Mobile Forced-Air Evaporative Cooling Chamber Design

CoolVeg's mobile forced-air evaporative cooling chamber was developed in collaboration with ColdHubs in Nigeria with support from the Efficiency for Access Research and Development Fund. This document provides design documentation and guidance for constructing CoolVeg's mobile forced-air evaporative cooling chamber, including:

- Photographs of the Mobile Chamber in Nigeria
- Chamber Materials and Construction Guidance
- 3-D Renderings for the Mobile Chamber in Nigeria
- Dimensional Diagrams for the Mobile Chamber in Nigeria

Additional information related to this technology is available in the technical research report from this project, including:

- The need for post-harvest storage and existing solutions
- Airflow pathway specifications for optimizing energy efficiency and performance
- Best practices for using the chambers
- Thermal performance testing, vegetable shelf-life testing, and user research
- Economic analysis

This report is available at: https://www.coolveg.org/cooling-chambers/portable-and-mobile

The dimensions of the mobile cooling chamber are based on the outer dimensions of the crates being stored. The most common vegetable crates used in Nigeria have a length, width, and height of 60 cm x 40 cm x 23 cm, and the chamber described in this document is designed to hold 32 crates, or 640 kg of produce.

A mobile chamber will need to be designed to fit on a selected trailer or vehicle. In addition to the trailer or truck bed on wheels, a metal shell is recommended to protect the evaporative cooler and insulation panels from damage while in transit. In addition to variations in the crate size, the dimensions of the chamber can be modified to fit the size of a given truck, trailer, etc.

When making changes to the chamber design, it is important to follow the guidance related to proper dimensions described in "Evaporative Cooler Specifications and Airflow Pathway" (page 20) of the Technical Report. This includes the airflow rate of the evaporative cooler, minimizing air bypassing the crates, having sufficient openings at the bottom of the crates, and avoiding flow constriction in unintended locations. These items will be discussed in more detail in the "Evaporative Cooler Specifications and Airflow Pathway" Section.

Contact, Eric Verploegen, CoolVeg Founder: eric@coolveg.org

CoolVeg ColdHubs EFFICIENCY FOR ACCESS
energy saving trust UKaid from the British people Transforming Energy Access IKEA Foundation ARTISANA

Mobile Forced-Air Evaporative Cooling Chamber

This chamber used the same core design principles as the portable chamber and was mounted on a custom-built trailer, shown in Figures 1, 2, and 3.

Figure 1: A trailer-based mobile forced-air evaporative cooling chamber, with the steel exterior side doors visible. The insulation chamber is housed inside the exterior metal shell and can be seen through the exhaust vents at the top of the side doors.

Figure 2: A trailer-based mobile forced-air evaporative cooling chamber with the front and right side visible. Two evaporative coolers are located in an enclosed front compartment, visible through the square windows in the front of the chamber.

Figure 3: Vendors loading produce into a trailer-based mobile forced-air evaporative cooling chamber. The chamber has a storage capacity of 32 crates, or 640 kgs of produce.

Chamber Materials and Construction Guidance

CoolVeg's chambers were designed to be as simple as possible using materials that can be readily sourced in many locations. The 2 most critical components are 1) an off-the-shelf evaporative cooler and 2) insulation panels to form the chamber body. The following is a list of materials and components needed for constructing a forced-air evaporative cooling chamber:

- An evaporative cooler to provide cool and humid air (details described above).
- Insulation panels:
    - Material: expanded polystyrene (EPS), extruded polystyrene (XPS), and polyurethane foam (PUF) are all suitable.
    - Clad in aluminum or galvanized steel on the inside and outside to prevent rust.
    - Thickness: 50 mm. The panels can be thicker if desired, but thinner panels are not recommended as the structural integrity and thermal performance will be negatively impacted.
    - Color: The panels should be white or reflective to minimize the heat absorbed through radiation from direct sunlight and the surrounding environment.
- Brackets to hold panels together.
    - Right angle brackets for most junctions.
    - Hinges for the doors.
- Metal rack to support the crates inside the chamber.
    - 40 mm steel square tube.
    - Galvanized, polymer-coated, or painted for rust protection.
- Metal rack to support the chamber off the ground.
    - 40 mm steel square tube.
    - Galvanized, polymer-coated, or painted for rust protection.
- Sealant for the insulation panel junctions.
    - There are several options that can be used to seal the panel junction, but the high-humidity environment must be considered. Given this consideration, caulk or other sealants that are intended for wet or humid environments is preferred to duct tape.
- Weather stripping or refrigerator door gasket to seal the chamber door.
    - The adhesive used to secure the gasket should be able to withstand getting wet and repeated opening and closing of the doors.
- Screens to protect the air outlets.
    - Metal or plastic mesh.
    - Openings 1-2 mm in size.
        - The opening supporting the screen should be oversized relative to the air outlet channel to prevent the screen from restricting airflow.
    - A coarser support structure (e.g., chicken wire) is recommended to support the finer screen and prevent damage to the finer screen.

