

# User Centred Design:

## The Design of Ambulances and Related Equipment

### What is User Centred Design (UCD)?

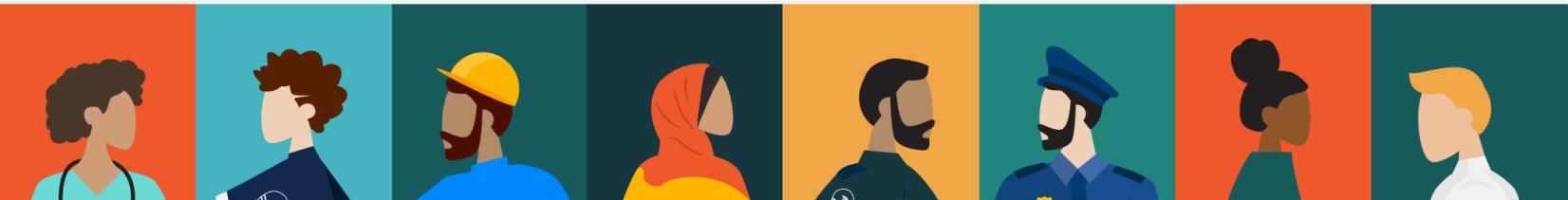
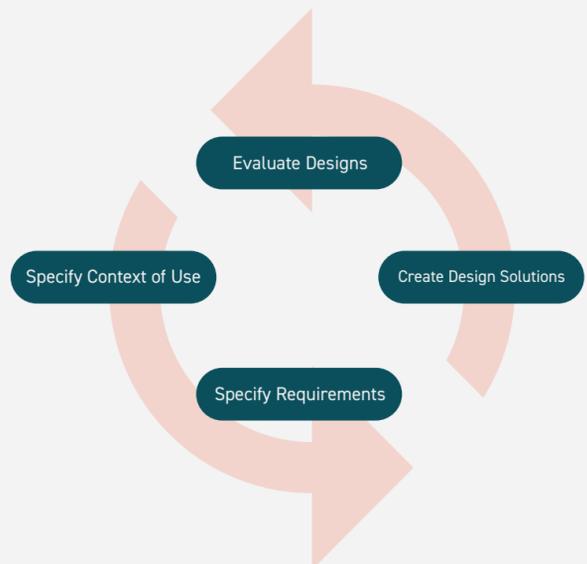
An approach to designing the environment for users, or to develop products, systems, layouts, and other items that aim to design the environment for users. It seeks to apply information from users who are affected by the process.

### Who Should Use It?

A multidisciplinary team of paramedics, managers, and design engineers.

### How Does It Work?

- define and understand the context of use;
- specify user requirements;
- create design solutions; and
- evaluate designs against requirements.



## The 10 Steps to Apply Ergonomic UCD In Ambulance Design



- 1. Identify target population:** paramedics, patients, fleet staff, and any other populations affected by the design.
- 2. Identify target population relevant characteristics** (e.g., body size, visual abilities, literacy, skills, knowledge).
- 3. Accommodate the full range of physical dimensions** using anthropometric database of the target population.
- 4. Use task analysis methods** to identify and describe the demands, goals, and intended outcomes of each task.
- 5. Identify Physical (vibration), emotional (stress) organizational (workplace practices), social (attitudes and culture), and legal characteristics** (specific requirements imposed by the authority having jurisdiction) that influence the design.
- 6. Apply ergonomic design consideration and requirements**
- 7. Ensure additional requirements are considered** to address human performance and health, safety, wellbeing and comfort of end of users
- 8. Create design concepts** that are reviewed by paramedics, managers and designers
- 9. Evaluate early-stage design concepts** against human factor and ergonomics criteria
- 10. Develop physical mock-ups and props** to evaluate later stage design concepts.

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# Ergonomic Design:

## General patient compartment and driver cabin ergonomic design

a user-centred design (UCD) process requires the design team to identify the specific needs of the users. The following checklist is intended to help manufacturers identify additional user needs.

### Manufacturers should

a) request procurement administrators to complete the checklist as a part of their Request for Proposal (RFP); and

Note: The checked boxes are the requirements from the Standard, and the unchecked boxes indicate a recommendation. However, the purchaser may provide additional specifications for each criterion, or add more features to meet the requirements of the authority having jurisdiction.

b) use the checklist to validate the final product against the specified user needs.

