination of the incident typologies and of the levels of severity. Each scenario should involve one type of incident at its different levels and the conditions where one typified incident crosses the borderline between the severity levels.

These scenarios are also part of the proposal of KRRI for emergency response planning in Korea. Based on these scenarios, KRRI proposes to develop standard operation procedures, indicating all the steps to follow, the conditions to be considered and the next steps depending on those conditions. These procedures should be described in flowcharts as the example of the following exhibit.

Exhibit 30. KRRI emergency response procedure definition proposal.

These flowcharts not only help to establish procedures for each type of emergency in an easy manner but also suppose a previous phase that permits to implement them in an information system. This way, and related to the previous recommendation, once the incident has been classified and the severity identified, the information system will be able to guide railway emergency staff through the emergency response in an automatic manner, asking all the necessary questions to take decisions such as mobilising certain resources, alerting specific agents or upgrading the level of severity.

4.9 EMERGENCY MANAGEMENT PLANS

Recommendation

Each Railway Bureau or railway joint venture in PRC should develop, under the guidance of MOR, a General Railway Emergency Management Plan, containing a description of the railway lines involved, station, station & depots, risk analysis (Containing disaster analysis), human and technical resources (Quantities, skills, etc), directions for the preparedness, response and recovery phases for every type of emergency.
(461) Existing specific emergency plans should be maintained and improved based on detailed risk assessment and geographical localization. Detailed climate disaster emergency plans should be developed to ensure proper preparedness and early warning systems implementation.

Rationale

(462) Emergency Plans can be very wide considering emergency interventions or can be very protocol oriented in an incident resolution. According to the last chapter, the incident/emergency classification is linked to a detailed set of protocols or plans that should be activated according to that classification.

(463) Although Railway Bureaus develop Emergency Plans for specific railway emergency situations, a general railway emergency preparedness plan, common to all type of possible incidents should also be considered. This Plan will have to be supervised and approved by MOR (or Safety Agency) in order to ensure a first step in the preparedness for possible future emergency situations in RB or railway joint ventures.

(464) The intervention of emergency response agents that may be external to MOR/RB emergency response organization (such as ambulances or other ministries’ resources) makes necessary an exhaustive definition of the responsibilities and coordination procedures and agreements between all of the agents. This must be one of the main objectives of the general emergency plans.

(465) As indicated in the Japan and Korea travel report, a proper development of more than one thousand emergency response plans in Korea, mainly cover all the possible emergencies. In addition, the European travel report points out the relevance of social and public collaboration that can be formalized using the correspondent Emergency Plans.

Description

(466) Taking into account railway emergency plans of the reference countries the main contents of this plans should be:

- Emergency training programme, practices and drills
- Emergency Classification
- Emergency management department composition and internal organizations involved. Roles and responsibilities definition.
- Identification of external organization when special skills are required.
- General approach for incident response:
  - Incident classification.
  - On-site responsible designation.
  - Zone securing measures.
  - Internal Information flow and communication protocols with external agents involved in emergency management (rescue and relief services).
  - Traffic restoration forecast.
  - Alternative traffic plans.
  - Technical resource mobilisation.
- Internal and external organizations coordination and communication protocols definition
- Communication procedures with relatives, authorities and media
- Railway network inventory including: lines maps, access maps, and risks maps (bridges, tunnels, etc)
- Technical resources inventory
- Post-disposal (dealing, claims issuing and settlement prices, improvement measures)
- Indemnities

(467) The contents concerning the recovery phase (Post-disposal and Indemnities) are already present in PRC Railway Bureaus specific emergency plans.

(468) Concerning the specific emergency plans, they should be based on risk analysis developed at RB level. The separately analysis in each concrete risk in a concrete geographic place of part of the track, permits to obtain a more detailed analysis and permits to develop in collaboration with the corresponding authorities more accurate specific plans indicating not only procedures and resources to solve them but also written agreements of collaboration and coordination.

(469) Besides, the Railway Bureaus update their specific emergency plans in a timely manner, but no periodicity is defined. These specific emergency plans, as well as the general emergency plan
recommended, should be updated with a fixed periodicity. Considering the current growth of the Chinese railway network, the Railway Bureaus and railway joint ventures should consider updating their plans anytime a modification need is detected (as feedback of real emergency situations) or every two years by default.

