



CONNECTING THE WORLD  
UNDERWATER INFRASTRUCTURE



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## Information on how to use these game rules in countries:

We deliberately have a mix of simple and more difficult tasks in the game rules. These rules are also used for the WRO International Final, where we expect to see many teams that can solve all missions. At a local, regional or national level however, there will be many teams that do not have the experience, knowledge or time to solve everything. This is intentional. By offering simple and more complicated tasks all teams will be able to solve parts of the challenge and can keep trying to improve their work. (Also see chapter 6)

## 1. Introduction

After the invention of the telegraph, it was suddenly possible to send long distance messages in a much faster way than ever before but sending a telegraph requires cables and, initially, sending a message to overseas still needed to be done by boat. This changed when the first telegraph cable was laid on the bottom of the sea between England and France in 1850. Plans were made soon to install a cable that would cross the full Atlantic Ocean. After many setbacks the submarine cables became a great success, and more were installed all over the world.

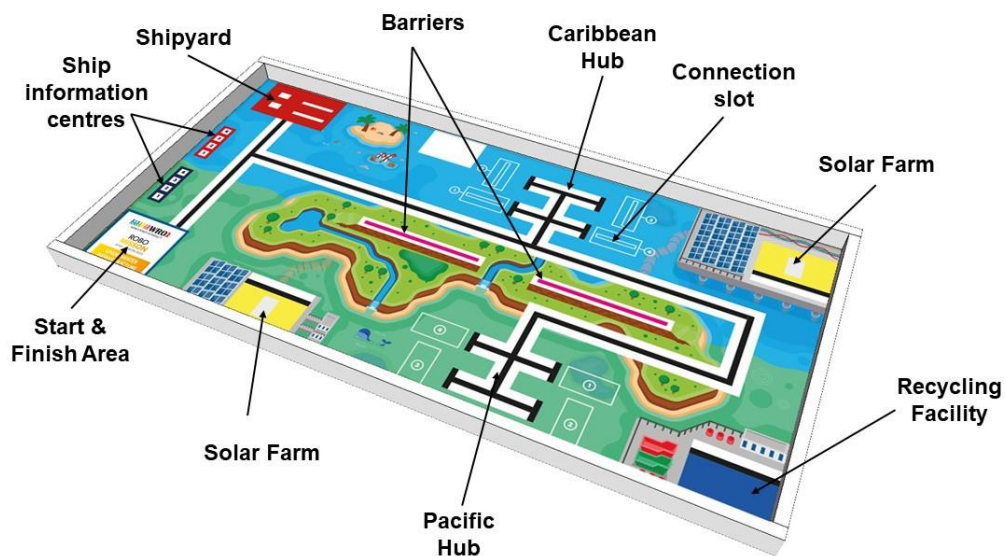
You might think that submarine cables are no longer necessary, with modern day satellites and Wi-Fi, but they are still crucial for communication, and they are the backbone of the internet. Modern fiber-optic cables can transmit data much faster than satellite connections. Sending a signal across the Atlantic Ocean by cable is around eight times faster than sending it by satellite\*. A place where submarine cables interconnect with each other is called a submarine cable hub. Panama is one of these hubs, where cables from the Caribbean Sea and Pacific Oceans connect. Underwater vessels and robots can help maintaining this infrastructure and help with new technical solutions at sea such as offshore solar farms and even submarine data centres.

\* Source: <https://www.submarinecablesystems.com/history>

**On the Junior game field, the robot will help to install and repair submarine cables, install submarine server farms, and activate offshore solar panels.**

## 2. Game Field

The following graphic shows the game field with the different areas.