## GENERAL



All exposed edges and corners have at least a 3 mm chamfer or 15 mm radius



All hangers or supports for equipment, lighting, controls, and other devices are mounted as flush as possible

### Energy-absorbent materials installed:



At the full width of the interior top sill of each door opening in the patient compartment

Adjacent to each seating position, where applicable

In areas to protect the elbow, shoulder, and head, where applicable



Containment areas for the incubation of viruses (airborne or transmitted in fluids) are minimized

## RESTRAINT SYSTEM



All seating positions are equipped with the appropriate safety restraint for each type of seating configuration



Complies with relevant CMVSRs

## LIGHTING



All cabinets have sufficient lighting to see the cabinet contents



Light switch is readily accessible from the primary or airway attendant seat

## EQUIPMENT RETENTION



Equipment mounts or retention devices provided for all equipment stowed outside of storage units



Mounts that hold between 1 and 10 kg comply with the performance requirements of the Ontario Provincial Land Ambulance and Emergency Response Vehicle Standard



Mounts that hold more than 10 kg comply with SAE J3043

# Ergonomic Design:

## Driver Cabin Requirements



### PARTITION WALL

Includes a window with a minimum opening of 75 000 mm<sup>2</sup>

Window is capable of being latched in the open or closed position and operable with one hand

### SEATS

Two-bucket style seats are provided: capable of sliding the full length of tracks as designed by the OEM; capable of reclining a minimum of 10° in the most rearward tracked position; and having a minimum of one armrest to the innermost side of the seat

### AUXILIARY CONTROLS AND EQUIPMENT

Mounted auxiliary controls and equipment are mounted such that they do not interfere with access to OEM controls; are accessible to both the driver and the attendant; are operable by a 5th percentile female or a 95th percentile male while the person is driving and restrained; and do not interfere with the airbag function

### HEAD LINER

Alterations to the head liner do not reduce the ceiling height directly over the driver and passenger seats by more than 12.5 mm



Alterations to the head liner or attachments at the top edge of the windshield do not reduce the vertical viewing angle to less than 15° for a 95th percentile male

### AUXILIARY LIGHTING

Driver cabin includes a minimum of one auxiliary light that meets the interior lighting requirements of BNQ 1013-110

### MIRRORS

Powered mirrors

Heated mirrors and side convex mirrors (where available from the OEM)

### CONSOLE

Includes a cover to prevent contents from escaping in a collision

Console and cover comply with equipment retention standards (see Clause 5.3 of CSA D500)

### STEERING

Tilt and telescopic steering (if provided by the OEM)

# Ergonomic Design: Patient Compartment

Page 1



## GENERAL

Accommodates at least one paramedic, one other passenger, and one patient located on the primary stretcher

## SEATING

### *General*

At least two primary seating positions available

#### Each seat

Permits upright seated posture with a torso-to-thigh angle not less than 90°

Accommodates a 5th percentile female and a 95th percentile male

Permanently affixed side-facing seats comply with SAE J3026

Occupant head clearance complies with AMD 025

### *Primary Attendant Seat*

Seat pan width accommodates a 95th percentile male hip breadth

Seat pan depth is greater than 384 mm but less than a 5th percentile female buttock to popliteal length

Backrest and lumbar support provided

### *Airway Attendant Seat*

If swivel seat is installed, it has a locking system only in the 0° and 180° positions with a tolerance of ±5°

If non-swivel seat is installed, it has a locking system only in the 180° position with a tolerance of ±5°

Seat pan width accommodates a 95th percentile male hip breadth

Seat pan depth is greater than 384 mm but less than a 5th percentile female buttock to popliteal length

Backrest and lumbar support provided

Capable of sliding forward and rearward to adjust the distance between the seat and the stretcher to at least 200 mm from the front edge of the seat pan to the stretcher mattress while the stretcher is in the supine position

## STORAGE UNITS

### *General*

All interior enclosed stowage devices comply with BNQ 1013-110, Clause 8.2.4.3

Maximum weight to be secured within a storage unit is clearly labelled

Attachments and safety nets are quick-release

Easily opened but do not come open due to vibration, ambulance motion, or collision

### *Pressure Vessels*

Fire extinguisher weighs at least 4.5 kg

Space provided for the fire extinguisher is large enough to allow the fastening system to open

Fire extinguisher is accessible without entering the ambulance

Pressure vessel mounts comply with SAE J3043 and AMD 028

# Ergonomic Design: Patient Compartment

Page 2



## Stretcher Retention

Stretcher retention system complies with SAE J3027

Ambulance floor and substructure comply with SAE J3102

Provides user with immediate visual or auditory feedback to indicate that the stretcher has been safely secured

## IV Holders

At least one IV holder is installed in the patient compartment

IV holders are able to fold and recess; are non-sway; provide hooks; and are able to hold a minimum of two 1000 cc IV infusion solution bags

