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# RoboCup Standard Platform League (Nao) Rule Book

RoboCup Technical Committee

(2008 rules, as of August 13, 2008)

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# 1 Setup of the Environment

## 1.1 Field Construction

The dimensions of the soccer field are shown in Figure 1. The construction of the goals is depicted in Figure 2.

## 1.2 Lines

All robot-visible lines on the soccer field (side lines, end lines, halfway line, centre circle, corner arcs and the lines surrounding the penalty areas) are 50 mm in width. The circle on the midfield line has a diameter of 1300 mm from the middle of the white stripe on one side to the middle of the white stripe on the other side. The throw-in lines and corner kick points are not robot visible. The throw-in lines will be marked on the field using a thin black or dotted line, while the corner kick points will be marked using black dots. As seen in Figure 1, the corner kick points (*shown in black dots only for visualization*) are closer to the penalty area than the ends of the throw-in lines.

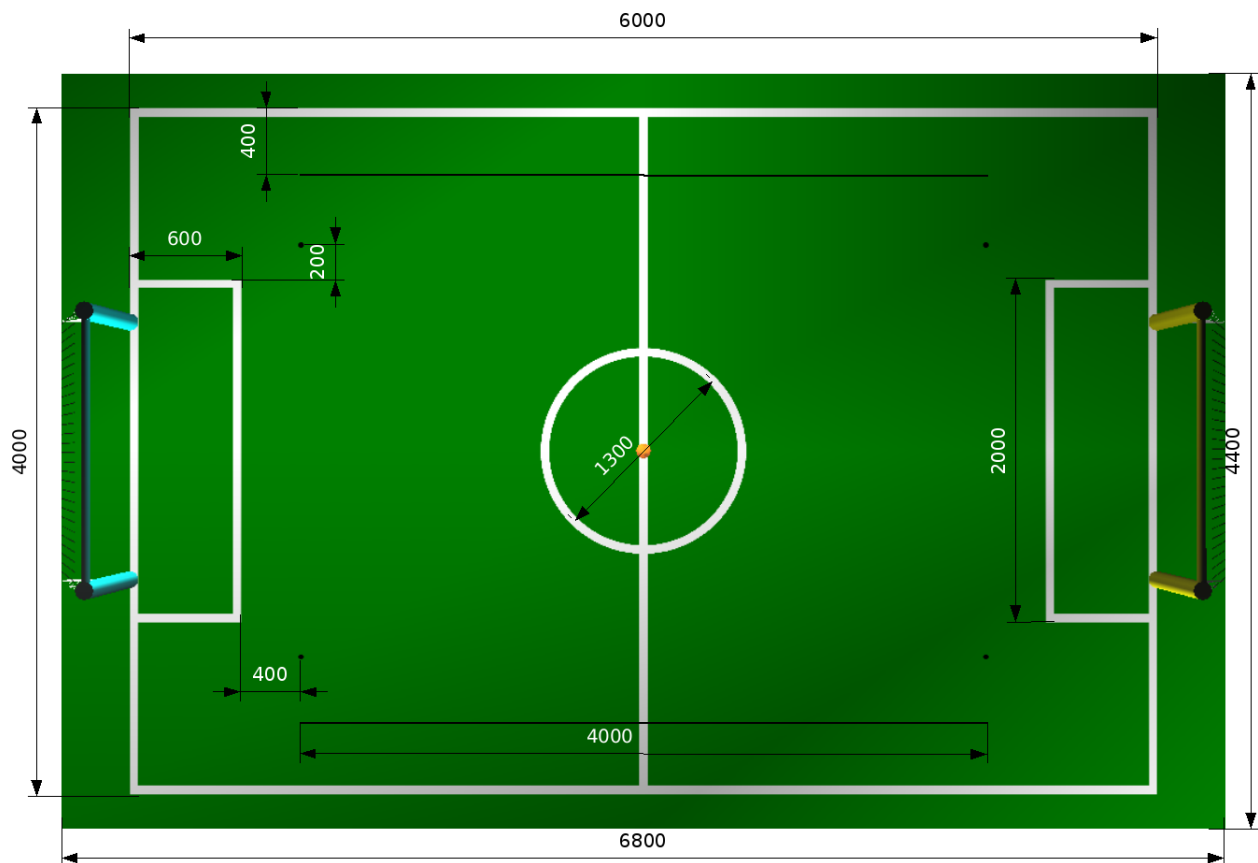


Figure 1: Scale diagram of entire field (dimensions in mm).

