SECTION 1 - INTRODUCTION

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1.1.0 BUS TRANSIT FACILITIES

RTD bus transit facilities are intermodal transfer facilities. They provide collection and distribution points for travelers who transfer between auto and transit (bus or rail) modes, single occupant vehicles and high occupancy vehicle (vanpools or carpools) modes, transit modes (bus to bus, bus to rail and rail to bus) or by other means. Bus transit facilities require proper planning and forethought to serve this array of modal transfers, which if accomplished will optimize the facility activity and better integrate it with the surrounding community. Other modes supported by a properly designed bus transit facility may include: pedestrian, bicycle, paratransit, inner- and inter-city bus transit, airport service and rail (LRT and commuter).

Differing transit facility design views are held within engineering and planning professions. At one extreme, the primary goal is to maximize its efficiency as an extension of the highway or transit network. At the other extreme, the primary goal maximizes community integration characteristics and reduces regional transportation connectivity needs. RTD integrates both extremes and provides a coordinated design that equally serves the highway transit network and community integration. The level of coordinated design shall be appropriate to the surrounding existing and planned roads and land uses.

Experience and surveys show that facilities achieve success (measured by demand and operating expense) if form follows function. Design professionals shall consider the various access, circulation and service modes of the transit facility and shall include pedestrian and bicycle movements. These concerns and design requirements are at the top of the design priority list. Close attention to these issues will produce a superior facility with reduced maintenance requirements, lower operating costs and manageable security risks.

Many components are required for the design and development of a successful multimodal and intermodal transit facility. These components fall into the following eight categories:

- Functional zones (access, transfer, circulation, plazas, boarding, seating, lighting, utilities, drainage, information and fare collection) of a transit facility
- Designing a community integrated facility
- Providing for the design needs of pedestrians and bicyclists
- Compliance with ADA requirements and guidelines
- Providing for the design requirements of transit vehicles, automobiles and maintenance equipment
- Design considerations for facility access management
- Design considerations for convenient, efficient and cost effective maintenance
- Design considerations for safety and security management

Although a hierarchy can be applied to the eight categories, each is important to the success of the proposed facility. All bus transit facility designs shall address and integrate each of the above categories.

Access, circulation, storage and parking for transit, automobile, bicycle and pedestrian modes, and their requirements, services, amenities and conveniences shall provide smooth and seamless transfer capabilities, and promote efficient facility management.

The pedestrian mode is a component for all commuter trips. Design considerations, within a facility and surrounding land uses, shall provide for and promote pedestrian flow.

Bicycle access, circulation and parking and storage design shall be included with the facility and integrated with adjacent bike routes and pedestrian paths. Bicycles and automobiles must be accommodated for on-site circulation and parking.

As required, automobile parking lot (park-and-ride; pnR) sizes will vary pursuant to estimated demands. The pnR design shall be based on site characteristics such as parcel shape, topography and available access. They are classified as small, medium and large:

- A small pnR may be located on a remnant few acres parcel along a freeway, adjacent to a freeway access ramp, or other site with no special access features, with a 200 space or less capacity, and a bus loading area along a parallel street.
- A medium pnR may be located on an 8 acre parcel with a parking capacity of more than 200 and less than 1,000 spaces, and a bus loading area within the facility and a dedicated transit vehicle access driveway loop.
- A large pnR lot may be located on a 15 acre site with a parking capacity of 1,000 or more spaces, with multiple transit vehicle loading areas and possibly different transit modes (e.g., I-25 & Broadway, Mineral or Wagon Road at I-25).

The following is an approximate parking space count to lot size ratio used by RTD for planning purposes:

- 70 spaces per acre for a large pnR with several bus loops, multiple plaza areas, many pedestrian circulation routes and extensive amenities
- 75 spaces per acre for a medium pnR with a single bus loop, several plaza areas, pedestrian circulation routes and other amenities
- 80 spaces per acre for a small pnR with no internal bus loop (street stop only), single plaza area, limited pedestrian circulation routes and few amenities

1.2.0 SCOPE

The Design Criteria take precedence over other standards referred to herein except those required by legislation.

Specific attention shall be given to the most recent version of the Americans with Disabilities Act (ADA).

