PD ISO/TR 19083-1:2016

BSI Standards Publication

Intelligent transport systems — Emergency evacuation and disaster response and recovery

Part 1: Framework and concept of operation

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National foreword

This Published Document is the UK implementation of ISO/TR 19083-1:2016.

The UK participation in its preparation was entrusted to Technical Committee EPL/278, Intelligent transport systems.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Published by BSI Standards Limited 2016

ISBN 978 0 580 94713 1
ICS 03.220.20; 13.200; 35.240.60

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This Published Document was published under the authority of the Standards Policy and Strategy Committee on 30 November 2016.

Amendments/corrigenda issued since publication

Date	Text affected

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TECHNICAL REPORT

ISO/TR 19083-1

First edition
2016-10-15

Intelligent transport systems — Emergency evacuation and disaster response and recovery —

Part 1: Framework and concept of operation

Systèmes intelligents de transport — Évacuation d'urgence et intervention en cas de catastrophe et rétablissement —

Partie 1: Cadre et concept opérationnel

Reference number
ISO/TR 19083-1:2016(E)

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Full document details: PD ISO/TR 19083-1:2016

Contents

Page

Foreword ... **iv**
Introduction ... **v**
1 Scope ... **1**
2 Normative references ... **1**
3 Terms and definitions ... **1**
4 Symbols and abbreviated terms ... **6**
5 Overview and framework requirements ... **6**
5.1 General ... 6
5.2 Criteria for using public transport for evacuation and disaster response ... 7
5.2.1 Overview ... 7
5.2.2 Planning assumptions for evacuations ... 8
5.2.3 Other key considerations for disaster response and recovery efforts ... 11
5.3 Agencies and organizations involved in a regionally supported evacuations and disaster response and recovery ... 13
5.3.1 Overview ... 13
5.3.2 Local ... 13
5.3.3 Regional ... 13
5.3.4 National agencies ... 14
5.3.5 Other agencies ... 14
5.4 Roles and responsibilities ... 14
5.4.1 General ... 14
5.4.2 Disaster response roles and responsibilities for transportation services ... 15
5.4.3 Disaster recovery roles and responsibilities ... 20
6 Concept of Operations template for Decision Support System for Public Transport Emergency Management ... **22**
6.1 General ... 22
6.1.1 Background ... 22
6.1.2 Overview ... 23
6.2 Scope of the PT-EEDRR-DSS ... 23
6.2.1 Operational need ... 23
6.2.2 User-oriented operational description ... 24
6.2.3 Scenario timelines and selections ... 30
6.2.4 Operational considerations for recovery effort ... 36
6.3 System overview ... 39
6.3.1 Operational environment ... 39
6.3.2 Support environment ... 42
6.4 Operational impacts ... 44
Annex A (informative) **Authorities and policies** ... **46**
Annex B (informative) **Primary command-level public transport role profiles** ... **48**
Bibliography ... **54**

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Full document details: PD ISO/TR 19083-1:2016

Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 204, *Intelligent transport systems*.

A list of all parts in the ISO series can be found on the ISO website.

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Introduction

This document defines the framework and concept of operation for developing a public transport decision support system for evacuations and disaster response and recovery. This includes establishing the criteria under which public transport prepares for, responds to, and recovers from a disaster. The criteria, as established by national, regional and local governance based on the type and severity of the emergency, are used to identify the roles and responsibilities of public transport within the boundaries of the Intelligent Transport System architecture. For example, the criteria for a localized disaster such as a chemical plant fire will be governed by local or regional response plans and requires fast response times. Whereas, a hurricane having a wider impact may be governed by national response plans, as well as local and regional, and allow pre-planning to take place because they are typically slower moving. It is important to emphasize that this document focuses only on those activities related to ground transportation and does not address societal issues (i.e. sheltering, aid, security, etc.) nor does it address air or rail transportation associated with disaster management. The reader is directed to ISO/TC 292 for societal issues and to ISO/TC 20 SC 17 and ISO/TC 269 for air and rail transportation issues associated with disasters. This document adheres to ISO 22300, which contains terms and definitions applicable to societal security to establish a common understanding so that consistent terms are used.

It is also important to note that this document relies on national, regional, and local policies and authorities to create a concept of operation. The concept of operations defines the set of requirements needed for designing, developing, and deploying a Decision Support System for evacuation and disaster response and recovery. The Decision Support System is an interactive software-based system intended to help public transport emergency services personnel compile useful information from a combination of raw data, documents, and personal knowledge, or traffic models. This knowledge is then used to identify and solve evacuation and disaster response and recovery problems and disseminate those decisions to emergency managers, traffic managers, public transport, and the public itself. The Decision Support System is a natural progression from Computer Aided Dispatch and Automatic Vehicle Location systems which has been the core Intelligent Transportation Systems (ITS) used by public transport. The Decision Support System combines the use of traffic models and analytic techniques with traditional ITS data access and retrieval functions to solve less well structured, underspecified evacuation and disaster response and recovery problems that upper level managers may face in a disaster.

