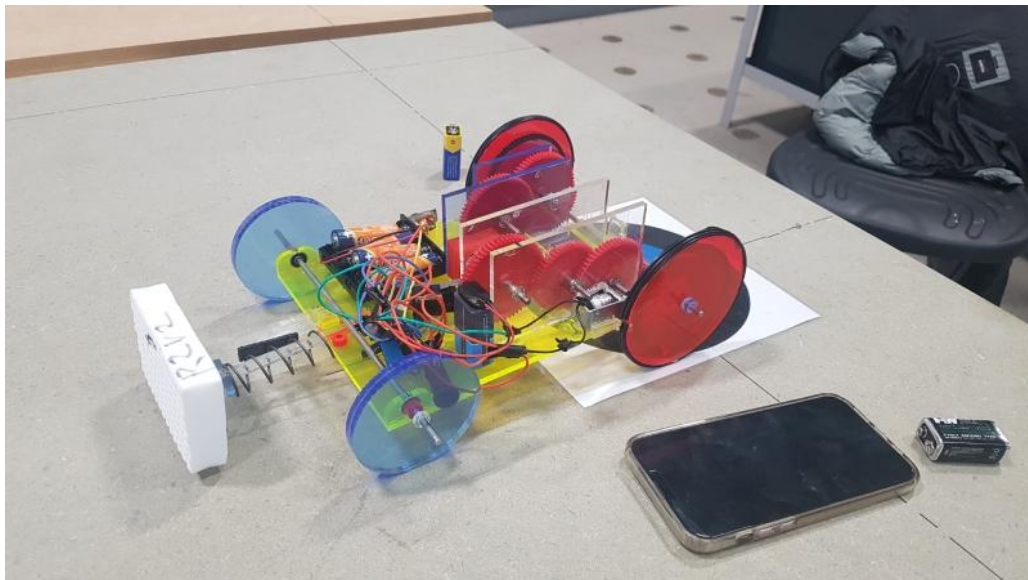


# DESIGN CHALLENGE PROJECT SPECIFICATION AND RULES 2025

Institution of  
**MECHANICAL  
ENGINEERS**

IMechE DESIGN CHALLENGE

AUTOMATED EV CHARGING



# **Project Specification and Rules for the 2025 Automated EV Charging Design Challenge**

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Note: this specification must be read alongside the  
"IMechE Design Challenge - General Specification 2025"  
available on the IMechE Design Challenge website.

**Please check the IMechE Design Challenge website for updates.**

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## List of Amendments:

Version	Page	Details	Date
0.1	-	First release	17/09/2024
1.0	-	Minor amendments and typo; Figure 16; 4.1.8; 4.1.10; 8.14; 8.19; 8.20; 9.12; 9.13; 9.16;9.20; 10.33; former 10.36.2 removed; new 10.40; 10.44	26/11/2024

## List of Major Changes Since 2024

- New device introduction
- Longer allowed run time
- Lane lengths intervals amended
- New scoring – cumulative
- Clarified penalties and criteria for disqualification

Please report any errors to [designchallenge@imeche.org](mailto:designchallenge@imeche.org) so that corrections can be made.

# 1. Introduction

The Design Challenge, organised by the Institution of Mechanical Engineers, is an annual competition for students on an undergraduate engineering degree programme, at UTC (University Technical College) or at engineering related sciences. The Design Challenge is made up of multiple elements, all of which are detailed in the General Specification.

This year the challenge is to design, build and test a device to simulate an autonomous robotic charging device; much like autonomous electric charging connectors for impaired users, or industrial vehicles with hot swap battery charging capability, with a key focus on automatic connection and disconnection.



*Figure 1 - Ford robotic charging demonstrator*



*Figure 2 - Sandvik TH550B heavy duty vehicles battery swapping and automated charging*

The competing device should be capable of undertaking a repeatable movement along a straight line, on a horizontal track. The device can be of any construction and propulsion method, limited only by cost and size, within the specification detailed in this document and the "IMechE Design Challenge - General Specification 2025". The device can be based on any moving technology with contact with the horizontal surface, such as wheeled, walking, sliding, jumping, rolling.

