WRS Future Convenience Store Challenge
Preliminary Competition 2018

“Stocking and Disposing” Tasks

Rulebook

2018/08/27

Revision History

August 27, 2018

- Added information regarding the number of participants for the renovation
- Added information regarding the positioning of the products during the stocking task
- Added information regarding the initial state and the orientation of the products in the disposal task

February 2, 2018

- Information about energy saving was added.

January 15, 2018

- First Draft

0. Terminology

Term	Definition
Mobile Robot	A robot that can move autonomously.
Infrastructure (Robot)	Unique infrastructure that can be installed inside convenience stores to assist in the robot's tasks. This equipment includes markings, IC tags, sensors, actuators and auxiliary tools to add equipment to products. Infrastructure made up of sensors and actuators can also be seen as stationary robots.
Manipulator	Robot arms, end effectors and other equipment that execute operations which can be installed on a mobile robot or as part of the infrastructure.
Product	Products found at a convenience store.
Customer	Person who visits the store to purchase products.
Container	Container used to hold and transport multiple products. A container may also be called "carton."
Product Display Area	Section of the convenience store with display cases or bookshelves installed.
Cashier Area	Section of the convenience store with the cashier counter installed.
Restroom Area	Section of the convenience store with the toilet installed (Abbreviation: Restroom).
Aisle Area	Section of the convenience store for customers and mobile robots to come and go. (Abbreviation: Aisle)
Backyard Area	Area of the convenience store where customers are not allowed (Abbreviation: Backyard).
Home	Standby station of the mobile robot. The standby station is located in a designated place inside the backyard area.
Display Case A	Case for displaying products. There are no products placed in this display initially.
Display Case B	Case for collecting disposal items. Multiple products are mixed in this case initially.
Disposal items	In the Disposal task, those products that the judges

	set to be disposed.

1. Overview

This challenge aims to develop technology to automate the stocking of products and collection of disposal items at a convenience store. Participants in this competitive task will develop a robot that autonomously moves and performs these tasks as well as infrastructure to install inside of the convenience store. In this challenge, participants will use the robots and infrastructure they develop to compete performing stocking and disposal demonstrations in a simulated convenience store.

The layout of the convenience store interior is provided in a separate document. In this challenge, participants use the backyard area, home station, aisles, display case A (case to display products that is initially empty) and display case B (case to collect disposal items that initially has a mixture of multiple products). Furthermore, display case A and B have a top shelf, a middle shelf and a bottom shelf.

The following tasks will be performed in the demonstration:

- Place the products stored in the container located in the home station into the designated place on display case A.
- Straighten the products positioned in display case B while collecting disposal items, and then carry the disposal items to the home station.

In addition, the proposed system must contribute to energy saving in general or to the reduction of the staff workload that leads to energy saving in convenience stores.

2. Flow of the Competition Task

The time limit for this competition task will be 20 minutes. The round will proceed in three phases with the following order:

(1) Renovation time
(2) Setting time
(3) Stocking and disposal demonstration

Participants can distribute the time to each phase as they prefer. Participants must indicate their progression to the judges when starting each phase and when completing the task.

2.1. Renovation time

Participants will be given a container with the products to stock and a container for the disposal items.

Participants can install infrastructure and replace the shelves. The work allowed during the renovation time is as follows:

- Installation of unique infrastructure inside the convenience store.
- Replacement of existing display cases and containers.
- Installation of unique infrastructure for products.

For this task, a maximum of 10 workers (participants) may enter the store. Participants should inform the judges when they finish their renovations or if renovations are not required and immediately return the disposal items to the judges.

2.2. Setting time

Judges will announce the disposal items and randomly place those products in display case B.

Next, the participants will set up the mobile robot to execute the task in any position inside of the field while putting the products in the container and placing the container in its initial position (attaching the container to the mobile robot, etc.).

Furthermore, participants will be allowed to input the labeling information regarding the disposal items into the system during this time (however, a person cannot input into the system the actual layout of the products placed in display case B).

Participants must indicate to the judges when they finish the setup.

2.3. Stocking, collection, and disposal demonstration

After the judges confirm that the preparations are finished, the demonstration will begin.

The participants will input the start command into the system that controls the mobile robot and infrastructure. The participants can decide the order in which to conduct the product stocking and disposal subtasks. However, participants must tell the judges in which order they will start the demonstration before the round starts.

After the system operation starts, no one is allowed to control the mobile robot or to take any actions that will influence the operation of the system. Any team that manipulates the operation of the system will be withdrawn from the task at that point.

However, up to two participants may enter the store in order to monitor for anomalies in the robot or infrastructure and to perform an emergency stop if necessary.

3. Details of Challenge

3.1. Layout of Products Inside the Container

Participants must store a total of 12 products inside of the container during the setting time: rice balls (2 types; total of 4 rice balls), drinks (2 types; total of 4 drinks) and lunch boxes (2 types; total of 4 lunch boxes). The products can be placed in the container in any orientation.

3.2. Initial Container Position and Product Transport

Participants can decide the initial container position (however, the container cannot be placed inside of the display case for the initial position).

The initial container position is set inside the home station. If the products can be transported to the display case A and one or more of those products are autonomously placed on the shelf, the product display will be deemed a success and double points will be earned for subsequent product stocking tasks.

3.3. Product Stocking

Points are awarded for extracting products from the container and placing them in the designated position and orientation in display case A. (Total 25 points)

- Rice balls will be placed on the top self. The same type of rice balls will be placed vertically (front to back) and a different type of rice ball will be placed next to it.
- Drinks will be placed on the middle shelf. The same type of drink will be placed vertically (front to back) and a different type of drink will be placed next to it.
- Lunch boxes will be placed on the bottom shelf. The same type of lunch box will be placed vertically (front to back) and a different type of lunch box will be placed next to it. Lunch boxes of the same type can be stacked.
- 2 points will be awarded for each product placed in the designated position. 1 point will be awarded for products placed on the shelf but not in the designated position.
- A bonus point (1 point) will be added if two or more of each product is

placed in the designated position on all three shelves.

Refer to the attached document for information about how the product should be positioned

3.4. Collecting Disposal Items and Facing Them Up

The products will be eight sandwiches (2 types: 4 of each type) and four of those eight sandwiches will be disposal items. Participants can determine the shelf to use from the three shelves in display case B, and then the judges will line up a mix of sandwiches. Disposal items will be collected by checking the expiration date (letters from A to H) written on the backside of the sandwiches. Products must be placed face up. Products near the expiration date will be collected as disposal items. Furthermore, products left on the shelf must face up (return the products to the designated position with the front side out). The same types of sandwiches will be bundled and lined up at this time.

Points are earned by arranging products in their designated positions and collecting disposal items. (Total: 25 points)

- 3 points are awarded for each disposal item stored in the container.
- 3 points are awarded for each remaining product facing up in the correct position.
- A bonus point (1 point) is awarded if the four disposal items are taken from the shelf or if the four remaining products are facing up in the correct position.

Refer to the attached document for information about the initial state of the sandwiches and how they should be arranged.

3.5. Disposal Item Transport

Disposal item transport will be deemed a success if one or more of the disposal items can be brought back to the home area after the disposal item collection task is complete to double the points earned in the disposal task.

In order to be considered as back to the home area, the robot and all containers must be brought back to the home area and stored in the starting position.

3.6. Retry

Participants can release a grasped object if the task is terminated during its manipulation and the object should be returned to the original position before the manipulation started. Under other circumstances, the participants will return the object to the position and orientation indicated by the primary judge supervising the progress of the task up until that point. The score also rolls back to the score before the manipulation started.

Participants can retry many times. However, the clock will continue to run while the demonstration is stopped.

4. Specifications and Restrictions

4.1. Products for the Task

There are four types of products for this task: rice balls, drinks, lunch boxes, and sandwiches. Each product will have two different flavors and approximately the same dimensions and weight. Examples of each product are outlined below. The competition organizers will prepare the products. Furthermore, some of these products may not be used for the competitive task on the day of the competitive challenge due to changes in the product line-up. An alternative product with similar product specifications will be used in the event of a change. These changes will be announced on the official competition homepage.

4.1.1. Rice Balls

- Product name: Red Salmon
- Outer dimensions: Approx. H75 x W80 x D35 mm
- Weight: Approx. 110 g

4.1.2. Drinks

- Product name: Café Latte (240 ml)
- Outer dimensions: Approx. H108 x W76 x D76 mm
- Weight: Approx. 260 g

4.1.3. Lunch Boxes

- Product name: Deep-fried Chicken Lunch Box
- Outer dimensions: Approx. H50 x W250 x D175 mm
- Weight: Approx. 535 g

4.1.4. Sandwiches

- Product Name: Egg Sandwich
- Outer dimensions: Approx. H140 x W90 x D70 mm
- Weight: Approx. 105 g

4.1.5. Adding Auxiliary Tools to Products

Participants can innovate the geometry and materials of the containers and packages of products as well as attach markings such as bar codes or IC

tags to more easily operate the manipulator. However, auxiliary tools that harm the presentation as a product, are unsanitary, interfere with storage or stocking, or cannot be used in the microwave are prohibited. Participants must set up auxiliary tools during the renovation time.

4.2. Container

4.2.1. Standard Container Specifications

- Sanko SN Container C#32S
- Outer dimensions: 716 x 460 x 128 mm
- Inner dimensions: 662 x 422 x 119 mm

4.2.2. Usage Restrictions for Unique Containers

Participants can create their own containers to use in place of the standard containers. However, the following requirements need to be satisfied:

- Products used for the stocking task must all fit inside the container.
- The containers must be able to stack.
- The size must be equivalent to the standard container (approx. 850x600 mm)

4.3. Display Case

4.3.1. Standard Display Case Specifications

- Slit-type system fixture (gondola shelving)
- Outer dimensions: H1500 x D454 (Shelf 400) x W950 mm
- Three display shelves (D400 x W900): top, center, and bottom
- Each shelf is transparent and has a transparent front rail to prevent products from falling (H35 mm)
- Both sides of the display case have a side mesh

4.3.2. Usage Restrictions for Unique Display Cases

Participants can create their own display cases to use as infrastructure instead of the standard display cases. However, the following requirements need to be satisfied:

- The outer dimensions must be within H2000 x D2000 x W2000 mm.
- Display cases must not protrude into the aisles.
- The display cases must have three or more shelves (D400 x W900) for the

stocking task and disposal task.

- Each shelf must be transparent or the lower shelf must be visible when there are no products (net, mesh, etc.), and measures must be taken to prevent products from falling.
- The display case must have 3 shelves (top, middle, and bottom). The distance between each shelf may be set by the participants.
- The products displayed on the shelves must be accessible to Customers.
- The display case cannot be secured to the ceiling, floor, or walls of the venue.

4.4. Mobile Robot and Infrastructure Restrictions

4.4.1. Hardware Restrictions

- There are no restrictions for the number of mobile robots.
- Each mobile robot must occupy less than 1 m x 1 m of floor space and all of the mobile robots must fit into the home area.
- A mobile robot must have a size within one square meter in its initial position and during movement. Furthermore, the container will be seen as one part of the robot if the container is built into the robot. However, the robot may exceed this size temporarily while unloading the container, stocking products, or collecting disposal items.
- Infrastructure can be installed anywhere inside of the convenience store, but different restrictions apply according to the area of the store. Please see the documents provided separately for more information.

4.4.2. Software Restrictions

- The mobile robots and infrastructure must operate autonomously after the start of the task. However, participants may monitor the internal status remotely to know the state of their system.
- Mobile robots are prohibited from moving outside of the convenience store.

4.4.3. Energy Source Restrictions

- Participants should prepare an energy source to use for their mobile robots.
- A power supply within AC100V/1500W is planned as the energy source for participants to use.

- Any energy source deemed to be dangerous or inappropriate for use will not be allowed.

4.4.4. Venue Restrictions

- Participants are prohibited from intentionally staining or damaging the convenience store.
- Infrastructure must be removed immediately after the competitive task ends to return the venue to its original state.
- The convenience store has no ceiling or walls.

4.4.5. Safety Restrictions

- Systems must have an emergency shutdown switch in case of an emergency. All of the movable parts included in the system must immediately stop operating if the emergency shutdown switch is pressed.
- The design must prevent the system from tipping over at all times, including during an emergency stop.
- Measures must be put in place to shield any area with a danger of entangling the arms or legs of people in the vicinity.
- Hot areas and sharp edges must not protrude.
- Energy sources utilizing fire or high temperatures are prohibited.
- Any laser used in the system must be class 1 or lower.
- Products and parts of robots must not eject anything.

5. Frequently Asked Questions

Q. Are deductions taken if a product is damaged?
A. Deductions are not taken. However, this may impact the evaluations by judges.

Q. Can the order of the stocking and disposal takes be switched?
A. The order to perform the tasks is not designated. Participants need to inform the judges of which task they will attempt in advance because judges and officials have the final say.

Q. Can we use multiple containers?
A. Yes, you can use multiple containers.

Q. What is the stacking strength of the containers?
A. Participants can use their own container as long as it does not exceed the standard container size (estimate: 850 x 600[mm])

Q. Is there a blueprint of the product shelves?
A. Details about each shelf are provided in 4.3.1. Please ask the appropriate manufacturer.

Q. Are there indicators such as borders around the home area?
A. The competition plans to use different color flooring for each area, but there are no clear barriers between these areas.

Q. Can the renovations and setup be conducted at the same time?
A. Yes.

Q. Can products be repackaged in original containers?
A. Yes, products can be repackaged. However, make sure original packaging is sanitary and maintains the same quality.