Insulation Panel Sizes for Mobile Chambers in Nigeria

Below is a table showing the dimensions of the insulated sandwich panels that are needed to construct the mobile chamber designed for crates measuring 60 cm x 40 cm x 23 cm (length, width, and height). These are the panel dimensions used in the design documentation described in this document.

The sandwich panels can be made from several types of insulation, including: Polyurethane Foam (PUF), Extruded Polystyrene (XPS), or Expanded Polystyrene (EPS). The metal cladding should be made of either aluminum or galvanized steel to prevent rusting. A hole in the front panel will need to be cut to allow air from the evaporative coolers to enter the chamber.

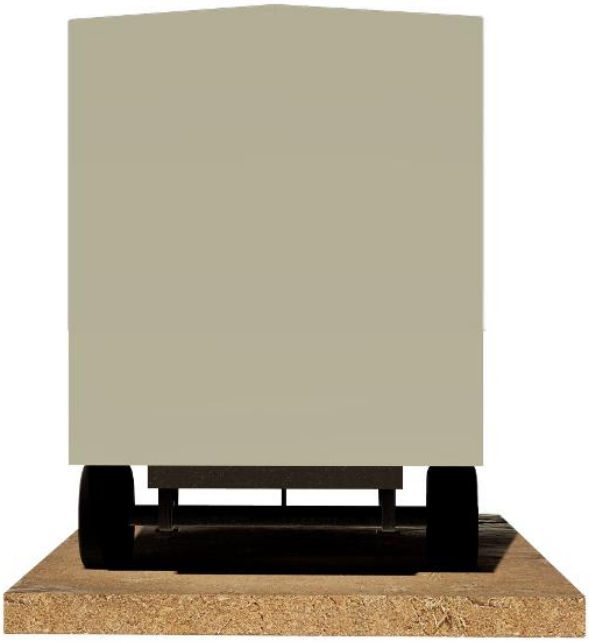
Panel	Material	Width (cm)	Height/Length (cm)	Thickness (cm)
Bottom	PUF sandwich panel	127	165	5
Top	PUF sandwich panel	127	172	5
Front	PUF sandwich panel	127	172	5
Rear	PUF sandwich panel	127	165	5
Left-front door	PUF sandwich panel	86	155	5
Left-rear door	PUF sandwich panel	86	155	5
Right-front door	PUF sandwich panel	86	155	5
Right-rear door	PUF sandwich panel	86	155	5
Center partition	PUF sandwich panel	162	165	5

3-D Renderings for the Mobile Chamber in Nigeria

Front (doors closed)

Front (doors open)

Rear



Rear (cut-away cross section)

3-D Renderings for the Mobile Chamber in Nigeria

Front – Right

Front – Left

Rear – Right

3-D Renderings for the Mobile Chamber in Nigeria

Above (All doors open)

3-D Renderings for the Mobile Chamber in Nigeria

Left side (exterior doors open)

Left side (one exterior door open)

3-D Renderings for the Mobile Chamber in Nigeria

Left side (one exterior and interior door open)

Left side (two exterior doors and one interior door open)