The device must be totally self-contained and the method of starting it must be attached to, and travel with, the device at all times. Points will be awarded for the accuracy of the device (based on returning to the starting point), the time

duration of engagement with a target and the accuracy of engaging with a simulated charging plug.

The competing device should:

- complete the specified mission of repeated movements within a maximum time of 3 minutes;
- be started manually and perform the mission autonomously, without any other external support or control;
- be capable of performing on a real installation where errors in horizontality and track flatness may be present and on a commercial substrate where real manufacturing tolerances are present, without requiring any post treatment or adjustment of the track surface;
- start, return and / or stop on specific targets on the horizontal surface;
- engage with the plug simulator onto the vertical surface target at single or different heights, see 5, 6 and 7;
- simulate the battery charging engagement by remaining in contact with the vertical surface for a given time.

Sections applicable or not applicable to a specific category of competing devices will be noted and identified in this document. Where relevant see "*IMechE Design Challenge - General Specification 2025*" - section 4 for further guidance.

## 2. Main competition general description

The devices will move on a 1m wide lane over a range of distance from 1.4m to 4.0m, to reach a vertical wall of 0.3m minimum height. The lane will be horizontal and the wall vertical, made with commercial materials. These wood-based materials should be considered equivalent: plywood, OSB, MDF. No surface treatment shall be required; the devices shall be capable of dealing with different surface friction, flatness and overall geometrical conditions.

The lanes' width shall be defined with suitable marking.

Commercial building boards may have a standardized width and length of 1.22 x 2.44m approx. The junction between two boards may not be flat: error in edge joint level up to 3mm and gap up to 2mm will be considered acceptable. Screws could be used to join the board to a support located underneath, providing the screws do not protrude from the surface and do not sit below the surface by more than 3mm. No longitudinal joint or junction shall be present within a single lane.

As substitution for board-based lane construction, the use of existing hard floor surfaces could be considered acceptable, after consultation with the IMechE and the DC Steering committee. In this case, the starting point shall be maintained constant, and the vertical limit (barrier) shall be movable N.B.: the starting point cannot be changed.

The competing area shall be structured so that multiple lanes of the same composition are available. Multiple lanes adjacent shall have a minimum distance between them of 1.0m, to allow for access. The lanes width shall be defined with suitable marking. Vertical movable barriers shall be installed to simulate different distances for the different missions, secured to the lanes to withstand the contact with the devices without resulting in their displacement.

The competing lanes could be located on a floor or on raised supports such as tables, trestles, sawhorses or similar, for accessibility and visibility reasons.

Track flatness and barrier verticality will be within normal building tolerances; example of level error 8mm over 1.5m horizontal and example of plumb error 8mm over 3m vertical.

On the same competition, all the lanes and barriers shall be provided with the same set of materials.

The distance to the vertical barrier will be varied over three ranges for the competition heats and finals, and teams will make attempts at each of the short, medium and long-range distances.

For each range, a target distance will be chosen by the organisers on the day of competition between the min. and max. limits, at intervals of 0.05m (50mm). Distance ranges for the three levels will be provided but the device shall be capable of dealing with any distance within the given range. In other words, the position of the vertical barrier for each distance is not fixed and could vary between the ranges specified below, to further assess the capability of the device.

