

Intelligent transport systems — Passenger-carrying public-area mobile robots

Systèmes de transport intelligents — Robots mobiles de l'espace public transportants de passagers

WD

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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Contents

1	Scope	1
2	Normative references	1
3	Terms and definitions	1
4	Abbreviations	3
5	Classification	4
5.1	Accompanied PC PMRs (A-PC PMRs).....	4
5.2	Independent PC PMRs (I-PC PMRs).....	4
6	Procedures	5
6.1	For Accompanied PC PMRs (A-PC PMRs).....	5
6.1.1	Manual Override.....	5
6.1.2	Switch to Independent Mode.....	5
6.2	For Independent PC PMRs (I-PC PMRs).....	5
6.2.1	Beginning of Journey.....	6
6.2.2	Status Reporting (breadcrumbs).....	6
6.2.3	Abort Journey.....	6
6.2.4	End of Journey.....	6
6.2.5	Passenger Responsiveness Reporting.....	6
6.2.6	P-Class I-PC PMR Breakdown.....	7
6.2.7	C-Class I-PC PMR Breakdown.....	7

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).

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The committee responsible for this document is ISO/TC 204 WG19.

The parts of ISO 4448 are proposed as deliverables, as a foundation for instantiation. Later, additional Standards deliverables may be required for specific applications.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This part of the 4448 series addresses passenger-carrying public-area mobile robots ("PC PMRs"). These are automated devices that transport (physically carry) humans. Examples are personal health assistant robots, automated wheelchairs that carry patients in a medical environment or travellers in an airport, mobile emergency helper robots that are used, possibly teleoperated, in fire, police, EMS, or evacuation applications carrying human passengers.

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Intelligent transport systems — Passenger-carrying public-area mobile robots

1 Scope

This document characterizes and provides recommendations, rules, and procedural guidelines for the deployment of passenger-carrying public-area mobile robots ("PC PMRs"), such as wheelchairs and micro-personal transit vehicles that *carry* passengers in an automated manner.

This document covers P-Class and C-Class PC PMRs. It does not cover R-Class PMRs that carry passengers as these are considered automated vehicles and shall be regulated according to standards that apply to them.

Out of scope are devices that *follow* humans to carry loads or to assist in a task, including assisting the blind.

2 Normative references

~~There are no normative references in this document.~~ [What about the four listed in the text?]

3 Terms and definitions

For the purposes of this document, the terms and definitions in ISO/TS 14812:2022 and the following terms and definitions apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

Key: **Noun** — *Variable* — **Procedure, method**

3.1

Accompanied Passenger-Carrying Public-area Mobile Robot (A-PC PMR)

a PC PMR that only carries people if accompanied by a **Companion**.

3.2

Bystanders

nearby humans, such as pedestrians or other active transportation participants, within the immediate operating vicinity of the PMR. Bystanders are not involved in the use or operation of the PMR.

3.3

C-Class Public-area Mobile Robot (C-Class PMR)

a PMR designed to primarily operate on cycleways.

3.4

Companion

a human operator that travels in close proximity to one or more **A-PC PMRs** in order to ensure passenger safety, comprehension, and comfort.

Note to entry: safety, comprehension, and comfort address any form of disability whether it's visual, auditory, cognitive, or age.

3.5

Deadman Brakes

an automatic emergency brake that engages in the event active braking control is lost; e.g., in the case of a power failure on a PMR, electric brakes are automatically engaged.

3.6

Fleet Operator

an entity responsible for the operation a fleet of PMRs.

Note to entry: this includes responsibility for all of the individual robots within a fleet, their trip planning, mechanical and power condition, task deployment, connectivity and responsiveness to a regional **Orchestration Manager** (if any), and human teleoperation or oversight.

Note to entry: this responsibility includes obtaining insurance, licenses, and certifications, as well as a rule following, and responsiveness to enforcement, teleoperator training, and crash clean-up.

3.7

Independent Mode

a mode where an **A-PC PMR** travels without a **Companion** or an **I-PC PMR** travels without passengers.

Note to entry: an A-PC PMR with a companion becomes, by definition, an I-PC PMR.

3.8

Independent Passenger-Carrying Public-area Mobile Robot (I-PC PMR)

a PC PMR that can carry passengers without the supervision of a **Companion**.

3.9

Macro Plan

a trip plan that extends from the immediate location of a PMR until the end location of the trip being planned or in progress; plan for an entire trip.

3.10

Orchestration Manager

a management system that orchestrates all of the PMRs in all of the fleets sharing the same **ODD**; the ODD may be a building, a facility such as a campus, a specific area of a city or an entire region that represents an integrated ODD.

Note to entry: this **Orchestration Manager** is an **ODD**-wide or regional system and has superior oversight over all OMR fleets compared to orchestration systems operated by individual fleet operators on behalf of their PMR fleet.

3.11

PathwayPullover

A physical control procedure providing a description for a PMR to move out of the way of other users of a human pathway

Note to entry: this is described in full in 4448-7.

3.12

PathwayStopping

A physical control procedure providing a description for a PMR to stop within a human pathway

Note to entry: this is described in full in 4448-7.