4.10 EMERGENCY RESPONSE AND RECOVERY INDICATORS

**Recommendation**

(470) PRC railways should further strengthen studies on response and recovery performance indicators to progressively achieve a more efficient process of emergencies response and recovery.

**Rationale**

(471) Railway authorities of the reference countries do not define nor handle emergency response and recovery indicators due to the fact that they do not develop the response by themselves. In the case of PRC railways it is very important to measure the efficiency and effectiveness of the response and recovery procedures of the RB or MOR, as the governmental emergency agencies which do through this type of indicators definition and analysis.

**Description**

(472) Regarding the response time PRC railways should optimize two targets considered by most of the railway companies of the reference countries: the time of arrival of the responsible on field and the time of arrival of the re-railing technical resources and relief trains.

(473) Regarding emergency response and recovery indicators to be analysed by PRC railways, and considering the specific emergency management functions developed by MOR and the RB, these indicators should be similar to those commonly handled in the governmental emergency agencies of the reference countries, which are easily obtained through the EMIS data exploitation module. They are:

- Nº of incidents
- Nº incidents by RB, by line, by specific risk zone
- Nº of calls
- Nº of emergency agencies involved
- Nº of resources involved within the different departments
- Nº of interventions by resource
- Effectiveness in protocols management
- Call response time
- Time to dispatch resources
- Time of arrival of the resources to the site of the emergency
- Time to dispatch additional resources when the first ones result insufficient
- Time until rescue and medical relief of people is finish
- Time until track relief and recovery actions is finish
- Time until total normal circulation recovery

(474) These response time indicators should be registered each time an emergency occurs and compiled annually in a report. Based on the results of this reports, the goals to achieve regarding this indicators should be defined, periodically revised and also taken into account during the drills and practices.

4.11 EMERGENCY MANAGEMENT STAFF STRUCTURE

**Recommendation**

(475) PRC railways should reinforce the Emergency Management Human Resources structure including specific professional profiles on field and in EMCs, which should be attached to the Emergency Management Office of MOR and the Railway Bureaus.

**Rationale**

(476) The new recommended EMCs and EMIS to be implemented, involve new functions and responsibilities and therefore the necessity of new profiles of qualified professionals within the emergency
management department. In addition, railway companies in all the reference countries give special importance to the emergency on field responsible. This responsible person has always a technical profile and coordinates all actions in the place of the incident and inform upper levels (EMC personnel). Although in PRC railways the ECT and the RB Director presence ensures the coordination and management on-field, MOR should consider reinforcing the command on-field with a overall responsible with technical skills in order to achieve unique command and unique information flow towards the EMC.

**Description**

(477) Consultants understand that the emergency management personnel structure considering the additional profiles should be composed of the following figures at EMCs and on-field:

**EMCs personnel**

- **Responsible for the EMC.** Would be the main responsible for the EMC. This should be a sole person present at the EMC during the working hours but available at any time, and should therefore live at 30 minutes of the EMC. The main responsibilities of the EMC Responsible should be:
  - Organization of the training programs for the EMC staff
  - Communication and information to the RB director or to MOR’s headquarters.
  - Statistics and performance indicators analysis and annual reporting
  - Crisis room leadership when needed

- **EMC room supervisor.** Would be a person in charge of all the operators in each Railway Bureau EMC and in MOR's EMC. There should be one supervisor of the EMC by shift and their main tasks should be:
  - Overall responsibility in case of emergency (at RB or at MOR level)
  - Supervision of EMC operators work
  - Approval of actions, resources mobilisation or other departments interventions, when these are not specified in the procedures but are considered necessary in a specific situation
  - External resources alerting and coordination (i.e.: ambulances, hospitals)