These Design Criteria relate to the following RTD design and construction elements:

- Bus Transit Facility Design
- Civil Design
- Urban and Landscape Design

- Bicycle Facilities
- Structural Design
- Driver Relief Station
- Signage
- Lighting and Electrical
- Communication, Fare Collection and Power
- Construction Documents
- Facility and System Safety and Security

1.3.0 PROCEDURES

Design Engineers shall prepare drawings and technical specifications for each project in accordance with their design contract, as applicable, and the following RTD documents:

- All RTD Design Criteria Manuals
- RTD CADD Standards
- Contract Requirements
- All other applicable requirements including codes, regulatory standards and environmental impact statements

Deviations may be made within the framework of the Design Criteria to meet specific case-by-case requirements. Any deviation, discrepancy or unusual solution must be discussed with and approved by RTD before it is advanced and included in the design. The Design Engineer shall identify, explain and justify all deviations from the criteria and secure written approval from RTD. Any variation from these Design Criteria must be submitted to and approved by RTD's Executive Safety and Security Committee. All proposed deviations to these criteria shall be approved by RTD in writing.

Where manufactured products are specified, alternative products are acceptable if the proposed substitution is an approved equivalent and approved by RTD in writing.

1.4.0 DESIGN CODES AND MANUALS

The Design Engineer shall comply with all applicable engineering codes, standards, and all Federal, State and local jurisdictional requirements.

The most recent edition(s) of codes, manuals and requirements specified herein shall be used. Responsibility for all designs remains with the Design Engineer in accordance with the terms and conditions of the design contract.

The Design Engineer shall identify all known or apparent code conflicts, shall notify RTD in writing and shall recommend a solution. The Design Engineer shall confirm those codes and manuals that have precedence.

Specific codes, standards and design guidelines include, but are not limited to, the following:

- Americans with Disabilities Act (ADA)
- Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)
- Americans with Disabilities Act Accessibility Guidelines for Transportation Vehicles
- Colorado Department of Transportation (CDOT) - Standard Specifications for Road and Bridge Construction
- CDOT - Standard Plans (M&S Standards)
- CDOT - Design Guide
- CDOT – Drainage Design Manual
- CDOT – Bridge Design Manual
- City and County of Denver - Rules for Street Standards
- City and County of Denver - Standard Construction Specifications
- FHWA - Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD)
- Metropolitan Government Pavement Engineers Council (MGPEC) - Pavement Design Standards and Construction Specifications
- RTD – Facilities Standard and Directive Drawings for Bus and Light Rail Transit Facility Projects (RTD Standard Drawings)
- Uniform Building Code (UBC)
- International Building Code (IBC)
- Uniform Fire Code (UFC)
- American Association of State Highway and Transportation Officials (AASHTO)
- American Institute of Steel Construction (AISC)
- American Welding Society (AWS)
- American Concrete Institute (ACI)
- American Society for the Testing of Materials (ASTM)
- National Bureau of Standards
- National Electric Code (NEC)
- National Electric Safety Code (NESC)
- American National Standards Institute (ANSI)
- National Fire Protection Association (NFPA) including NFPA 130 and 101
- Local jurisdictional codes, requirements and ordinances, as applicable

Individual sections of these criteria may also define additional code requirements.

1.5.0 CLIMATIC CONDITIONS FOR SYSTEMS DESIGN

The Denver metropolitan area, within which RTD operates, is situated east of the Rocky Mountains, near and within the eastern slopes of the Rocky Mountain foothills in central Colorado. The area has a semi-arid climate similar to the High Plains, but is modified by the Rocky Mountains located west of the area. Denver lies in a belt where there is a fairly rapid change in climate from the foothills to the plains. This change is largely caused by the increase in elevation towards the westerly foothills. Denver has an elevation of 5,280 feet.

The average annual temperature is about 50°F and it varies a few degrees with changes in elevation. The wide average range in daily temperature of 25° to 30°F in the Denver metropolitan area and a wide average range in annual temperature are typical for the High Plains. Variations in temperature are wide from day to day; extremely hot weather in summer and extremely cold weather in the winter normally do not last long and are followed by much more moderate temperatures.