3-D Renderings for the Mobile Chamber in Nigeria

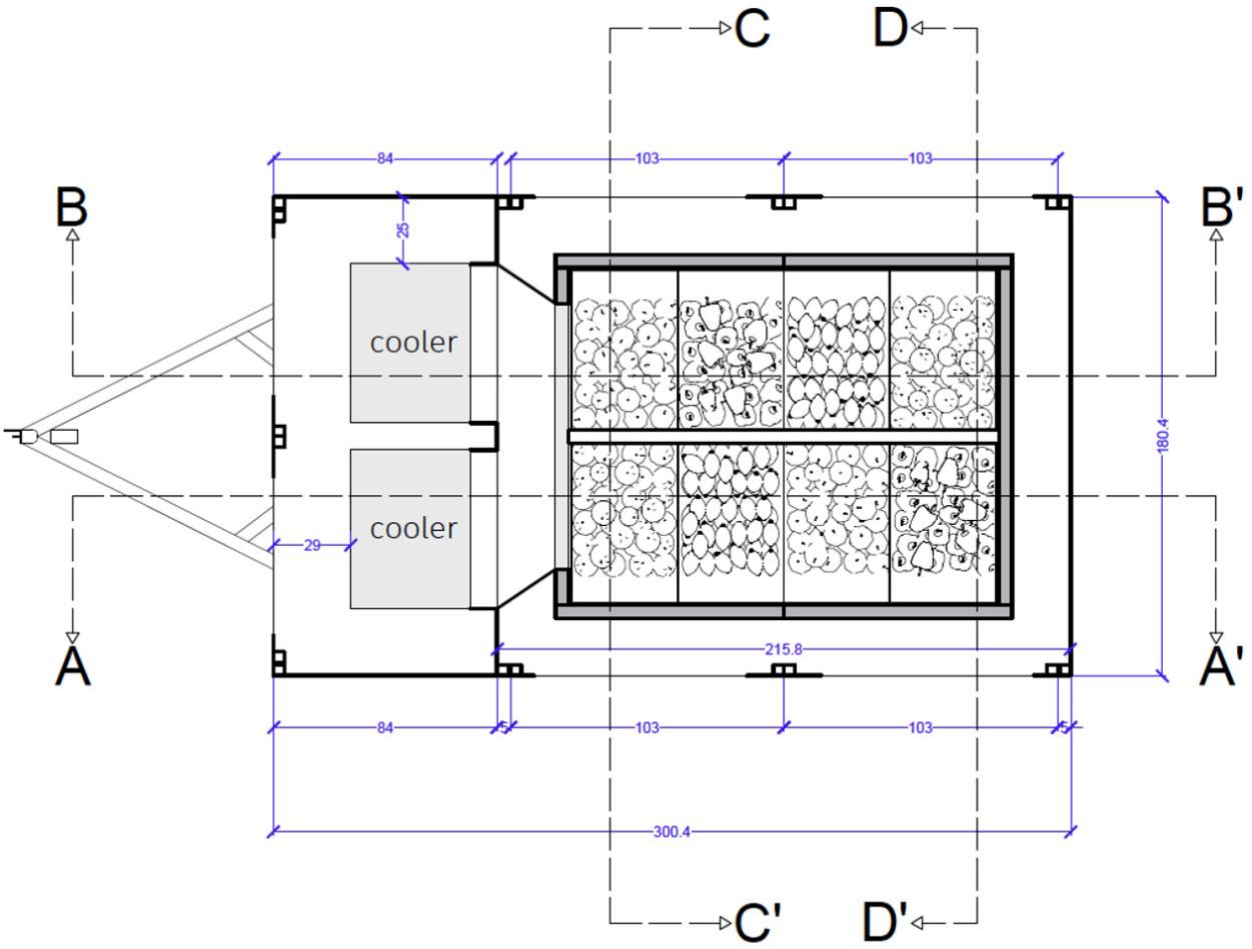
Left side (exterior and interior doors open)

Rear – Left (exterior and interior doors open)

3-D Renderings for the Mobile Chamber in Nigeria

Front – Left (exterior and interior doors open)

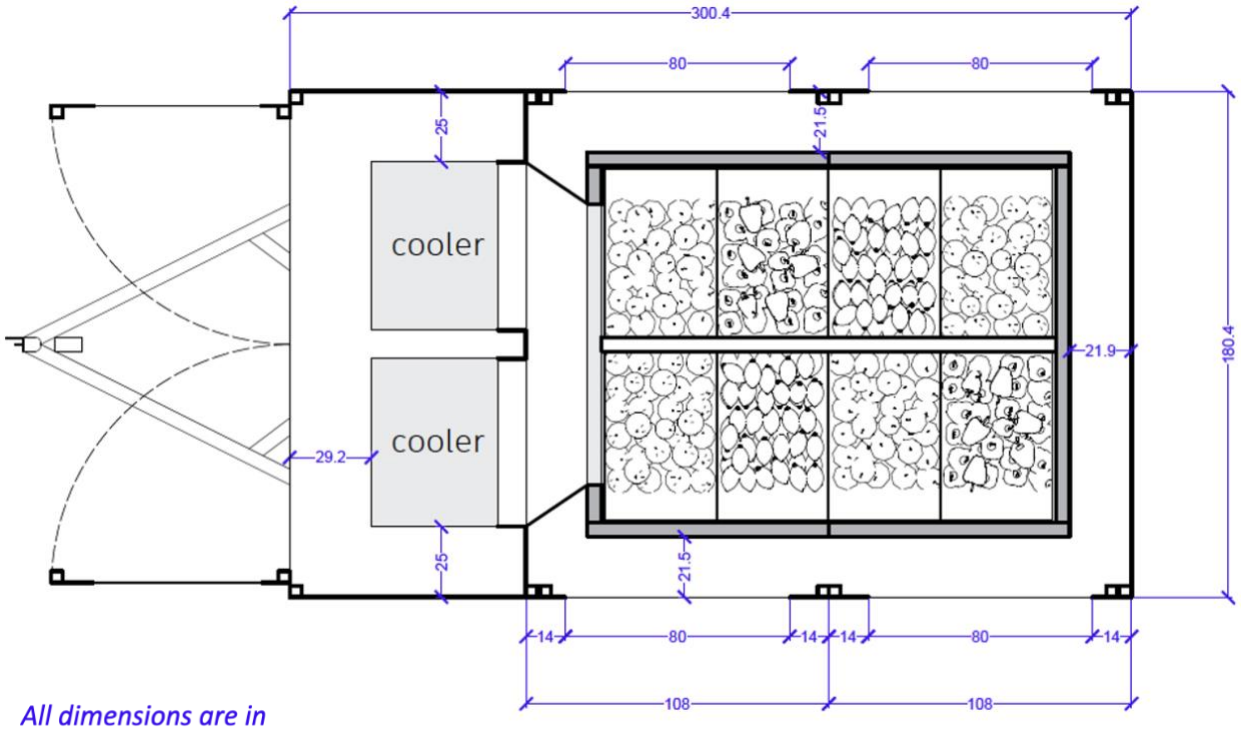
Dimensional Diagrams for the Mobile Chamber in Nigeria