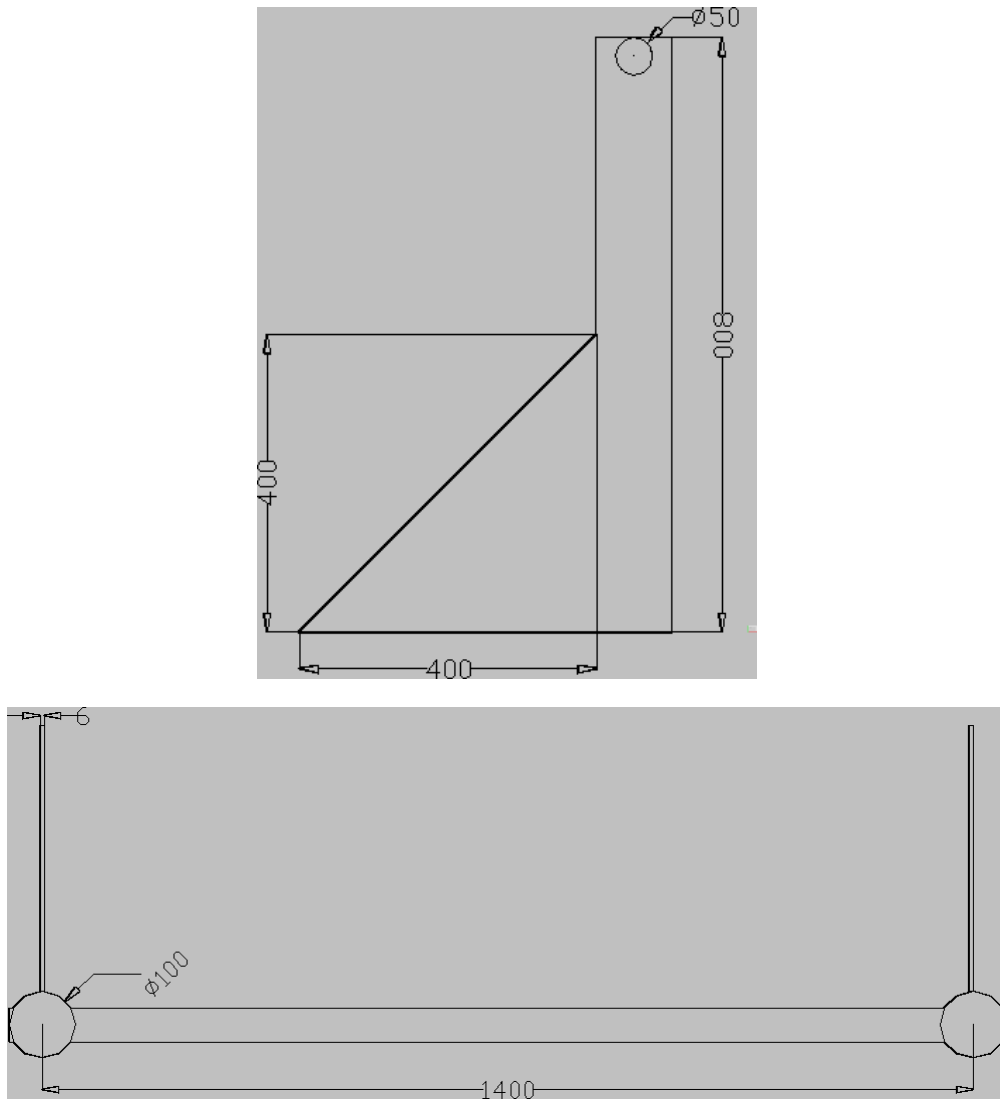


Figure 2: Dimensions of the goal, viewed from above and from the side

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### 1.3 Field Colors

The colors of the soccer field are shown in Figure 4. All items on the RoboCup field are color-coded:

- The field (carpet) itself is green.
- The lines on the field are white.
- The red team defends the yellow goal.
- The blue team defends the sky-blue goal.
- Goals (cf. Figure 3). The posts and top cross bar are either yellow or sky-blue. The support triangles on back of the posts and the net are white.

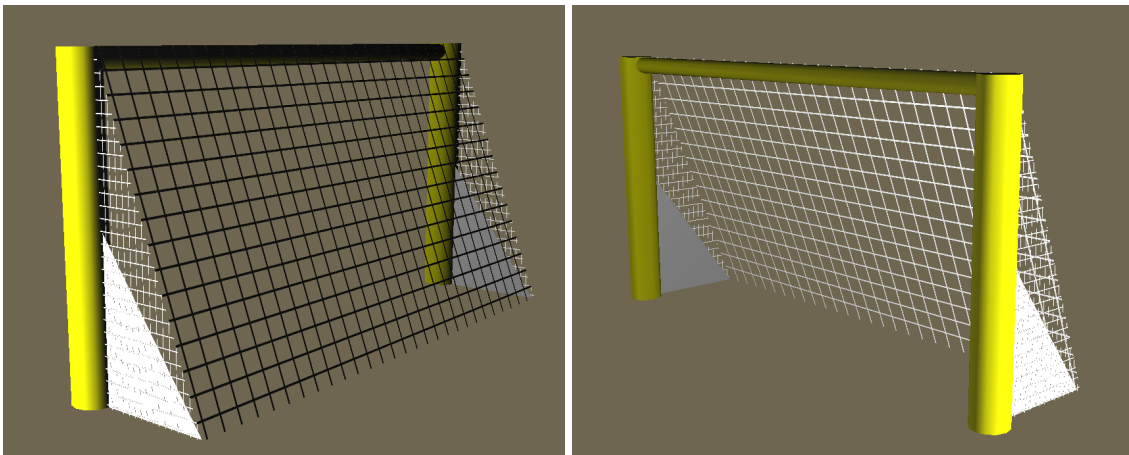


Figure 3: Appearance of the yellow goal. Notice that the support triangles are white

### 1.4 Lighting Conditions

The lighting conditions depend on the actual competition site. Lighting temperature may differ significantly from previous years, as only ceiling lights may be used. The lighting will be approximately 1000 lux, i. e. it will be similar to that used in previous years.

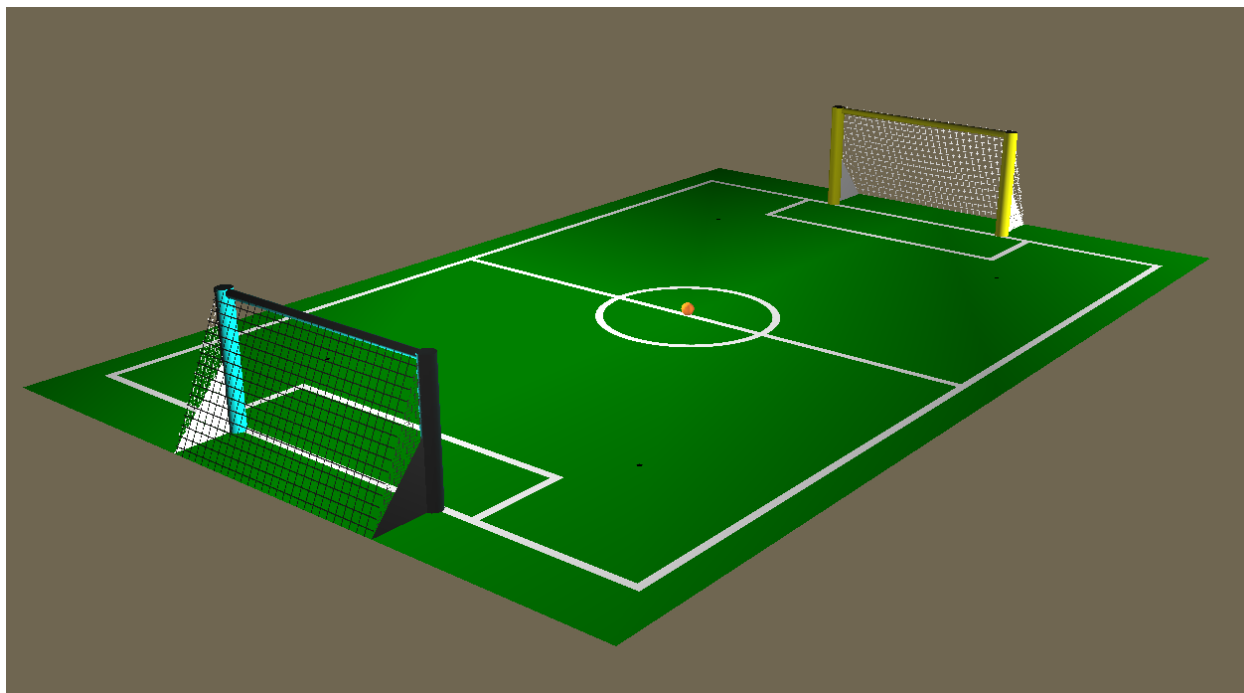


Figure 4: Field colors and layout.