The goal of this document is to save lives and aid recovery by using ITS technologies to coordinate a comprehensive transportation response to disaster. This includes using the Decision Support System to identify routes and manage equipment and personnel to ensure public transport is used to evacuate people out of harm's way and provide transportation support for all response and recovery efforts from major disasters such as hurricanes, tsunamis, or catastrophic accidents. This document recommends public transport to serve as the primary mobility agent for all transportation-related actions before, during and after a disaster. This represents a paradigm shift from past response and recovery efforts such as the Great Japan Earthquake 2011 or Hurricane Katrina in the US, which typically see transportation-related activities coordinated by emergency managers who rely on traffic managers and public transport service operators to provide the services. While the emergency manager is the responsible individual for any disaster and will continue to do so, the role of coordinating transportation between traffic management, emergency services and public transport should be assigned to a public transport professional. The reasoning for this shift of responsibility is that public transport has the most experience and the resources to move large numbers of people efficiently and in a timely manner, which is paramount before, during and after a disaster. This may present problems in rural areas as ITS technologies, equipment and personnel may not be available to carry out these assignments. Additionally, problems may exist due to differences in country-based operational methodology between Asia, North America, and Europe. In Asia, public transport is predominantly run by privately owned and publicly traded mass transit and real estate conglomerates. In North America, public transport is predominantly run by municipal transit authorities. In Europe, public transport is predominantly run by both public-owned and private companies. The ideal solution is to ensure that a public entity is responsible for the public transport emergency management and that personnel operating the Decision Support System are professionals from the public transport sector.

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The ISO/TR 19803- series recommends the creation of a cloud-based Emergency Evacuation and Disaster Response and Recovery (EEDRR) Decision Support System to assist, coordinate, and direct all transportation services, including those used by emergency management, traffic management and public transport. The cloud-based solution allows different services (i.e. servers, storage and applications) to be delivered to emergency management/public transport computers and devices through the Internet; thus, providing access to the EEDRR even when access to the physical area is not possible because of the disaster. The major actors involved in coordinating transportation services related to a disaster and the systems required for communicating the associated information are shown in Figure 1.

