RULES OF SEK Category – 2022

Version 1.0 – April, 2022

1 Introduction

In a rough terrain land in the city of Big River there is a gas pipeline submerged in a toxic water channel. However, parts of the pipeline have been damaged due to a strong earthquake. Because of Big River's lands and waters are diffcult to access, this scenario has become perfect for testing new autonomous robots capable of solving this problem.

As many robots showed up, the pipeline company has run a competition to see which robots would be best suited for this purpose.

2 General objective

Participants should construct **up to** two robots capable of identifying the parts of the missing gas pipeline and collect the pipes that will be available on the surface to repair them.

3 The Robots

Teams that only have one robot, it should be hybrid, i.e. it will act both on the surface and submerged. Thus, the robot can move through all areas of the arena allowed to the team.

Teams that have two robots, the robots should act collaboratively, being one robot for the surface and the other one for the water only. The **only** area both robots can attend is the meeting area. Thus, the robot acting on the surface **can not enter** the green area, even if it frequents the **pipe collection areas** and **white areas**. In the meantime, the robot for water **may not cross the black line**, only going to the white area, the green ramp and the water. The entrance to the pipe collection areas is prohibited for the robot for water.

Communication is allowed only between the two robots from the same team and during the match. This communication can be via Bluetooth, Wi-Fi, or otherwise depending on the Robotic Kits used.

The maximum permissible size of the robots is a cube with 27cm X 27cm X 27cm with them fully developed. They do not have a maximum number of parts, sensors or controllers for their robots. However, it is noteworthy that they can only have pieces of a single robotic kit.

For example, if the chosen kit is the LEGO® Kit, no part or accessory from any other manufacturer (Vex®, pETe® or FischerTechnik®) may be used.

Robots must be fully autonomous, and no external interference is allowed unless authorized by the referee.

4 The Pipes

The pipes are built with standard PVC pipes with diameter of 50mm (approximately 2 inches) and with three different lengths. They are arranged randomly on the surface.

They will have two supports of 3cm high each, at their ends, as shown in Figure 1. These supports are made of plastic (made with a 3D printer in PLA or ABS) and will be glued to the tubes permanently, forming a single piece. The complete description of the supports is in the FAC of the category.

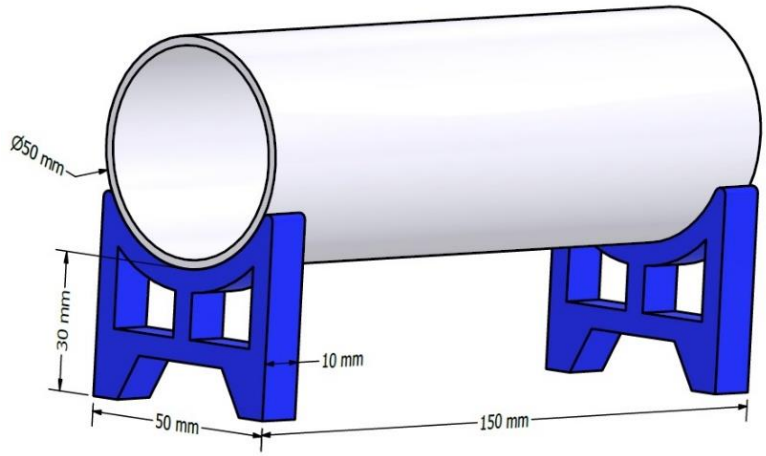

Figure 1 - Illustration of an example of a 15cm long tube. Tube and support colors are irrelevant. The two supports must be 3cm from the end of the tube in relation to the floor and glued.

The colors of the pipes are irrelevant, that is, they can be of any color. Marks on the inside of the tubes may be placed to facilitate their identication. In the Figures here in this document, the pipe colors are merely illustrative. The **important** is the color of the surface where the pipe originally is, which defines the size of the pipe.

Each tube is placed on a base that identifies its length: the yellow base will have 10cm long tubes, the red base will have 15cm tubes and the blue base will have 20cm tubes. In Figure 2, we can see an illustration of the tube collection areas with a tube of the corresponding size in each.