- **EMC operators.** Each EMC should have several operators, working on shifts in charge of the coordination of every type of incident. At RB level, the EMC operators would be in charge of the incidents from the lower level to those emergencies responsibility of the RB. In case of incident affecting several RBs or of emergencies of higher levels and great disasters, MOR EMC operators would be in charge of the coordination. The main tasks of the EMC operators should be:
  - Emergency department cameras observation
  - Early alert systems monitoring
  - Climate risks management
  - Reception of alerts from field in case of incident or emergency
  - Data collection and incident/emergency classification
  - Performance of the emergency response procedure corresponding to the incident classification under the surveillance of the Responsible for the EMC
  - Alerting and coordination with other departments involved (i.e.: Traffic Control division, Equipment division, Security Monitoring department, Health and Labour department, etc).
  - Rescue and technical resources mobilisation
  - Permanent communication with on-field responsible
  - Permanent information to the supervisor and to the responsible for the EMC

- **Technical support staff.** Each EMC should have personnel to provide technical support to ensure the all the information systems work correctly 7/7 and 24/24. These tasks can be developed by several persons working on shifts. They can be permanently present in the EMC during the corresponding shift or on duty, with the commitment to arrive in the EMC in less than 15 minutes. One person by shift should be enough for most of the EMC, although the MOR EMC and biggest RB EMC should consider having 2 people for technical support in each shift.

**On-field personnel**

- **On-site Emergency Coordinator.** Currently, in case of emergency the RB Director moves to the site and becomes the responsible for the Emergency Command Team on field. However, considering the geographical extension of each Railway Bureau, each one of them should have several qualified people spread along their area capable to rush into the site of the incident in less than 45 minutes and command the ECT and the rescue team in a technical manner during the response phase. This person, as seen in the reference countries, should count with an identification element in clothes, a signalled meeting point and a vehicle equipped with communication technology to maintain the contact
with the rest of the emergency agents. This way, RB Director’s tasks would be limited to an overall coordination of actions on field and in EMCs. Its main task would be to inform MOR’s headquarters and provincial authorities if necessary. The main tasks of the On-site Emergency Coordinator should be:

- **Arrival on-field in less than 45 minutes**
- **Situation evaluation**
- **Validation of correct first measures taken**
- **Coordination and command of the rescue and relief personnel (Rescue team)**
- **Coordination and command of the technical resources on-field**
- **Permanent communication with the emergency management centre operator who has undertaken the incident management from the notification**

**Emergency Command Team (ECT).** This team already exists in MOR and RB emergency management organization. The ECT travels to the site of the incident and set up emergency coordination groups to supervise the emergency response actions of the Rescue Team. It is also in charge of reporting after the emergency. The ECT should be now commanded by the On-site Emergency Coordinator and not directly by the RB Director.

**On-site Rescue Team** is the group of people responsible for rescue implementation. This group already exists in MOR and RB emergency management organization and consists of professionals related to emergency rescue in the fields of locomotive, rolling stock, electricity, civil engineering, public security and medical services.

The technical staff in charge of trains and track relief (locomotive, rolling stock, civil engineering fields) should remain attached to their respective departments of transport, rolling stock, etc. as well as the public security staff and medical experts who should remain attached to the Public Security Bureau and Labour & Health department. Although these departments should coordinate with the EMO through the EMCs, on field, the whole Rescue Team, including this technical staff, should work under the command of the ECT and the On-site Emergency Coordinator.

On the other hand, MOR fire fighters and rescue specialist should be attached to the Emergency Management Office of MOR or of the Railway Bureaus. Their tasks are limited to the rescue and relief actions, also under the command of the ECT and the On-site Emergency Coordinator.

(478) Regarding all these proposed profiles; a structure of professional carriers should be created, defining qualifications and promotion procedures, which would permit the professionalization of MOR’s railway emergency management personnel.

(479) The communications with the government and other authorities should remain responsibility of the RB at province level and MOR at national level. MOR and the RB should also strengthen communication and coordination with other ministries, which may be involved in emergency solving. For instance, in case of hazardous goods spread emergency, the Environmental Ministry should collaborate with experts who would collaborate on field with the EMO human resources. When a specific typified emergency needs the collaboration of other ministries, they should be informed timely for support.
4.12 TRAINING PROGRAM

**Recommendation**

(480) Regarding the training for PRC railway emergency management personnel, MOR in collaboration with the Railway Bureaus should perfect a well defined training program to ensure the different agents involved in emergency response obtain appropriate skills to face an emergency situation according to their different tasks.