## 2 Robot Players

### 2.1 Hardware

All teams must use Nao humanoid robot manufactured by Aldebaran Robotics. Absolutely no modifications or additions to the robot hardware are allowed. No additional hardware is permitted including off-board sensing or processing systems. Additional sensors besides those originally installed on the robots are likewise not allowed. The only exceptions are:

- Attaching the official red or blue plastic team markers to the robots.
- Attaching the jersey numbers provided by the league to the robots.
- Adding black and white sponsor or team logos to the upper legs of the robots. These logos must be at least 50% white by area.
- Setting the passive wrist joints to a fixed position either with glue or a transparent duct tape.

A computer will be provided by the event organizers for the purpose of sending GameController messages to the robots.

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## 2.2 Teams

*Each team consists of no more than 2<sup>1</sup> robots including the goal keeper. For 2008 only, the closest player to the goal area was permitted to play as a goal keeper.*

## 2.3 Goal Keeper

The goal keeper is the only player that is allowed to stay within the penalty area of its own team and to touch the ball with its arms/hands. It always has the jersey number “1”.

## 2.4 Field Players

The field players are not allowed to enter their own penalty area. The three field players robots have the jersey numbers “2” and “3”.

## 2.5 Team Markers

Red and blue colored plastic parts manufactured by Aldebaran Robotics will be used as team markers. All markers must be attached to each robot playing in a game (cf. Figure 5). Teams may play without the colored markers on the feet and on the shoulders.

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<sup>1</sup>It is expected that in 2009 we will return to 4 players per team

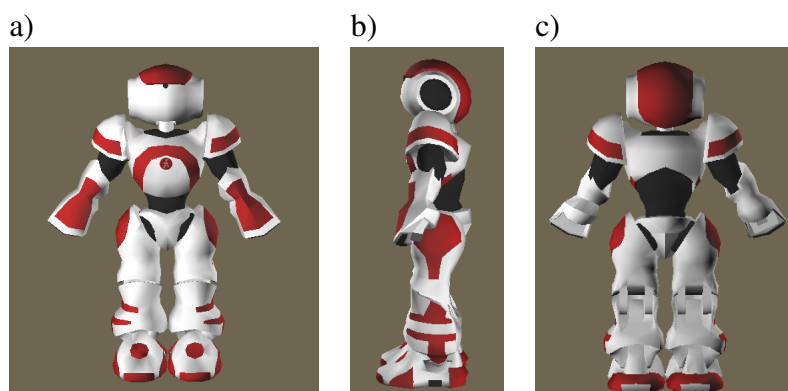


Figure 5: Nao team markers. a) Front view. b) Side view. c) Back view.

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## 2.6 Sponsorship/Team Logo Placement

Teams may add a black and white logo to the upper part of the leg (cf. Figure 6). This logo must be at least 50% white by area.

## 2.7 Communications

The robots should play without human control. Communication is only allowed among robots on the field and between the robots and the referee's controller.

### 2.7.1 Acoustic Communications

There are no restrictions on communication between the robots using a microphone or a speaker.

### 2.7.2 Wireless Communications

The only wireless hardware allowed to be used by the teams are the wireless network cards built into the Naos, and the access points provided by the event organizers. All other wireless hardware must be deactivated. A team may be disqualified if one of the team members violates this rule. The MAC-addresses of all Naos participating in the competition will be registered. Only these MAC-addresses can be reached through the access points provided by the event organizers. In addition, the access points will be secured by different SSIDs and WEP-keys. Two of the access points will be connected to PCs running GameController. A third access point is used for practise. It is connected to a hub with one port for each team. Teams must bring their own ethernet cables.



Figure 6: Example Sponsor/Team Logo placement.

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Each team will get a range of IP-addresses that can be used both for their robots and their computers. The IP-addresses, channels, SSIDs, and WEP-keys of the fields will be announced at the competition site.

Teams can use a bandwidth of up to 500 Kbps of the wireless. This includes any data transferred, namely the actual payload and any protocol overhead created, e. g., by TCP, UDP, or the GameController.

Any form of wireless robot-to-robot communication is allowed, as long as it uses the access points provided by the event organizers (using the so-called ad-hoc mode is prohibited), it does not conflict with TCP/IP or UDP, and the maximum bandwidth allowed for each team is not exceeded. Each team will be assigned a range of 256 IP-addresses that can be used for direct robot-to-robot communication. Each team will also be allocated a limited range of UDP ports on which broadcast will be permitted.

The GameController will use UDP to connect to the robots. The source distribution of the GameController provides the header file *RoboCupGameControlData.h* that defines all messages sent by the GameController to the robots. They correspond to the *robot states* described in Section 3.2.

The use of remote processing/sensing is prohibited.

## 3 Game Process

### 3.1 Structure of the Game

A game consists of three parts, i. e. the first half, a half-time break, and the second half. Each half is 10 minutes. The clock stops during stoppages of play<sup>2</sup> (such as kick-offs after goals). The extra time over ten minutes total is referred to as “lost time”. The half-time break is also ten minutes, during this time both teams may change robots, change programs, or anything else that can be done within the time allotted. In the preliminaries a game can finish in a draw as no penalty shoot-out will follow. In the finals a game that ends in a draw will be followed by a penalty shoot-out (see Section 3.8).

The teams will change the goal defended and color of the team markers during the half-time break.

### 3.2 Robot States

Robots can be in six different states (cf. Figure 7). If the wireless is available, these states will be set by the GameController. For 2008, the GameController support is optional. However, indication of the game state, team color and the kickoff state is mandatory.

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<sup>2</sup>This may not be the case during the preliminary games.