All dimensions are in centimeters (cm)

Plan (doors closed)

Dimensional Diagrams for the Mobile Chamber in Nigeria

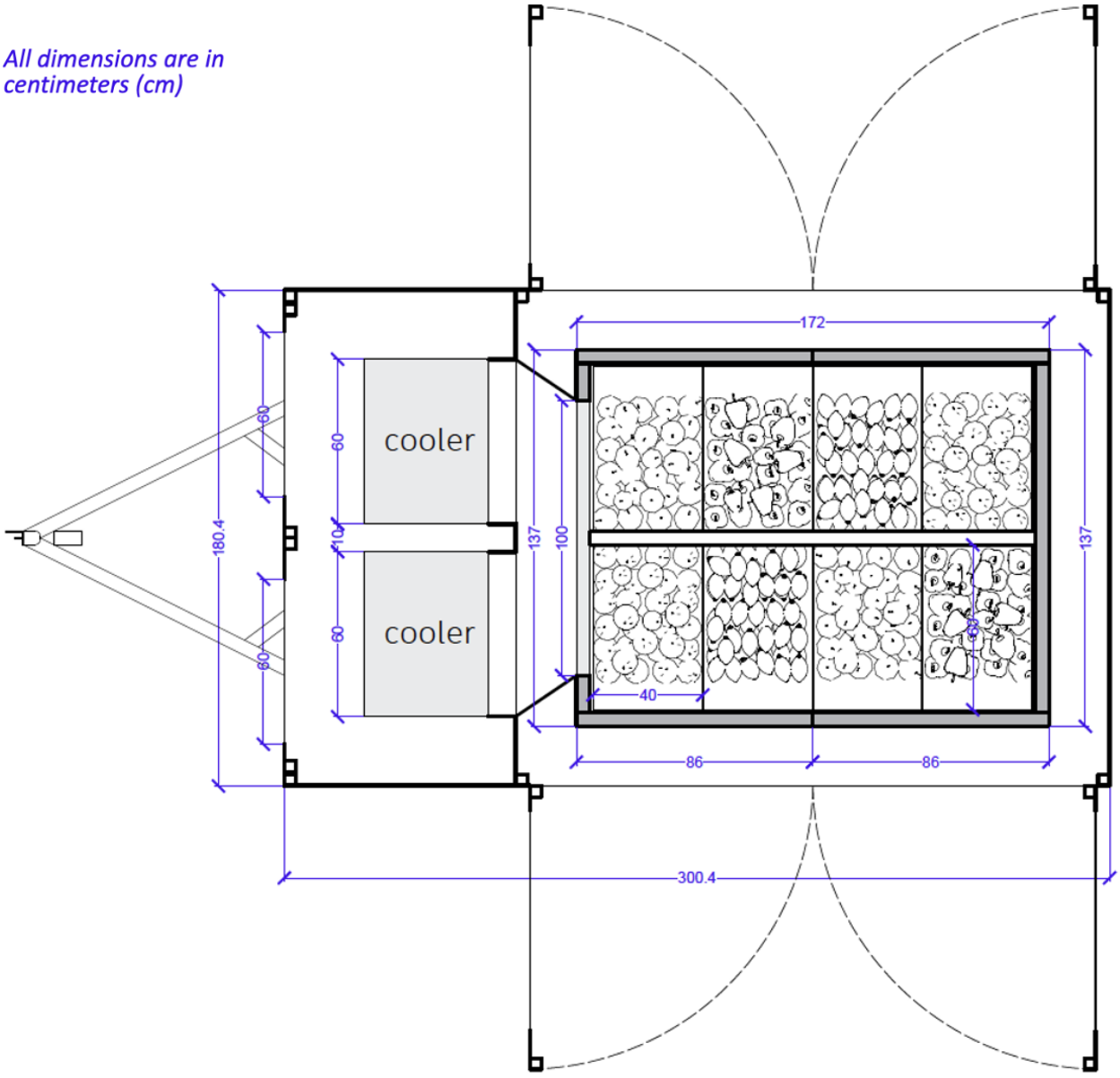


All dimensions are in centimeters (cm)

Plan (front doors opened)