Facilities materials and equipment shall be capable of maintaining operation within the following conditions:

TABLE 1A – CLIMATIC CONDITIONS

Ambient Temperature	-30°F to +110°F
Relative Humidity	8 to 100%
Maximum Rainfall in 24 Hours	1.88 inches
Maximum Snowfall in 24 Hours	10.1 inches
Maximum Wind Speed	54 mph
Average Elevation Range	5,000 – 8,000 feet

TABLE 1B – TEMPERATURE AND PRECIPITATION

MONTH	TEMPERATURE				PRECIPITATION			
	AVERAGE DAILY MAXIMUM	AVERAGE DAILY MINIMUM	2 YEARS IN 10 WILL HAVE AT LEAST 4 DAYS WITH		AVG TOTAL	2 YEARS IN 10 WILL HAVE		AVG NO. DAYS WITH SNOW COVER
			MAX TEMP EQUAL OR HIGHER THAN	MIN TEMP EQUAL OR LOWER THAN		LESS THAN	MORE THAN	
	°F	°F	°F	°F	IN	IN	IN	
JAN	43	14	61	-6	0.4	0	0.8	8
FEB	47	18	64	-2	0.4	0	0.7	9
MAR	52	23	70	4	0.8	0	1.6	7
APRIL	62	33	79	19	1.8	0	2.8	3
MAY	71	42	86	32	2.5	0	3.7	1
JUNE	84	51	96	40	1.5	0	2.6	0
JULY	91	57	99	50	2.0	1	3.2	0
AUG	89	56	98	49	1.4	0	2.1	0
SEPT	80	47	94	35	1.1	0	1.7	***
OCT	69	36	83	25	0.7	0	1.5	1
NOV	54	23	71	7	0.5	0	0.9	5
DEC	46	18	64	2	0.4	0	0.6	7
YEAR	66	35	*101	**-	14.	9	18.	41

* Average annual highest temperature
** Average annual lowest temperature
*** Less than one-half day

Data for long periods indicate that the average annual precipitation ranges from 13.5 to 14.5 inches, with the highest precipitation occurring at the western edge of the metropolitan area. Particularly in summer and spring, precipitation may vary from year to year and in different areas in the same year. Precipitation in the winter is more in the western part of the Denver metropolitan area than it is in other parts. These differences are small but consistent from October to May. The annual snowfall is about 59 inches. The eastern part of the metropolitan area, however, usually receives more rainfall in summer than the west, but local rainfall varies widely from year to year.

The relative humidity averages 39% during the day and 62% at night, but these averages are slightly higher in winter than in summer. In an average year, the percentage of sunshine is about 69%.

Hailstorms cause some local damage almost every year. The hail usually falls in strips 1 mile wide and 6 miles long. These storms are more common in the eastern part of the Denver metropolitan area than the western part and they generally occur from about May 15 to September 1 but are most common in June and July.

Requirements for climatic conditions defined in other sections of these Design Criteria take precedence.

1.6.0 ACRONYMS AND ABBREVIATIONS

The following defined acronyms and abbreviations may appear in this document:

AASHTO	American Association of State Highways and Transportation Officials
ACI	American Concrete Institute
ACOE	Army Corps of Engineers
ADA	Americans with Disabilities Act
ADAAG	Americans with Disabilities Act Accessibility Guidelines
APTA	American Public Transit Association
ASTM	American Society for Testing and Materials
CCD	City and County of Denver
CCTV	Closed Circuit Television
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CFR	Code of Federal Regulations
DBE	Disadvantaged Business Enterprise
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
HVAC	Heating, Ventilating and Air Conditioning
IBC	International Building Code
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society
ISO	International Organization for Standards

LED	Light Emitting Diode
LOS	Level of Service
LRT	Light Rail Transit
LRV	Light Rail Vehicle
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
NETA	National Electrical Testing Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
PUC	Public Utilities Commission
ROW	Right of Way
TOD	Transit Oriented Development
TVM	Ticket Vending Machine
UBC	Uniform Building Code
UDFCD	Urban Drainage and Flood Control District
UFC	Uniform Fire Code
UL	Underwriters Laboratories, Inc
USDCM	Urban Storm Drainage Criteria Manual
USDOT	United States Department of Transportation