The maximum limit will be five tubes of each length, totaling up to 15 tubes arranged in the arena per round.

It is worth pointing out that the pipe collection areas may be in different and random positions each match. However, the relationship between the color of the base and the length of the tube it contains is fixed. Regarding the placement of tubes in the collection area, there is no defined rule. Tubes can be placed completely at random.

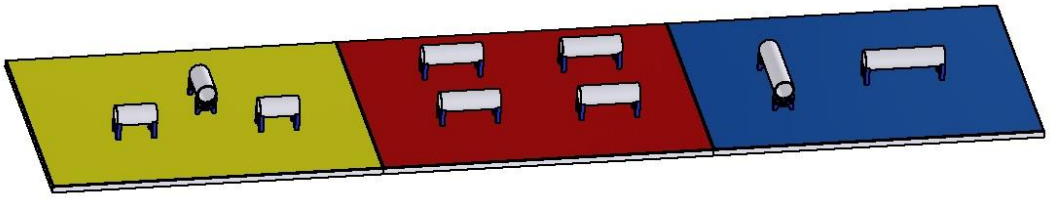

Figure 2 - Tube Collection Area - Colored bases identify the dimensions of the tubes, where the tubes are randomly arranged.

5 The Arena

ATTENTION! The arena dimensions have been updated from those used in 2019 and 2021.

The arena consists of four main parts: pipe collection area (blue, red and yellow), interaction surface (white), water access ramp (green) and water (blue). The gas pipeline (Section 5.1) will necessarily be "**inside the water**".

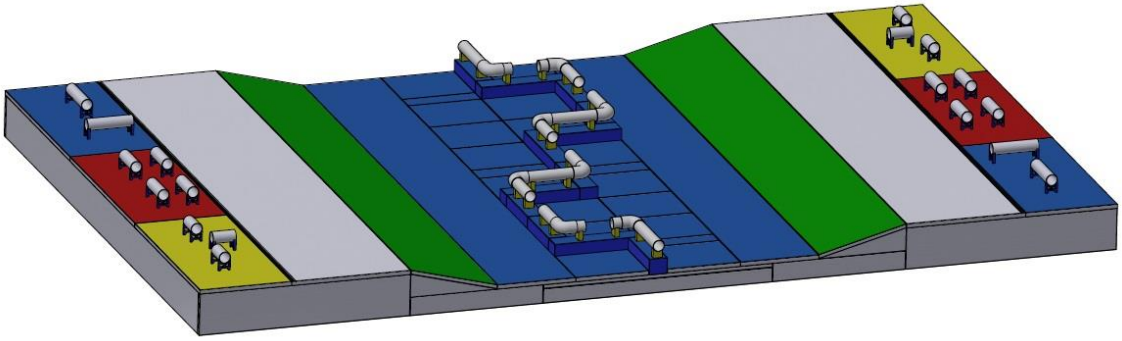

Figure 3 - Isometric view of an example arena. The position and quantity of pipes, in addition to the pipeline layout, are merely illustrative. Its composition is detailed below.

The surface will have an elevation of 10cm in relation to the water will have an elevation of 10cm in relation to the ground. The access of the water to the surface is through a ramp with slope of approximately 15° identified in green color.

The surface will also have an area bounded by a line made of black tape approximately 19mm wide, leaving an area of 1.25m^2 in white, which will serve as a meeting point between the two robots, being the proper place to have the interaction, as shown in Figure 5.

The dimensions of the arena are shown in Figures 4 and 5, and an isometric perspective of the arena is shown in Figure 3.