Q. Will a network be available to use for monitoring the status of the robot?
A. Participants should configure this network. However, each group is

responsible for this network because limitations such as the wireless LAN bandwidth are not currently taken into account. Furthermore, underlay of cables that inhibits movement in the aisles will not be permitted.

Q. Is the size of the robot (1m x 1m) a restriction for the initial position?
A. Transformations are allowed as long as the robot can return to its original state at the end of the task.

[Acceptable Example] The robot exceeds the 1 m x 1 m size restriction when the manipulator is extended, but does not exceed this size in its initial posture.

[Unacceptable Example] The robot moves along its route while dropping items, but these items cannot be picked up afterwards.

Q. Will there be water droplets on the products?
A. Products are store up to the competitive task in accordance with the storage instructions designated on the products. Participants should appropriately handle water droplets and other issues with products during the setting time.

Q. Does the size restriction apply to robots with containers built-in?
A. Yes, the size restrictions apply.

6. Other

This rulebook is subject to change without notice.

Number of items

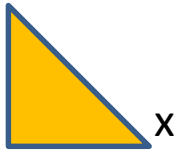
Display task

Rice ball  x 1~3 +  x 1~3 = 4

Drink  x 1~3 +  x 1~3 = 4

Lunch box  x 1~3 +  x 1~3 = 4

Disposal task

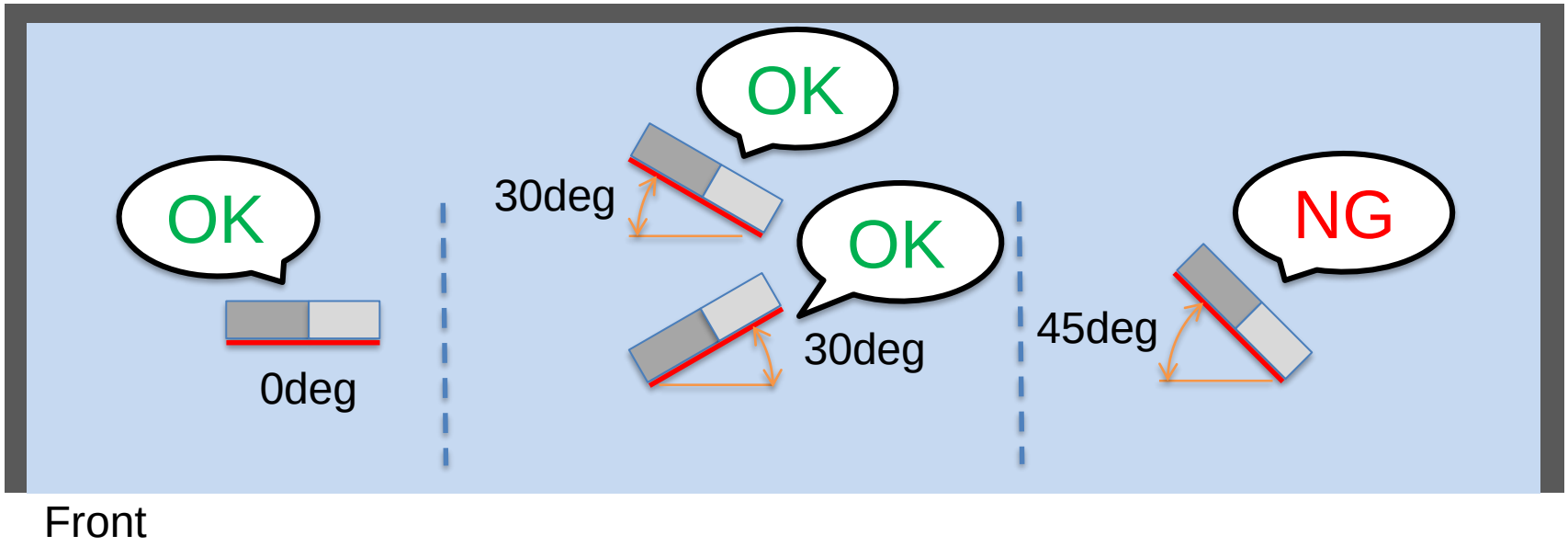
Sandwich  x 4 +  x 4 = 8

There are two kinds of each product

Position and posture of the Rice Balls for Display

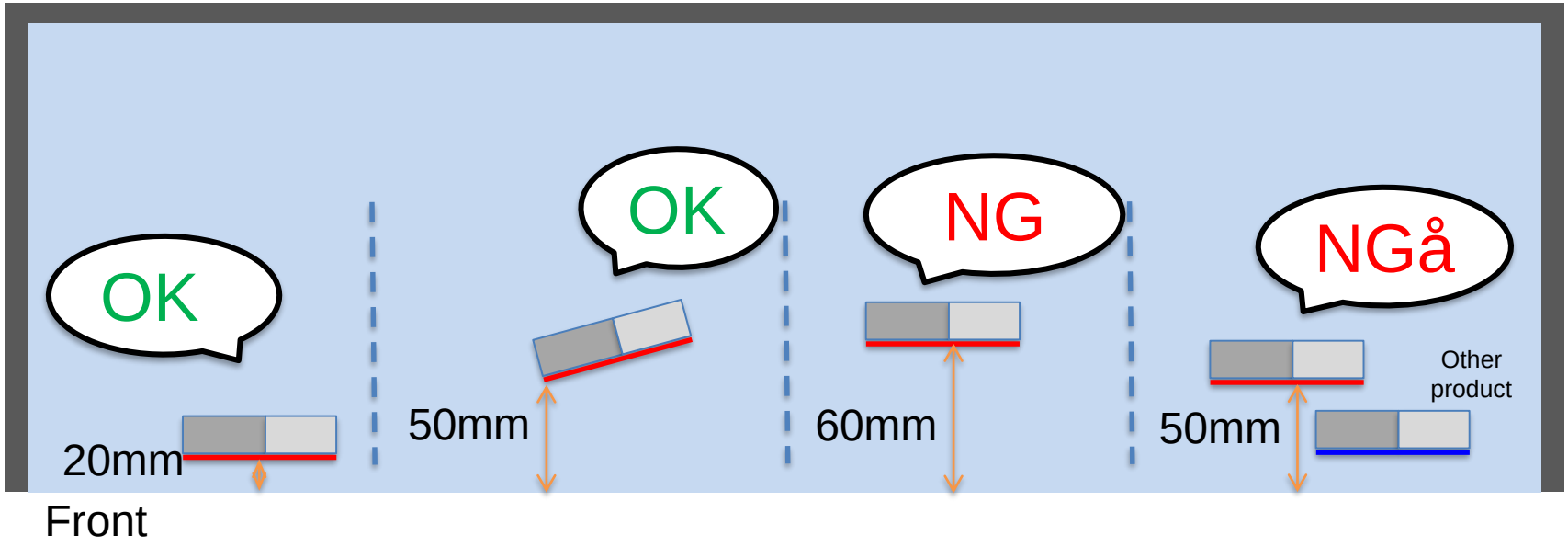
Posture (Yaw angle)

The label of the item must face the front.
The tolerance of orientation is 30degrees.



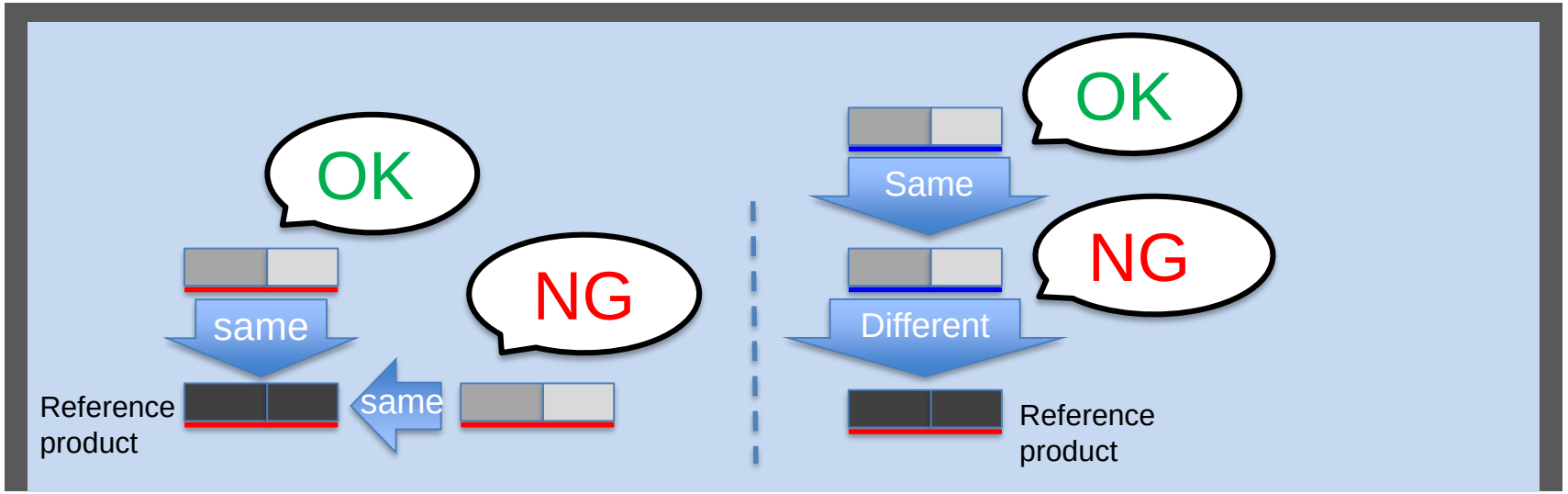
Position of the reference product

The product in the front row(reference product) should be placed within 50mm from the front edge of the shelf. Also, it should not be hidden behind different products.



Position of the other products

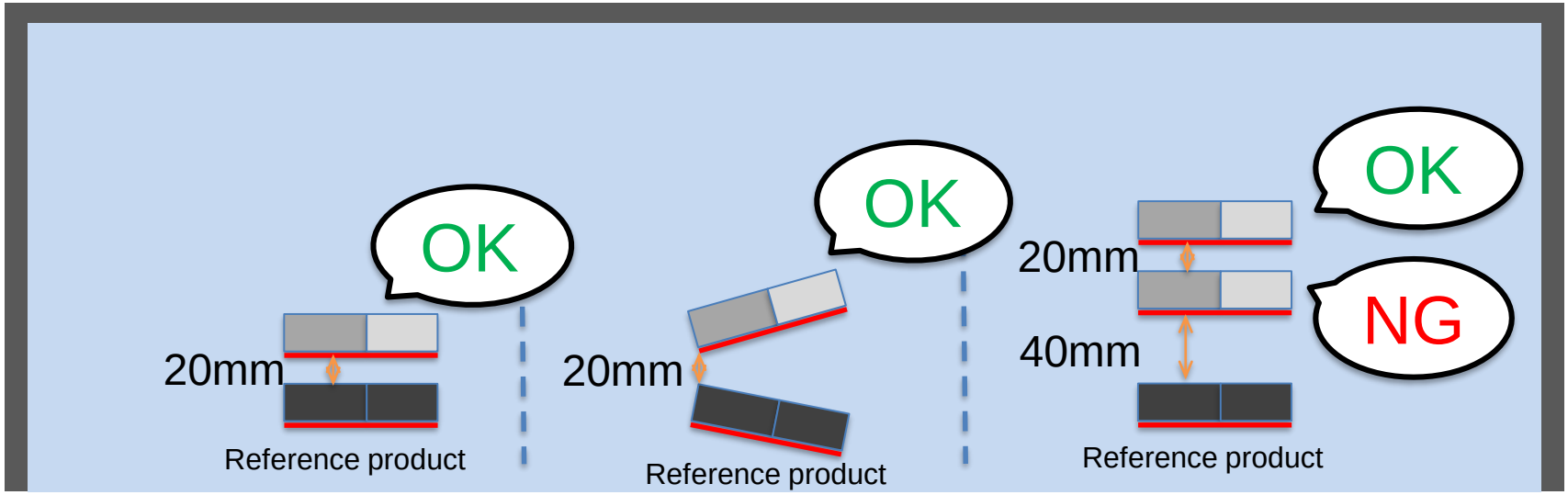
Products in the second and subsequent rows must be placed behind same products.