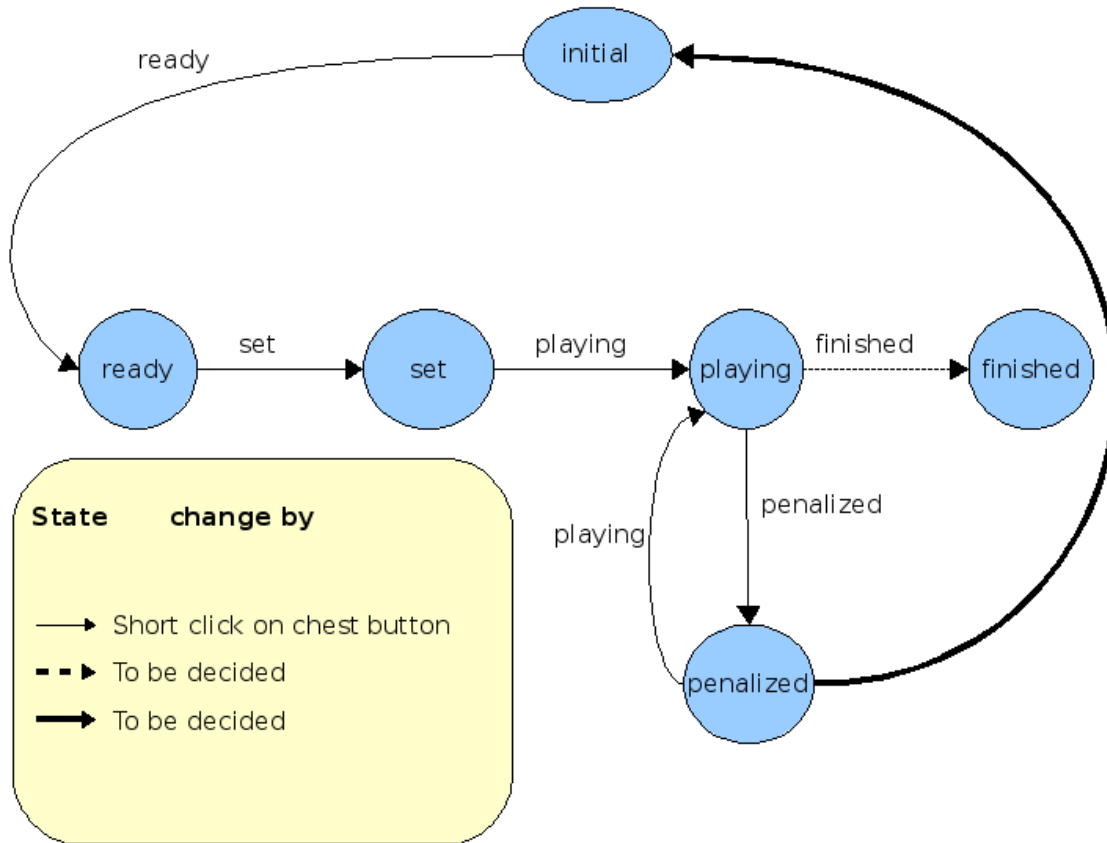


Figure 7: Robot states.

**Initial.** After booting, the robots are in their *initial* state. In this state, the button interface for manually setting the team color and whether the team has kick-off is active. The robots are not allowed moving in any fashion besides initially standing up. Pressing the left foot bump sensor will switch the team color while pressing the right foot bump sensor will switch the kickoff state. Shortly pressing the chest button will switch the robot to the *ready* state.

**Ready.** In this state, the robots walk to their legal kick-off positions (cf. Section 3.5). They remain in this state, until the head referee decides that there is no significant progress anymore (usually 45 seconds). Shortly pressing the chest button will switch the robot to the *set* state. Robots may be disentangled by the referees at the start of the Ready state. After that, any robots which are close to each other (cf. Section 4.9) will be placed manually to the positions shown in Figure 8.

**Set.** In this state, the robots stop and wait for kick-off (cf. Section 3.5). If they are not at legal positions, they will be placed manually by the assistant referees to the positions shown in Figure 8. They are allowed to move their heads and tails before the game (re)starts but are not allowed moving their legs or locomote in any fashion. Shortly pressing the chest button will switch the robot to the *playing* state.

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**Playing.** In the *playing* state, the robots are playing soccer. Shortly pressing the chest button will switch the robot to the *penalized* state.

**Penalized.** A robot is in this state when it has been penalized. It is not allowed moving in any fashion, i. e. also the head has to stop turning. Shortly pressing the chest button will switch the robot back to the *playing* state.

**Finished.** This state is reached when a half is finished.

The team color should be displayed during the whole game. The selection whether the robot's team has kick-off should be visible in the states *initial*, *ready* and *set*. Both selections should also be visualized if the wireless is working. The current state of the robot should be displayed on the LED in torso and the LEDs on left and right foot should display the team color (blue/red) and whether the team has kickoff or not (white/off), respectively. The colors corresponding to the game states are:

- Initial: Off
- Ready: Blue
- Set: Yellow
- Playing: Green
- Penalized: Red
- Finished: Off

*For 2008 only, teams were permitted to initially connect via an ethernet cable, solely for the purpose of setting the robot into a playing state. Once play has started, the robot must be set to play, and the ethernet cable removed.*

### 3.3 Goal

A goal is achieved when the entire ball (not only the center of the ball) goes over the goal-side edge of the goal line, i. e. the ball is completely inside the goal area<sup>3</sup>. The restart after the goal shall adopt the same rules as the kick-off.

### 3.4 Applying Penalties

See Section 4.2.

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<sup>3</sup>The goal line is part of the field.

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## 3.5 Kick-off

For kick-off, the robots listening to the wireless GameController run through three states: *ready*, *set*, and *playing*. Robots not listening to the GameController are simply penalized and manually placed for kick-off<sup>4</sup>.

In the ready state, the robots should walk to their legal kick-off positions. These positions are always located inside their own side of the field. Only one field player of the attacking team can walk to positions between the center line and the middle of their side. He may put his leg(s) on the center circle line, but no leg may be inside the circle line. The other field players (one of attacking team, three of the defending team) have to be located behind the middle of their side (none of their legs are allowed to be in front of the middle line), and their feet must be outside the penalty area. In contrast, the feet of the goal keeper must be *inside* the penalty area.

**If robots collide during the autonomous placement, the “Goalie Pushing” and the “Field Player Pushing” rules are applied, but the penalty is manual placement by the assistant referees.**

The robots have a maximum of 30 seconds to reach their positions. If all the robots have reached legal positions and have stopped, or if 30 seconds has passed, the robots will be switched into the *set* state, in which they must stop walking. Each robot that is not at a legal position at this point in time will be placed manually by the assistant referees to the positions as shown in Figure 8. Robots that are legally positioned will not be moved by the assistant referees unless a manual position is requested by the team leader.

There are extra restrictions on the legal positions of manually positioned robots. The kicking-off robot shall be 50cm away from the center circle, while one robot of the team receiving the kick-off shall be just in front of one corner of the penalty area. The other robots shall be on the left and on the right of their own penalty area. As autonomously placed robots are allowed to be much closer to the ball, successful autonomous placement results in a significant advantage over manual placement.

Just before the set state is called, the ball is placed on the center point of the center circle by one of the referees. If it is moved by one of the robots before set is called it is replaced by one of the referees.

After the head referee has signalled the kick-off, the robot’s state is switched to *playing* (again either by the GameController or manually), in which they can actually play soccer.

Note that a goal can never be scored directly from a shot from the kick-off. See Section 4.5 for details.

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<sup>4</sup> Note that robots being manually placed because they are not listening to the GameController must still be placed in the restricted set of legal positions for manually placed robots. It is to a team’s advantage to have their robots listen to the GameController.