Do not have rigid support arms

## Sharps Containers

Puncture-resistant construction, leak-proof on sides and bottom, and consistent with the current legislative colour requirements

Remains upright

## Stair Chair

Storage space for stair chair is no higher than a 5th percentile female standing waist height (measured from the bottom of stair chair); and permits users to retrieve or replace stair chair without exceeding a horizontal reach distance equivalent to a 5th percentile female elbow to fingertip distance



## Spare Tire

When carried internally, a storage area is provided of sufficient size to accommodate the winter tread model of the certified tire for the ambulance

## INGRESS AND EGRESS

Door handles, handholds, and steps permit safe entry and exit to/ from the patient compartment in various weather conditions (in dry, wet, wintry, and reduced visibility weather conditions) while wearing gloves and boots

Door handles, handholds, and steps accommodate the standing reach and size of a 5th percentile female or a 95th percentile male

## DOORS

### General

Includes a minimum of two openings: one at the rear and one at the primary attendant side of the patient compartment

Rear door permits ready loading of a stretcher

Primary attendant side door permits ready loading of an ambulatory patient

All doors have effective seals for sounds, fluids, and gases

Doors have door stops

# Ergonomic Design: Patient Compartment

Page 3



**Height of rear doorsill does not exceed a 5th percentile female waist height**

*Door Latches, Hinges, and Hardware*

**Hinges, latches, and door-checks do not protrude into the access area when doors are opened**

**Hardware for the type and size of doors prevents inadvertent closing**

**Vertical hinges of rear doors open to a minimum door angle of 150°**

**Weather-resistant hardware used**

**Door handles accommodate the hand length, circumference, and breadth of a 5th percentile female and a 95th percentile male; and provide hand clearance of at least 63.5 mm (measured between the mounting surface and the handle)**

*Door Locks*

**Lock and unlock from inside without key**

**Lock and unlock from outside with key**

**All patient compartment door locks are identically keyed**

*Door Dimensions*

**Minimum rear door opening: W: 1120 mm × H: 1270 mm**

**Minimum side door opening: W: 660 mm × H: 1600 mm**

*Door-Activated Switches*

**Side door(s) fitted with switch(es) that operate primary attendant interior patient compartment lights and primary attendant scene lights when opened**

**Rear entrance door(s) fitted with switches that operate primary attendant interior patient compartment lights and the rear scene lights when door(s) is (are) open**

**Audible and/or visual warning signal when any external door is not completely closed when ambulance ignition is on**

*Handholds*

**Mounted on the inside of entrance doors and immediately inside each entrance to the patient compartment**

**Grab handles and grab rails are installed in a position to assist persons moving around in the ambulance, seated in the ambulance, or entering and leaving the ambulance**

**Grab rails or grab handles comply with Ontario Provincial Land Ambulance and Emergency Response Vehicle Standard**

**Finished with a high-visibility material**

**One overhead grab rail, with a minimum length of 1500 mm, and between 22 mm and 32 mm in diameter, is located on the ceiling centrally over the primary stretcher, with padded or curved-up ends and rounded corners**

**Grab rails do not interfere with the stretcher or incubator**

*Emergency Egress*

**Emergency opening system is provided for rear access door and side access door**

**Emergency opening system has at least two separate locks per door, independent from the usual door-leaf opening mechanism, and is able to operate at all times (not applicable to Type 2 ambulances)**

# Ergonomic Design: Patient Compartment

Page 4



## STEPS

### *General*

**Minimum depth of 254 mm**

**Illuminated when the door is opened in accordance with CSA D409**

**Free of sharp edges**

**Surfaced with ridged anti-skid open grating material**

**Comply with AMD 018**

**Reflective stripe on the leading edge**

### *Rear Step Design*

**Step(s) installed for ambulance that exceed 425 mm (measured from the ground to the finished floor)**

**Leading edge of the step is lower than the top edge of the ambulance floor when folded**

**Height of each step does not exceed 425 mm**

**If the step(s) does not cover the full width of the rear opening, the portion that does not have the step(s) has a clear, highly visible indication on the floor stating "NO STEP"**

### *Side Step Design*

**If the distance from the ground to the finished floor of the ambulance at the side entry location exceeds 300 mm, a step or steps are installed**

**Height of each step does not exceed 425 mm**

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## WINDOWS

**Fixed tinted windows are mounted in the rear and primary attendant doors**

**Designed to ensure patient privacy**

**Permit between 3% and 7% light transmission**

**Window material is transparent polycarbonate and bears a permanent identifying mark that certifies compliance with local regulations for motor vehicle glazing**