Front

Distance between each product

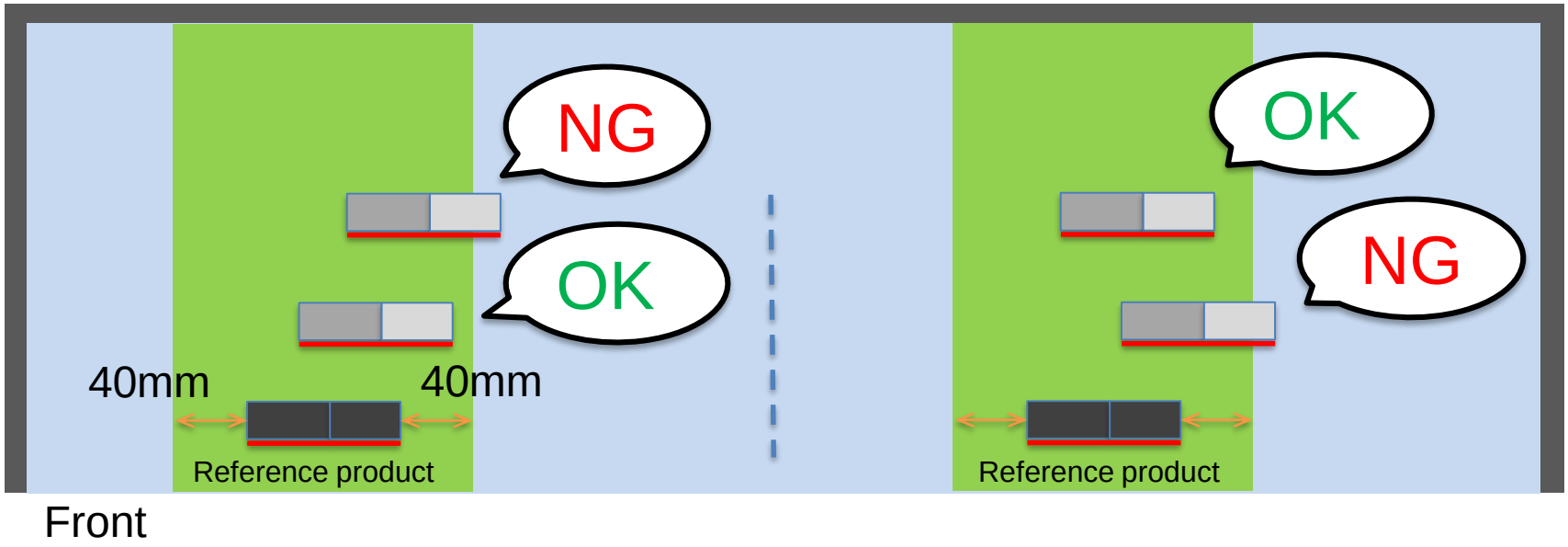
Allowable maximum distance between each product is 20mm.



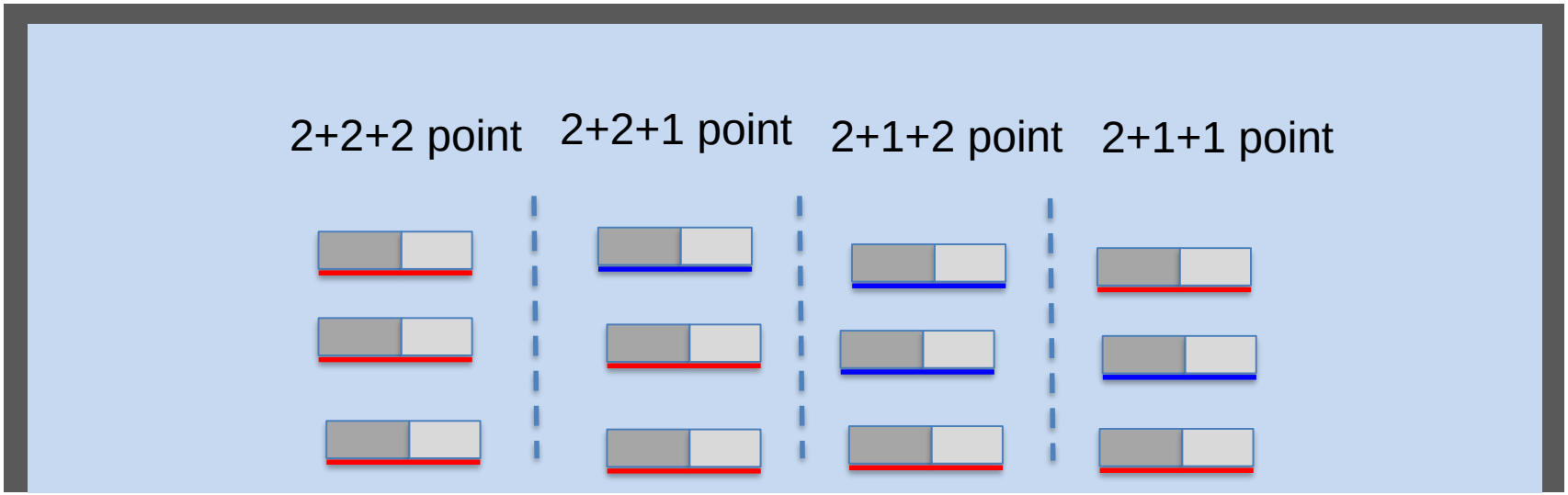
Front

Lateral position of the products

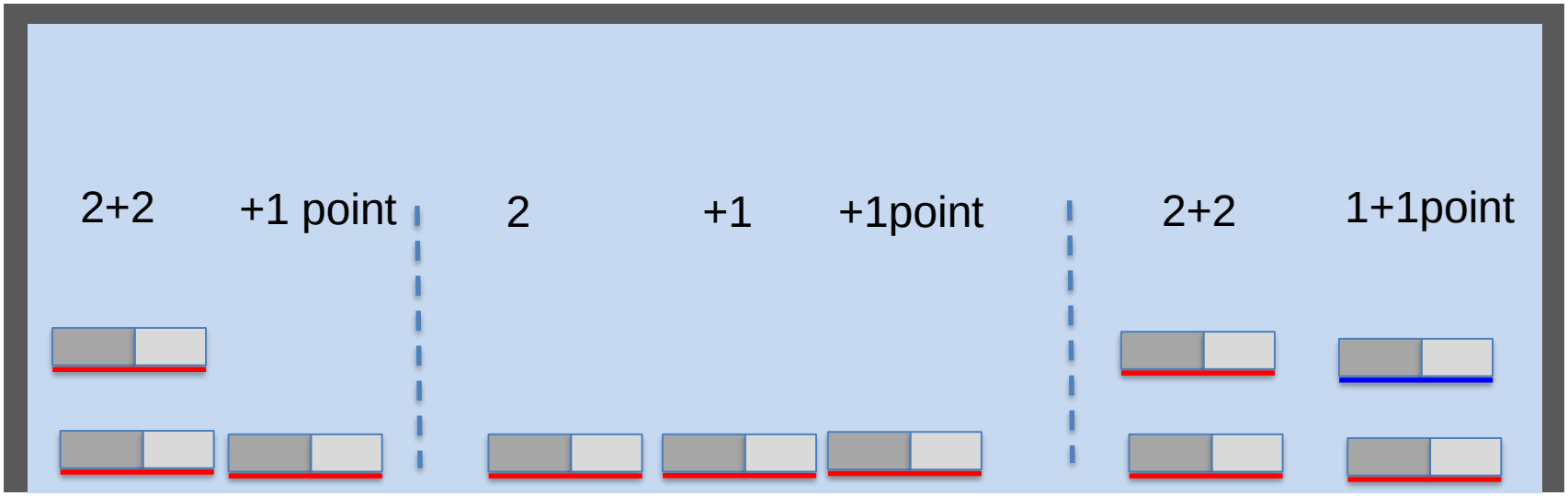
Lateral deviation is allowed up to 40mm with reference to the item in the first row.



Scoring example



Front

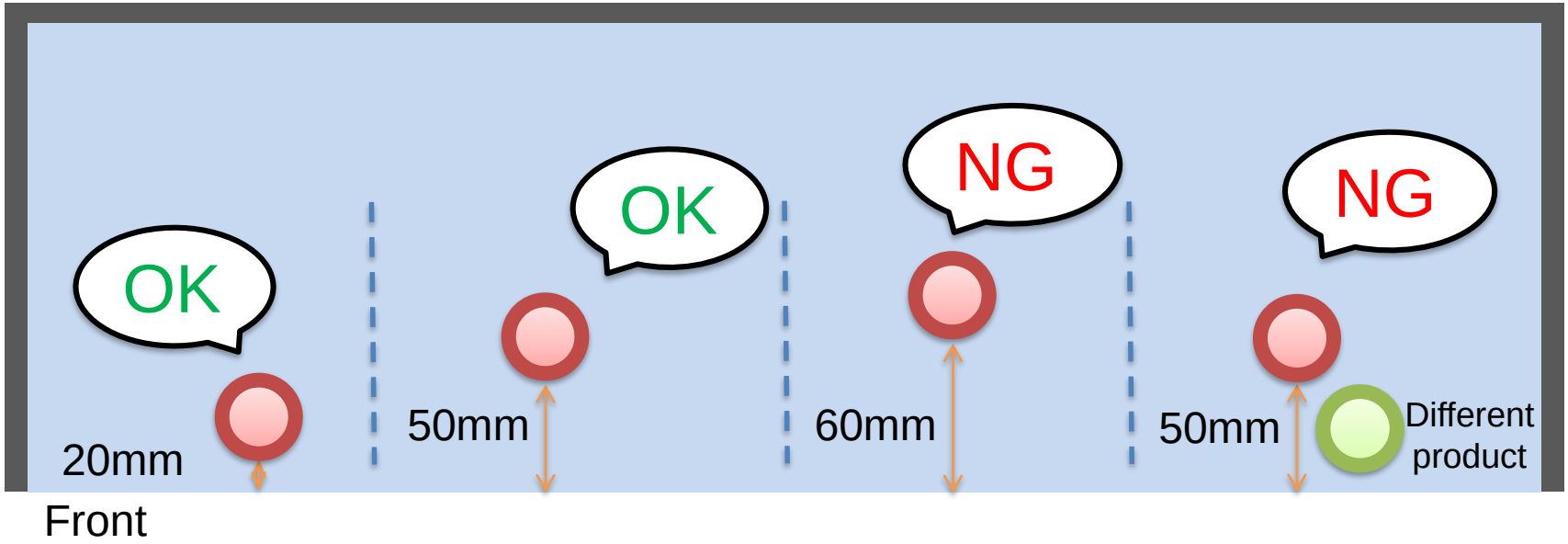


Front

Position and posture of the Drinks for Display

Position of the reference product

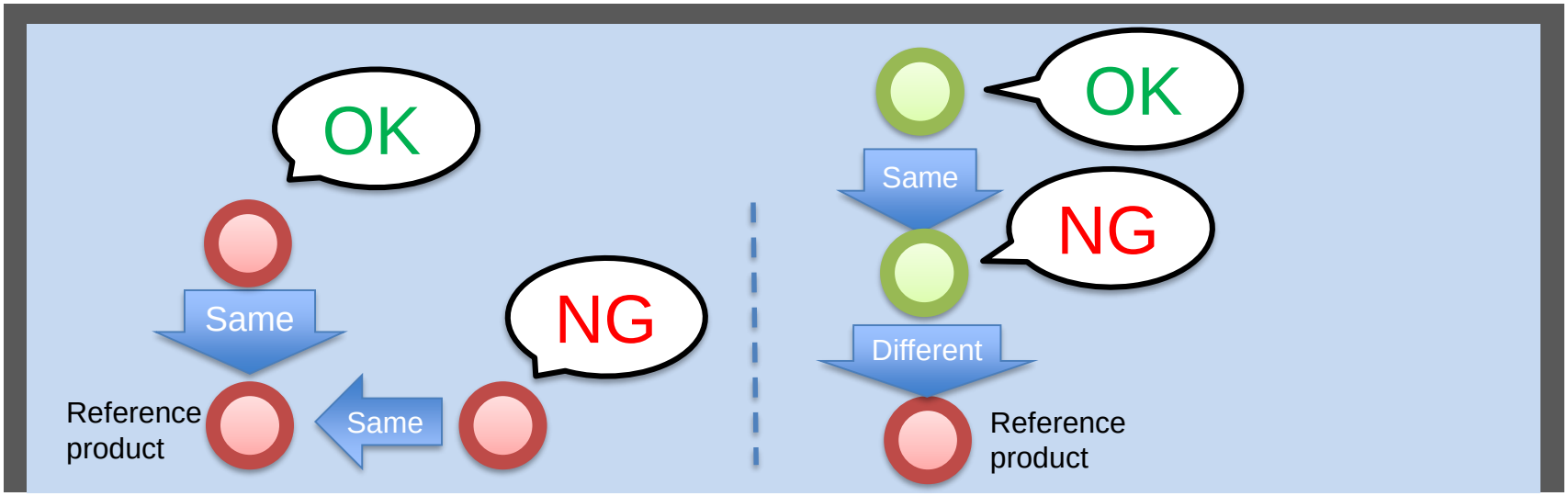
The product in the front row(reference product) should be placed within 50mm from the front edge of the shelf. Also, it should not be hidden behind different products.



NG= No good.

Position of the other products

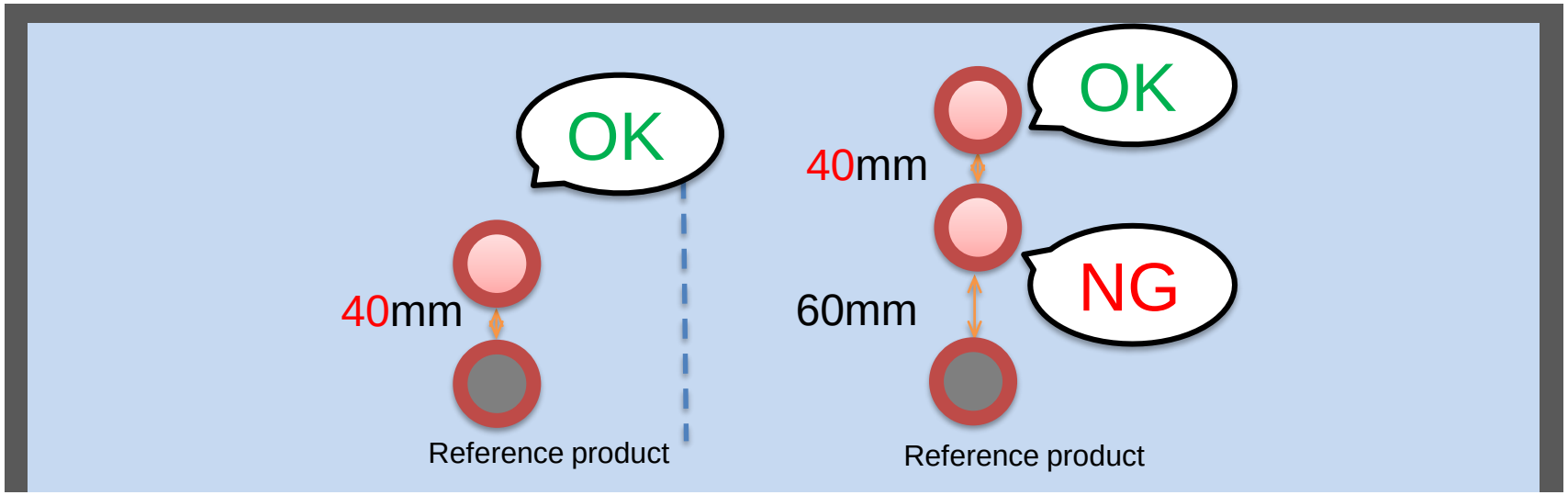
Products in the second and subsequent rows must be placed behind same products.