3.13

Passenger-Carrying Public-area Mobile Robot (PC PMR)

a robot used primarily for transporting passengers.

3.14

Passenger Responsiveness Check

a method of determining that a passenger on an **I-PC PMR** has not, since the start of an instance of use of the device, lost the ability to be aware, responsive and able to signal for help.

Note to entry: this seeks to ensure that there has been *no decline* in passenger responsiveness.

3.15

Passenger Response Interval

the time interval within which an I-PC PMR must prompt its passenger for a response.

3.16

P-Class Public-area Mobile Robot (P-Class PMR)

a PMR designed to primarily operate on pedestrian pathways (footways).

3.17

ShyDistance Dynamic

the minimum distance to be maintained between a PMR and a non-stationary object.

3.18

Start Trip Button

a control on an I-PC PMR that a passenger uses in order for the PMR to commence the trip.

3.19

Startup Duration

a period of time set by the **ODD** jurisdiction authority in which the I-PC PMR must signal to passengers that it is about to commence motion.

Note to entry: This has a default value that may be changed in context.

3.20

Startup Sequence

the series of events that takes place in order for an I-PC PMR to commence motion.

3.21

Stop Trip Button

a control on an I-PC PMR that a passenger may use in order to stop the PMR.

Note to entry: This may have to be specified as an emergency stop button in some jurisdictions.

3.22

Trip Plan

A **Macro Plan** provided by an **Orchestration Manager**.

4 Abbreviations

JDR journey data recorder

ODD operational design domain

PMR public-area mobile robot

PUDO pickup/drop off

5 Classification

PC-PMRs are classified into two size classes: pathway (**P-Class**), and cycleway (**C-Class**). They may also be classified based on function: carrying passengers, carrying goods or providing a service. This part of the 4448 series, is focussed on carrying human passengers.

P-Class PC PMRs include automated wheelchairs and mobility scooters. They operate on pathways among **bystanders**. They generally carry one passenger. They are either accompanied by a **Companion** or unaccompanied.

C-Class PC PMRs operate primarily in cycleways and carry one or more passengers. This category includes self-driven pedicabs. A **Trip Plan** may authorize them to stop on a pathway, however, arbitrary travel not described within a Trip Plan shall not be permitted.

5.1 Accompanied PC PMRs (A-PC PMRs)

A-PC PMRs are PC PMRs that carry persons and are accompanied by a **Companion**. These PMRs may be used to carry persons with mobility disabilities, in a medical evacuation, or in a similar task carrying persons that may be incapacitated.

A-PC PMRs shall be designed to comply with the standards of their equivalent, non-robotic devices. These standards include (but are not limited to):

- IEC 60601-2-52:2009
- ISO 9999:2016

5.2 Independent PC PMRs (I-PC PMRs)

I-PC PMRs are PC PMRs that carry people without the supervision of a **Companion**. These PMRs may be used to carry both able-bodied passengers as well as those with mobility limitations.

I-PC PMRs shall have sensors to indicate whether a passenger is securely loaded and have a method to indicate passenger load security condition. An I-PC PMR shall have a **Start Trip Button** within easy reach by the passenger that the passenger must activate for the trip to commence.

I-PC PMRs shall have a **Stop Trip Button** within easy reach by the passenger that may be activated at any time during the trip. This button shall act as an emergency stop button. Passengers that are unable to activate the Stop Trip Button shall not use an I-PC PMR.

I-PC PMRs shall have **Deadman Brakes** for the event of a power failure.

I-PC PMRs shall have the ability to detect whether a passenger has cleared the I-PC PMR by a minimum distance of *ShyDistanceDynamic*.

I-PC PMRs shall have a mechanism for ensuring its passenger is responsive. This mechanism shall be activated according to the specified *passengerResponseInterval*.

Table 1: I-PC PMR Parameters (all to be determined locally)

I-PC PMR Parameter	Unit	Tolerance	Default	Preferred	Notes
<i>startupDuration</i>	secs	1	5	Set for context	

<i>passengerResponseInterval</i>	secs	120	300	Set for context	
<i>shyDistanceDynamic</i>	mm	60	600	Set for context	too small?

I-PC PMRs shall be designed to be compliant to the standards of their equivalent, non-robotic devices. These standards include (but are not limited to):

- EN 12184:2022
- ISO 7176-1:2014

6 Procedures

6.1 For Accompanied PC PMRs (A-PC PMRs)

Procedures defined in 4448-7 and 4448-14 that apply to **PA PMRs** shall apply to **A-PC PMRs**.

6.1.1 Manual Override

Companions shall be enabled to manually control an A-PC PMR. There shall be a **Manual Override Button** that is clearly visible, easy to activate, and located at the rear of the PC PMR at a height between 0.7m to 1.7m from the bottom of the PMR's wheels or feet.

6.1.2 Switch to Independent Mode

It may be necessary for an A-PC PMRs to execute a trip independently of any proximate human passenger or companion. This may be required to enable a PMR to return to an original location, a logistics base, or other location.