1.7.0 TRANSIT FACILITY TYPES

The types of bus transit facilities are as follows:

- Park and Ride (pnR)
- Bus Rapid Transit (BRT) with/without expanded "Super Stop"
- Transfer Station (pulse point) with no, or limited short-term parking (kiss-and-ride)
- Street-side Bus Stop

The functions and services include modal transfers to other buses, rail and personal vehicles (autos, trucks, vans and bicycles). Vehicle, pedestrian and bicycle circulation shall be accommodated within the transit facility. Additionally these movements may occur to and from adjacent areas of Transit Oriented Development (TOD), residence, employment, commerce, industry, learning, sport and entertainment centers. All shall adhere to applicable ADA requirements.

The functional zones of transit facilities associated with specific bus operating activities are further discussed in the following sections.

A facility type and the size of its functional zones shall depend upon specific planning, community and environmental requirements. For example, an informal or opportunistic lot may provide only long-term parking and a transit loading area. In another case, the functional requirements of bus operations may require a specific number of bus loading bays, while identifying the need for independent bus arrivals and departures. In conjunction with RTD, the Design Engineer shall design site layouts that accommodate the number of transit vehicles and also determine the need for other transit facility types.

The Design Criteria shall be carefully applied so that the design fits local conditions, safely connects with roadway networks, meets local government codes and regulations and is easily maintained. RTD supports creativity and flexibility to encourage solutions that are constrained by local conditions and to use standard transit design elements that maximizes maintenance efficiencies. Many of the design parameters relate to the bus-oriented pnR facility. These concepts can also be directly applied to rail oriented pnR facilities.

Call-n-Ride services may be incorporated at any RTD bus transit facility in coordination with RTD service development division.

1.8.0 COMMUNITY INTEGRATION AND TRANSIT ORIENTED DEVELOPMENT (TOD)

Some concerns about bus transit facilities are that they do not discourage private automobile travel, have undesirable community and environmental impacts and are perceived to attract criminal activity. A successfully integrated design will mitigate these concerns, ease other apprehensions associated with bus transit facilities and provide the community with better transit facilities.

The community demands well built public works projects, and is very attentive to projects in areas where vacant land is scarce, environmental concerns are dominant, and local development or in-fill redevelopment activities are vigorous. In these areas, transit is becoming the solution to resolving traffic congestion, air pollution concerns and economic development. A community integrated facility will provide the maximum benefit to be realized from a fully intermodal/multimodal transit facility.

A community integrated facility benefits transit ridership and increases potential revenue streams for RTD and the community tax base. Better access improves community integration and promotes adjacent development. An integrated pnR can provide a focal point for future urban and transit oriented development (TOD).

A coordinated effort is required for a successfully integrated transit facility, and may involve several jurisdictions. Transit oriented zoning, platting and deed restrictions (easements) that promote transit facilities and TOD in the vicinity of the facility are beneficial for a successful community integration. There must also be a market for the facility and accompanying transit services in the community.

1.9.0 PEDESTRIAN AND PASSENGER FACILITY REQUIREMENTS

A transit facility consists of four elements:

1. personal vehicle (car, motorcycle and bicycle) accommodation
2. passenger facility
3. pedestrian access space
4. open space (detention and landscaping)

Efficient operations require that all elements work in harmony, which provides a smooth and seamless intermodal transition from the personal vehicle, via the pedestrian mode to the transit system. Other access and egress modes shall be included within this three-part system.

Pedestrian related factors shall be considered when designing a successful transit facility. At the site-specific level, the design shall include: the general site layout, pedestrian and vehicle circulation routes and the intermodal bus plaza area.

The following shall be considered when designing for pedestrians:

- Separation of competing modes
- Provision of pedestrian pathways
- Provision of adequate pedestrian waiting areas (4 sf/ person min.)
- Compliance with the ADA requirements and guidelines
- Provide safe environments (adequate lighting and shelter)
- Manage conflict points between pedestrian, bus and vehicle movements

1.10.0 DISABILITY RIGHTS LAWS

Specific attention should be given to the Americans with Disabilities Act (ADA), the ADA Accessibility Guidelines for Building and Facilities (ADAAG), the ADA Accessibility Guidelines for Transportation Vehicles and to any succeeding modifications that may be issued. Their applicability is noted in several sections of this Manual where apparent or appropriate significance apply. Adherence to ADA and ADA related guidelines is required for all areas of this Manual, regardless of explicit, implied or lack of reference herein.