Front

Distance between each product

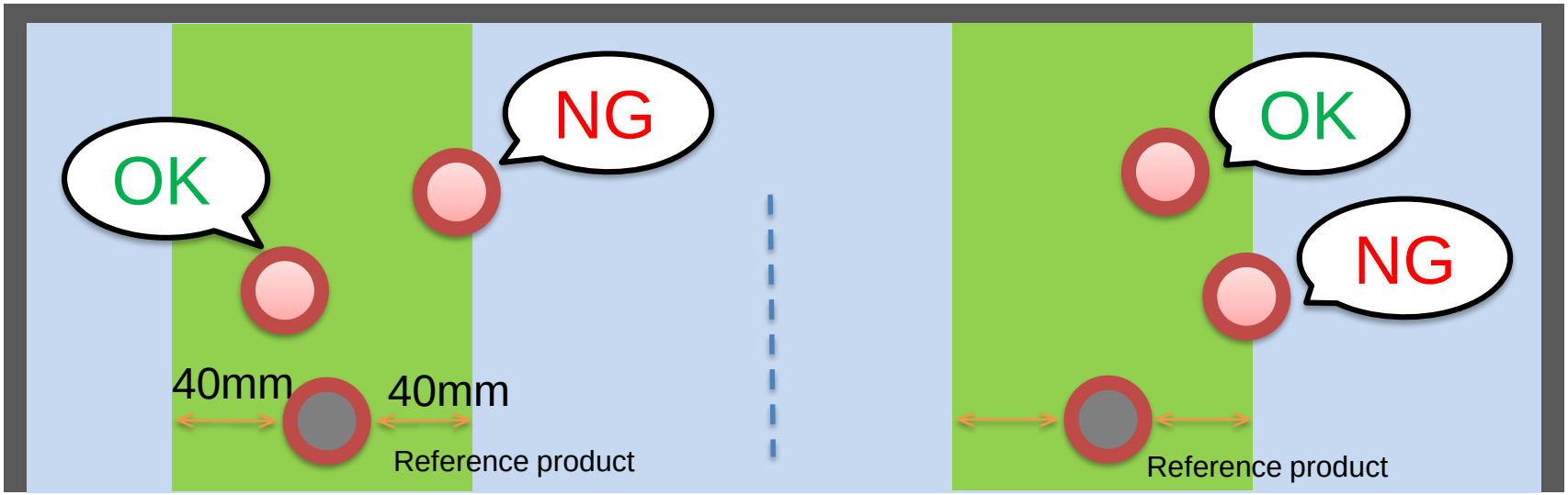
Allowable maximum distance between each product is 40mm.



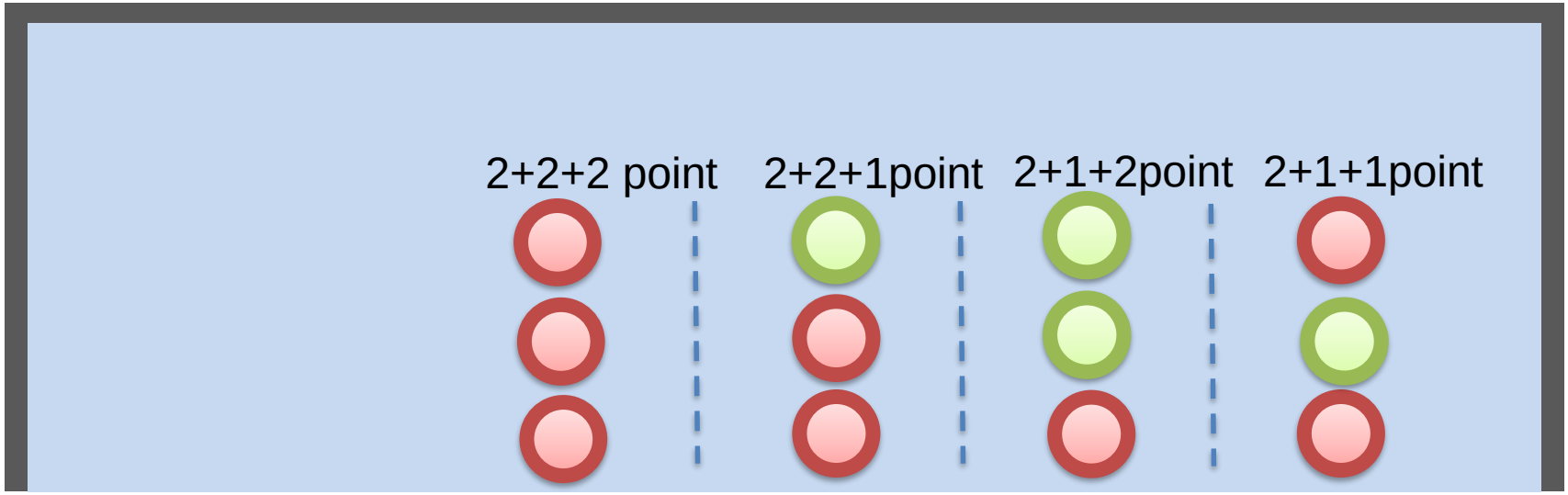
Front

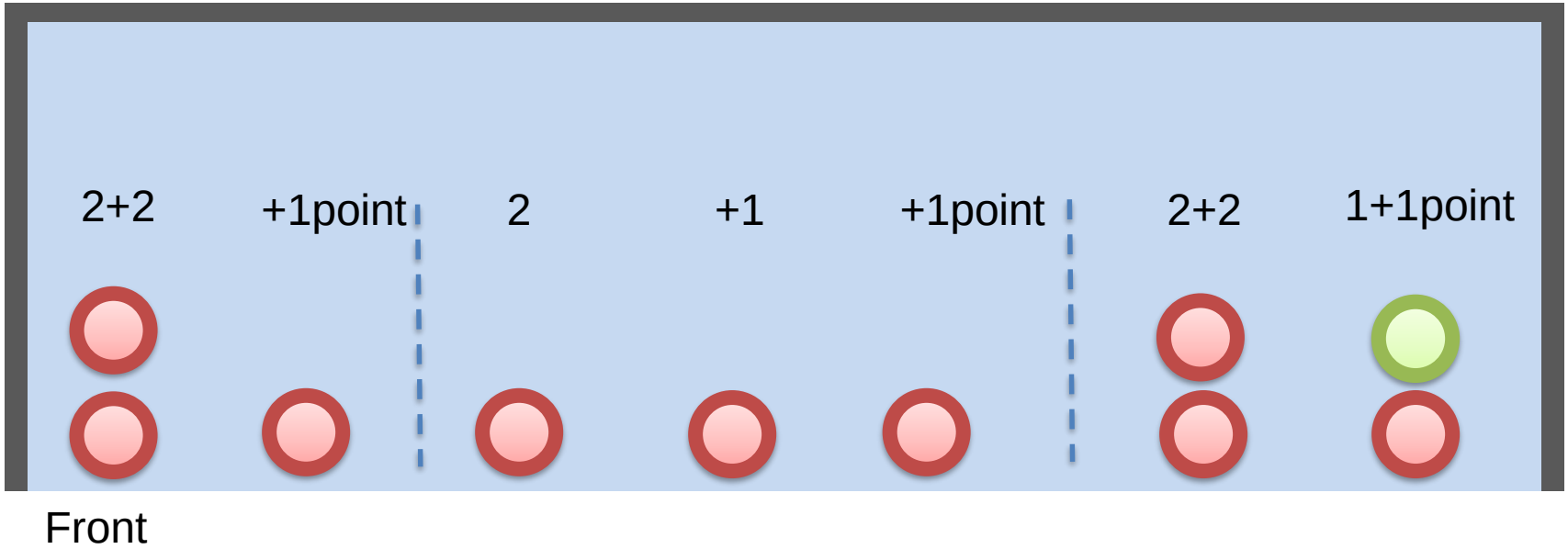
Lateral position of the products

Lateral deviation is allowed up to 40mm with reference to the item in the first row.



Scoring example

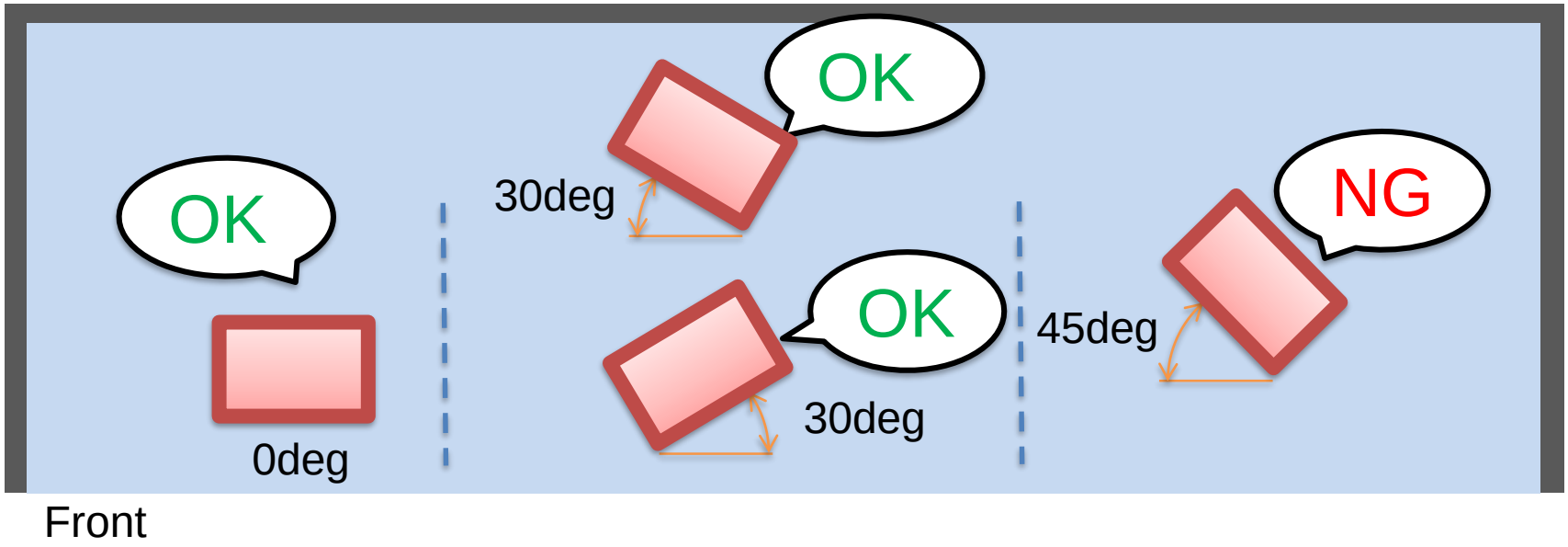




Position and posture of the Lunchboxes for Display

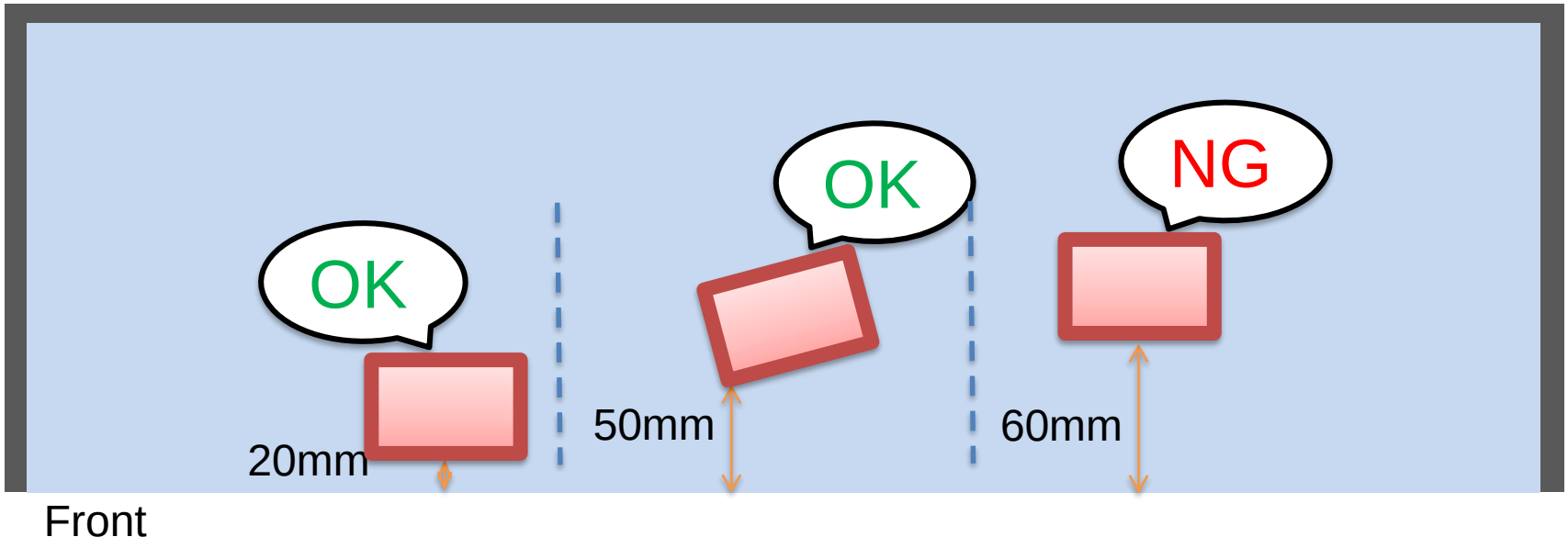
Posture (Yaw angle)

The tolerance of orientation is 30degrees.