**Rationale**

(481) Although nowadays PRC railways develop different activities at MOR and RB levels, it should further strengthen coordination and organization.

**Description**

(482) This training should contemplate education for all the departments involved: railway operation staff, emergency management staff, EMCs staff and officers of each RB and MOR. Education for passengers, as seen in some of the reference countries should also be considered including brochures and basic safety elements information in trains, stations and web sites.

---

**Source:** Consultants analysis.
Concerning staff training, the first component of the training programs should be initial and refreshing lectures. These lectures should have a common component regarding generalities of emergency management and specific chapters corresponding with each department functions and tasks in emergencies. Attending to the practices of the reference countries, in particular to the case of Korea, the periodicity of the refreshing lectures could be two days per year. Based on the best practice found in the USA where the FRA proposes to the railway companies the training programs structure, the contents of these theory training could be as follows:

- **On board staff initial training should include:**
  - Rail equipment familiarization
  - Situation awareness
  - Passenger evacuation methods
  - Coordination of functions with other staff (stations, centres, technical resources)
  - Instruction about location, function and operation of on-board emergency equipment

- **EMC personnel training should include:**
  - Familiarization with railway infrastructures
  - Resources dimensioning and dispatching
  - Protocols for internal communication
  - EMIS management

- **Rescue and relief personnel training should include:**
  - Rail and rescue equipment familiarization
  - Situation awareness
  - Protocols of coordination with EMCs

The training should also include a program of drills and practices. Each Railway Bureau should consider developing at least one drill per year, and these drills should be related to specific identified and evaluated risks (e.g.: fire in a tunnel of more than 250 metres, train stoppage and evacuation near a bridge in case of earthquake, etc). In addition, MOR should consider preparing an annual drill related to an emergency or an emergency involving several RBs.

Training with external organisations should also be considered through the development of drills. It would be advisable to develop such type of drills at RBs once a year.

Other trend of the reference countries regarding staff training that PRC railways should consider is the development of emergency simulation, which would permit the RB and their respective station and depots to carry out practices from the EMC without deploying the trains, resources, vehicles, etc. on-field. Although they do not allow to practice on-field emergency response activities (such as rescue, medical and technical relief, zone securing techniques, etc), these simulations permit to reinforce emergency department personnel knowledge about internal and external communication and coordination protocols.
Simulations are usually based on real emergencies cases and each RB could consider developing one or two simulation practices per year, depending on its emergency occurrence frequency. The previously mentioned EMIS have training and simulation modules that permit the development of such type of simulations.

(487) Concerning RBs officers training, it should be focused in the emergency management technologies, such as safety and early alarm systems, EMIS and technological surveillance. Foreign capacity building through the participation in international meetings and forums would permit MOR and RBs officer know the best and latest practices of the reference countries in each of this areas (Japanese railways early alert systems, European EMIS and EMCs, etc.)

(488) Once again, the risk analysis by lines or areas (RB) is crucial to decide the training needs, the contents of the lectures, the subject of the annual drill and the periodicity of the simulations practices.
5. ACTION PLAN