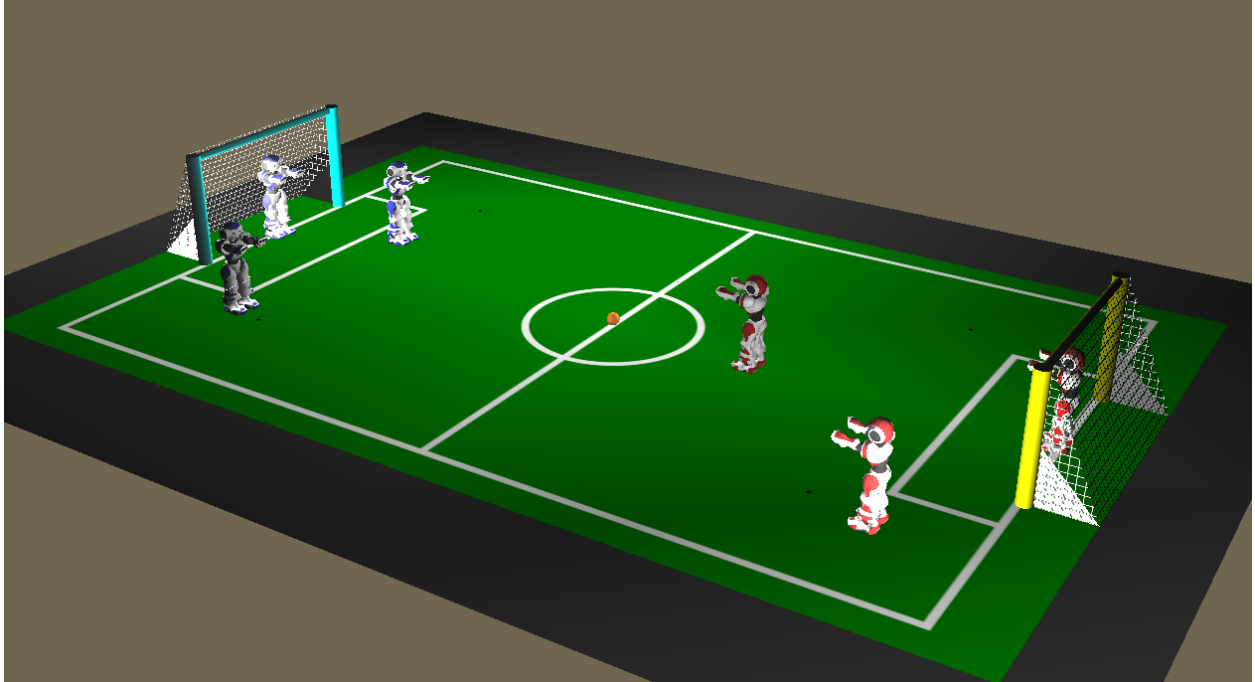


Figure 8: Manual setup for kick-off.

If the assistant referees have misconfigured the robots (e. g. they set the wrong team color), the kick-off is repeated. In this case, goals scored with at least one misconfigured robot on the field are not counted. The time that was played with a wrong configuration is counted as “lost time”, i. e. the half should be lengthened by it. Note that the assistant referees are only responsible for setting team colour on kick-off. Robots replaced after a request for pickup are the responsibility of the team.

The current GameController requires robots to know both their team number and their robot number within the team. It is each team’s responsibility to make sure this is correctly configured. It is recommended that the robot indicates its number within the team on bootup so that this can be easily checked at the start of the game.

### 3.6 Free Kick

None.

### 3.7 Penalty Kick

A penalty kick is carried out with one attacking robot and one goalie. Other robots should be powered off and stay outside of the field. Teams are allowed to switch to specially designed

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software for a penalty kick. The attacker has 1 minute in which to score a goal. If the ball leaves the playing area it is not replaced and this penalty kick attempt is deemed unsuccessful.

Standard penalty kicks are taken against the opponent goal (i. e. a red robot will attack the blue goal). For a penalty shootout, see Section 3.8.

The ball is placed 1.5m from the centre of the field in the direction of the defender's goal. The attacking robot is positioned *at least* 50cm behind the ball. The goalie is placed with its feet on the goal line and in the centre of the goal. *for 2008 only, the penalty kicks were played without a goal keeper.* Neither robot shall move their legs before the penalty kick starts. Movements of the robot's head and arms are allowed as long as the robot does not locomote. Technically, the robots are in the *set* state when waiting for the penalty kick to start. The robots are started by setting it into the *playing* state. The penalty kick ends when the kicker scores the goal, the time expires or the ball leaves the field. The time limit for the kicker is 1 minute after the penalty kick starts. The ball must be in the goal within this time limit in order to count as a goal.

The goalie is not allowed to touch the ball outside the penalty area (i. e. one foot outside) and the attacking robot is not allowed to touch the ball inside the penalty area (i. e. one foot inside the area). If the attacker touched the ball inside the penalty area then the penalty shot is deemed unsuccessful. If the goalie touches the ball outside the penalty area then a goal will be awarded to the attacking team.

All the rules such as "Ball Holding", "Goalie Pushing" and others are also applied during the penalty kick. The only exception is the "Illegal Defender" rule, i. e. the penalty shooter is allowed to enter its own penalty area.

### **3.8 Penalty Kick Shoot-out**

*For 2008 Only, the penalty shoot-out was decided by 'sudden death', that is, the rules were applied as if the first five kicks had already been taken. In addition, the time allowed to score was 3 minutes, and if no goal was scored by either team, the team that had moved the ball closest to the goal at any point during the taking of the kick was deemed to be the winner. The distance to the goal was measured as the distance to the nearest point on the goal side edge of the goal line between the goal posts.*

A penalty kick shoot-out is used to determine the outcome of a tied game. The penalty kick shoot-out will initially consist of five penalty shots *per* team. At the conclusion of these shots the team who has scored the most goals will be declared the winner. Note that a winner can be declared before the conclusion of the penalty shoot-out if a team can no longer win, i. e. a team requires 3 goals to win but only has 2 attempts remaining. If the two teams still remain tied then a sudden death shoot-out will follow until a definite winner is found.

The procedure for each attempt is the same as for the normal penalty kick described in Section 3.7. For the first five attempts, the standard time limit of 1 minute is applied. However, for the sixth

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and later attempts the time limit is two minutes. These attempts will be timed, i. e. if both teams score, the faster team wins, but only if the faster team is at least two seconds faster than the other team. Otherwise, the timed attempt is repeated until a winner is found.

Each team selects an attacking robot to be used in the penalty kick shoot-out. They also select a goalie robot. The software on the robots cannot be changed in between kicks.

In a penalty kick shoot-out, all penalty kicks are taken against the *blue* goal. This will require each team to do a jersey colour swap on one robot before the penalty shoot-out can start.

### 3.9 Throw-in

A ball is considered to have left the field when there is no part of the ball over the boundary line (i. e. the line itself is in). If the ball leaves the field it will be replaced on the field by an assistant referee. There is *no* stoppage in play.

If the ball goes over a side-line then the assistant referee will replace the ball back on the field on the throw-in line on the same side of the field as the ball went out of play.

The ball will be replaced in one of three positions on the throw-in line:

- If the referee cannot determine which robot was the last to touch the ball before it left the field, then the ball is replaced on the throw-in line directly in from the point at which the ball left the field.
- Otherwise, the ball is placed back on the throw-in line one metre back from the point it went out, where ‘back’ is defined as being towards the goal of the team that last touched the ball.