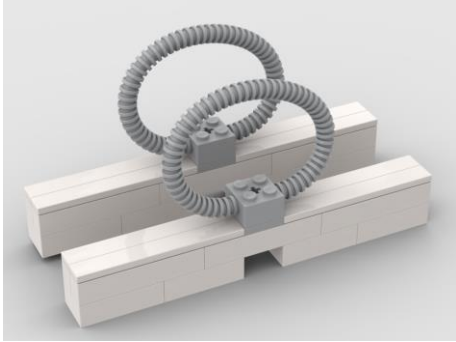
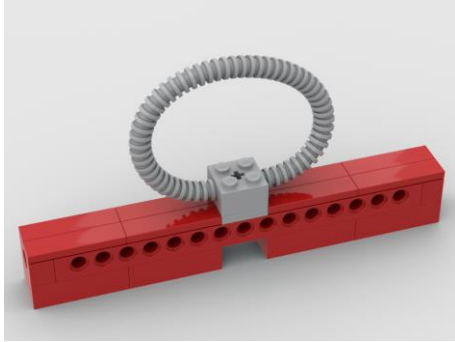
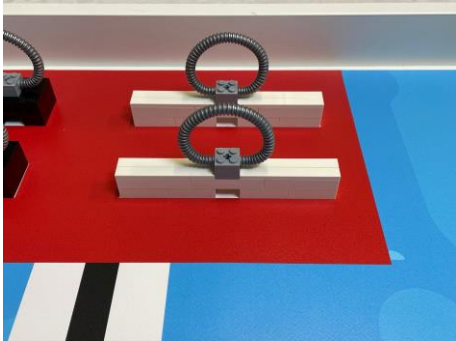

If the table is larger than the game mat, place the two sides of the start area against the walls. **For more information about the table and game mat specifications, please take a look at PRO RoboMission General Rules, chapter 6.**

### 3. Game Objects, Positioning, Randomization

#### Submarine Cables (2x white, 1x red)

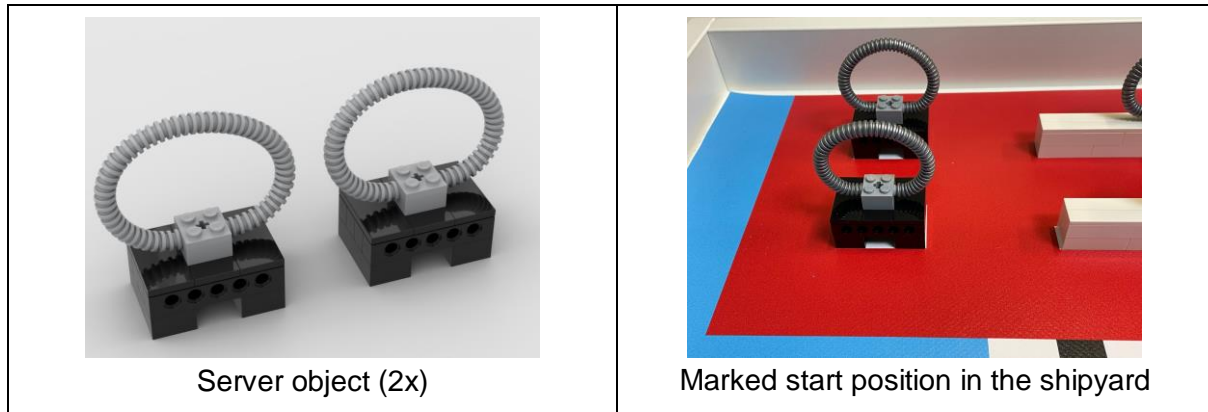
In every round there are three submarine cables on the game field:

- Two white submarine cables are placed on the two positions in the shipyard.
- The red 'broken' submarine cable is randomly placed on any of the four connection slots in the Caribbean hub

 <p>White cable (2x)</p>	 <p>Red Cable (1x)</p>
 <p>Start position in the two marked areas in the shipyard</p>	 <p>One possible start position in one of the four connection slots in the Caribbean hub</p>