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Period</th>
<th>Main Activities</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Implement an Emergency Management Information System (EMIS)</td>
<td>ST</td>
<td>• Study to define the final functions to be implemented. Procurement documents.</td>
<td>• A tool for the efficient and effective Emergency Management of resources in the most accurate way to deal with Emergency situations.</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Procurement of the EMIS</td>
<td>• Record of every Emergency, off-line training and statistics analysis.</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• First prototype implementation in one RB and at MOR offices.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LT</td>
<td>• Deployment in the rest of the RBs</td>
<td></td>
</tr>
<tr>
<td>2  Develop Emergency Management Centres (EMC)</td>
<td>ST</td>
<td>• Definition of the definitive model of the EMC (emergency and traffic departments separation or integration)</td>
<td>• Define a general coordination and reference point for emergency management</td>
</tr>
<tr>
<td></td>
<td>ST</td>
<td>• EMC location and design by RB</td>
<td>• Integrate all the emergency management agents and functions</td>
</tr>
<tr>
<td></td>
<td>ST</td>
<td>• EMC personnel dimensioning based on the incident volume and background analysis of each RB.</td>
<td>• Allow interaction with other departments</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• EMCs deployment and systems integration</td>
<td></td>
</tr>
<tr>
<td>3  Mobile Emergency Management Centres (MEMC)</td>
<td>MT</td>
<td>• Final evaluation of needs. Document on MEMC assessment in PRC</td>
<td>• Improvement in on-site coordination</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Technical specifications documents</td>
<td>• Support to ECT and Incident coordination.</td>
</tr>
<tr>
<td></td>
<td>MT-LT</td>
<td>• Deployment of MEMC in RBs.</td>
<td>• Better data gathering to EMCs.</td>
</tr>
<tr>
<td>Recommendation</td>
<td>Period</td>
<td>Main Activities</td>
<td>Impact</td>
</tr>
<tr>
<td>----------------</td>
<td>--------</td>
<td>----------------</td>
<td>--------</td>
</tr>
<tr>
<td><strong>4 Mobile (wireless) network deployment</strong></td>
<td>MT</td>
<td>• GSM-R mobile extension for conventional railway sections.</td>
<td>• Ensure the communication between the emergency site and the EMC.</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• GSM terminal distribution for operation staff and maintenance brigades</td>
<td>• Improve communications facilities until the full implementation of a GSM-R or wireless system.</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Wireless system implementation as base for emergency response.</td>
<td>• Ensure the communication between the emergency site and the EMC.</td>
</tr>
<tr>
<td></td>
<td>LT</td>
<td>• Invest on satellite communications.</td>
<td>• Ensure continuity of communications in the case of a failure in the main route.</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Wireless access network installation.</td>
<td>• Permit video transmission from incident site to the EMC.</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Video images integration into EMIS.</td>
<td>• Ensure a complete EMIS implementation.</td>
</tr>
<tr>
<td></td>
<td>LT</td>
<td>• Airborne video supported by helicopters.</td>
<td>• Permit real time video from incident site in major accidents and crisis situations.</td>
</tr>
<tr>
<td><strong>5 Availability of video images at EMC</strong></td>
<td>ST</td>
<td>• Continue investing in signalling systems.</td>
<td>• Eliminate risks and improves safe train traffic.</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Define procedures and automatic communication links among MOR, railway companies, the climate Bureau and the seismological Bureau</td>
<td>• Ensure accurate and early information about natural and climate disasters forecast such as expected high rains and typhoons.</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Identify and classify risk areas where early warning and natural disaster safety system may be installed.</td>
<td>• Permit efficiency efforts in early warning and natural disaster safety system.</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Invest on early earthquake alarm systems.</td>
<td>• Ensure early warning.</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Invest on strong wind warning systems.</td>
<td>• Ensure effective use of early warning systems through the connection with signalling systems</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Invest on landslide and rock fall detecting systems.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Invest on rain observation systems.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LT</td>
<td>• Connect early alert system to the rail interlock signalling system.</td>
<td></td>
</tr>
<tr>
<td>Recommendation</td>
<td>Period</td>
<td>Main Activities</td>
<td>Impact</td>
</tr>
<tr>
<td>----------------</td>
<td>--------</td>
<td>----------------</td>
<td>--------</td>
</tr>
<tr>
<td>7 Procure or upgrade technical resources for people rescue and tracks and rolling stock relief</td>
<td><strong>ST</strong></td>
<td>• Definition of different technical resources response times goals</td>
<td>• Ensure achievement of acceptable response times in technical resources in case of emergency</td>
</tr>
<tr>
<td></td>
<td><strong>MT</strong></td>
<td>• Analysis of technical resources response times goals achievement</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>MT</strong></td>
<td>• Analysis of the necessity of procuring new technical resources where response time goals are not achieved</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>ST</strong></td>