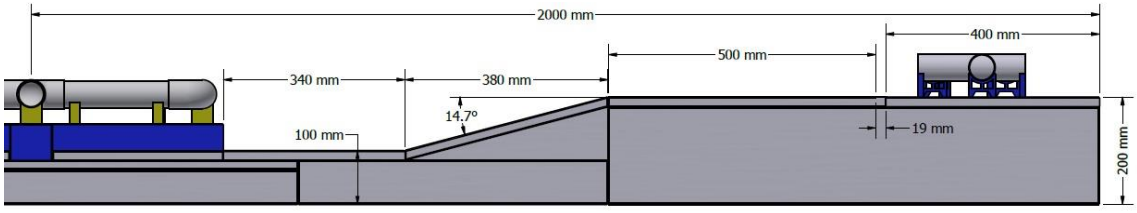

Figure 4 - Front view of half of the arena with its dimensions.

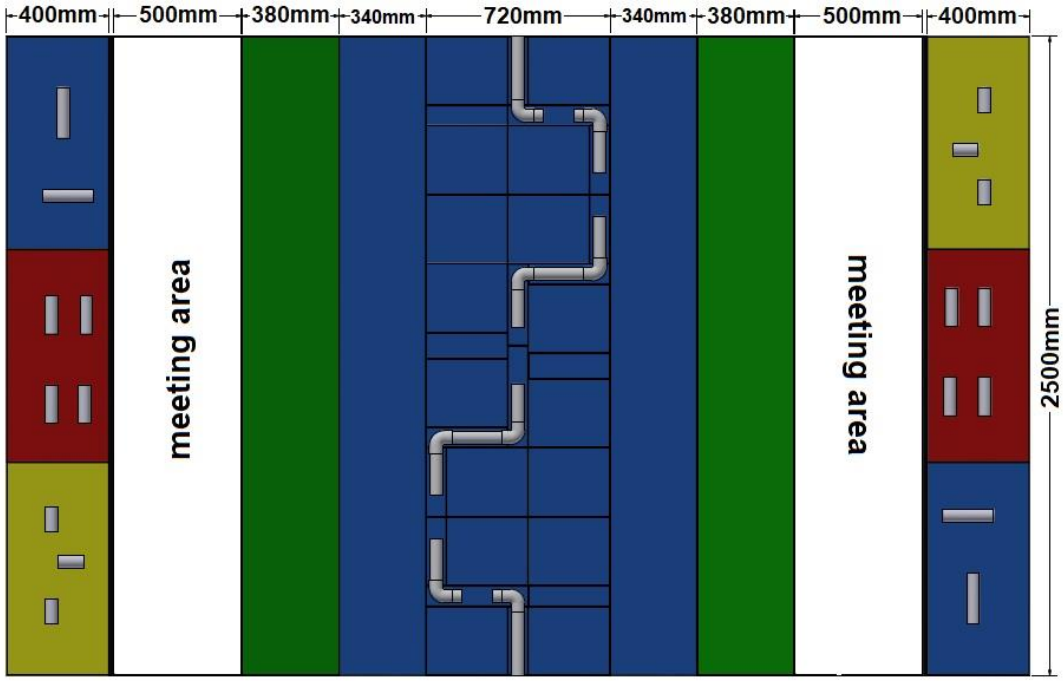

Figure 5 - Top view of an example arena with its dimensions. The pipeline is for illustrative purposes only and its layout is detailed in the next section.

5.1 The Pipeline

The pipeline shall be represented on top of a platform with an elevation of 5cm from the base of the water. The pipes are assembled as described in Section 4. It is worth mentioning that the configuration of the pipeline is random, following the possibilities of the modular blocks defined in Section 5.2. When the robots are competing, a robot can not invade the area of action of the opposing team.

The pipeline is shared by both teams who must not remove or change the pipes in their initial configuration. It is allowed only to add pipes to the pipeline. An example of a pipeline is shown in Figure 3.

The GAPs (spaces between the fixed tubes that symbolize the defects in the gas pipeline) will have as dimensions the values stipulated by the three standard tubes (10, 15 and 20 cm) plus one centimeter on both sides. Thus, the defects in the pipeline referring to the 10cm tubes will have a spacing of exactly 12cm. For the 15cm tube, a spacing of 17cm and for the 20cm tube, a spacing of 22cm. It is not allowed to place two consecutive GAPs in the pipeline.