Dimensional Diagrams for the Mobile Chamber in Nigeria

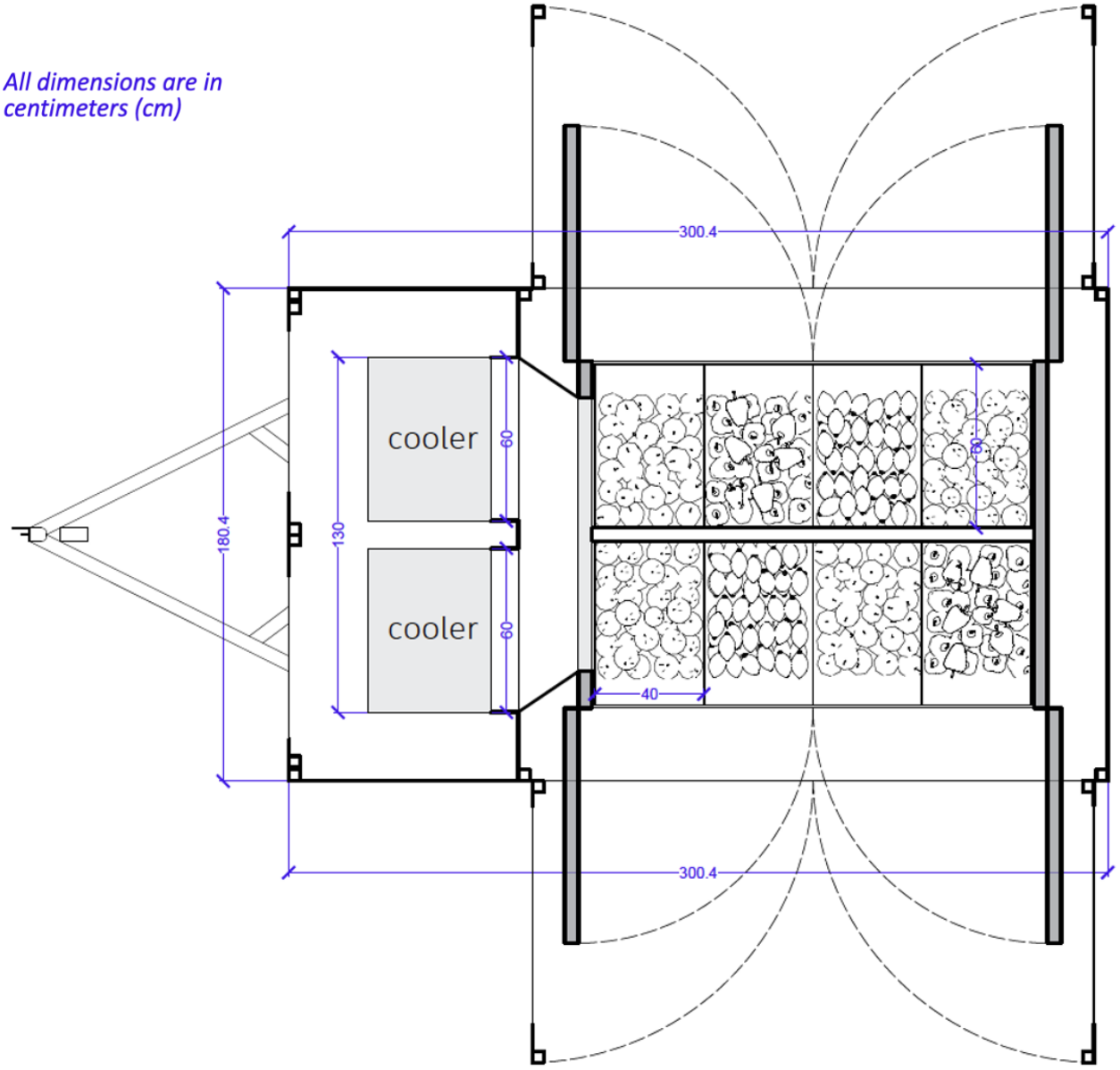
All dimensions are in centimeters (cm)



Plan (side doors opened)

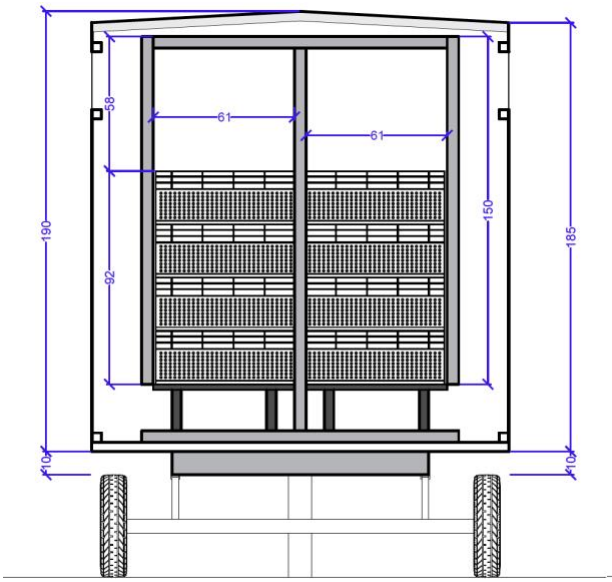
Dimensional Diagrams for the Mobile Chamber in Nigeria

All dimensions are in centimeters (cm)