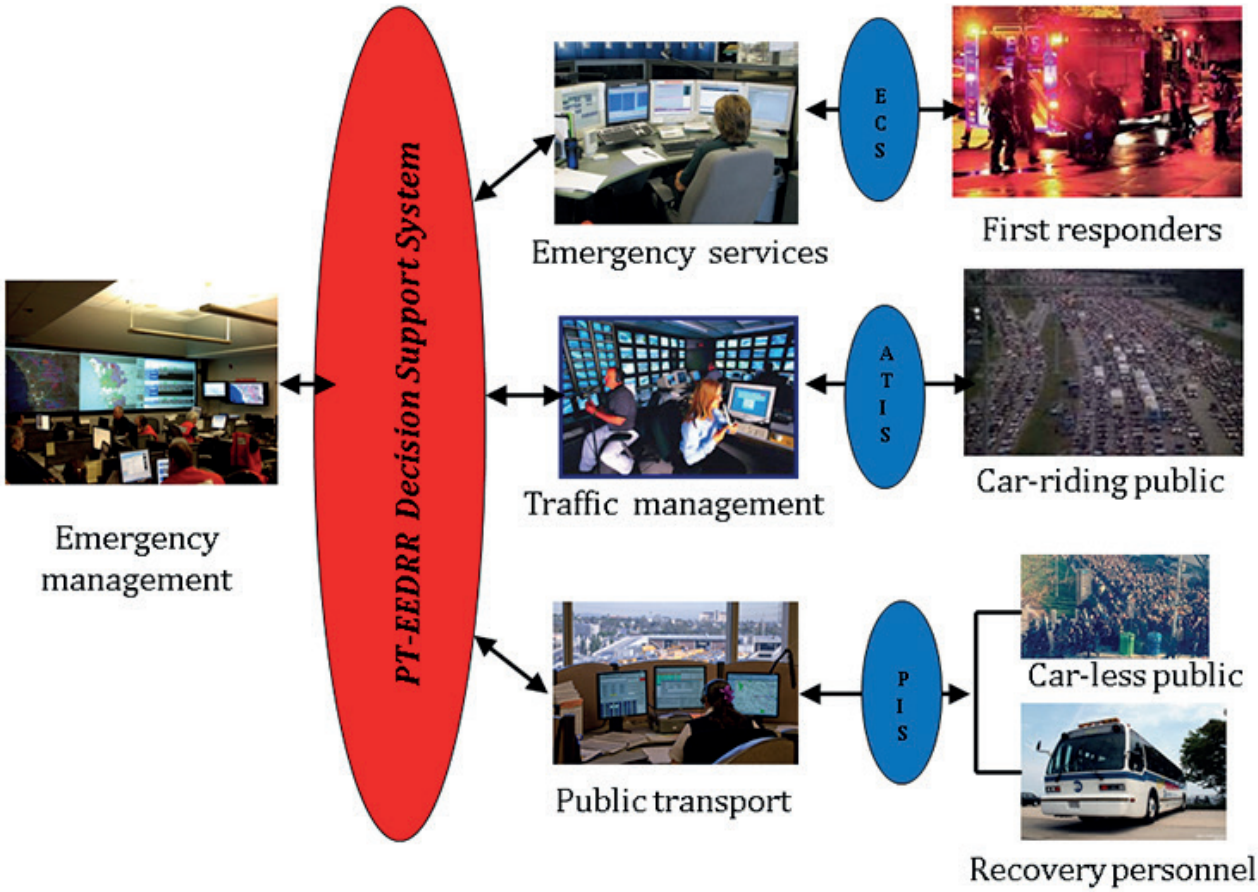

Figure 1 — Coordinated transportation services for disasters

As shown, there are eight major actors associated with transportation service during a disaster. Details of the roles and responsibilities are included in 5.4. The actors are at a group level and may vary from country to country. For instance, first responders include various people such as firefighter, emergency medical personnel, and police. In addition to these, those people who are managing infrastructures like electricity, water, sewage and gas play may also be part of the first responders. Moreover, individuals such as teachers may also act as first responders and be responsible for taking care of their students. The primary role and responsibility addressed by this family of standards is the coordination of emergency transportation services through existing communication channels by professional transportation planners and operators in public transport. The existing communication channels include emergency communications systems (ECS) used by first responders, advanced traveller information systems (ATIS) used by traffic managers, and passenger information systems (PIS) used by public transport. The cornerstone of this document is the EEDRR Decision Support System which will maintain the data and information sets used by public transport to make knowledgeable transportation-related decisions during the chaotic times leading up to, during and after a disaster. Figure 1 depicts the EEDRR Decision Support System being operated by public transport as part of emergency management. Transportation-

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related information and data are collected from and transportation-related decisions and actions are communicated to the other entities involved in the disaster.

The EEDRR Decision Support System is a computer-based transportation information system that supports critical transportation-related decision making activities during a disaster. The EEDRR Decision Support System is part of the Emergency Operations Centre and serves the emergency management, operations, and planning levels of the emergency management organization where planning levels mean those individuals who are responsible for planning the response as opposed to those individuals that are performing the actions required in a response. This system is operated by public transport emergency services personnel and helps to make transportation routing and equipment and personnel resource decisions, which may be rapidly changing and not easily specified in advance. It is an interactive software-based system that aids decision makers by compiling useful information from a combination of raw traffic and public transport data, policy documents, personal knowledge, and traffic models to identify and solve problems and assist transportation professionals in decision making. To ensure the information is useful and the sources are reliable, requires that data suppliers be vetted, data distribution networks are resilient, data management is expandable and modular, and data processing is organized into thematic applications such as floods, hurricanes, fires, earthquakes, etc.

Typical information that the EEDRR Decision Support System gathers and presents includes:

— local, regional, and national criteria for disaster evacuation, response, and recovery based on policies, plans and directives;

— benchmark evacuation times established by evacuation plans through best practices, regulations, or simulations;

— transportation resources available for evacuation, response, and recovery effort including traffic management and public transport;

— digital maps, images, political boundaries, sensor data, integrated transportation network models and other GIS related information;

— weather forecast, alerts, demand forecast, incident notification, and other real time information for mitigating traffic delays;

— damage assessments, risk factors, situational analysis, desired outcomes, and other real time information from field reporting;

— demographics for the regional population, passenger counts, special needs persons, and other information needed to estimate/determine the number of car-less persons in an area of interest;

— social media reporting of situation awareness as reported from various social media outlets (i.e. Facebook, Twitter, Line, Cyworld, Sina Weibo, etc.)