5.2 Arena Assembly

The entire arena will be assembled with parts made of MDF/MDP, separated into 5 large blocks: a modular block that represents the water and the base of the

pipeline, two blocks for the surface access ramps and the other two blocks for the surfaces.

The blocks are covered with colored adhesive paper in the colors indicated in Figure 5.

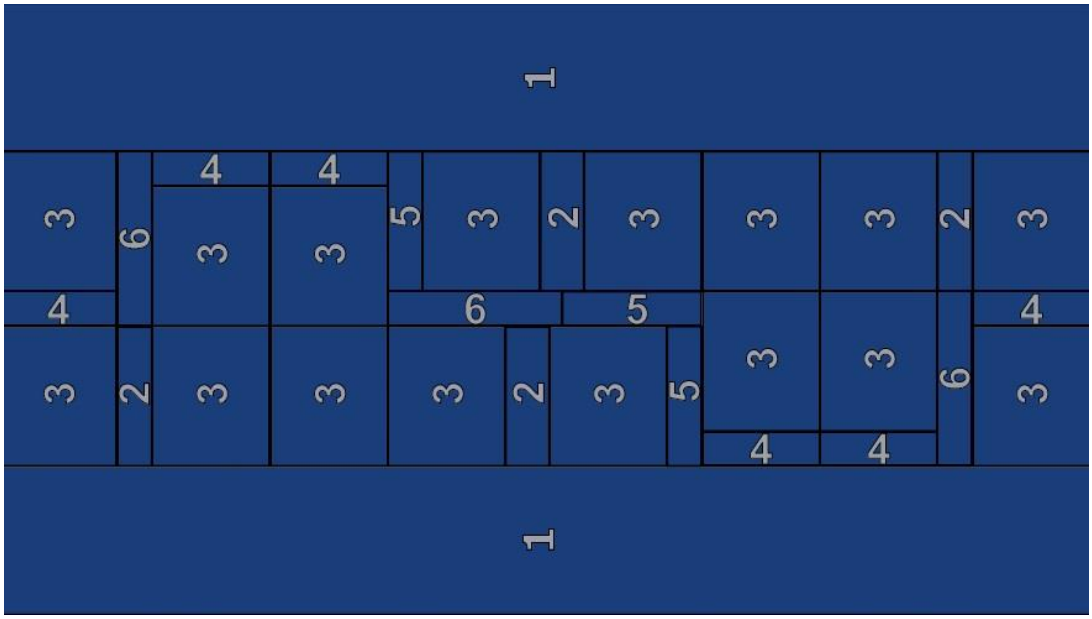

Figure 6 - Example of the assembly of the modular block where the water and the base of the gas pipeline will be. Pieces numbered 1, 2 and 3 have a height of 10cm and pieces numbered 4, 5 and 6 have a height of 15cm.

The water block is 1,4m X 2,5m, as described in the Figures 4 and 5. MDF/MDP pieces compose this part of the arena with heights of 0,1m for the robot displacement in the water and 0,15m in which the pipeline will be on. Figure 4 helps to illustrate it. Six different types of MDF/MDP pieces are required to build this part of the arena and they are shown in Figures 6 and 7.

The types are:

- **Block 1** – 2 pieces with blue top of 0,34m X 2,5m, height of 0,1m responsible for the sides;
- **Block 2** - 8 pieces with blue top of 0,08m X 0,32m, height of 0,1m responsible for the composition of the moving area near the pipelines;
- **Block 3** - 16 pieces with blue top of 0,27m X 0,32m, height of 0,1m responsible for the composition of the moving area near the pipelines;
- **Block 4** - 8 completely blue pieces of 0,08m X 0,27m, with a height of 0,15m, responsible for the composition of the pipeline support;
- **Block 5** - 4 completely blue pieces of 0,08m X 0,32m, with a height of 0,15m, responsible for the composition of the pipeline support;

- **Block 6** - 4 completely blue pieces of 0,08m X 0,40m, with a height of 0,15m, responsible for the composition of the pipeline support.