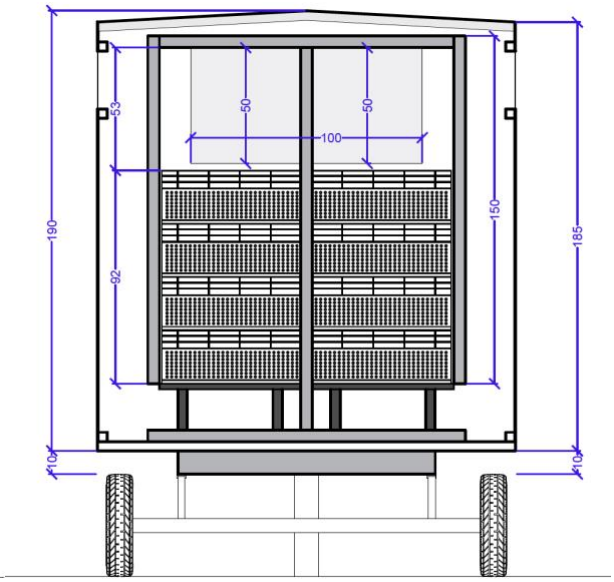


Plan (inner doors opened)

Dimensional Diagrams for the Mobile Chamber in Nigeria

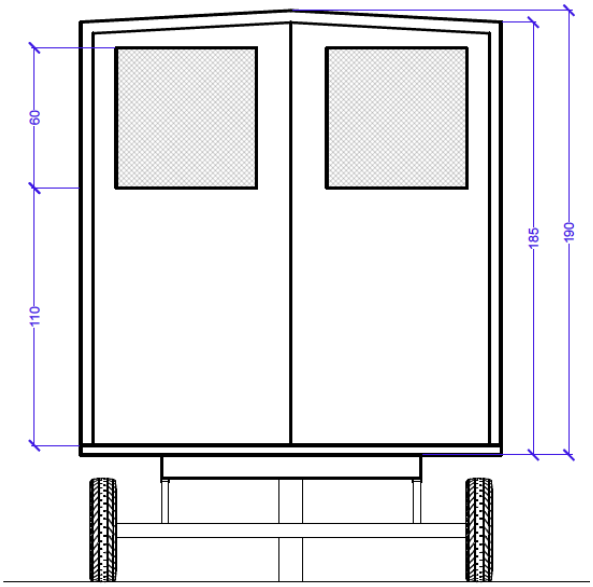


Section CC'



Section DD'

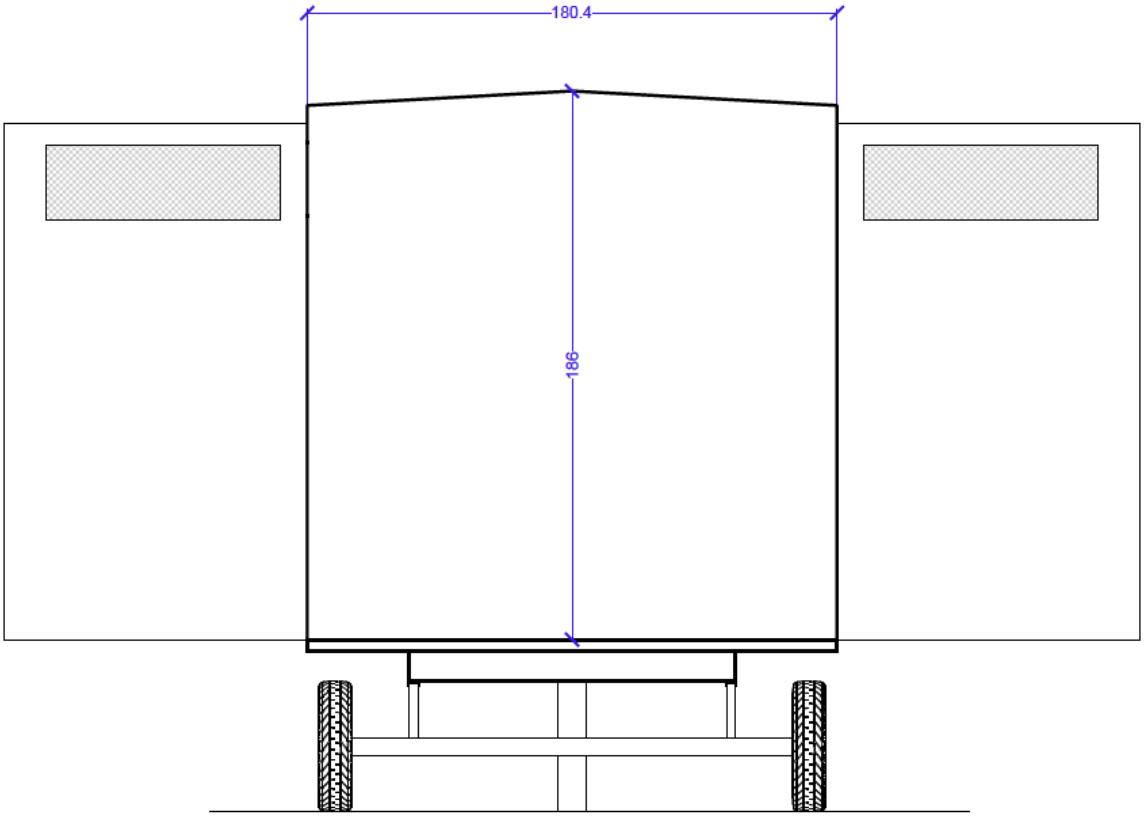
All dimensions are in centimeters (cm)