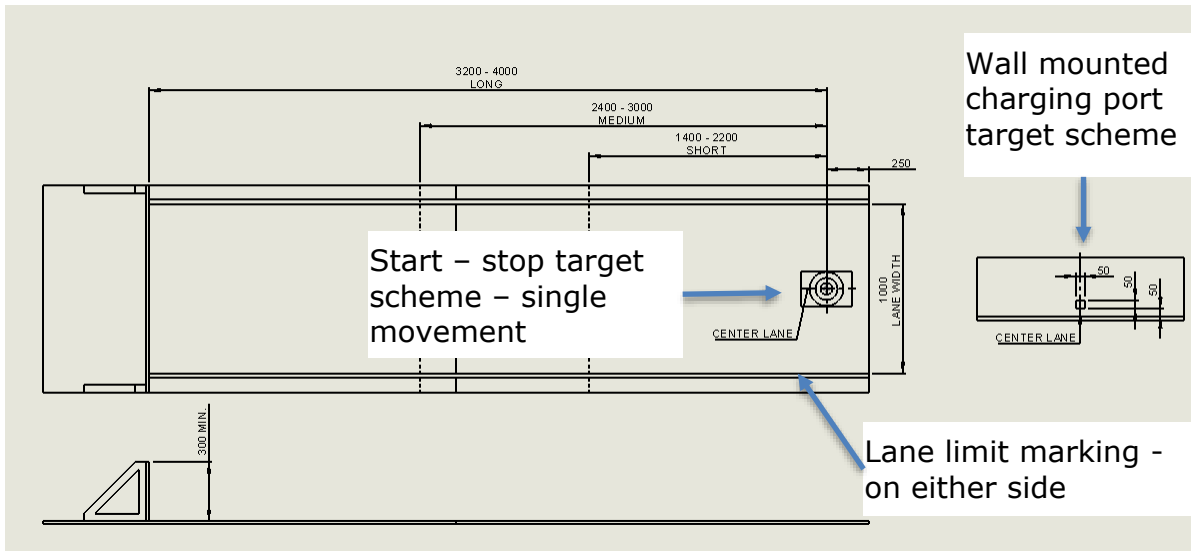


Figure 3 - Typical lane set-up with single targets (single start / stop and single charging port simulator). Dimensions in mm

The device shall hit a target in a specific area of the vertical barrier with a dedicated protrusion, simulating the engagement of a charging plug in a socket to recharge a vehicle or a battery system.

The range distances (minimum to maximum) and are as follows:

- Short range            1.4m – 2.2m
- Medium range        2.4m – 3.0m
- Long range            3.2m – 4.0m

The vertical target should be positioned at 50mm from the horizontal track surface for the single target competition. Two vertical targets at 150 and 50mm from the horizontal surface respectively will be available for the double target competition.

All the necessary dimensions will be verified with a single commercially available tape measure; distances will be considered equivalent with  $\pm 10\text{mm}$  of uncertainty of the measurement reading. The calibration of the tape measure will not be assessed. A single operator will be selected to carry out all the measurements.



### 3. Device categories and competition conditions

Referring to "IMechE Design Challenge - General Specification 2025":

- the devices in category *Concept Challenge* (IMechE Design Challenge - General Specification 2025 – 4.15.1) shall be designed to perform as per 6 - Note: no physical device built; design elements only
- the devices in category *Foundation Challenge* (IMechE Design Challenge - General Specification 2025 – 4.15.2) shall be designed and built to perform as per 6
- the devices in category *Advanced Challenge* (IMechE Design Challenge - General Specification 2025 – 4.15.3) shall be designed and built to perform as per 7

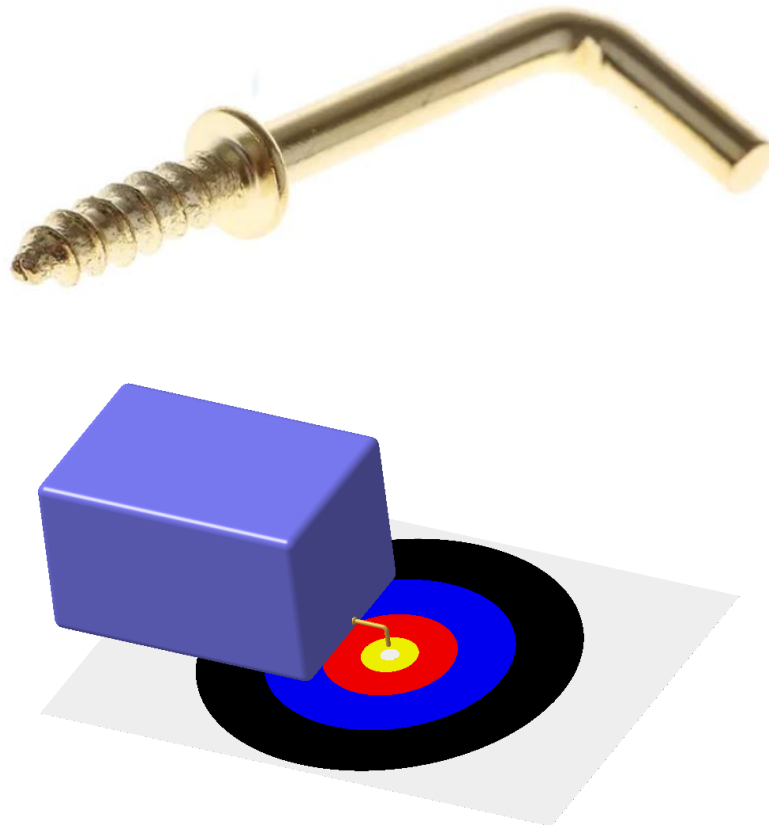
At the competition, the tracks will be cleaned as per a normal industrial installation (wiped with paper or vacuum cleaned).