— and in the future, heuristic classifications that may be used to create an expert system as the use of artificial intelligence matures.

The EEDRR Decision Support System is an information processing system that runs on the public transport emergency services personnel PCs. The framework takes into account that each local jurisdiction has its own requirements, and thus in order to be useful this set of international standard should provide generic text that local jurisdictions can make distinctive to their own needs and communities by adding to and/or replacing the generic text with specific details. ISO/TR 19083 includes three parts:

— Part 1 — Framework and concept of operation for the use of public transport during an emergency evacuation or large scale disaster

— Part 2 — Information flow between Public Transport Passenger Information Systems, Public Transport Command and Control Systems, and Regional Emergency Operation Centres during a disaster

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— Part 3 — Use cases needed to support public transport actions in disaster drills/exercises.

The framework for the ISO/TR 19083 series and an associated concept of operation is provided in Clauses 5 and 6, respectively.

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Intelligent transport systems — Emergency evacuation and disaster response and recovery —

Part 1: Framework and concept of operation

1 Scope

This document

— defines the framework for the ISO/TR 19083 series of standards related to emergency evacuation and disaster response and recovery,

— establishes the criteria under which public transport should support evacuations and disaster response and recovery based on the magnitude of the disaster and the location as these factors drive the policies, directives and plans for each countries disaster prevention/evacuation systems,

— identifies the types of agencies and organizations involved in a regionally supported evacuation and disaster,

— defines the roles and responsibilities public transport entities should provide in planning, preparing for, and conducting evacuations and disaster response and recovery efforts in support of regional authorities,

— recommends the type of information required and necessary actions to be followed by public transport to ensure efficient and effective transportation in response to recovery from a disaster,

— provides a concept of operation describing the characteristics of the EEDRR Decision Support System from the viewpoint of an individual who will use the system for public transport disaster support, it is the guiding document for public transport services operators who voluntarily wish to develop EEDRR Decision Support Systems, and

— identifies guidelines to improve coordination among regional authorities when public transport disaster support is required.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
actor
entity that fulfils a role

Note 1 to entry: The same definition can also be found in EN 302 665.

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3.2
command-level decision making
decisions made by managers to manage and mitigate critical incidents

3.3
command-level decision makers
managers within public transport tasked with making decisions during critical incidents

3.4
command-level roles
management positions within public transport tasked with making decisions during critical incidents

3.5
commercial vehicle
any type of motor vehicle used for transporting goods or paid passengers

3.6
computer-aided dispatch/automatic vehicle location systems
central software used by dispatchers for operations management that periodically receives real-time updates on fleet vehicle locations

Note 1 to entry: Computer-aided dispatch systems use one or more servers located in a central dispatch office, which communicate with computer terminals in a communications centre or with mobile data terminals installed in vehicles.

Note 2 to entry: Utilize the capabilities of geographic information systems (GIS) and GPS-based automatic vehicle location (AVL) to show real time vehicle location on a map display.

3.7
data
reinterpretable representation of information in a formalized manner suitable for communication, interpretation or processing

Note 1 to entry: Data can be processed by humans or by automatic means.

[SOURCE: ISO/IEC 15944-5:2008, 3.35 modified]

3.8
disaster
situation where widespread human, material, economic or environmental losses have occurred which exceeded the ability of the affected organization, community or society to respond and recover using its own resources

[SOURCE: ISO 22300:2012, 2.1.11]

3.9
disaster planning
first phase of disaster management cycle consisting of prevention and preparedness

3.10
disaster recovery
recovery phase that starts after the immediate threat to human life has subsided with the immediate goal to bring the affected area back to normalcy as quickly as possible

3.11
disaster response
second phase of the disaster management cycle consisting of warning/evacuation, search and rescue, providing immediate assistance, assessing damage caused by the disaster, continuing assistance and the immediate restoration of infrastructure

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3.12
emergency management organization
group of people that has its own functions with responsibilities, authorities and relationships to the overall approach preventing and managing emergencies that might occur

Note 1 to entry: In general, emergency management utilizes a risk management approach to prevention, preparedness, response and recovery before, during and after potentially destabilizing or disruptive events.

[SOURCE: ISO 22320:2011, 3.35 modified]

3.13
emergency operations centre
EOC
central location from which local, regional or national governments can provide interagency coordination and executive decision making in support of disaster response and recovery operations

Note 1 to entry: to entry. The purpose is to provide a centralized location where public safety, emergency response, and support agencies coordinate planning, preparedness, and response activities.