Front elevation

Dimensional Diagrams for the Mobile Chamber in Nigeria

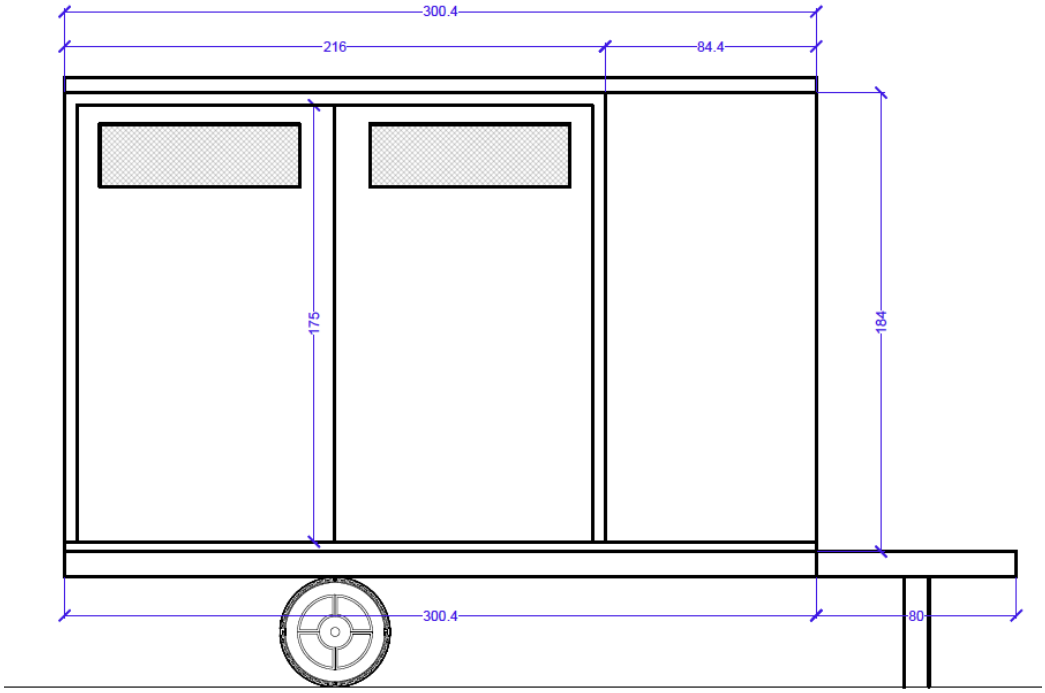
All dimensions are in centimeters (cm)



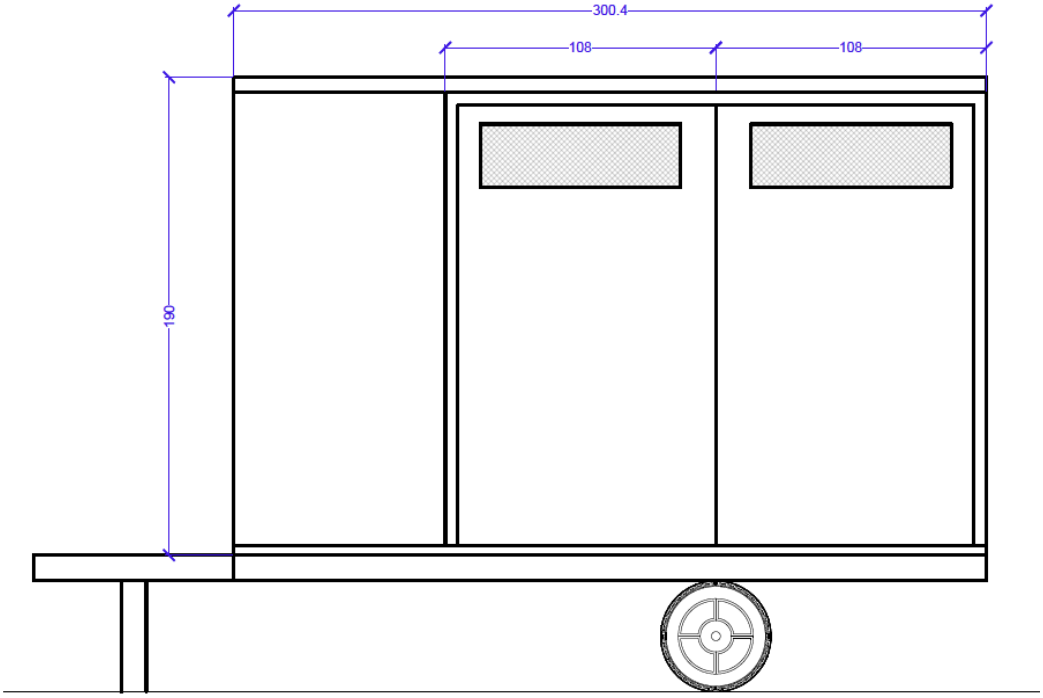
Rear elevation

Dimensional Diagrams for the Mobile Chamber in Nigeria

All dimensions are in centimeters (cm)