The team competing will not be allowed to select a specific track: all the tracks shall be verified by the judging panel and considered equivalent, within real tolerances and conditions as previously described.

## 4 Technical regulations for the device

Below the major characteristics of the devices competing

- 4.1.1 The device can be of any type, but it must be totally self-contained and fit within a working envelope of 400x400x400mm. This includes rear datum pointer and front plug simulation feature.
- 4.1.2 The device must fit within the maximum working envelope at all times during competition.
- 4.1.3 The starting and final position of the device will be determined from the datum pointer on the rear of the device (the area opposite to the movement forward to the wall), with maximum distance of 6mm from the horizontal track surface. The datum pointer shall always be held and retained in vertical position, pointing downwards. The datum point element can be purchased from RS Components - part number 397-4954. The pointer shall be included in the BoM, with all the characteristics listed to fulfil the BoM requirements.



*Figure 4 - Datum pointer*

*Figure 5 - Example of relative position of the device, the datum pointer at the rear and the horizontal target*

- 4.1.4 The front of the device shall be fitted with a plunger – plug simulator protrusion to engage with the vertical wall target. The dimension of the

front plunger – protrusion shall not exceed 10x10mm. The plunger shall be the foremost element of the vehicle, protruding when not engaged a minimum of 10mm from any other element of the device.