### **Server objects (2x)**

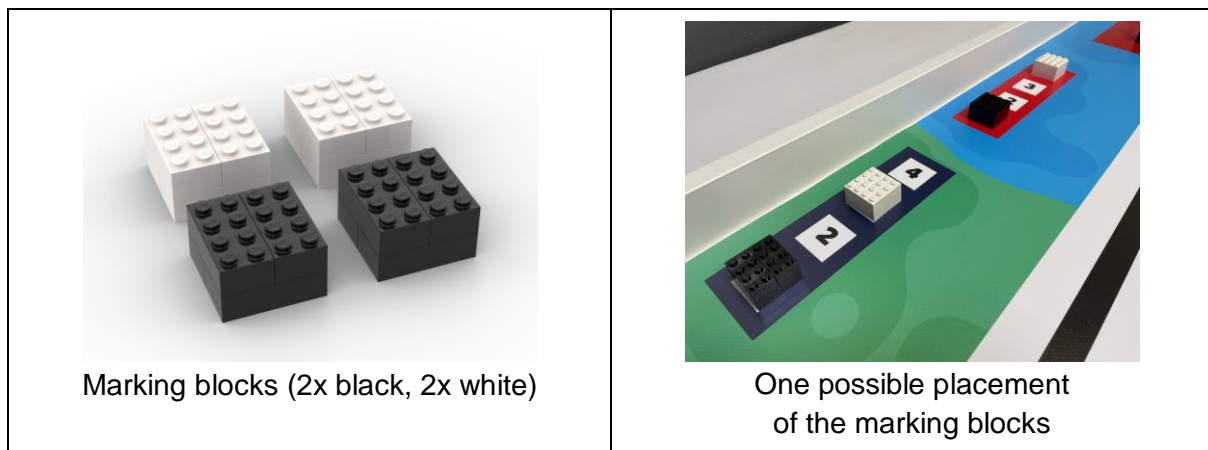
There are two black objects that represent materials that are needed to setup an underwater server farm. At the beginning, these objects are placed on the two positions in the shipyard.



### **Marking blocks (2x white, 2x black)**

The marking blocks are placed in the ship information centre. They are used to determine the placement where the robot should bring the server objects (black marking blocks) and submarine cables (white marking blocks).. One white and one black marking block are randomly placed on the little areas marked 1.- 4. on the Pacific side.

The other white and black marking block are randomly placed on the little areas marked 1.- 4. on the Caribbean side.

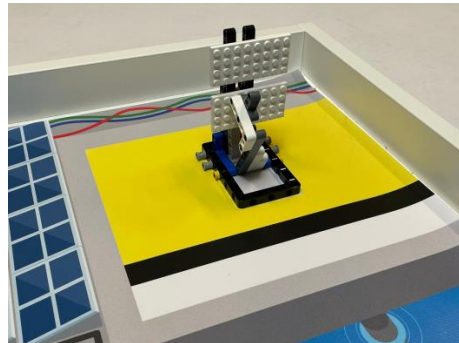


### **Solar panels (2x)**

There are two game objects that represent solar panels for an offshore solar farm. These objects need to be fixed on the game field (see General Rules, chapter 6) and are placed in the yellow offshore solar farm areas (one in each)



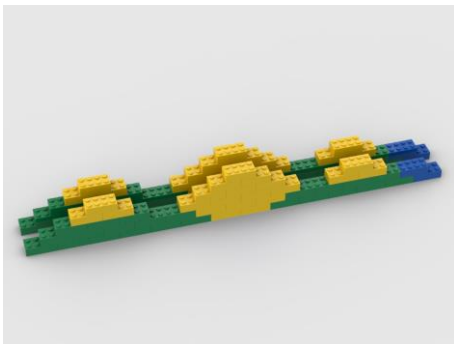
Solar panels (2x)



Placement of the solar panels in the offshore solar farm areas.

### **Barriers (2x)**

There are two barriers on the field that divide the field into the Caribbean and Pacific area, both barriers are not allowed to be moved or damaged.



Barriers (2x)



Placement of the barriers at the beginning of each round, they are placed with the blue part looking towards the centre of the field.