An A-PC PMR shall have at least one of three methods, in order of preference, to accomplish **Independent Mode**.

6.1.2.1 The PMR shall be provided with a **TripPlan** according to an ODD-wide **Orchestration Manager** (see 4448-5); this method shall be chosen in the case of the operation of such an orchestration manager. (Note: not all fleets are subject to such an orchestration manager)

6.1.2.2 or the PMR shall be provided with a **Macro Plan** from its **Fleet Operator**. This shall be chosen in the case that the Fleet Operator's system is operational and the **ODD-wide Orchestration Manager** is non-existent or non-responsive.

6.1.2.3 or the PMR shall be equipped with appropriate maps and software to self-determine a **Macro Plan** to proceed to the required location. This shall be considered equivalent to the previous method.

In the event of failure of all three of these methods, an A-PC PMR shall be equipped with a method to signal for help. This is critical for Independent Mode.

6.2 For Independent PC PMRs (I-PC PMRs)

Procedures defined in 4448-7 shall apply to I-PC PMRs. An I-PC PMRs shall receive a **TripPlan** or a **Macro Plan** in order to begin navigation.

6.2.1 Beginning of Journey

An I-PC PMR shall not commence motion until it is safe to do so. Its **Startup Sequence** is defined as:

- The Startup Sequence shall commence
 - IF the PMR has one of a **TripPlan** or a **Macro Plan**
 - IF the Passenger is *securely loaded* (defined locally according to applicable standards)
 - IF no dynamic obstacle is within *shyDistanceDynamic*
 - AND the **Start Trip Button** has been pressed
- The Startup Sequence shall persist for *startupDuration* seconds
- During the Startup Sequence
 - The PC PMR shall provide a *startup auditory signal* (see 4448-8)
 - The PC PMR shall provide a *startup visual signal* (see 4448-8)
- The Startup Sequence shall terminate
 - IF the **Stop Trip Button** has been pressed
 - IF any dynamic obstacle is within *shyDistanceDynamic*
- The PC PMR shall commence navigation
 - IF the Startup Sequence completes without interruption

6.2.2 Status Reporting (breadcrumbs)

An I-PC PMR shall provide a status report to its **Fleet Operator** every 5 seconds. This report shall include the time, the PMR's velocity, passenger load condition, and GNSS (or indoor positioning) coordinates. (See 4448-16)

6.2.3 Abort Journey

If the passenger presses the **Stop Trip Button**, the I-PC PMR shall employ one of procedure **PathwayStopping** or **PathwayPullover**.

6.2.4 End of Journey

The **I-PC PMR** shall provide an auditory and visual signal indicating to the passenger that the trip has been completed. It shall not commence a new trip until its sensors indicate:

- it is no longer carrying a passenger
- *startupDuration* seconds have elapsed since it has ceased carrying a passenger
- no person or dynamic obstacle is within the radius of *shyDistanceDynamic*.

6.2.5 Passenger Responsiveness Reporting

An I-PC PMR shall be equipped with a method to determine whether its human passenger is aware, responsive, and able to signal for help. This method is called a **PassengerResponsivenessCheck**, and

- is contextually determined
- may be active in the style of a Dead Man brake
- may be passive in the style of a device that monitors an alertness or consciousness indicator
- shall be reliable for the operating circumstance in which the PMR is to be deployed while carrying a passenger
- shall be integrated in such a way that the PMR cannot carry passengers if the method is not operational; i.e., the method cannot be readily disabled or circumvented by the passenger
- is not detailed in this standard series

The I-PC PMR shall perform a **PassengerResponsivenessCheck** every *passengerResponseInterval* seconds from the commencement of the trip. If there is no response from the passenger within

startupDuration seconds, the PMR shall report an emergency to the **Fleet Operator**. (Note: this may be integrated with breadcrumb transmission.)

6.2.6 P-Class I-PC PMR Breakdown

In the event of a breakdown, a PMR shall perform procedure **PathwayPullover** or **PathwayStopping** (see 4448-7) in that preferred order and shall provide audio and visual signals indicating that the passenger may disembark.

6.2.7 C-Class I-PC PMR Breakdown

When a C-Class IPC PMR encounters a breakdown (machine or communications failure), the PMR shall employ the procedure **AuxiliaryPullover** defined as follows:

- The PMR shall wait in one of the following zones (see 4448-7) in order of preference:
 - 1) Pathway Waiting Area
 - 2) Cycle Lane Buffer
 - 3) Sidewalk Curb Zone
 - 4) Frontage Zone
 - 5) Kerbside Loading Zone on the Roadway
- The PMR shall employ procedure **PathwayStopping**
- The PMR shall use signal **WaitLong** if possible
- The PMR shall provide audio and visual signals telling the passenger(s) to disembark.

Depending on the nature of the breakdown, the PMR may fail to execute some or all of these behaviors. If such a breakdown is possible beyond the line of sight of a fleet operator, the **breadcrumb** method of 4448-16 shall be operational in a way to ensure that a PMR does not become lost or missing relative to its **Fleet Operator**.

[end current working draft — 2023 09 23 — PAUSED]