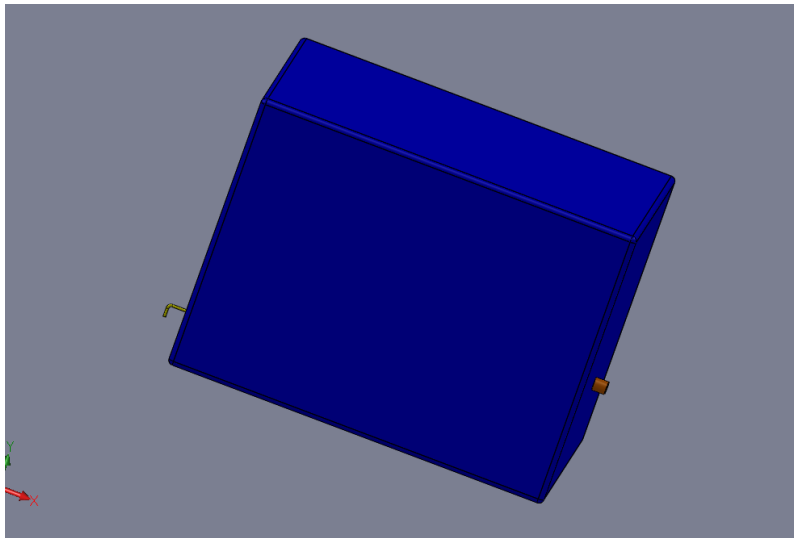


Figure 6 – Front plunger - protrusion

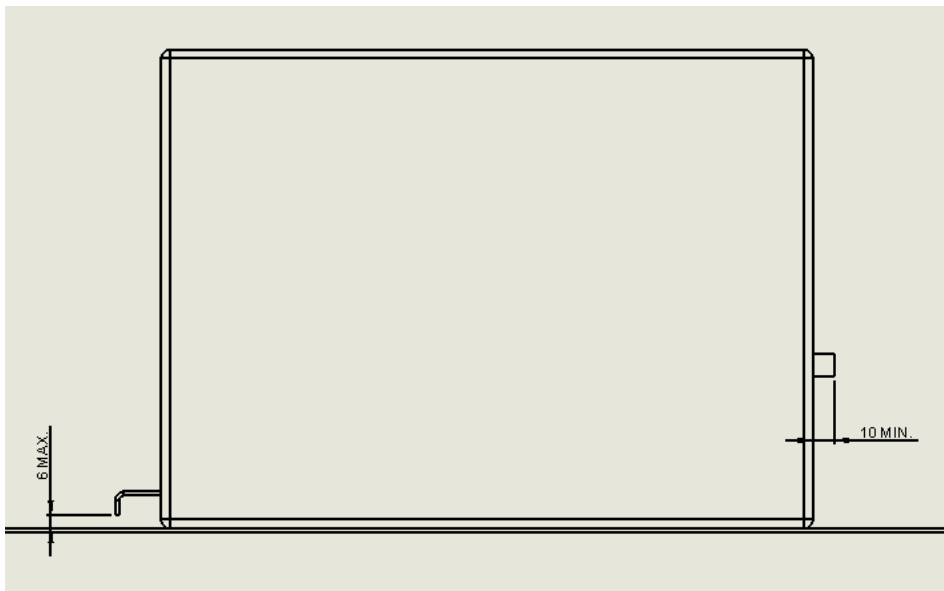


Figure 7 – Rear datum pointer and front plunger – protrusion reference geometries

- 4.1.5 Regardless of the category competing, each device shall be equipped with a single front plunger – plug simulator.
- 4.1.6 For devices in category *Advanced Challenge* (IMechE Design Challenge - General Specification 2025 – 4.15.3), the single plunger shall reposition vertically between the two different heights without any human intervention within a single run. It is possible to manually reset – reposition the plunger on the starting position between runs.
- 4.1.7 The device should have a visible green light, to be on for the whole duration of the run.

- 4.1.8 When the front plunger – plug simulator engages with the wall, an additional visible red light should be switched on and a sound shall be emitted via an electronic source (buzzer or similar).
- 4.1.9 Any repair eventually needed shall be performed within the given time, either before or between runs.
- 4.1.10 In the categories *Concept Challenge* and *Foundation Challenge* no programmable circuitry is allowed. All the electric and electronic layout shall be based on analogue circuitry principles.
- 4.1.11 In the category *Advanced Challenge*, programmable devices such as Raspberry Pi, Arduino, NodeMCU, Teensy and similar are allowed. Such devices shall be purchased as non-pre-programmed. The team shall show evidence of independent coding techniques capacity.
- 4.1.12 In the category *Advanced Challenge* (IMechE Design Challenge - General Specification 2025 – 4.15.3), the programmable electronic selected and installed shall not include any type of wireless communication, including but not limited to Wi-Fi, Bluetooth, Zigbee and similar protocols. If a programmable electronic has any sort of wireless communication capability, such function must be disabled.
- 4.1.13 In the category *Advanced Challenge*, the code shall not include any element that requires editing between runs.
- 4.1.14 In the category *Advanced Challenge*, no software re programming or tuning is allowed between runs.

## 5 Targets, scoring zones and alignment

The horizontal target is made of a series of circles, of different sizes, with dimensions as detailed in Figure 8 and Table 1. Each band between the circles represents a score; the highest score being the target centre; the points will then become progressively fewer as the circles increase in diameter.