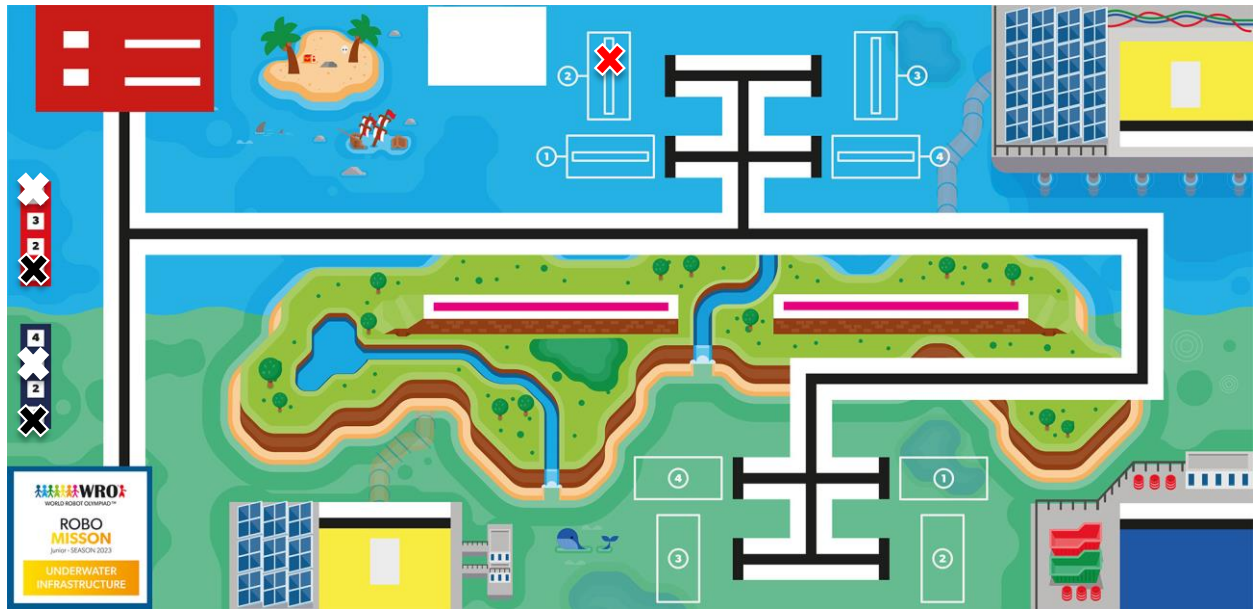
### Summary randomization

On this field, the following objects are **randomly placed in each round**:

- One white and one black marking block on the 1-4 area on the Pacific side.
- One white and one black marking block on the 1-4 area on the Caribbean side.
- Red 'broken' cable on one of the 4 connection slots in the Caribbean hub

One possible randomization you can see here:

- White marking block Pacific No. 3, Black marking block Pacific No. 1
- White marking block Caribbean No. 4, Black marking block Caribbean No. 1
- Red 'broken' cable on connection slot No. 2 on the Caribbean side





## 4. Robot Missions

For greater clarity, the missions will be explained in multiple sections. The team can decide which parts of the missions they will do and in which order. Final scoring will be based on the situation on the field at the end of the run.

### 4.1 Underwater deployment

The robot should help to install underwater infrastructure for the world-wide internet data network. For that, the robot should transport the submarine cables and server objects from the shipyard to the connection slots.

The connection slots are determined by the marking blocks in the ship information centres for the Caribbean and Pacific side, for example: a white marking block on Pacific no. 1 **and a black marking block is placed on Pacific no. 3** means that a submarine cable should be placed in the connection slot no. 1 **and the server object on connection slot no. 3**.

Full points are awarded if an object is completely inside one connection slot. Extra points are awarded if both objects on one side (Caribbean or Pacific) are installed.

### 4.2 Find broken cable

The existing submarine infrastructure must be maintained, and an underwater robot vessel should help identifying broken and old elements (the red object). In this case, the robot should find the red object and bring it to the repair facility that is above the water. There it can be repaired or recycled.

Full points are awarded if the broken element is completely inside the repair facility (blue area).

### 4.3 Activate offshore solar farm

IT infrastructure, if underwater or on land, requires a lot of energy. And worldwide we use more and more digital tools and IT infrastructure. Therefore, it is important to have a sustainable approach when it comes to energy usage. Offshore solar farms can help with this.

The robot should help to setup offshore solar farms and activate the first solar panels of this farm. Full points are awarded if the level of the model is pulled and the solar panels are standing upright.

### 4.4 Bonus points

Bonus points will be awarded for not moving or damaging the barriers on the field.

### 4.5 Park the robot

The mission is complete when the robot returns to the Start & Finish area, stops, and the projection of the robot is **partly (top-view) within the Start & Finish area**.