<td>• Review risk analysis development at MOR and RB levels</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>ST</strong></td>
<td>• Incident classification redefinition considering several factors</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>ST</strong></td>
<td>• Level of severity classification redefinition avoiding quantitative criteria</td>
<td>• Better define the incident classification, incident procedures and the specific emergency plans through the risk analysis</td>
</tr>
<tr>
<td></td>
<td><strong>MT</strong></td>
<td>• Definition of specific procedures and flowcharts for each type of incident</td>
<td>• Make easier the procedure definition including the resources needed for each type of incident</td>
</tr>
<tr>
<td></td>
<td><strong>MT</strong></td>
<td>• Implementation of classifications and procedures in an EMIS</td>
<td>• Permit the computerization of incident classification and procedure assignment tasks</td>
</tr>
<tr>
<td></td>
<td><strong>MT</strong></td>
<td>• Establishment of a fax based incident classification and notification procedure while the EMIS is being developed.</td>
<td></td>
</tr>
<tr>
<td>Recommendation</td>
<td>Period</td>
<td>Main Activities</td>
<td>Impact</td>
</tr>
<tr>
<td>----------------</td>
<td>--------</td>
<td>----------------</td>
<td>--------</td>
</tr>
<tr>
<td><strong>9 Improve Emergency Plans</strong></td>
<td>ST</td>
<td>• Exhaustive risk analysis development at MOR and RB levels</td>
<td>• Disseminate the general principles and guidelines in case of incident among all agents involved</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Definition of general instructions and principles regarding incident response and operation in case of incident</td>
<td>• Give MOR a global vision of the emergency preparedness of RBs</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Definition of the training program</td>
<td>• Define the responsibilities of all internal departments in case of emergency.</td>
</tr>
<tr>
<td></td>
<td>ST</td>
<td>• Human and technical resources inventories definition</td>
<td>• Define the responsibilities and coordination procedures and agreements between all of the agents.</td>
</tr>
<tr>
<td></td>
<td>ST</td>
<td>• Internal coordination protocols definition</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Definition of coordination and communication protocols and written agreements with external emergency organizations and with authorities</td>
<td></td>
</tr>
<tr>
<td><strong>10 Response and Recovery indicators definition</strong></td>
<td>ST</td>
<td>• Definition of response and recovery indicators and goals.</td>
<td>• Permit monitoring and analysis of response performance quality</td>
</tr>
<tr>
<td></td>
<td>ST</td>
<td>• Definition of the procedure for periodical reporting and reports format</td>
<td>• Permit improvements in response procedures and coordination protocols</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Definition of the procedures for analysis of the outcomes of the indicator reports and improvement measures definition at RB and MOR levels</td>
<td></td>
</tr>
<tr>
<td><strong>11 Reinforce Human Resources</strong></td>
<td>MT</td>
<td>• Definition of new professional profiles, qualifications and functions for on-field management</td>
<td>• Professionalize the emergency management personnel structure, permitting station and depot personnel to concentrate efforts in their tasks</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Definition of new professional profiles, qualifications and functions for EMC personnel</td>
<td>• Ensure a unique command profile on-field to coordinate different working groups</td>
</tr>
<tr>
<td>Recommendation</td>
<td>Period</td>
<td>Main Activities</td>
<td>Impact</td>
</tr>
<tr>
<td>----------------</td>
<td>--------</td>
<td>----------------</td>
<td>--------</td>
</tr>
<tr>
<td>12 Establish EMS training programs at MOR and RB levels</td>
<td>MT</td>
<td>• Definition of hierarchy and coordination procedures between on-field and EMC personnel, other departments and RB or MOR officers</td>
<td>• Better define responsibilities and improve the unique coordination and command chain</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• New on-field staff selection and training</td>
<td>• Ensure the optimal performance of the future EMCs functions through specialized and qualified personnel</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• New EMC staff selection and training</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Definition of initial lectures and theoretical training contents specific to each agent involved in emergency management: rescue and relief, on board, on-site coordination personnel and EMC personnel. Common to all RB and MOR.</td>
<td>• Ensure the best qualification and training of each profile to develop its specific tasks in case of emergency</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>• Definition of refresher theoretical training and lectures contents and periodicity. Common to all RB and MOR.</td>
<td>• Ensure a better knowledge of coordination procedures and avoids miss-coordination in case of emergency</td>
</tr>
<tr>
<td></td>
<td>ST</td>
<td>• Periodicity definition for drills and simulations.</td>
<td>• Ensure a clear responsibilities assignment and avoids interference in case of a real emergency</td>
</tr>
<tr>
<td></td>
<td>ST</td>
<td>• Definition of drill contents; periodically at RB level based on risk analysis outputs.</td>
<td>• Permit to analyze possible failures in emergency response procedures and systems and to correct them before a real emergency arises</td>
</tr>
</tbody>
</table>