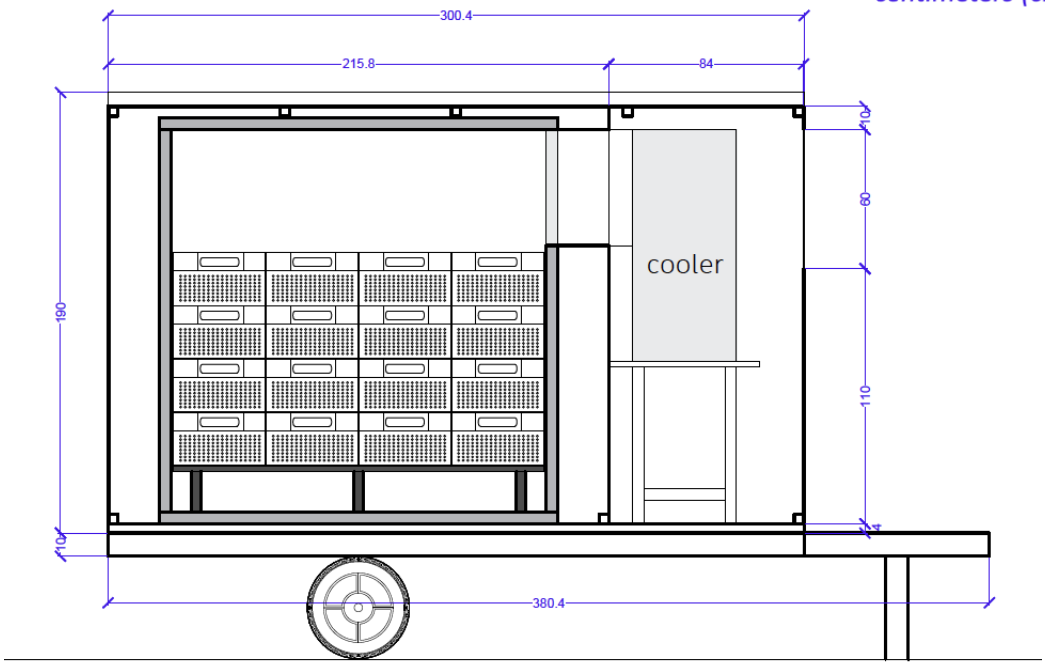
Left side Elevation



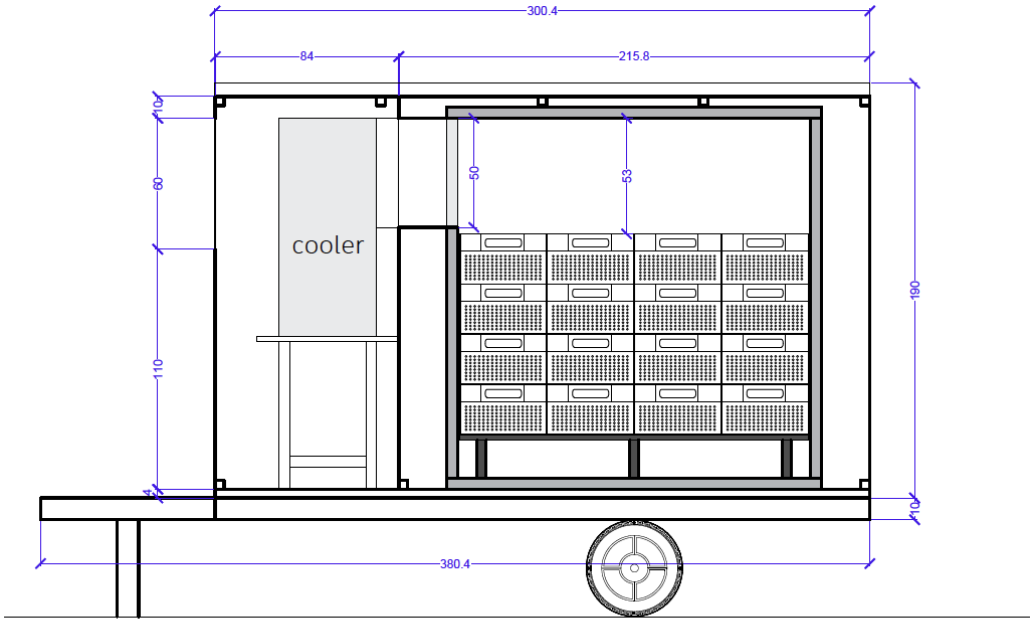
Right side Elevation

Dimensional Diagrams for the Mobile Chamber in Nigeria

All dimensions are in centimeters (cm)



Section AA'



Section BB'