**Each rear access door has a fixed window**

**Primary attendant door has a fixed window (might or might not be capable of opening)**

## LABELLING AND IDENTIFICATION

**Signage in both official languages is installed to convey operating or occupational health and safety instructions pertaining to chassis design, conversion design, or equipment installations**

**Gauge function of voltmeter is clearly labelled**

**Illuminated voltmeter is provided to monitor the condition of both the OEM and conversion batteries**

# Ergonomic Design: Patient Compartment

Page 5



Fixed decals are provided for incubator plugs, accessory receptacles, and other electrical outlets

Clearly visible (either illuminated or etched on back lit panels) and permanent signage is provided for all switches, indicators, and control devices supplied by the manufacturer

## LIGHTING

Two independently controlled lighting zones on the left and right sides of the patient compartment are provided

Lighting zones are capable of high and low settings or are dimmable

Off switch for patient compartment lights is provided in the driver cabin

Lights do not protrude more than 30 mm from the ceiling

When the side or rear access doors are opened, the dome lighting automatically activates at an intensity of 75 to 250 lx and automatically switches off  $15\text{ s} \pm 2\text{ s}$  after the access doors are closed

Lighting is provided to illuminate the side and rear entry doors and steps to a value of 100 to 150 lx when the doors are open, in accordance with The Lighting Handbook of the Illuminating Engineers Society

Each interior storage cabinet has a minimum of one cabinet light

One independently operated light is located in the approximate centre mass of the patient and stretcher with a value of at least 1000 lx; light switch for this light is readily accessible from both the primary attendant seat and airway attendant seat

All interior lighting is of a uniform colour range of 2700 to 3500 K (with the exception of blue cabinet lighting)



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# Ergonomic Design:

## Workspace Layout, Placement and Accessibility

Page 1



### GENERAL

*General*

Shoreline power input is located between 1016 and 1371.6mm from the ground

### PATIENT COMPARTMENT SEATING LAYOUT

Seated and restrained 5th percentile female or 95th percentile male in the primary attendant seat can reach a restrained supine 95th percentile patient's body from the crown of the head to the kneecap

Seated and restrained 5th percentile female or 95th percentile male in the airway attendant seat can reach a restrained patient's head, neck, and upper torso with both hands

Airway attendant seat is located at the head of the stretcher and centred in relation to the middle of the stretcher's width (tolerance of  $\pm 75$  mm)

### WASTE AND SHARPS DISPOSAL LAYOUT

Disposal units are located within reach of a 5th percentile female from a seated and restrained position



Waste and sharps disposal units are located in the immediate area where sharps are used or placed

### STRETCHER CLEARANCE

*Foot of Stretcher*

Minimum clearance of 205 mm between the rearmost part of the stretcher and the nearest obstruction

*Side of Stretcher*

A minimum 250 mm wide clear aisle is provided between the main stretcher and the face of the primary and airway attendant seating locations

### IV HOLDERS

IV holder is not placed directly over the patient's head

### ACTION WALL

*General*

Located where it is accessible and within the functional field of view of the primary and airway attendant seats while in a seated and restrained position

*Switches*

Switches are accessible from both the primary and airway attendant seats: patient compartment light switches and the exhaust fan

# Ergonomic Design:

## Workspace Layout, Placement and Accessibility

Page 2



Switches are accessible from either the primary or airway attendant seat: main oxygen outlet and controls; suction outlet and controls (if prescribed); attendant control console; thermostat for HVAC system(s); and reading light

### OXYGEN OUTLETS

Safe clearance is provided and includes space for the flow meter, humidifier bottle, etc.

If an additional outlet is installed on the ceiling of the patient compartment above the stretcher (located in the first third from the foot of the stretcher), it protrudes no more than 20mm from the ceiling

Location of oxygen ports and outlets allows a 5th percentile female or a 95th percentile male to readily access and use oxygen for patient care while not introducing risks to the safety of the patient or the paramedic

### SUCTION SYSTEM

Location of suction outlet is readily accessible to a 5th percentile female or a 95th percentile male in a seated and restrained position while not introducing risks to the safety of the patient or the paramedic

### INCUBATOR RECEPTACLES

Two 12 V polarized outlets are installed in the ambulance, of which one outlet is located near the head end of the primary stretcher

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### RADIO MOUNTING SPACE

Remote handset mounting space is located on or near the primary attendant action wall, and is accessible to a 5th percentile female seated and restrained in primary attendant seat

### FIRE EXTINGUISHER

Fire extinguisher is accessible without entering the ambulance