Source: Consultants analysis.
6. ANNEXES

(489) The annexes included in this Report are those which following are described.

(490) Annex 1. Railway Emergency response case studies. As a result of the research work, Consultants have obtained the following case study reports that present railway emergency response real cases in difficult access zones in the reference countries. These case studies highlight not only good practices but also bad practices in emergency management, all of which have been taken into account for the recommendations of the present report: The case studies included are:

- B. Channel Tunnel Fire (France/United Kingdom) in 1996.
- C. Eschede Train Disaster (Germany) in 1998.
- D. Daegu Subway Station Fire (Korea) in 2003.

(491) Annex 2. Safety systems. Information about the most remarkable natural disasters early alert and safety systems installed in Japan Railways is included in this Annex. Japan and Korea railways are the references on which the natural disasters safety systems recommendation is based. The following documents are included:

- A. Natural Disasters Countermeasures (report and presentation).
- B. Tokaido Shinkansen Earthquake Rapid Alarm System.

(492) Annex 3. Emergency Management Information Systems. This Annex includes documents provided by the international EMIS vendors visited by the Consultants. These documents are the basis for the description of the EMIS proposed by the Consultants for PRC railways:

- A. Siemens IT Solutions and Services
- C. Indra Sistemas S.A.

(493) Annex 4. International Training Reports. The reports developed by MOR delegations as a result of the International Training through the reference countries are included in this Annex. These reports highlight best practices found in French, German, Japanese and Korean railways, which are in the same line that those identified and proposed by the Consultants and have therefore been integrated in the present report.

(494) Annex 5. Information sources. The information sources which Consultants have used for this Report are identified.
ANNEX 1. RAILWAY EMERGENCY RESPONSE CASE STUDIES
A. CASE STUDY. REVIEW OF THE EXPRESS RAILWAY DISASTER IN AMAGASAKI (JAPAN) IN 2005.
B. CASE STUDY. CHANNEL TUNNEL FIRE (FRANCE/UNITED KINGDOM) IN 1996..
C. CASE STUDY: ESCHEDE TRAIN DISASTER (GERMANY) IN 1998.
D. CASE STUDY. DAEGU SUBWAY STATION FIRE (KOREA) IN 2003.
6.2 ANNEX 2. SAFETY SYSTEMS
A. NATURAL DISASTERS COUNTERMEASURES (REPORT AND PRESENTATION).
B. TOKAIDO SHINKANSEN EARTHQUAKE RAPID ALARM SYSTEM
ANNEX 3. EMERGENCY MANAGEMENT INFORMATION SYSTEMS
A. SIEMENS IT SOLUTIONS AND SERVICES
B. THALES GROUP – SECURITY SOLUTIONS & SERVICE DIVISION.
C. INDRA SISTEMAS S.A.
6.4 ANNEX 4. INTERNATIONAL TRAINING REPORTS
A. REPORT ON STUDY OF GERMAN AND FRENCH RAILWAYS EMERGENCY MANAGEMENT SYSTEMS
B. REPORT ON STUDY OF JAPANESE AND SOUTH KOREAN RAILWAYS EMERGENCY MANAGEMENT
6.5 ANNEX 5. INFORMATION SOURCES

(495) The team has met different international Emergency Management Information System vendors in order to have the further information about the current technical solutions used for emergency management in the benchmarked countries. The following vendors have been visited:

- Siemens IT Solutions and Services.
- Optelecom-NKF.
- Fedetec (Amper Sistemas S.A.).

(496) Other sources of information used for this Final Report are:

- http://pdm.medicine.wisc.edu/21-5%20PDFs/nakayama.pdf
- http://www.mace.manchester.ac.uk/project/research/structures/strucfire/CaseStudy/HistoricFires/InfrastructuralFires/channelTunnel.htm
- http://www.emergency-management.net/fire1.htm
- http://www.emergency-management.net/risk.htm
- http://www.mace.manchester.ac.uk/project/research/structures/strucfire/CaseStudy/HistoricFires/InfrastructuralFires/default.htm