Note 2 to entry: to entry. The EOC does not command or control on-scene response efforts, but does carry out the coordination functions through

a) collecting, evaluating and disseminating disaster related information,

b) analysing jurisdictional impacts and setting priority actions, and

c) managing requests, procurement and utilization of resources.

3.14
exercise
process to train for, assess, practice, and improve performance in an organization

Note 1 to entry: Exercises can be used for validating policies, plans, procedures, training, equipment, and inter-organizational agreements; clarifying and training personnel in roles and responsibilities; improving inter-organizational coordination and communications; identifying gaps in resources; improving individual performance; and identifying opportunities for improvement, and controlled opportunity to practice improvisation.

Note 2 to entry: A test is a unique and particular type of exercise, which incorporates an expectation of a pass or fail element within the goal or objectives of the exercise being planned.

[SOURCE: ISO 22300:2012, 2.4.9]

3.15
hazardous material
any item or agent (biological, chemical, radiological, and/or physical), which has the potential to cause harm to humans, animals, or the environment, either by itself or through interaction with other factors

3.16
incident
situation that might be, or could lead to, a disruption, loss, emergency or crisis

[SOURCE: ISO 22300:2012, 2.1.15]

3.17
man-made disaster
disastrous event caused directly and principally by one or more identifiable deliberate or negligent human actions

3.18
private vehicle
two- or four-wheel vehicle that are not used to carry passengers for a fee

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3.19
public safety agency
includes emergency management agencies, law enforcement agencies, fire departments, rescue squads, emergency medical services and other such entities whose purpose is to enhance the public welfare

3.20
public transport
shared transport service which is available for use by the general public and includes city buses, trolleybuses, trams (or light rail) and passenger trains, rapid transit (metro/subways/undergrounds, etc.) and ferries

3.21
public transport emergency management
managerial function charged with creating the framework within which public transport reduce vulnerability to hazards and cope with disasters

3.22
public transport emergency services personnel
persons within public transport responsible for transportation-related mitigation activities in an evacuation or disaster including pre-disaster planning, response, and recovery

3.23
public transport emergency response team
persons within public transport responsible for transportation-related mitigation activities in an evacuation or disaster including pre-disaster response planning and disaster response

3.24
public transport recovery team
persons within public transport responsible for transportation-related mitigation activities in an evacuation or disaster including pre-disaster recovery planning disaster recovery

3.25
public transport emergency manager
person responsible for the overall strategic command of the emergency response effort such as risk identification and mitigation

3.26
public transport emergency operations coordinator
person responsible for managing the tactical functions such as coordination with field supervisors, assigning vehicles and drivers/operators to routes, monitoring traffic flow, etc.

3.27
public transport emergency planning coordinator
person responsible for the collection, evaluation, forecasting, dissemination, and use of the information about the emergency incident and status of resources

3.28
public transport recovery manager
person responsible for the overall strategic plan of the recovery effort to include damage assessment and recovery planning for short-term, intermediate, and long-term mitigation

3.29
public transport recovery communication coordinator
person responsible for informing outside organizations and the public of recovery plans and services

3.30
public transport recovery project coordinator
person responsible for managing mutual aid request and work associated with infrastructure repair

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3.31
public transport emergency logistics coordinator
person responsible for managing logistical support such as personnel, vehicles, equipment, and supplies

3.32
public transport operator
private, profit-driven entity that provides shared transport service which are available for use by the general public and includes city buses, trolleybuses, trams (or light rail), passenger trains, rapid transit (metro/subways/undergrounds, etc.) and ferries

3.33
public transport service manager
public entity that manages and may provide shared transport service which are available for use by the general public and includes city buses, trolleybuses, trams (or light rail), passenger trains, rapid transit (metro/subways/undergrounds, etc.) and ferries

3.34
regional
layer within the emergency management hierarchy that exists between national and local

Note 1 to entry: Local is this instances means a government entity covering a small geographic area such as a town or city.

3.35
shared-use vehicle
vehicle used by several different individuals throughout the day

Note 1 to entry: There are three basic shared-use vehicle system models: neighbourhood car sharing, station cars, and multimodal shared-use vehicles.