In any case, the ball cannot be placed off the end of the throw-in line, or equivalently, closer than 1 metre to either end of the field.

If the ball goes over an end-line then the assistant referee will replace the ball back on the field according to the following rules:

- If the referee cannot determine which robot was the last to touch the ball before it left the field, then the ball is replaced on 1 metre in from the edge of the field and on the throw-in line.
- If the ball was last touched by the defensive team then the ball is replaced on the closest ‘corner kick’ point. The ‘corner kick’ points, as shown in Figure 1 (red dots), are the same distance away from the center line as the ends of the throw-in lines, but are closer to the penalty area.

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- If the ball was last touched by the offensive team then the ball is placed on the halfway line on the side of the field the ball went out.

Balls are deemed to be out based on the team that last touched the ball, irrespective of who actually kicked the ball.

**Example 1.** The red goalie kicks the ball out the end of the field to the right of the yellow goal. The ball is placed on ‘corner kick’ point to the right of the yellow goal.

**Example 2.** A blue robot kicks the ball out the end of the field to the right of the yellow goal. The ball is placed on the intersection of the right throw-in line and the halfway line.

**Example 3.** A blue robot kicks the ball over the left sideline 2 metres into the yellow half of the field. The ball is replaced on the left throw-in line 1 metre into the yellow half of the field.

**Example 4.** The ball is kicked out over the end of the field. The referees are not sure which robot was last to touch the ball. The ball is replaced on the throw-in line 1 metre from the end of the field.

**Example 5.** A blue robot kicks the ball but the ball touches a red robot before leaving the field near the centre line. The ball is regarded as out by red and therefore is replaced on the throw-in line 1 metre closer to the yellow goal.

## 3.10 Game Stuck

### 3.10.1 Local Game Stuck

In the event of no substantial change in the game state for 30 seconds, the referee shall pick up the nearest robot to the ball and move the robot to the half way line. The referee does *not* replace the ball. If the ball is accidentally bumped when removing the robots, the ball should be replaced where it was when the game stuck was called. As a special exception, if the goalie is involved in a game stuck situation while having one foot in its own half (on half line or closer to goal), the goalie will not be removed from the game stuck situation. Instead, the ball will be placed on the center point.

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### **3.10.2 Global Game Stuck**

If no robot touches the ball for 30 seconds, the referee shall stop the game and restart the game from the kick-off formation. The kick-off will be awarded to the team defending the side of the field the ball is on when the game stuck is called.

### **3.11 Request for Pick-up**

Either team may request that one of their players be picked up only for hardware dysfunction and software crashes at any point in the game (called “Request for Pick-up”). It is permitted to change batteries, fix mechanical problems or, if necessary, reboot the robots, but not to change or adjust their program. Any strategic “Request for Pick-up” is not allowed. The head referee will indicate when the robot is no longer affecting play and can be removed from the field by an assistant referee. The robot will be replaced on the half way line after 30 seconds following the normal replacement procedure used after the standard removal penalty (see Section 4.3).

If a robot has been rebooted and the wireless is not working , it is the responsibility of the team members (not the assistant referees) to configure its team color correctly. The robot should be returned to the assistant referees in the ‘Penalized’ state so that the assistant referees cannot accidentally change the robot’s team color.

### **3.12 Request for Timeout**

At any stoppage of play (after a goal, stuck game, before half, etc.) either team may call a timeout. Each team can call a maximum of 1 timeout per game with a total time totalling no more than 5 minutes. During this time, both teams may change robots, change programs, or anything else that can be done within the time allotted. The timeout ends when the team that called the timeout says they are finished, at which time they must be ready to play. At this time the other team must either be ready to play or call a timeout of its own. The clock stops during timeouts, even during the preliminaries.

After the completion of the timeout, the game resumes with a kick off for the team which did not call the timeout.

If a team is not ready to play at the assigned time for a game, the referee will call the timeout for that team. After the expiration of such a timeout, if the team is still not ready to play then they must either forfeit the game, or the referee shall start the game with only one team on the field. The team that wasn’t ready can return its robots to the field as per the rules for “Request for Pick-up”.



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### 3.13 Winner and Rankings

The team which scored more goals than the other is the winner of the match. If the two teams scored the same number of goals, the game will be a draw. The draw will follow the same system defined in Section 3.1. Total (and final) standings will be decided on points as follows (the points will be given based on the result of each game):

Win = 3 pts

Draw = 1

Lose = 0 pts

If a team's obtained points is the same as another team's after the preliminary round is complete, the following evaluations will be applied in order to qualify the finalists.

1. The points obtained
2. The average difference between goals for and goals against per game
3. The average goals for per game
4. Game result between the teams directly

### 3.14 Rules for Forfeiting

If a team chooses to forfeit a match then the result will be 10-0 against the team that forfeited. Teams may choose to forfeit games at any stage. Any game with a final score differential greater than 10 points will be considered a forfeit.

## 4 Forbidden Actions and Penalties

The following actions are forbidden. In general, when a penalty applies, the robot shall be replaced, not the ball. For penalties that are timed, the penalty time is considered to be over whenever the game time stops (for goals, half-time, and game stuck).

### 4.1 Locomotion Type

Robots should clearly demonstrate bipedal walking similar to human walk. Other types of locomotion involving other parts than feet (crawling etc.) are strictly forbidden. It is duty of the head referee to decide whether a robot's locomotion is appropriate.

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## 4.2 Penalty procedure

When a robot commits a foul, the head referee shall call out the infraction committed, the jersey color of the robot, and the jersey number of the robot. Each robot will be labelled with a jersey number before the game. The penalty for the infraction will be applied immediately by an assistant referee. The assistant referees should perform the actual movement of the robots for the penalty so that the head referee can continue focusing on the game. The operator of the GameController will send the appropriate signal to the robots indicating the infraction committed.

## 4.3 Standard Removal Penalty

Most infractions in this league result in the removal of the infringing robot from the field of play for a period of time. This process is called the standard removal penalty. When the head referee indicates a foul has been committed that results in the standard removal penalty, the assistant referee closest to the robot will remove the robot immediately from the field of play. The robot should be removed in such a way as to minimize the movement of the other robots and the ball. If the ball is inadvertently moved when removing the robot, the ball should be replaced to the position it was in when the robot was removed.

The operator of the GameController will send the appropriate signal to the robot indicating the infraction committed. If the wireless is not working and the penalty is timed, the assistant referee handling the robot will reset the robot into the *penalized* state for the duration of the penalty. This may not be done if the penalty is not timed, i. e. it is a 0 seconds penalty. After a penalty is signalled to the robot, it is not allowed to move in any fashion, such as being in the *initial* state. The removed robot will be placed outside of the field facing away from the field of play.