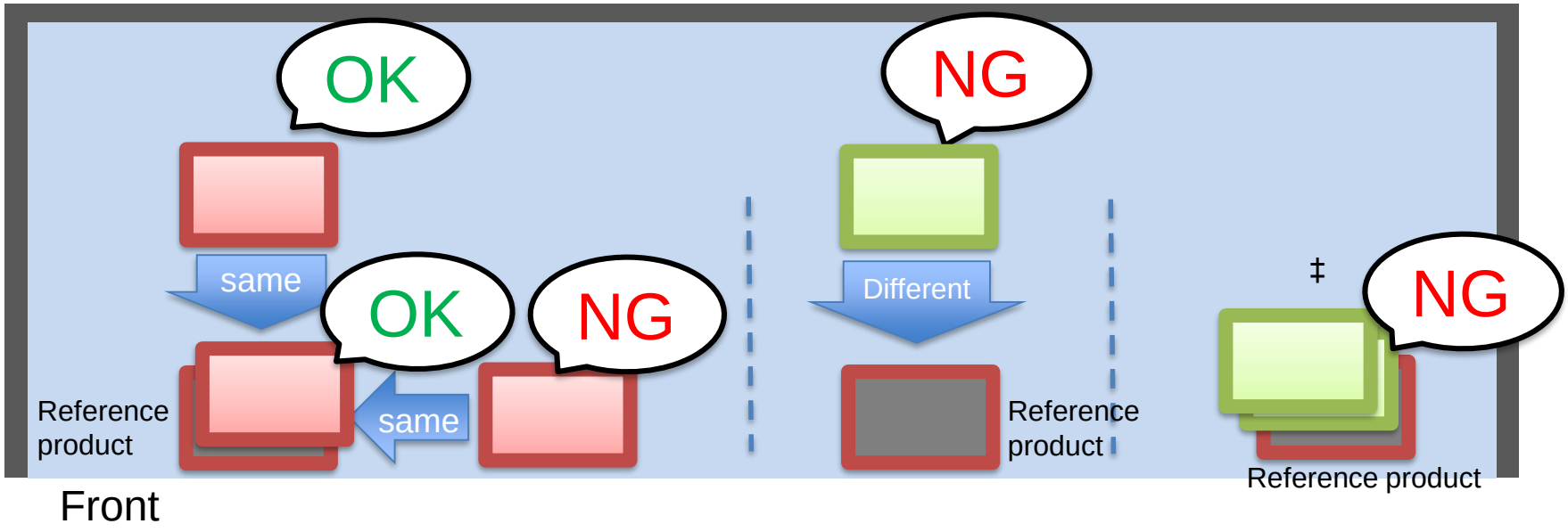
Position of the reference product

The product in the front row(reference product) should be placed within 50mm from the front edge of the shelf. Also, it should not be hidden behind different products.



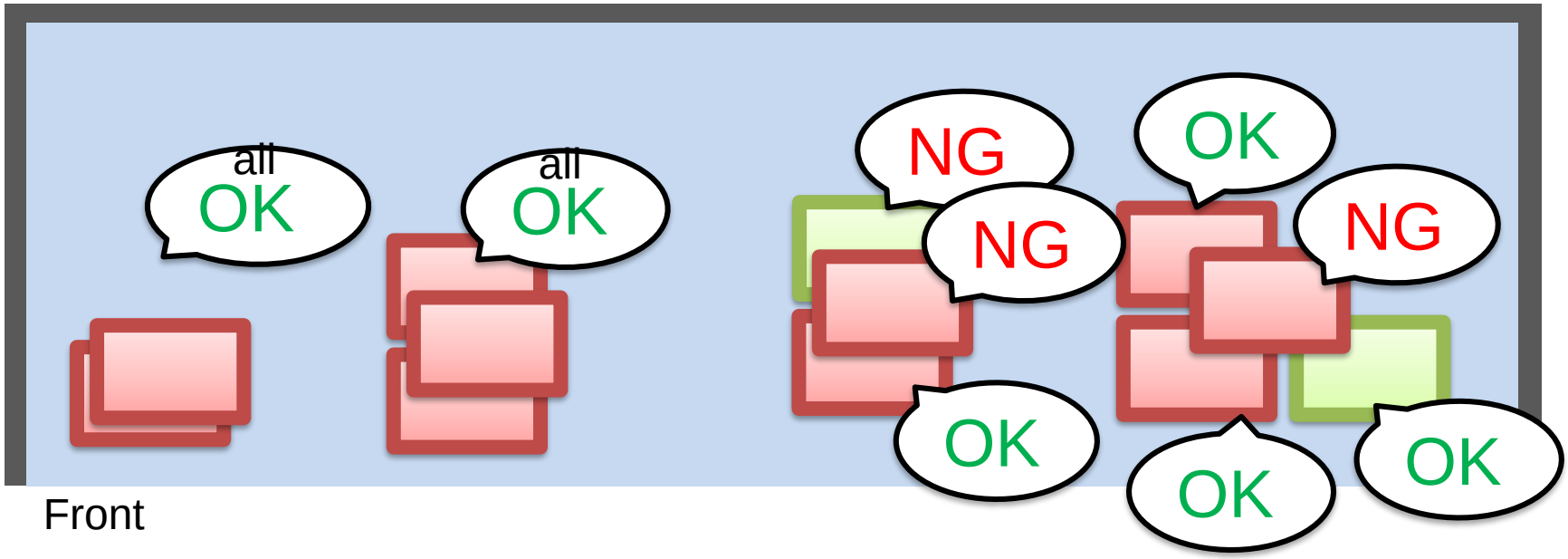
Position of the other products

Products after the second one must be placed behind the same product or stacked on the same product.



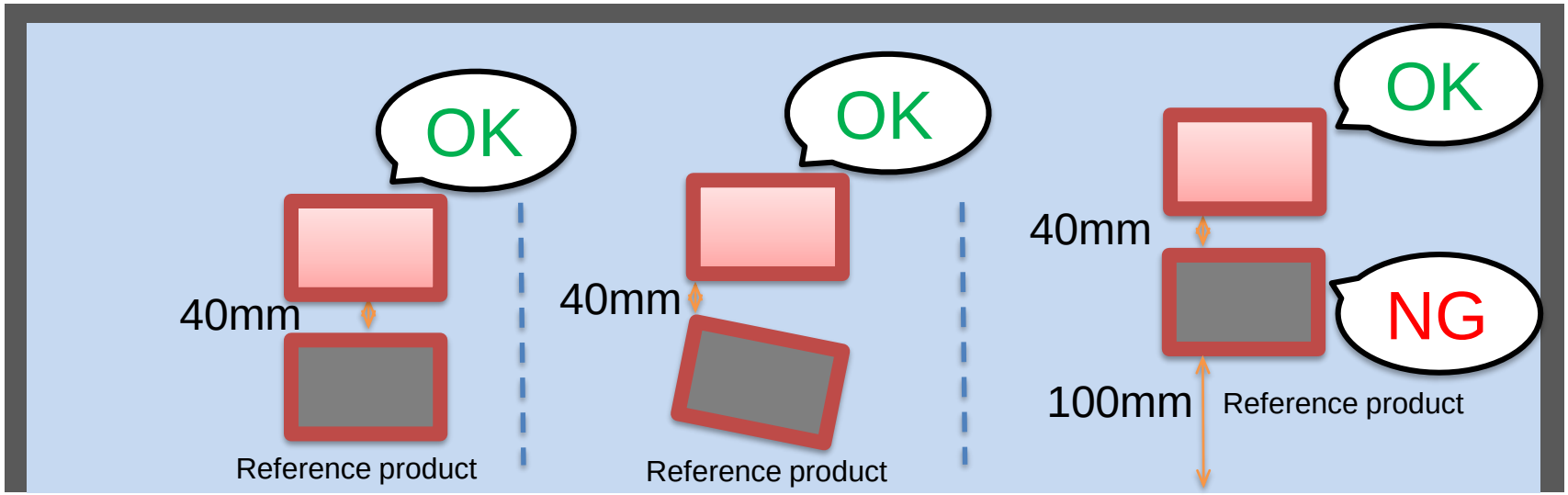
Stacking of the products

Products stacked up must not touch different type products.



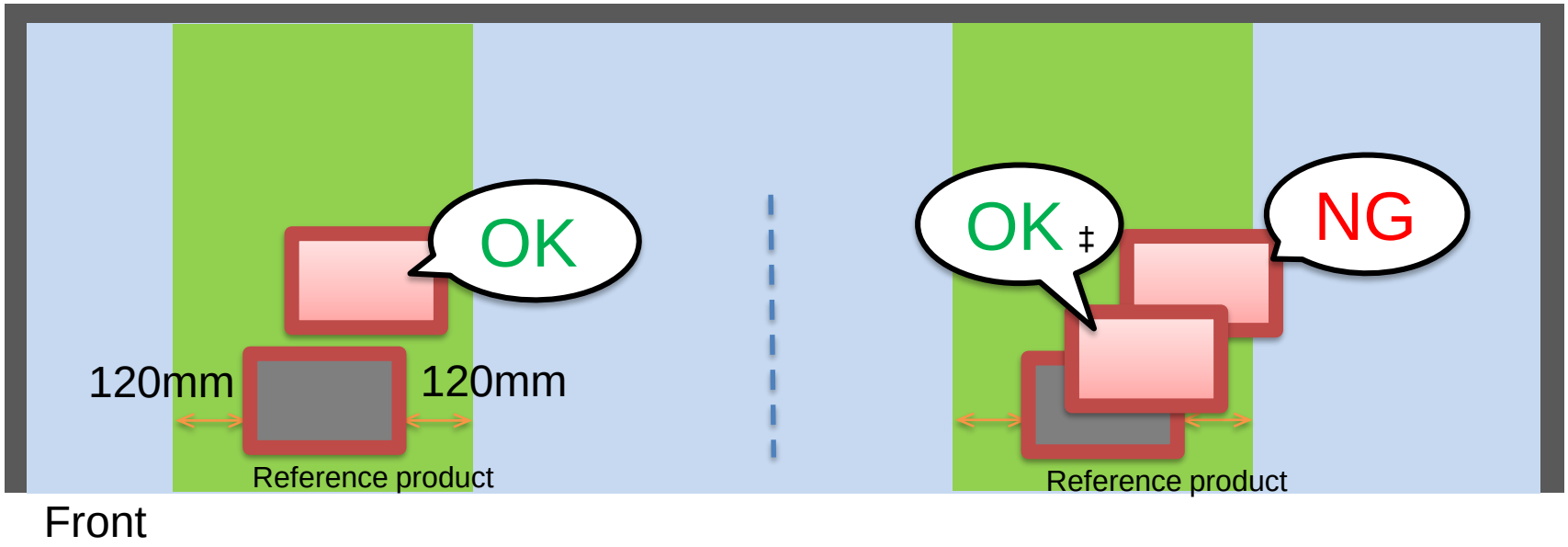
Distance between each product

Allowable maximum distance between each product is 80mm.