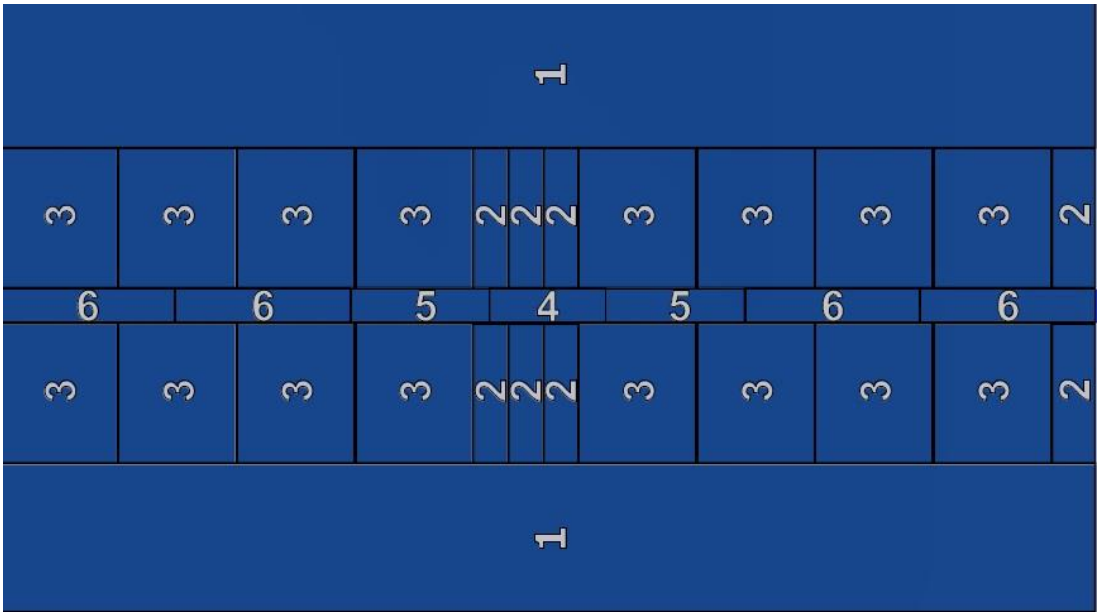

Figure 7 - Another example of assembling the modular block where the water and the base of the gas pipeline will be.

The pipeline support parts will have pipes over them (pipeline), with missing pipes to be filled by the teams.

6 The Matches

Each team competes on one side of the pipeline, aiming to relocate as many pipes as possible with the correct dimensions, into the possible free spaces. The team with the highest score (scores available in the Section 7) will be declared the winner.

Each match will have a referee that will determine the teams scores, arrange the arena colors and the management of the pieces and colors in the dispute.

All robots start in a random position on the meeting area, placed by the referee, always aiming for symmetry between the teams.

The layout of the pipeline shall be defined by the referee before the start of each round. Furthermore, the referee defines the number and position of missing pipes to be replaced.

The quantity of tubes and position of each tube in the collection area will also be determined by the referee before the start of each round.

During the match, if the robot accidentally moves or knocks the pipes off the pipeline, the team may request the referee for repositioning the pipes. However, this operation presents a penalty described in the score (scores available in Section 7).

Every time a team has problems with the robot(s) and needs to touch it(them), reposition it(them), restart the program, reassemble some loose piece or if the robot(s) just had a bug, it will be considered a restart.

When one of the teams has successfully placed the last tube in the correct GAP, the match will automatically be considered over.

The referee will be allowed to place pipes in the pipeline shortly after the start of the match, filling in the spaces symmetrically and with pipes of the correct dimensions.

The referee will be allowed to fill in ALL spaces in the pipeline, either before or after the start of the match. If this happens, the team that makes the complete scan and finds that the gas pipeline is not defective, will have to demonstrate to the referee (through an audible or light signal, or some atypical movement of the actuators) that the challenge is complete and thus winning the match.