3.36
strategic command
organization responsible for formulating the strategy for dealing with the incident

3.37
tactical functions
formulated from strategic plans the sets of actions dealing with the incident that are completed in the field

3.38
traffic flow models
use of computer modelling to simulate the of interactions between vehicles, drivers, pedestrians, cyclists, other travellers and infrastructure (including highways, signage, and traffic control devices), with the aim of understanding and developing an optimal road network with efficient movement of traffic and minimal traffic congestion problems

3.39
use case
sequence of actions that an actor (usually a person, but perhaps an external entity, such as another system) performs within a system to achieve a particular goal

[SOURCE: ISO 25102:2008, 2.12 modified]

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4 Symbols and abbreviated terms

ATIS	advanced traveller information system
CAD/AVL	computer aided dispatch/automatic vehicle location
DSS	decision support system
ECS	emergency communications system
EEDRR	emergency evacuation and disaster response and recovery
EOC	emergency operations centre
HAZMAT	hazardous materials
ISDM	interagency shared data message
ISO	International Organization for Standardization
ISR	interagency service request
ITS	intelligent transport systems
I2V	infrastructure to vehicle communications.
MOU	memorandum of understanding
NRC	United States Nuclear Regulatory Commission
PIS	Passenger Information System
PT	public transport
PT-EEDRR-DSS	public transport decision support system for emergency evacuation and disaster response and recovery
PTMS-IAM	public transport management system interagency message
TERA	transit emergency response application
TMC	traffic management centre
V2I	vehicle to infrastructure communications

5 Overview and framework requirements

5.1 General

The ISO/TR 19083 series is designed to assist public transport in creating a Decision Support System that is scalable to and integrates with a regional Emergency Operations Centre (EOC). The primary goal is to use this document to develop a formal set of requirements that would be used to acquire an EEDRR Decision Support System. The content and design of the ISO/TR 19083 series provides a foundation from which public transport agencies can develop a customized EEDRR Decision Support System using national, regional, and local guidance, and the wealth of information and expertise available in the emergency management community.

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The ISO/TR 19083 series includes three parts:

— Part 1 — Framework and concept of operation for the use of public transport during an emergency evacuation or large scale disaster

This provides the framework and concept of operation for the ISO/TR 19083 series. The framework describes the criteria required for involving public transport in an evacuation, the actors involved in the event, and the roles and responsibilities of public transport. The concept of operation contains the operational concepts developed by the United States Department of Transportation Federal Highway Administration for evacuation transportation management and includes specific operational scenarios for public transport. It is impossible to list all possible disaster scenarios. But, it is important to note that a scenario should reflect the most catastrophic imaginable disaster. Before the Great East Japan Earthquake occurred on 11 March 2011, the target disaster of a disaster prevention plan had been the maximum one in scale that occurred in the past. However, the Great East Japan Earthquake and the tsunami were beyond expectation and caused unprecedented damages to Japan. Disasters of this kind occur very rarely, once in several thousand years, and hence there is usually no record left in many cases. However, if it does occur, the damage is enormous. Therefore, it is recommended that the most catastrophic imaginable disaster be included in emergency management planning.

— Part 2 — Information flow between Public Transport Passenger Information Systems, Public Transport Command and Control Systems, and Regional Emergency Operation Centres during a disaster

This identifies the information exchanged between public transport service operators and Emergency Operations Centres during an evacuation or as part of a disaster response and recovery effort. This includes a common message structured in a uniform and open format, to enable the exchange of information among multiple agencies with unique requirements, policies, and operating environments. Two interagency shared data messages (ISDM) are planned, the interagency service requests (ISR) and the Public Transport Management System interagency message (PTMS-IAM). The ISR specifically requests services rendered by public safety agencies and secondary responder services. ISRs may be between Public Transport Decision Support Systems for Emergency Evacuation and Disaster Response and Recovery (PT-EEDRR-DSS) and Emergency Operation Centres (EOC) to specifically request public transport safety and secondary responder services. The IAM relates to public transport control requests between PT-EEDRR-DSS and the EOC.

— Part 3 — Use cases needed to support public transport actions in disaster drills/exercises

This provides the use cases that are relevant to public transports participation in disaster drills and exercises. The objective is to develop a mechanism that improves the effectiveness of Public Transport Evacuation Decision Support System by employing use case diagrams that can easily be added or changed as the system evolves and be used as a feedback instrument to enhance requirements for future systems.

5.2 Criteria for using public transport for evacuation and disaster response

5.2.1 Overview

Establishing the criteria by which public transport is used to evacuate populated areas and respond to disasters is highly dependent on local, regional and national authorities and policies. Additionally, these authorities and policies often change in response to a large scale disaster. A prime example is the Department of Homeland Security (DHS), formed as a result of the 9/11 terrorist attack, and is the ultimate authority for disaster response and recovery in the United States. Similarly, the Post-Katrina Emergency Management Reform Act of 2006 and the Pets Evacuation and Transportation Standards Act of 2006 were laws enacted by the United States to provide policies and funding for emergency planning as a result of Hurricane Katrina. These authorities and policies define the criteria for using public transport to evacuate residents. Annex A provides a list of those policies and directives for each participating country.