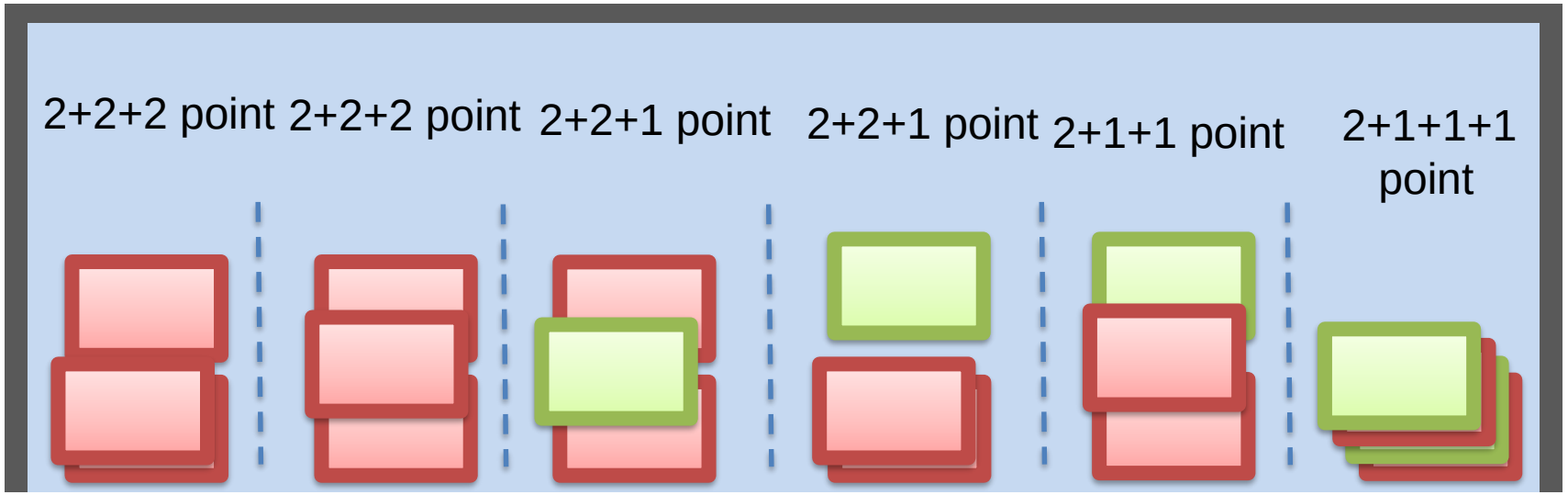


Lateral position of the products

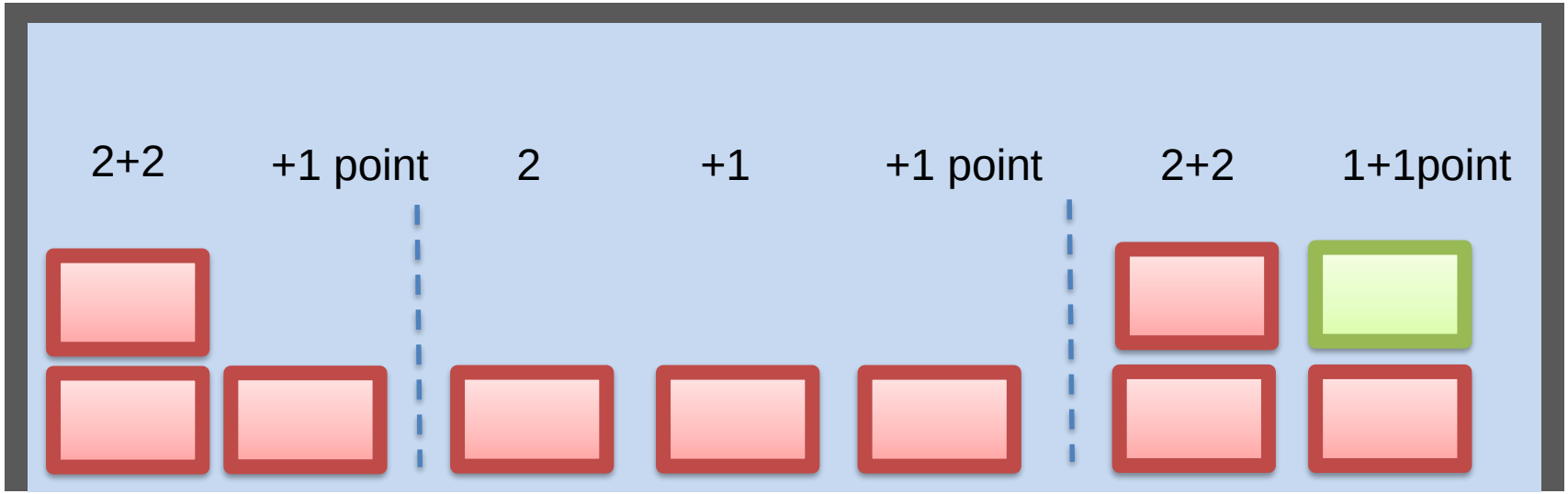
Lateral deviation is allowed up to 120mm with reference to the item in the first row.



Scoring example



Front

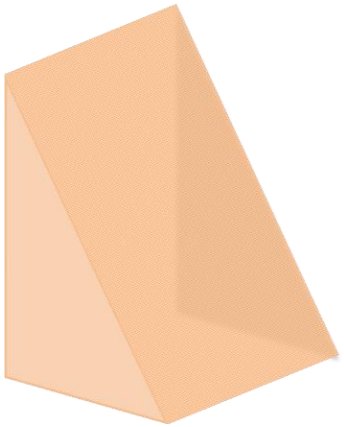


Front

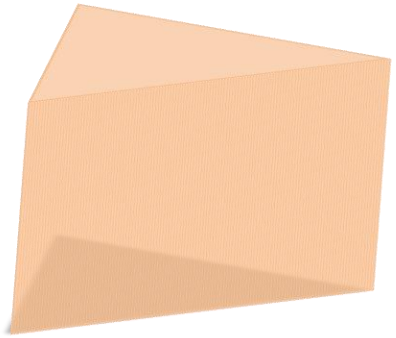
Initial positon and posture of the products for disposal task

Initial posture of the product

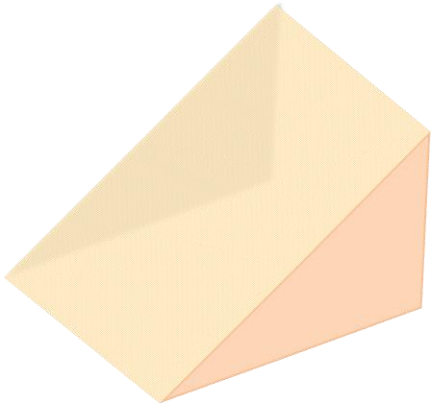
The sandwiches are placed with either side grounded as shown below.
The orientation of the yaw axis is undefined.



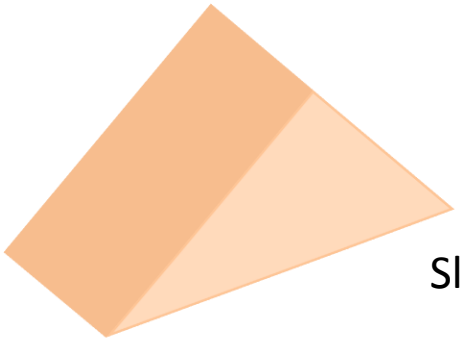
Bottom
(Standard)



Side



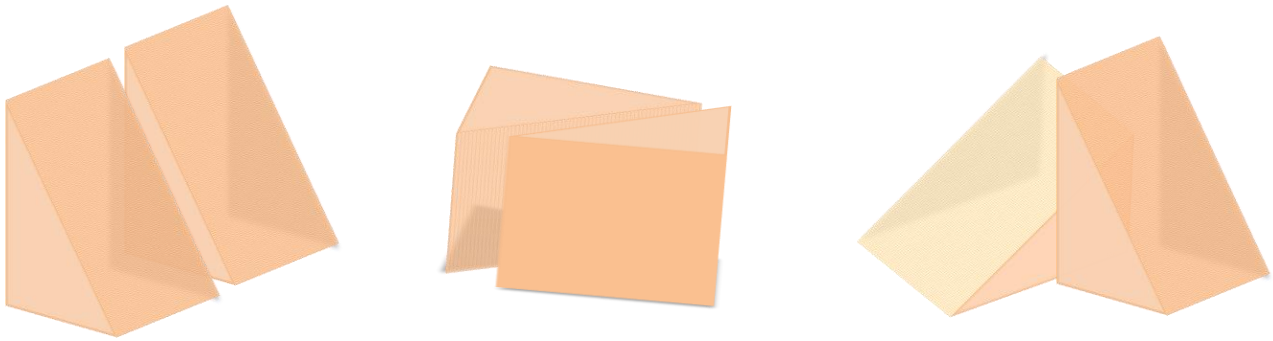
Back



Slope

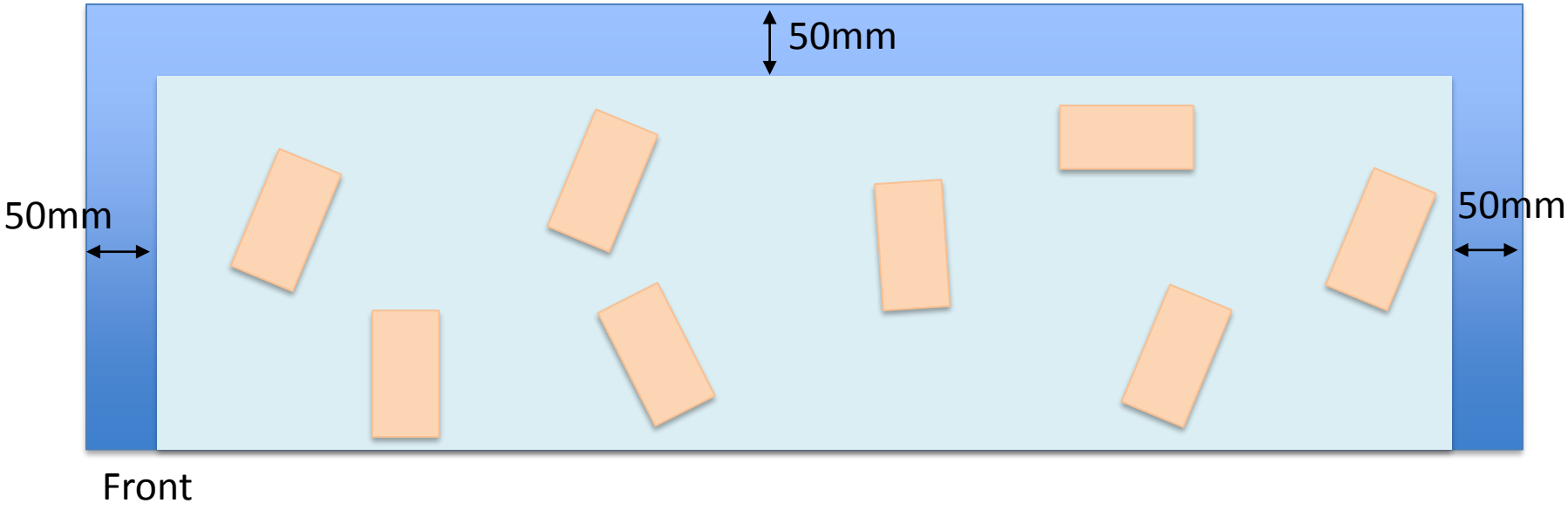
Example of initial postures of the products

It will be placed so that the surfaces of the sandwich do not touch each other.
Therefore, the initial states as shown in the figure below does not occur.



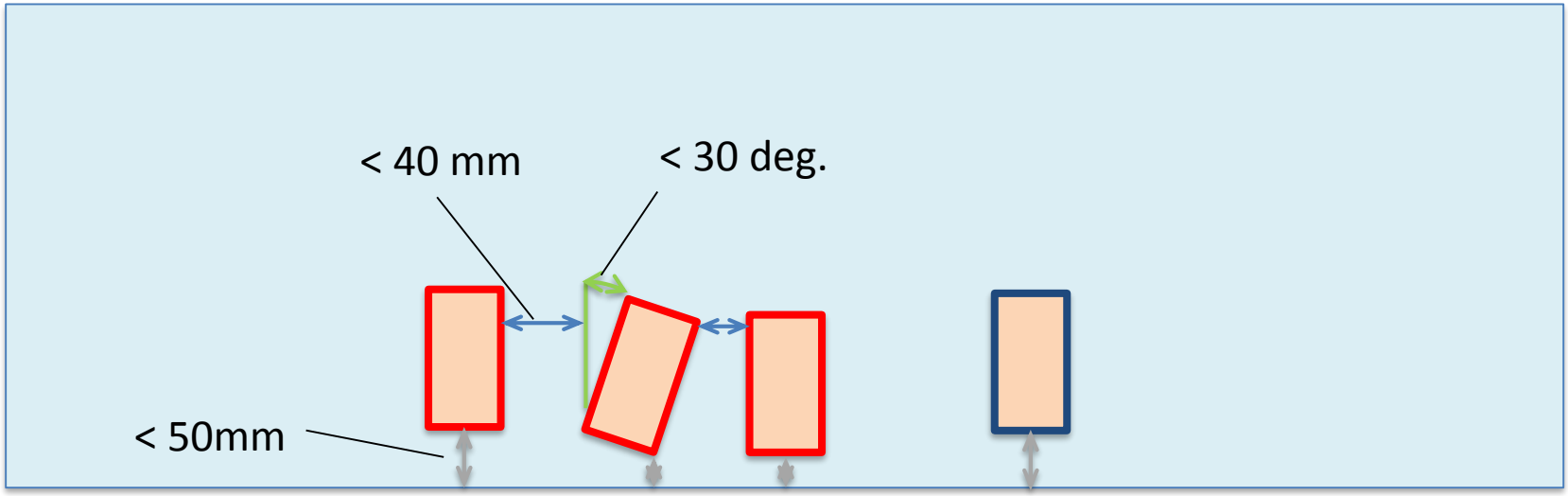
Example of initial positions

Sandwiches must not be placed within 50 mm of the ends or back of the shelf.