## 5. Scoring

### Definitions for the scoring

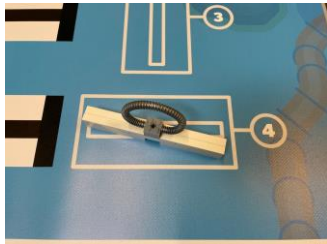
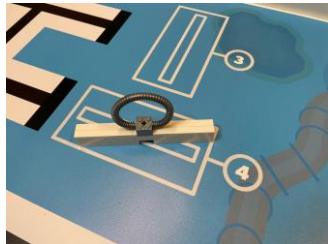
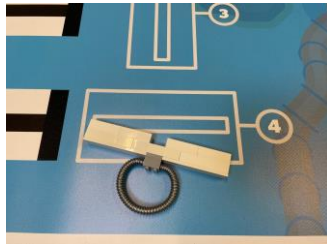
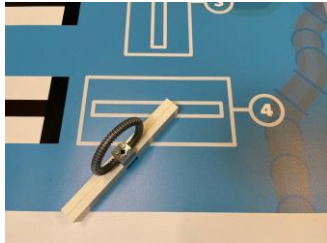
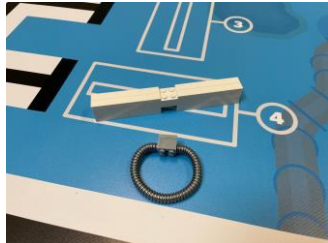
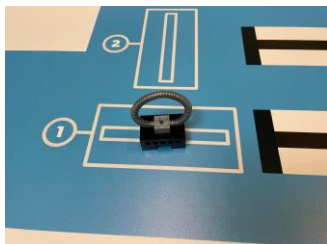
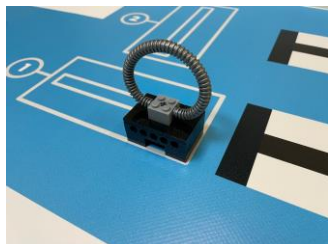
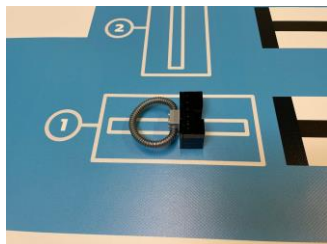

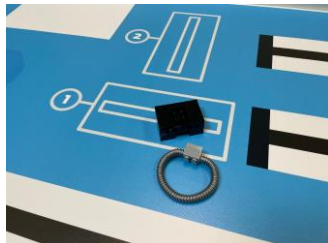
“**Completely**” means that the game object is only touching the corresponding area (not including the black lines).

Please note that there is a new rule about damaged game objects in the RoboMission General Rules (Rule 6.8).

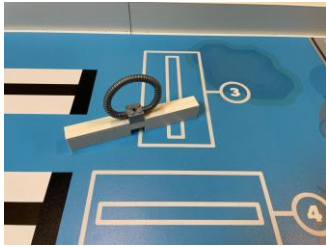
Tasks	Each	Max.
<b>Underwater deployment</b>		
Submarine cable is <u>completely</u> inside the correct connection slot	12	24
Submarine cable is <u>touching</u> the correct connection slot	7	
Server object is <u>completely</u> inside the correct connection slot	12	24
Server object is <u>touching</u> the correct connection slot	7	
Server object or Submarine cable is <u>touching or inside wrong the</u> connection slot (max. one object per connection slot)	4	
Additional: Both the submarine cable and the server object of the Caribbean and/or Pacific side are completely inside the correct slot	6	12
<b>Find broken cable</b>		
Broken cable <u>completely</u> inside the repair facility		13
Broken cable <u>touching</u> the repair facility		9
<b>Activate offshore solar farm</b>		
Solar panel of solar farm is activated	11	22
<b>Get bonus points</b>		
Island barrier is not moved or damaged	6	12
<b>Park the robot</b>		
Projection of the robot is partly in the Start & Finish Area <i>(only if other points, not bonus, are assigned)</i>		13
<b>Maximum Score</b>		<b>120</b>

## Scoring Interpretation

**Please note:** The scoring interpretation for the cables and server objects follow the randomization of marking blocks from page 7 as an example!