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5.2.2 Planning assumptions for evacuations

With regard to authorities and policies around the world, a common logic exists as to when evacuation, response and recovery measures should be taken. The logic is based on need, evacuation times, and resources. However, evacuation is not always required or possible. Whether to evacuate is dependent on the type and magnitude of the disaster. For example, if a strong earthquake occurs in the western part of Japan, a big tsunami will hit the coastal area in five minutes. In this case, evacuation by car or PT is useless. The only way is to go upstairs and shelter in place. In this case, the transportation needs shift from emergency evacuation to disaster response and recovery. Additionally, the machinery and equipment for monitoring and controlling routes will be damaged by the disaster, so these functions will not be available for some time after a big disaster. In these cases, the primary effort will focus on assessing the damage and requesting resources from areas outside the disaster area to aid in the response and recovery efforts.

5.2.2.1 Identifying the need

The information described in this subclause is focused on pre-disaster evacuations such as would occur when a hurricane or cyclone is approaching an area. Transportation need in this case is driven by the demographics of the population to be evacuated and need to develop evacuation models which typically use four population segments:

— permanent residents (employed, unemployed, retired) and transient population (visitors and tourist) using private automobiles;

— public transport-dependent permanent residents and transient population using public transport;

— special facility residents (e.g. hospitals, prisons, nursing homes, etc.);

— school populations.

Additionally, special needs exist for public safety personnel who are involved in the response and recovery efforts as they will require transport into and out of the impacted areas. Each of these populations requires unique transportation services during an evacuation or disaster.

The use of private transportation which includes automobiles, trucks, motorcycles, bicycles, etc. by residents and transient population during a disaster will vary depending on whether the impact area is urban, suburban, or rural. The numbers of private transportation users can overwhelm the available roadways, potentially causing gridlock and posing a significant challenge to traffic management. Traffic managers are the key actor in planning evacuation routes and managing traffic flow for private transportation. Numerous ITS technologies exist to assist with traffic flow models as well as monitoring and controlling routes. The Concept of Operation references the role and responsibility of traffic managers but does not provide detailed operational procedures but rather references to where these procedures can be found and more importantly what information is required from traffic management.

Public transport dependent permanent residents and transient populations include those who do not have access to a vehicle or are dependent upon help from outside the home to evacuate. This population group may include:

— households

  — with no vehicle,

  — with unsupervised latchkey children,

  — with one vehicle that is at work and would not return,

  — where residents have limitations on driving (e.g. elderly who do not drive at night or do not drive distances of more than a few miles), and

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— dependent on specialized transportation such as wheelchair vans or ambulances;

— commercial venues and businesses, such as hotels and motels, malls, restaurants, etc. that may house populations without automobiles due to accessibility by public transport;

— airports, train stations, port terminals, etc. where transient populations may be entering the area.

Identification of this population is a key consideration for any successful evacuation and as such a key function for the Concept of Operation. Surveys are helpful in identifying the site specific demographics of this population group; however, they have proven to be of limited value in the response phase of an evacuation. A more useful method is the development of a network that uses key people and organizations that already have relationships with members of these populations to identify and communicate with during an evacuation. For example in the United States and other countries, public transport service operators provide specialized transportation services to the elderly and disabled. These organizations maintain accurate records of the riders who utilize these services and as such can easily identify the population within an impact area. Other such agencies and organization exist and should be leveraged by public transport service operators to identify and communicate with the public transport dependent populations.

Special facilities residents require specialized transportation such as ambulances, wheelchair accessibility, or secure transport. The number of vehicles available to provide these services are limited and as such require lengthy evacuation times. Additionally, coordination of these services requires significant time and is usually spread across emergency services and public transport or in some cases, traffic managers. Advanced planning is required to ensure this population is accounted for in a disaster. This includes ensuring that these facilities are part of any evacuation exercise and that inventories are maintained of vehicles required by the facilities.

School populations also present a unique challenge because of the wide array of setting that exists. These populations include early years (ages 3 to 4), primary education (ages 5 to 11), secondary education (ages 12 to 18), and tertiary education (18+). Again as with special facilities residents, advanced planning is required and significant coordination is needed to ensure this population receives the resources needed.

But, this identification is not easy as the use of a network that uses key people and organizations does not always work successfully because key people and/or organizations are impacted by a disaster and therefore special agreements must be put in place to ensure that key people especially in public transport understand and accept these responsibilities. In addition, special facilities residents do not always stay at the same place. It may be necessary to trace their movement but enacting similar special agreements with special facilities personnel.