Whenever a round of matches is started, all robots must be within reach of the referee. Moreover, no team can make any changes to any of the robots.

The maximum time of each match is 12 minutes. In the event of a tie, the following tiebreaker criteria will define the winning team in order of importance:

1°- Number of 20cm pipes successfully placed in the pipeline;

2°- Number of 15cm pipes successfully placed in the pipeline;

3°- Number of 10cm pipes successfully placed in the pipeline;

4°- Least number of restarts;

5°- Least number of lost pipes (see Section 8);

6°- Fewest pipes knocked off the top of the pipeline;

7°- Lowest number of inactivity penalties;

8°- Coin flipping.

6.1 End of a Match

There are four ways to determine the end of a match:

- **Time-out**: the time of 12 minutes ends. Thus, the team with the highest score at the end of time will be the winner.
- **Give-up:** one of the teams gives up the game. Thus, the opposing team is immediately the winner.
- **Undamaged pipeline**: when the team signals to the referee that the gas pipeline is not defective. Then, the team will be declared the winner.
- **Accomplished task:** when the pipeline is completely repaired. Therefore, the team with the highest score at the end of the match is the winner.

7 The Scores

- Each 20cm pipe successfully placed in the pipeline: 250 points.
- Each 15cm pipe successfully placed in the pipeline: 210 points.
- Each 10cm pipe successfully placed in the pipeline: 170 points.
- Each lost pipe (see Section 8): -25 points.
- Each time a robot exceeds its permitted delimited area or leaves the lane: -20 points and the robot will be relocated in the meeting area at the place established by the match referee.
- Each restart of a robot: -25 points.
- Each pipe knocked off the pipeline that had been placed by the opposing team or that was in the same since the beginning of the match: -30 points and the pipe will be repositioned by the referee.
- Each repositioning of the pipes in the pipe collection area during the match: -15 points.
- Each tube, of shorter length, placed in some larger space, will have a penalty: -30 points. The referee must remove the tube immediately so as not to harm the other team.
- For every 30 seconds with the robot inactive: -20 points.

8 Important Comments

- A pipe is considered delivered successfully when it is static in the horizontal position on the support of the pipeline.
  If a team "A", during the match, moves or knocks over a pipe correctly positioned by team "B", the score achieved by team "B" will not be affected, only team "A" will be penalized.
- A pipe is considered lost when one of the robots removes it from its initial location (pipe collection area) and this pipe is misplaced in any other place but the pipeline support.

- A robot is considered inactive when stopped or making any other movement that is not related with pipeline inspection, pipe collection, pipeline repair, or robot interaction with the same team (case of two robots).
- A pipe can be passed from one robot to another in the meeting area and the ground robot is allowed to discharge the pipe onto the ground for the other robot to pick up. If this pipe remains in the ground in the end of the match, this fact is a penalty.
- If any robot clearly demonstrates that it is not trying to perform any of the challenges (in order not to score negative), it will be considered an inactive robot.

9 Requirements to Participate

Those interested in participating in the Latin American Robotics Competition LARC IEEE SEK category must form teams of undergraduate students in any educational institution in any country. Nevertheless, high school students will also be allowed to participate. To register, teams must submit a document describing the development and operation of the robot (TDP) in IEEE format. This TDP will be used for the winners to make a brief report to the other competitors. Please, verify the deadlines on the event website.

10 The Jury

The JURY is composed by a member of organizing chairs, an auxiliary of the organization and a member of other team that is not competing in the match, chosen before the match starts.

11 Extraordinary Situations During the Competition

If there is any situation not covered under the above mentioned rules, or any doubt about the score, it will be up to the judges and the organizers of the competition to consider the case in the greatest possible impartiality and make a decision. It is important to mention that any fact that it is not explicit in the rules cannot be automatically considered as allowable in the competition. Missing facts will always be treated as an **extraordinary situation** and they must be judged as allowable or not by the judges and organization.