The GameController will keep track of the time of the penalty. The operator of the GameController will signal the assistant referees when the penalty is over, so that one of them can put the robot back on the field. The assistant referee will then place the robot on the field on the halfway line as close to the sideline as possible. The robot should be pointed towards the opposite sideline. The robot should be placed on the side of the field furthest from the ball. If there is another robot already in this position, the robot should be replaced at a nearby location along the sideline facing towards the opposite sideline. If there are no practical locations nearby, a location along one of the sidelines should be found that is away from the ball (the robot should be set down facing the opposite sideline). When finding a nearby location, locations away from the ball should be preferred.

When the robot is on the field again, the operator of the GameController will send the *playing* signal to it. If the wireless is not working, the assistant referee who placed the robot back on the field has to bring it into the *playing* state again.

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## 4.4 Manual Interaction by Team Members

Manual interaction with the robots, either directly or via some communications mechanism, is not permitted. Team members can only touch one of their robots when an assistant referee hands it over to them after a “Request for Pick-up”.

## 4.5 Kick-off Shot

A “kick-off shot” can never score a goal. A “kick-off shot” is a shot taken after a kick-off before the entire ball having left the center circle, including the boundary line. The ball must touch a player from the kick-off team after leaving the center circle before a goal can be scored by the team taking the kick-off. If a kick-off shot enters the goal (either directly or via contact with an opposing robot), no goal will be scored and a kick-off will be awarded to the defending team (as per Section 3.5).

## 4.6 Ball Holding

The goalie is allowed to hold the ball for up to 5 seconds as long as it has one foot inside in its own penalty area. In all other cases, robots are allowed to hold the ball for up to 3 seconds. Holding the ball for longer than this is “Ball Holding” and is not allowed.

A robot which does not leave enough open space around the ball will be penalized as “Ball Holding” if that situation continues more than 3 seconds or if the robot moves the ball over 50cm while continuing to hold the ball. The occupation of the ball is judged using the convex hull of the projection of the lower part of the robot’s body (i.e. legs) onto the ground. “Enough open space” means that at least the half of the ball is not covered by the convex hull. It is not important whether the robot actually touches the ball.

Intentional continual holding is prohibited even if each individual holding time does not continue for up to the time limit. In general robots should release the ball for approximately as long as they were holding it to reset the clock. Without a sufficient release, the continual holding is regarded as a continuous hold from the very beginning and the holding rule is strictly applied. The violation of this rule will result in having the penalized robot removed from the field for 30 seconds as per the standard removal penalty (see Section 4.3 for details). In case of a violation by the goal keeper, the robot will be removed for 0 seconds as per the standard removal penalty, i. e. it will be placed on the halfway line immediately (no need to be kept outside of the field). The ball should be removed from the possession of the robot and placed where the foul occurred. If the robot that held the ball has moved the ball before the robot can be removed, the ball shall be replaced where the foul occurred.

If a robot is transitioning from a hold into a dribble without holding, then the robot should be careful to make a clear release of the ball between the two movements.

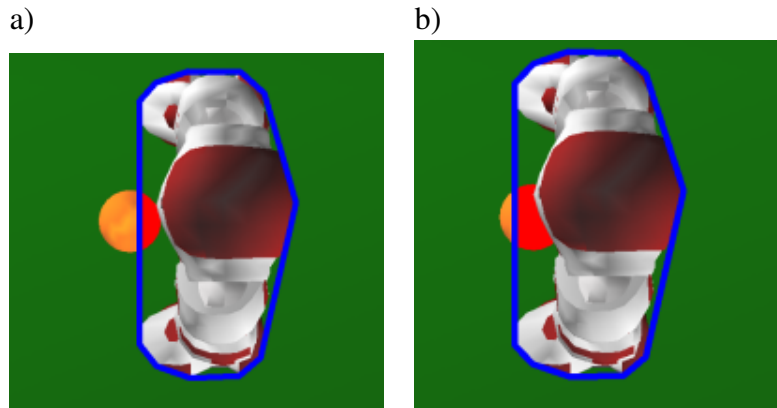


Figure 9: Examples for “Ball Holding”. The orange circle is the ball, the blue polygon visualizes the convex hull of the robot’s projection onto the ground and the red area shows the occupied portion of the ball. Situations a) is legal, whereas b) violates the rule.

It is not possible to score an offensive goal while holding the ball. If the ball passes over the goal line while the robot is in holding position, then the ball is considered out and the assistant referee shall replace it at the intersection of the half line and the closer “throw-in line”. However, it is still possible for a goal keeper to score a goal for the opposing team while holding the ball.

**Example.** A robot holds the ball and before the referees can remove the robot, it shoots the ball into the goal. The goal will not be counted and the ball will be replaced where the robot held the ball.

## 4.7 Fallen Robots

If a robot is fallen during the game, it should start executing the getup action (if any) within 5 seconds. A robot which failed to do that after 5 seconds will get a zero seconds penalty and the robot will be placed at one of the following positions, whichever is more of a disadvantage:

- The opposite side of the field with the ball, at the halfway line.
- 1m away from the ball.
- The same place that the robot has fallen.

## 4.8 Goalie Pushing

See 4.9.

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## 4.9 Field Player Pushing

Any type of physical contact between robots is not allowed. In order to prevent physical contact, if two robots get within the falling distance of each other (50 cm), they will be moved 1m apart. If the encounter happens again in 3 seconds, the farther and/or the one which is not going to the ball will get a zero seconds penalty (it will be immediately placed on the halfway line at the opposite side of the field). Goalies cannot be called for violating the 50 cm rule as long as they stay in their own penalty area. Application of this rule to the teammates is left to the teams. If a team wants to allow their robots to get close, this will be allowed. Further clarification on this rule will be discussed and finalized at RoboCup.

Any robot pushing another robot for more than 3 seconds will be removed from play for 30 seconds as per the standard removal penalty (see Section 4.3). The closest robot (including the goal keeper) to the ball on each team, if it is within 50cm of the ball, cannot be called for pushing. If a robot is standing still it cannot be called for pushing. If two moving robots are charging into each other then both robots are removed. The goalie cannot be called for pushing as long as it has at least two feet within its penalty area *and is deemed to be active. Active means the goal keeper either: (i) is tracking the ball; (ii) has previously successfully seen the ball, and is now seeking to locate the ball.*

*A robot that: (a) has recently perceived the ball; (b) is within 50cm of the ball; (c) is active in moving towards the ball or positioning itself around the ball; and (d) is closer than any other robot, is said to have 'possession of the ball' (this should be clearly called by the Referee, by a statement such as 'Possession to Blue number 3'). Once a robot has possession of the ball, it cannot be called for pushing.*

*A robot loses possession of the ball when any of the following happens: (a) It becomes more than 50cm away from the ball (either by moving away from the ball, or by kicking the ball); (b) If in the opinion of the referee, it has lost direct perception of the ball for more than 15seconds; or (c) An opposing robot that has previously been penalized for pushing against the same robot during the same possession of the ball, again approaches within 50cm. In this latter case, the opposing robot gains possession of the ball, and the original robot is penalised for pushing.*

**Example 1.** A robot is going to the ball while a second robot approaches the ball from behind the first robot and the distance between two robots became smaller than 50cm. In that case the second robot will be removed.