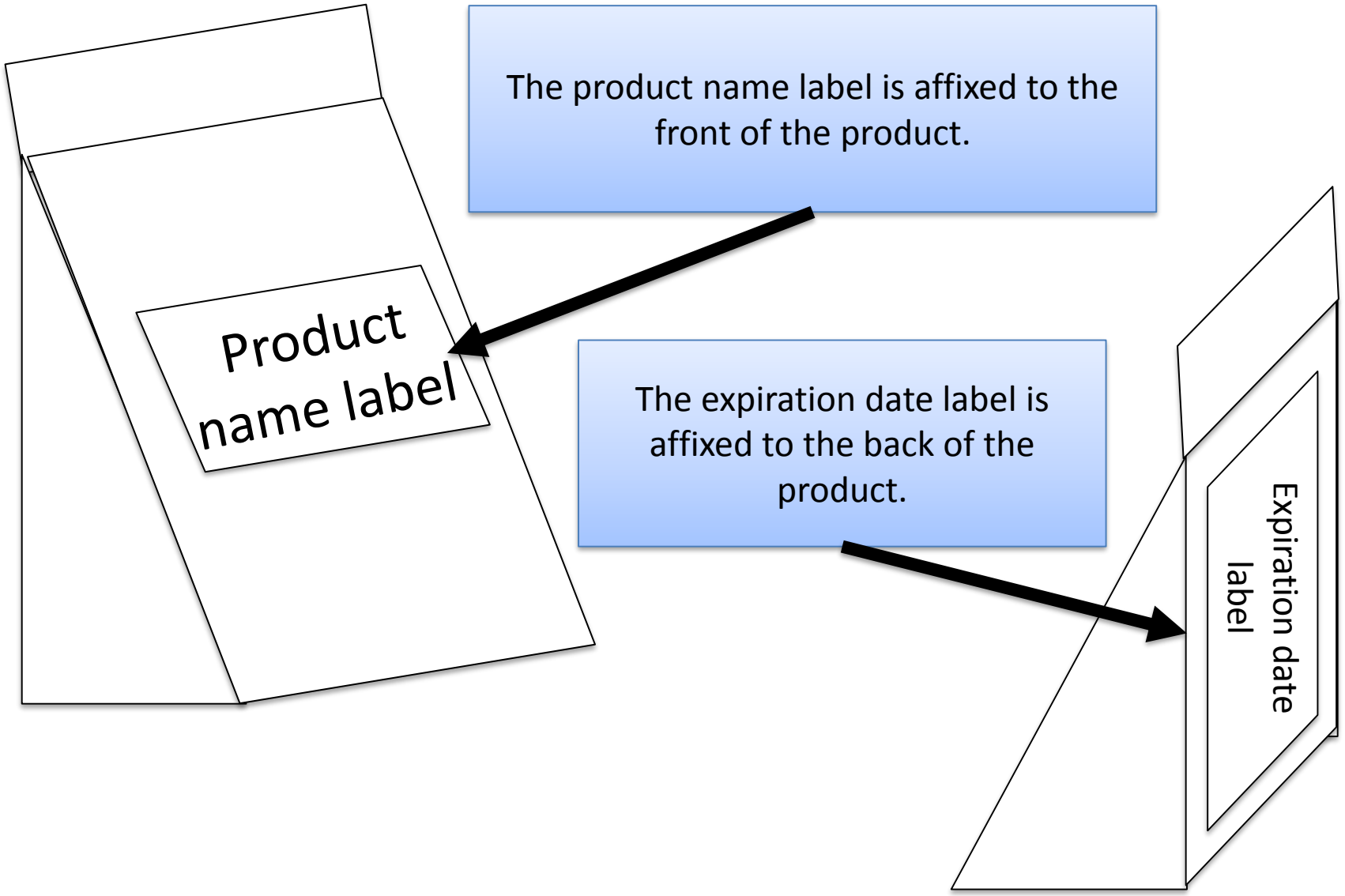
Face-up position

(1) The bottom surface of the product must be in contact with the shelf surface.
(2) The label of the product must face the front. The tolerance of orientation is 30 degrees.
(3) All products should be placed within 50 mm from the front edge of the shelf.
(4) The same products must be placed within 40 mm.

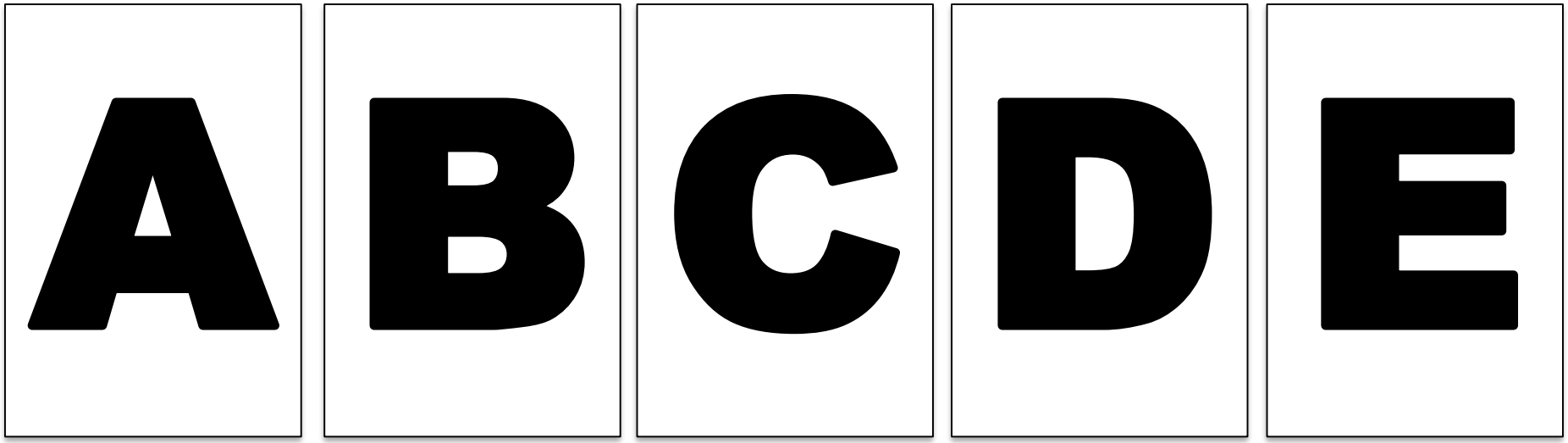


Front

About the Product Label



Specification of the Expiration Label



Items targeted for disposal must have their ID in Arial Black 166 pt. font.

The labels are attached over the original expiration date label.

WRS Future Convenience Store Challenge
Preliminary Competition 2018

Task: Customer Interaction

Rulebook

2018 /08/27

World Robot Challenge

Revision History

August 27, 2018

- A note on the official language (English) for the demonstrations has been added.

February 2, 2018

- A subject about an energy saving has been added.

January 15, 2018

- First Draft

0. Terminology

Term	Definition
Mobile Robot	A robot that can move autonomously.
Infrastructure (Robot)	Unique infrastructure that can be installed inside convenience stores to assist in the robot's task. This equipment includes markings, IC tags, sensors, actuators and auxiliary tools to add equipment to products. Infrastructure made up of sensors and actuators can also be seen as stationary robots.
Manipulator	Robot arms, end effectors and other equipment that execute operations which can be installed on a mobile robot or as part of the infrastructure.
Product	Products found at a convenience store.
Customer	Person who visits the store to purchase products.
Container	Container used to hold and transport multiple products. A container may also be called "carton."
Product Display Area	Section of the convenience store with display cases or bookshelves installed.
Cashier Area	Section of the convenience store with the cashier counter installed.
Restroom Area	Section of the convenience store with the toilet installed (Abbreviation: Restroom).
Aisle Area	Section of the convenience store for customers and mobile robots to come and go. (Abbreviation: Aisle)
Backyard Area	Area of the convenience store where customers are not allowed (Abbreviation: Backyard).
Home	Standby station of the mobile robot. The standby station is located in a designated place inside the backyard area.
Display Case A	Case for displaying products. There are no products placed in this display initially.
Display Case B	Case for collecting disposal items. Multiple products are mixed in this case initially.
Disposal items	In the Disposal task, those products that the judges set

	to be disposed.

1. Overview

This challenge aims to develop technology to automate customer interaction, which is part of the job for employees at a convenience store. Participants of this competition task will develop a robot that autonomously moves and interacts with customers, as well as infrastructure to install inside of a simulated convenience store. In this challenge, participants will use the robots and infrastructure they develop to compete in terms of the innovation, viability and feasibility of their systems when performing customer interaction demonstrations in a simulated convenience store space.

The layout of the convenience store interior consists of a product display area, cashier area, restroom area, aisles, and backyard area as shown in a document provided separately.

Participants can freely choose a customer interaction challenge and perform a system demonstration within the time limit of the round.

In addition, the proposed system will be required to contribute to energy saving and an efficiency of work in convenience stores.

2. Flow of the Round

The time limit for this task will be 20 minutes. The task will proceed in four phases with the following order:

(1) Renovation time
(2) Setting time
(3) Presentations
(4) Customer interaction demonstrations

Participants can distribute the time to each phase as they prefer. Participants must indicate their progression to the judges when starting each phase and when completing the task.

Please note that the presentations and the customer interaction demonstrations MUST be spoken in English, which is the official language of this competition.

2.1. Renovation time

Participants will add or replace furniture such as shelves or other infrastructure. The work allowed during the renovation time is as follows:

- Installation of unique infrastructure inside the convenience store.
- Replacement of existing furniture such as display cases and the cashier counter.

Participants should inform the judges when they finish their renovations or if renovations are not required.

2.2. Setting time

Participants will set up their robot and necessary products. Participants will arrange the robot and products in any initial position inside the simulated convenience store. Participants must inform the judges when they finish their setup or if the setup is not required.

2.3. Presentations

Participants will explain the purpose and an overview of the system they developed. The presentation may also be conducted at the same time as the demonstration. Participants must inform the judges when the presentation is over or if the presentation will be conducted at the same time as the demonstration.

2.4. Customer Interaction Demonstration

After the judges confirm that the preparations are finished, the demonstration will begin.

The participants will input the start command into the system.

After the system operation starts, the participants are not allowed to control the robot or to take any actions that will influence the operation of the system. Any team that manipulates the operation of the system will be withdrawn from the task at that point.

The participants can decide to retry the task as described hereafter, if continuing the demonstration is deemed difficult due to system malfunction.

3. Details of Challenge

3.1. Customer Interaction Challenge

Participants can freely choose a customer interaction challenge and perform a system demonstration within the time limit of the round. For example, the competition expects a demonstration similar to those below.

- Heating purchased products (lunch boxes, etc.) or bagging products
- Receiving orders and retrieving products for products ordered through a clerk such as hot snacks and cigarettes
- New services based on recognizing gender, age and products customers are hesitant to purchase
- Recommendation of products
- Prevention of shoplifting
- Customer service for customers with special needs such as elderly, foreign nationals, or people who use a wheelchair
- Assistance and other services

These are only a few examples of customer interaction. Not all of these services need to be implemented. However, the competition expects proposal and demonstrations that foresee a future of new services including the interaction between people (staff/customers) and robots. The competition also expects participants to generate appeal by illustrating the specific use prescribed to their system in their demonstration via role-playing and other means. The judging panel evaluates those customer interaction from the perspectives outlined below.

Judges score customer interaction by awarding points based on the following criteria:

- Presentation
- Viability
- Feasibility

Furthermore, role-playing customers for the demonstrations should be

arranged by the participants.

3.2. Retry

Participants can ask the judges to terminate the demonstration to retry the task if the system malfunctions and continuing the demonstration is deemed difficult.

Participants can retry many times. However, the clock will continue to run while the demonstration is stopped. The participants can decide in what state to resume the task.

4. Specifications and Restrictions

4.1. Simulated Convenience Store

The convenience store will be an 8 m × 7 m space which consists of a product display area, cashier area, restroom area, aisles, and a backyard area. The cashier area will have a counter. The product display area will include display cases and bookshelves. Detailed information about the layout, counter and display cases inside the convenience store will be provided in a separate document.

Participants are not allowed to make changes to the layout inside the convenience store during the renovations such as rearranging the display cases in the aisles

4.2. Products

Participants shall prepare the products to use in the demonstration.

4.3. Mobile Robot and Infrastructure Restrictions

4.3.1. Hardware Restrictions

- There are no restrictions for the number of mobile robots.
- Each mobile robot must occupy less than 1 m x 1 m of floor space and all of the mobile robots must fit into the home area.
- Infrastructure can be installed anywhere inside the convenience store, but different restrictions apply according to the area of the store. Please see the documents provided separately for more information.

4.3.2. Software Restrictions

- The robots and infrastructure must operate autonomously after the start of the task. However, participants may monitor the internal status remotely to know the state of their system.
- Mobile robots are prohibited from moving outside of the convenience store.

4.3.3. Energy Source Restrictions

- Participants should prepare an energy source to use for their robots.
- A power supply within AC100V/1500W is planned as the energy source for participants to use.
- Any energy source deemed to be dangerous or inappropriate for use will not be allowed.

4.3.4. Venue Restrictions

- Participants are prohibited from intentionally staining or damaging the convenience store.
- Infrastructure must be removed immediately after the task ends to return the venue to its original state.
- The convenience store has no ceiling or walls.

4.3.5. Safety Restrictions

- Systems must have an emergency shutdown switch in case of an emergency. All of the movable parts included in the system must immediately stop operating if the emergency shutdown switch is pressed.
- The design must prevent the system from tipping over at all times, including during an emergency stop.
- Measures must be put in place to shield any area with a danger of entangling the arms or legs of people in the vicinity.
- Hot areas and sharp edges must not protrude.
- Energy sources utilizing fire or high temperatures are prohibited.
- Any laser used in the system must be class 1 or lower.
- Products and parts of robots must not eject anything.

5. Other

This rulebook is subject to change without notice.