1.10.1 ADA Accessible Parking

The number of ADA accessible parking spaces shall be coordinated with local jurisdictions to ensure that their requirements are met. If local codes are more stringent than Federal guidelines, the more stringent shall be followed. At least one van accessible space shall be placed at the site, and additional ones for every eight ADA spaces are required. Table 1C summarizes the number of accessible car parking spaces required per facility by current ADA requirements.

TABLE 1C – ADA Parking

Total Parking in Lot	Required Minimum Number of Accessible Spaces
1 to 25	1
26 to 50	2
51 to 75	3
76 to 100	4
101 to 150	5
151 to 200	6
201 to 300	7
301 to 400	8
401 to 500	9
501 to 1000	2% of total
1001 and over	20 plus 1 for each 100 over 1000

A facility design shall promote safe and convenient access for all patrons, and provide adequate ADA accessible parking stalls at the site. Design requirements for individual ADA accessible parking stall layouts can be found in the ADAAG. Grade changes and barriers between the ADA accessible parking stalls and the transit loading area should be eliminated. All facilities shall be clearly signed for restricted use according to ADA requirements and MUTCD standards.

1.11.0 BUS BOARDING AND ALIGHTING AREAS

Consideration for the disabled patron at transit loading facilities is required. Bus boarding and alighting areas shall have a firm, durable and stable surface (generally concrete). These areas shall be 30 feet long measured parallel to the roadway and 8 feet wide. Bus boarding and alighting areas shall be connected to streets, sidewalks or pedestrian paths by an ADA accessible route.

Parallel to the roadway, the bus stop boarding and alighting area longitudinal slope shall be the same as the roadway. The bus stop boarding and alighting area slope perpendicular (cross-slope) to the roadway shall be 2%, typically sloped toward the roadway.

All pedestrian facilities shall be designed to meet the requirements and guidelines of ADA and ADAAG. At a minimum, pedestrian areas shall be provided with ramps through curbs and other vertical barriers, textured pavement surfaces and a barrier-free "accessible" path between ADA accessible parking spaces and the transit terminal. Adequate space for full deployment and loading of vehicle lifts shall be provided adjacent to each bus platform in accordance with ADAAG. Additional features such as Braille signage and audible signals shall be considered as aids to visually impaired patrons.

1.12.0 PROVIDING FOR THE TRANSIT VEHICLE

The required transit facility service will determine the design vehicle parameters. Transit service and access is as important as pedestrian access. Specific transit design elements for individual facilities will depend on the vehicles accessing and serving the site and the operational requirements. The design parameters may include Bus Rapid Transit (BRT) systems. The Design Engineer shall coordinate with RTD and determine the types and number of vehicles that must be designed for at the respective facility.

A precise definition of BRT is elusive. It generally includes services that are faster than traditional "local bus" service and may include a separated fixed guideway. The elements of a BRT system include the bus type, bus priority, fast boarding and alighting, fast fare collection and a uniquely identifiable system image. The pnR facilities that incorporate BRT should address vehicle characteristics, and the unique features that distinguish BRT from other transit buses. See Section 2 of this Manual for more information about BRT.

1.13.0 DESIGNING FOR THE TRANSIT VEHICLE

Designing adequate service roadways and features, both external and internal to the transit facility, are important to assure efficient transit access to the proposed facility and sufficient transit service. The design shall include the following important features:

- Allowances for minimum horizontal and lateral bus clearances (dynamic envelope), including external bike racks
- Allowances for minimum turning radii, movements and curb returns
- Accommodation of acceleration needs and grade issues
- Provision of adequate clear sight distances
- Construction of adequate pavement
- Incorporation of appropriate roadway and driveway widths for transit operations
- Allowances for underside road clearance at driveways, speed humps, dips, speed tables, raised pedestrian paths and railroad crossings

1.13.1 Bus Access and Parking Requirements

Bus access to the transit facility shall generally be separated from private vehicle access, but allowances shall be considered if this is not practical for the entire access route. For off-street transit terminals, the bus loading area shall be separated from general purpose traffic. Timed transfer scheduling, called “pulsing,” occurs when several routes converge at a single transit facility at the same general time, dwell, and simultaneously leave the facility. These facilities are “pulse points” and the timed transfer or pulse point scheduling of independent routes generally require more bus bays.