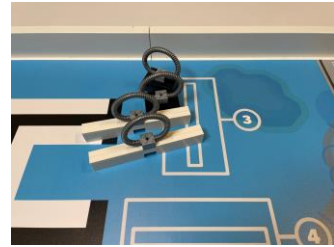
Submarine cable is <u>completely</u> inside correct connection slot → 12 points Submarine cable is <u>touching</u> correct connection slot → 7 points		
		
12 points (completely inside)	12 points (completely inside, white line counts as inside)	7 points (only touching)
		
7 points (only touching)	0 points (object damaged)	
Server object is <u>completely</u> inside correct connection slot. → 12 points Server object is <u>touching</u> correct connection slot → 7 points		
		
12 points (completely inside)	12 points (completely inside)	12 points (completely inside)
		
7 points (only touching)	0 points (object damaged)	

Server object or Submarine cable is touching or inside wrong connection slot → 4 points.



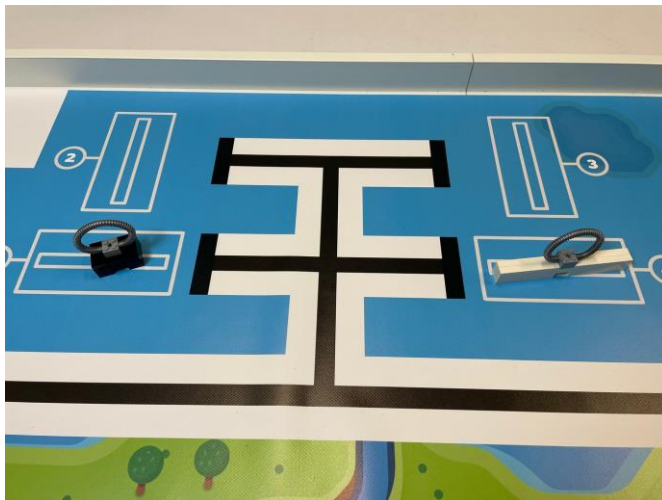
4 points

*Note: This example follows the randomization on page 7 where the cable should be brought in connection slot no. 4. That means that a placement in connection slot no. 3 needs to be considered as a wrong slot.*



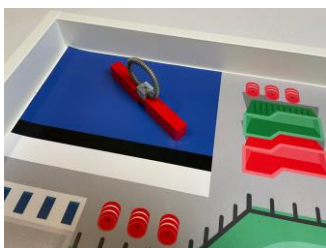
No, no, no 😊 only one object per connection slot counts, 4 points.

Additional: Both the submarine cable and the server object of the Caribbean and/or Pacific side are completely inside the correct slot. → 6 points.

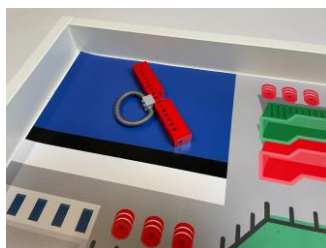


*Note: This example follows the randomization on page 7 where the cable should be brought in connection slot no. 4 and the server object in connection slot no. 1.*

Broken cable completely inside the repair facility → 13 points.  
 Broken cable touching the repair facility → 9 points.  
*Please note: The repair facility is considered to be the blue area only.*





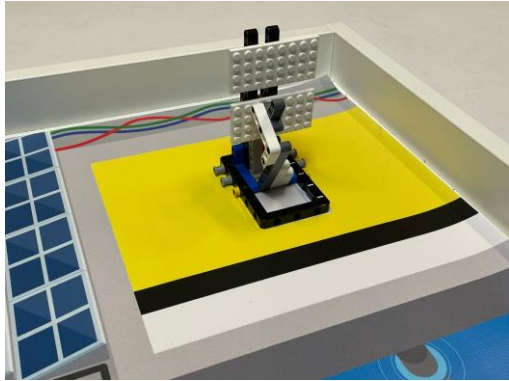
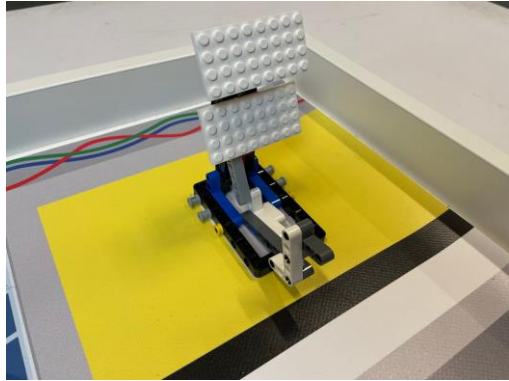