WRS Future Convenience Store Challenge
Preliminary Competition 2018

Task: Toilet Cleaning

Rulebook

2018/8/27

World Robot Challenge

Revision History

August 27, 2018

- Added information regarding the number of participants for the renovation task
- Added information regarding the simulated urine and spraying
- Added information about floor materials
- Added information regarding the ceiling

February 2, 2018

- Added information about energy saving.

January 15, 2018

- First Draft

0. Terminology

Term	Definition
Mobile Robot	A robot that can move autonomously.
Infrastructure (Robot)	Unique infrastructure that can be installed inside convenience stores to assist in the robot's tasks. This equipment includes markings, IC tags, sensors, actuators and auxiliary tools that add equipment to products. Infrastructure made up of sensors and actuators can also be seen as stationary robots.
Manipulator	Robot arms, end effectors and other equipment that execute operations which can be installed on a mobile robot or as part of the infrastructure.
Product	Products found at a convenience store.
Customer	Person who visits the store to purchase products.
Container	Container used to hold and transport multiple products. A container may also be called "carton."
Product Display Area	Section of the convenience store with display cases or bookshelves installed.
Cashier Area	Section of the convenience store with the cashier counter installed.
Restroom Area	Section of the convenience store with the toilet installed (Abbreviation: Restroom).
Aisle Area	Section of the convenience store for customers and mobile robots to come and go (Abbreviation: Aisle).
Backyard Area	Area of the convenience store where customers are not allowed (Abbreviation: Backyard).
Home	Standby station of the mobile robot. The standby station is located in a designated place inside the backyard area.
Display Case A	Case for displaying products. There are no products placed in this display initially.
Display Case B	Case for collecting disposal items. Multiple products are mixed in this case initially.
Disposal items	In the Disposal task, those products that the judges set to be disposed.

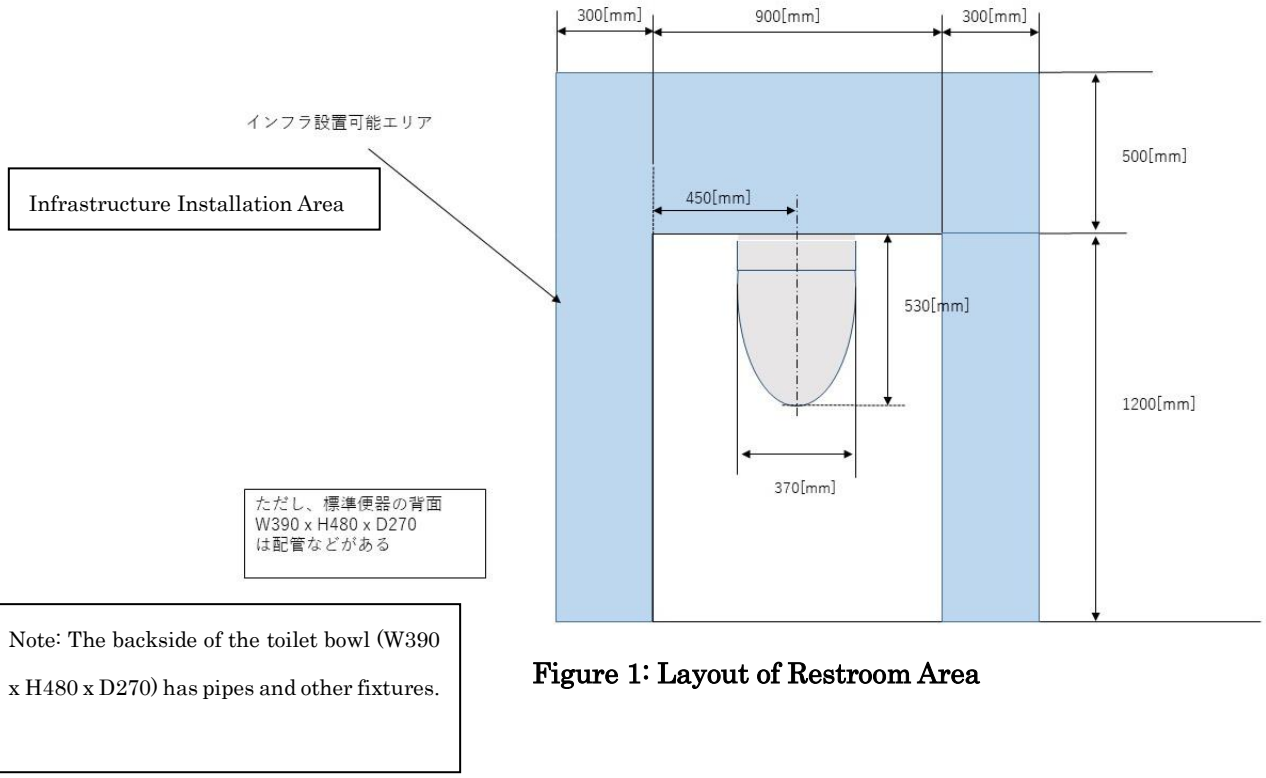
1. Overview

This challenge aims to develop technology to automate the restroom cleaning task, which is a daily task for employees at a convenience store. Participants of this competition task will develop a robot that operates autonomously and performs cleaning operations, as well as infrastructure to perform cleaning operations that can be installed inside of the restroom area. In this challenge, participants will use the robots and infrastructure they develop to compete performing a demonstration of cleaning a toilet and the floor of a simulated restroom space.

The restroom area consists of a toilet, floor and an area to install infrastructure in the layout shown inFigure 1.
The demonstration will consist of the following two subtasks:

- Cleaning simulated urine on the toilet. The rim (top of toilet bowl), the toilet seat (when up), and the floor around the toilet should be cleaned. The inside of the toilet bowl does not need to be cleaned.
- Cleaning garbage scattered on the floor (roll and scraps of toilet paper).

A comprehensive explanation about the cleaning will be described in the following sections.
In addition, the proposed system must contribute to energy saving in general or to the reduction of the staff workload that leads to energy saving in convenience stores.



Note: The backside of the toilet bowl (W390 x H480 x D270) has pipes and other fixtures.

Figure 1: Layout of Restroom Area

2. Flow of the Round

The time limit for this task will be 20 minutes. The task will proceed in three phases with the following order:

(1) Renovation time
(2) Setting time
(3) Cleaning demonstration

The total amount of time for (1) to (3) is 20 minutes. Participants can distribute the time to each phase as they prefer. Participants must indicate their progression to the judges when starting each phase and when completing the task.

2.1. Renovation time

Participants will install their infrastructure inside Infrastructure Installation Area. Participants should inform the judges when they finish their renovations or if renovations are not required.
For this task, a maximum of 10 team members may enter the store.

2.2. Setting time

Participants will set up their mobile robot. Participants will place the mobile robot to perform the task in the home area outside the restroom area or in an initial position anywhere inside the area where infrastructure can be installed. Participants must inform the judges when they finish their setup or if the setup is not required.

2.3. Cleaning Demonstration

After the judges confirm that the preparations are finished, the judges will add the simulated urine described hereafter and scatter garbage. Afterwards, the demonstration will begin.

The participants will input the start command into the system that controls the mobile robot and infrastructure.

After the system operation starts, participants are not allowed to control the robot or to take any actions that will influence the operation of the system. Any team that manipulates the operation of the system will be withdrawn

from the task at that point.

However, participants can decide to retry the task as described hereafter if continuing the demonstration is deemed difficult due to system malfunction.

3. Details of Challenge

The challenge will have a maximum score of 100 points:

- Cleaning the simulated urine: 50 points
- Cleaning the garbage: 50 points

3.1. Cleaning the Simulated Urine

Judges disperse simulated urine (300 ml) around the restroom by spraying the simulated urine around the toilet bowl with the toilet seat open using a sprayer (peeing boy statue) (Fig. 2). The simulated urine is a fluorescent paint (UV ink) diluted with water.

Images will be taken to record the state of the restroom before spraying the simulated urine as well as before and after cleaning, and the removal rate of the simulate urine will be measured. The full 50 points will be given to participants with an 80% or higher removal rate. The simulated urine left in the restroom area after scoring will be cleaned by the venue staff.

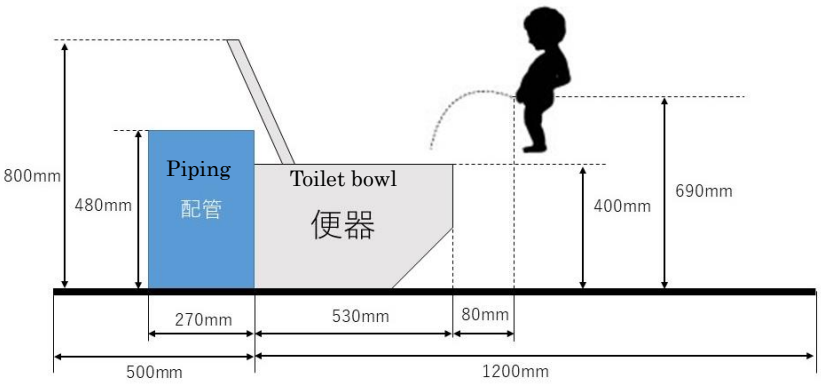


Fig. 2 Sprayer and toilet bowl position

3.2. Cleaning the Garbage

Judges will scatter a total of five pieces of garbage randomly composed of four scraps of toilet paper (maximum length of approx. 5 cm) and one toilet paper roll. Furthermore, the garbage will be scattered after the simulated urine is sprayed and may become slightly wet due to the simulated urine previously dispersed. The restroom will be deemed as clean by either throwing the garbage in the garbage can or storing the garbage inside the robot itself.

Participants are allowed to decide the shape of the garbage can and this garbage can be placed in the area for the mobile robot and in the infrastructure installation area during the renovation time or setting time. 10 points will be awarded for each piece of garbage that is cleaned. (Maximum of 50 points)

3.3. Retry

Participants can ask the judges to terminate the demonstration in order to retry the task if the system malfunctions and continuing the demonstration is deemed difficult. Participants can retry many times.

However, the clock will continue to run while the demonstration is stopped. Furthermore, the mobile robot and infrastructure will be returned to their initial state. The points awarded for cleaning the simulated urine will be a reference score. In other words, cleaning will be 0 points and multiple participants with the same score will be determined superior or inferior based on the removal rate. Participants will keep the points already earned for pieces of garbage that have been cleaned, the garbage still left to clean will be returned to its position before the demonstration was stopped, and then the task will resume.

4. Specifications and Restrictions

4.1. Standard Toilet Bowl

The standard toilet bowl and toilet seat installed at the venue are as follows:

- Toilet bowl: TOTO Pure Rest QR
- Toilet seat: Standard toilet seat for above

Furthermore, simulated urine will be sprayed while the toilet seat is up.

4.2. Original Toilet Bowl

Participants can use a toilet bowl that has unique geometry and functionality instead of the standard toilet bowl. However, the original toilet bowl must satisfy the following requirements:

- The toilet bowl has a pool of water.
- The toilet bowl can be used for both stool and urine.
- The toilet seat is down when sitting and the height of the toilet seat is approximately 400 mm from the floor.
- The toilet bowl accommodates men to pee while standing.
- The toilet must have a projected area of approximately W370 x D530 mm protruding from the floor.

4.3. Floor

The floor will be a black, vinyl chloride sheet.

4.4. Mobile Robot and Infrastructure Restrictions

4.4.1. Hardware Restrictions

- There are no restrictions for the number of mobile robots.
- Each mobile robot must occupy less than 1 m x 1 m of floor space and all of the mobile robots must fit into the home area.
- The initial position of mobile robots must fit in the Infrastructure

Installation Area if the mobile robots will be placed inside such area.

- The initial position of infrastructure must be within the Infrastructure Installation Area.
- Mobile robots and infrastructure may not have an external supply of water. However, a total of one liter of water may be carried inside the robot to use.
- The use of cleansers is prohibited.

4.4.2. Software Restrictions

- The robots and infrastructure must operate autonomously after the start of the task. However, participants may monitor the internal status remotely to know the state of their system.
- Mobile robots are prohibited from moving outside of the convenience store.
- The mobile robot must exit the restroom area or return to the Infrastructure Installation Area. Infrastructure must return to the Infrastructure Installation Area.

4.4.3. Energy Source Restrictions

- Participants should prepare an energy source to use for their robots.
- A power supply within AC100V/1500W is planned as the energy source for participants to use.
- Any energy source deemed to be dangerous or inappropriate for use will not be allowed.

4.4.4. Venue Restrictions

- Participants are prohibited from intentionally flooding, staining or damaging the convenience store or restroom area.
- Infrastructure must be removed immediately after the task ends to return the venue to its original state.
- A beam will be installed 2 m above the floor and below the ceiling in the toilet area. Lightweight measuring devices such as a camera will be mounted into the beam. This camera measures the simulated urine and there must not be any interference with its operation.
- The convenience store have no ceiling or walls.

4.4.5. Safety Restrictions

- Systems must have an emergency shutdown switch in case of an emergency. All of the movable parts included in the system must immediately stop operating if the emergency shutdown switch is pressed.
- The design must prevent the system from tipping over at all times, including during an emergency stop.
- Measures must be put in place to shield any area with a danger of entangling the arms or legs of people in the vicinity.
- Hot areas and sharp edges must not protrude.
- Energy sources utilizing fire or high temperatures are prohibited.
- Any laser used in the system must be class 1 or lower.
- Products and parts of robots must not eject anything.

5. Other

This rulebook is subject to change without notice.