**Example 2.** A robot is going to the ball while a second robot approaches the ball from the opposite direction of the first robot and the distance between two robots became smaller than 50cm. In that case the farthest robot will be removed.

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**Example 3.** The ball is in front of a robot but the robot does not show interest in the ball while a second robot is approaching the ball and the distance between two robots became smaller than 50cm. In that case, the first robot will be removed.

## **4.10 Playing with Arms/Hands**

A field player or a goalie outside its own penalty box that intentionally touch the ball with its arms/hands in a manipulative manner (i.e. to stop the ball, to kick the ball etc.) will be removed for 30 seconds as per the standard removal penalty.

## **4.11 Damage to the Field**

A robot that knocks over one of the beacons will be removed for 30 seconds as per the standard removal penalty (see Section 4.3). A robot that damages the field will be removed from the field for the remainder of the game. Similarly a robot that poses a threat to the spectator's safety will also be removed. In such a case, a normal penalty kick will be awarded to the opposing team (cf. Section 3.7).

## **4.12 Leaving the Field**

A robot that leaves the 4.4m × 6.8m carpeted area will be removed for 30 seconds as per the standard removal penalty (see Section 4.3). A robot may leave the 4mx6m playing field, but must stay within the 4.4mx6.8m area.

A robot that chases the ball off the field, and then turns and moves directly back onto the playing area when the ball is replaced on the field, shall not be penalized.

## **4.13 Illegal Defender**

Only the goalie can be within its team's penalty area. Having both legs inside the penalty area is the definition of being in the penalty area and that situation is not allowed for defending field players. When other defending robots enter the area, they will be removed for 30 seconds as per the standard removal penalty (see Section 4.3). This is called the "Illegal Defender Rule". This rule will be applied even if the goalie is outside of the penalty area, but not if an operational defender is pushed into the penalty area by an opponent.

If an illegal defender kicks an own goal, the goal is scored for the opponent. If there is any doubt about whether a goal should count (e.g. The illegal defender infraction is called, but the robot scores the own goal immediately afterwards, before it is removed) then the decision shall be against the infringing robot.

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## 4.14 Jamming

During the match any robot shall never jam the communication and the sensor systems of the opponents:

**Wireless communication.** Teams can use a bandwidth of up to 500 Kbps of the wireless. This includes any data transferred, namely the actual payload and any protocol overhead created, e. g., by TCP or UDP. If a team uses more bandwidth over a couple of seconds in a game, it will be disqualified for that game. Except for the wireless cards and the access points provided by the organizers of the competition, nobody close to the field is allowed using 2.4 GHz radio equipment (including cellular phones and/or Bluetooth devices).

**Acoustic communication.** If acoustic communication is used by both teams, they shall negotiate before the match how they can reduce interference. If only one team uses acoustic communication, the robots of the other team shall avoid producing any sound. In addition, both the teams and the audience shall avoid intentionally confusing the robots by producing similar sounds to those used for communication.

**Visual perception.** To avoid confusing other robots, the robots are only allowed to use the white, green, and red LEDs. In particular, orange LEDs are not allowed. In general, the use of flashlights is not allowed during the games.

## 5 Judgement

The referees are the only persons that are allowed inside the playing area.

### 5.1 Head Referee

The head referee signals game starts, restarts, when a goal was scored, the case of *game stuck*, and penalties by a single whistle. In general, the head referee first whistles and then announces the reason for the whistle. The only exception is the case of the kick-off, in which the reason for the whistle is obvious. The whistle defines the point in time at which the decision is made. If the head referee has to announce many decisions in short sequence, he may skip whistling. For penalties, he announces the infraction committed, the team color, and the jersey number of the robot, e. g. “illegal defender, blue number 4”. In case of a goal scored, local or global game stuck, this is also announced verbally. By two whistles, the head referee terminates the first half; by three whistles he terminates the second half, i. e. the whole game. The head referee is also responsible for keeping the time of each half, i. e., he or she stops the clock after a goal or game stuck, and continues it at

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the kick-off<sup>5</sup>. The head referee may choose to delegate this task to the gamecontroller, it should be noted that the ultimate responsibility for correct time keeping still remains with the head referee.

In the penalty kick shoot-out, the head referee keeps the time.

Any decision of the head referee is valid. There is no discussion about decisions during the game, neither between the assistant referees and the head referee, nor between the audience or the teams and the head referee.

## **5.2 Assistant Referees**

The two assistant referees handle the robots. They start them if the wireless is not working, they move them manually to legal kick-off positions, they take them out when the robots are penalized, and they put them in again. If a team requests picking up a robot, an assistant referee will pick it up and give it to one of the team members. An assistant referee will also put the robot back on the field. In addition, the assistant referees can indicate violations against the rules committed by robots to the head referee, so that the head referee can decide whether to penalize a certain robot or not.

## **5.3 Operator of the GameController**

The operator of the GameController sits at a PC outside the playing area. He or she will signal any change in the game state to the robots via the wireless as they are announced by the head referee. He or she will also inform the assistant referees when a timed penalty is over and a robot has to be placed back on the field. The operator may also be responsible for time keeping if the head referee has delegated this task.

## **5.4 Selection of the Referees**

At least in the preliminaries, the games will be refereed by members of teams from a different Round-Robin group. Each team has to referee a number of these games. For each of the games, it can either provide the head referee and the operator of the GameController, or the two assistant referees. These persons must have good knowledge of the rules as applied in the tournament, and the operator of the GameController must be experienced in using that software. The persons should be selected among the more senior members of a team, and preferably have prior experience with games in the RoboCup Standard Platform (formerly Four Legged) league.

Referees for playoff games will need to be certified (i. e. deemed fit to referee) by at least half the teams in the playoffs. Unless they have no eligible referees, each team in the playoffs shall supply

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<sup>5</sup>The clock may not be stopped during the preliminaries.



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at least one referee for the playoffs. For a particular game, each of the teams playing shall be able to veto one and only one eligible referee with no reason required.

### **5.5 Referees During the Match**

The head referee and the assistant referees should wear black clothing and black socks/shoes and avoid reserved colors for the ball, the goals, and player markings in their clothing. They may enter the field in particular situations, e. g., to remove a robot when applying a penalty. They should avoid interfering with the robots as much as possible.

## **6 Questions/Comments**

Questions or comments on these rules should be mailed to [spl\\_tech@tzi.de](mailto:spl_tech@tzi.de)