13 points (completely inside)



13 points (completely inside)



9 points (touching)

		
<p>9 points (touching)</p>	<p>0 points (object damaged)</p>	
<p>Solar panel of solar farm is activated. → 11 points.</p>		
		
<p>Start position (not activated)</p>	<p>11 points (activated, the lever of the model is pulled)</p>	
<p>Island barrier is not moved or damaged. → 6 points.</p>		
<p><i>Please note: The barrier is considered to be moved if it is moved outside of the white area, it is considered as damaged if even just one brick has come loose.</i></p>		
		
<p>6 points, OK, still in white area.</p>	<p>0 points, not OK, moved outside white area.</p>	<p>0 points, not OK, damaged.</p>

Projection of the robot is partly in the Start & Finish Area  
(only if other points, not bonus, are assigned) → 13 points

*Please note: The blue line surrounding the area does not belong to the area, the project has to be over the white inner area. Cables only do not count for the projection of the robot.*



The projection of the robot is not in the area, 0 points.



The projection of the robot is partly in the area, 15 points.



The projection of the robot is completely in the area, 15 points.





# Scoring Sheet

Team name: \_\_\_\_\_

Round: \_\_\_\_\_

Tasks	Each	Max.	#	Total
<b>Underwater deployment</b>				
Submarine cable is <u>completely</u> inside the correct connection slot	12	24		
Submarine cable is <u>touching</u> the correct connection slot	7			
Server object is <u>completely</u> inside the correct connection slot	12	24		
Server object is <u>touching the</u> correct connection slot	7			
Server object or Submarine cable is <u>touching or inside the wrong</u> connection slot (max. one object per connection slot)	4			
Additional: Both the submarine cable and the server object of the Caribbean and/or Pacific side are completely inside the correct slot	6	12		
<b>Find broken cable</b>				
Broken cable <u>completely</u> inside the repair facility		13		
Broken cable <u>touching</u> the repair facility		9		
<b>Activate offshore solar farm</b>				
Solar panel of solar farm is activated	11	22		
<b>Get bonus points</b>				
Island barrier is not moved or damaged	6	12		
<b>Park the robot</b>				
Projection of the robot is partly in the Start & Finish Area <i>(only if other points, not bonus, are assigned)</i>		13		
<b>Maximum Score</b>		<b>120</b>		
<b>Surprise Rule</b>				
<b>Total Score in this run</b>				
<b>Time in full seconds</b>				





## 6. Local, regional, and international events

WRO competitions take place in around 90 countries, and we know that teams in each country expect a different level of complexity. The challenge as described in this document will be used for international WRO events. This is the last stage of the competition, where the teams with the best solutions participate. That is why the game rules are challenging.

PRO feels that all participants need to be able to have a good experience in the competition. Teams with less experience should also be able to score points and succeed. This builds confidence in their ability to master technical skills, which is important for their future choices in education.

We deliberately have a mix of simple and more difficult tasks in the game rules. This means that all teams will be able to solve parts of the challenge and can keep trying to improve their work.

**PRO Association recommend that our National Organizers consider the situation in their country. They can adapt the rules for events in their country even further. They can decide to make the challenges easier for local, regional, and national events, so that all participants have a positive experience.**

**All National Organizers can make their own choices, so each competition fits their specific situation and ideas. Here we provide some ideas to make the challenges easier.**

### Ideas for simplifications:

- Have the randomization only for one part (Pacific or Caribbean).
- Have no randomization and place the marking blocks always in the same position in the ship information centres.
- Have a fixed position for the red cable in one of the connection slots.
- Take out one or both barriers (in this case adjust the scoring for bonus points)