An alternative may be to utilize location data from mobile phones. Most mobile phones in use today transmit time stamped location data to cell towers for use by carriers and phone makers. The resulting massive data sets which are collected almost in real time may be used to identify where people are congregating in a disaster. This is an evolving technology that should be evaluated as a viable source for identifying the need.

This all assumes that people should evacuate if a disaster happens. But, this does not always hold true. Some disasters may not require departure from the building but rather moving to higher areas of the building or just sheltering in place. The need must also delineate between horizontal evacuations (fleeing an area) and vertical evacuations (sheltering in place).

5.2.2.2 Response times

Once the population base has been identified, an estimate is required for the time to evacuate those residents impacted by the disaster. Estimating the response time is accomplished using modelling techniques. This set of standards selected the process published by the United States Nuclear Regulatory Commission *Criteria for Development of Evacuation Time Estimate Studies, Sandia National Laboratories, and November 2011*.

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This study identified the importance of reviewing local and regional emergency plans to ensure there are processes and procedures in place to provide transportation to public transport dependent residents during an emergency response. Where local plans exist, they should be used to develop the estimated response times for evacuation. The Emergency Operations Centre (EOC) is responsible for making protective action recommendations and decisions. It is necessary to obtain this information in order to complete the estimated time for evacuation. Developing the routes to be followed by the buses and the time it will take to complete a trip is assumed to be a key function within the Concept of Operation and should be based on evacuation directives issued by the EOC.

Evacuation response times are also impacted by when it occurs, how much warning, and what damage has occurred. The time of day, day of the week and time of year all may have varying impacts to an evacuation. Week day traffic is different at rush hour versus late at night or on the weekend. Holidays, seasons, and special events also impact response times. Additionally, no-warning disasters change the evacuation response times because of the damage in all likelihood will cause road closures and damage electrical and communication infrastructure. Models in these situations will offer little help and it will be the experience and knowledge of the public transport, traffic management, and emergency management personnel that will be needed to make real time life-saving decisions.

5.2.2.3 Resource assignment

With the routes and time estimates for completing an evacuation in place, the task of assigning resources to complete the evacuation becomes the next challenge. The seating capacity of municipal buses is based on adults. A reasonable estimate for buses is 50 % of the stated seating capacity (NRC, 2008a) with no credit taken for standing room capacity. Care should be taken not to double-count resources when calculating transportation needs for populations dependent on public transport and the transportation needs for special facility residents. Special facility residents are those residents that are housed in special facilities which are assumed to provide their own transportation. However, a subset of public transport dependent residents includes people with disabilities and those with access and functional needs that live independent of a special facility. Surveys conducted in the United States found that 6 % of respondents said they, or someone in their household, would need special assistance to evacuate. Information on households with residents dependent on specialized transportation such as wheelchair vans or ambulances should be developed and quantified separately from the other residents. This assumes that wheelchair equipped vans will be dispatched to individual homes while the traditional fixed route buses would be dispatched to staging areas. A summary of the total number of vehicles (e.g. buses, vans, specialized transport vehicles) available to support the evacuation of public transport dependent residents, as well as people with disabilities and those with access and functional needs, not residing in special facilities should be developed. This will support the determination of how many evacuation runs may be needed. Assigning operators, briefing personnel (supervisors, dispatchers, maintenance, operators, etc.) and initiating an orderly pull-out will signal the launch of the evacuation. This describes an optimistic evacuation in an orderly world without damage and loss of life. When a disaster does strike, the infrastructures of public transport and electric power supply may be damaged. In addition, drivers, operators and other persons are not able to assemble. These situations must be considered and planned for in advance. Moreover, the ambulances that may have been used for evacuation will then be used for the rescue of those who are injured. The number of ambulances is, therefore, not sufficient for evacuation.

Once the evacuation is underway, the monitoring phase begins and is required to ensure an orderly response to the changing nature of an evacuation. During the initial stages of the evacuation routes may change or additional resources may be required based on the activities being reported from the field. Public transport responsibilities during the monitoring phase depend on the longevity of the event. For planning purposes, it should be safe to assume that the monitoring phase will last for days or possibly weeks and will include not only the initial evacuation efforts to move people to shelters but also satisfying the continuing need for transportation once an evacuee is settled in a shelter. Intermediate and long term support in the way of new routes or demand response services will require additional resources for those evacuees in shelters and without transportation. Also it is assumed that during the monitoring phase, a plan for returning evacuees is developed.

Another key challenge of an evacuation is the need to transport humanitarian assistance cargo. As the monitoring phase may last for days or possibly weeks, the needs of evacuees change drastically during

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