Bus parking space requirements shall be based on the maximum number of transit vehicles requiring independent pull-in and pull-out bays at the same time. If all buses operate independently and access the transit facility simultaneously, curb space sufficient to park all vehicles must be provided.

However, if a reduction in costs can be achieved with staggered bus arrivals and departures, individual bus bays can be shared. The design of "shared" bays must be coordinated with RTD. Extreme care is required to ensure the reliability of staggered bus-bays for each intersecting route through a single transit center, especially if transfers are expected between routes.

Bus bay configurations that may be used within a transit facility include:

- Linear bays with successive transit vehicle lining up in single file
- Sawtooth bus bays providing individual bays for specific routes (generally preferred configuration)
- Angled or diagonal bays require back outs, and are typically used only when buses have extended dwell times (e.g., intercity bus terminal)
- Drive-through bays are used in compact areas, and allow bus front destination signs to face arriving passengers (e.g. rail station exits)

The Design Engineer shall coordinate an appropriate bay configuration for the site with RTD during the conceptual design phase.

1.13.2 Other Operational Design Considerations

The following design considerations, which are generated by on site operations, shall be incorporated within a transit facility:

- Provide layover space for scheduled down time
- Provide necessary driver amenities

A layover is a scheduled time during which a transit vehicle dwells at a specific location for longer than needed to load passengers. Layovers can often be identified within a route schedule by location, as having a listed arrival and departure time. Driver amenities may include a driver relief station (DRS), vending machines and break areas.

Layover Space: As required, and determined in coordination with RTD, an adequate transit facility area shall be designed for layovers, preferably at a location separated from passenger loading bays. Buses using layover locations can re-enter the internal transit stream and pick up passengers after a layover is complete. This reduces passenger confusion and frustration with transit vehicles not leaving the transit stop promptly upon loading.

Dimensions for adequate layover space shall be determined by the number of buses to be stored at the site and the physical dimensions of the critical design vehicle. The required layover space length is also determined by the scheduled layover overlaps, and by clear line of sight requirements. Typical layover spaces require:

- 40 to 60 feet layover length per dwelling transit vehicle
- 7:1 taper for pull in and 4:1 taper for pull out
- 10 feet clearance between dwelling transit vehicle

- 12 feet layover stall width

Drivers Relief Station (DRS): A DRS for transit operators shall be provided at layover and end of line locations and should be accommodated within a pnR facility, transfer facility or any other major operational activity. See Section 7 of this Manual for additional requirements.

1.14.0 PROVIDING FOR PRIVATE VEHICLES (AUTO, BIKE & MOTORCYCLE)

Pedestrian and transit movements within the facility must be emphasized to assure successful community integration and efficient facility operations. Private vehicles and transit elements are the primary modes for which intermodal transit facilities are designed. They are often the principal measure of effectiveness (MOE) for a facility (i.e., vehicle usage is often the main MOE that justifies the investment). In addition to providing pleasant and safe pedestrian environments and efficient transit operations, a successful transit facility must provide adequate and secure parking facilities for automobiles, motorcycles and bicycles.

As required by specific facility operational needs, private vehicle parking areas shall be provided to accommodate long-term (extended duration), all-day/part-time commuting, and short-term or “kiss-n-ride” activities. Major design elements and considerations for these operations shall include:

- Surface or structured parking
- Parking layout and stall alignment
- Bike locker and rack locations
- Onsite circulation (including pavement markings and signage)
- Facility access geometry and elements
- Parking demand management (may include pay-n-park alternatives)
- ADA accessibility and parking requirements
- Pavement designs
- Grading, drainage and utility needs
- Illumination needs
- “Kiss-n-ride” activities
- Landscape and architectural elements
- Maintenance and operations
- Safety and security