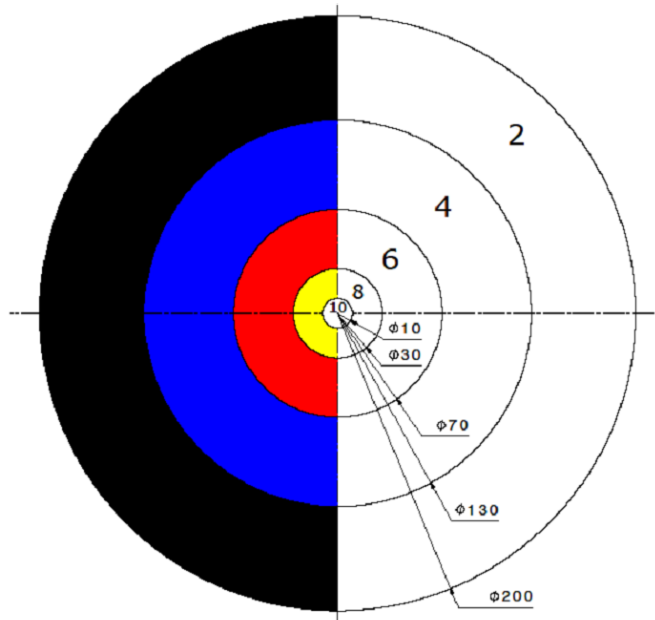


Figure 8 – Horizontal target Area and Scoring Zones (not full size / not to scale). Dimensions in mm

Table 1 - Horizontal target dimensions and scores

Circle outer diameter (mm)	Points	Colour (reference)
10	10	White 255,255,255
30	8	Yellow 255,255,0
70	6	Red 255,0,0
130	4	Blue 0,0,255
200	2	Black 0,0,0

The horizontal target area shall be printed on a single A4 sheet as a peelable sticker with white background.

The vertical target consists of two separate squares, measuring 50 x 50mm, positioned on the centre of the running lane, and distant vertically respectively 50 and 150mm from the horizontal – running surface. They simulate a successful engagement at charging connection of the vehicle.

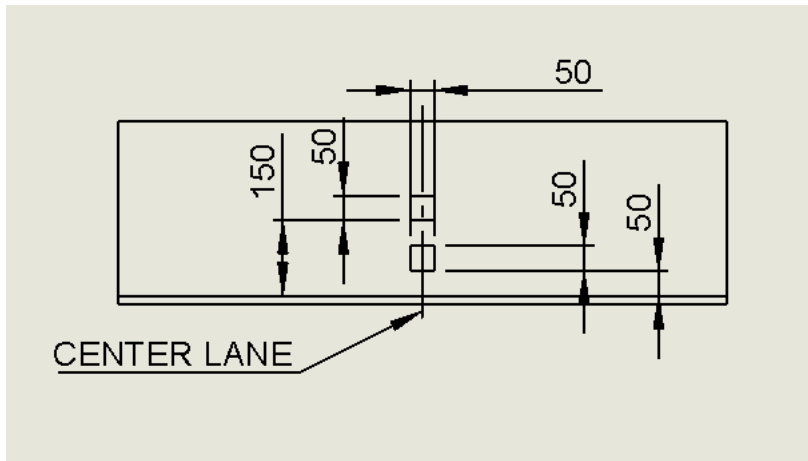


Figure 9 – Vertical targets (not full size / not to scale). Dimensions in mm

The vertical targets can be printed on a single or on separate adhesive stickers, as preferred.

It is recommended to print some light marking – centrelines, centred to the targets and protruding on the non-scoring area of the stickers to enable an easier alignment to the track centreline and verification of distances, see Figure 10 and Figure 11.

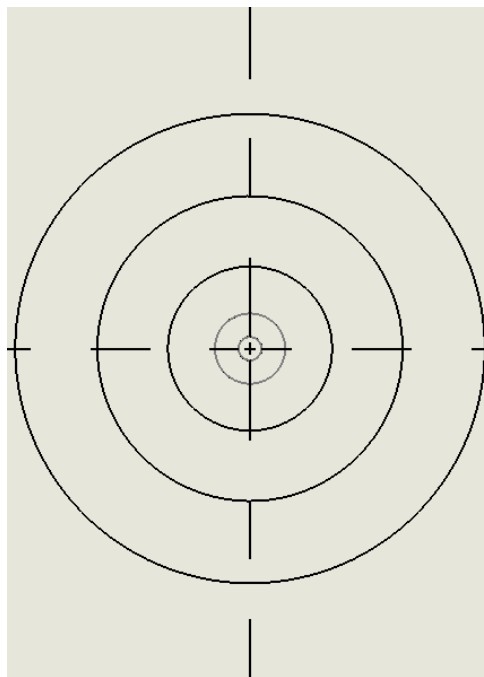
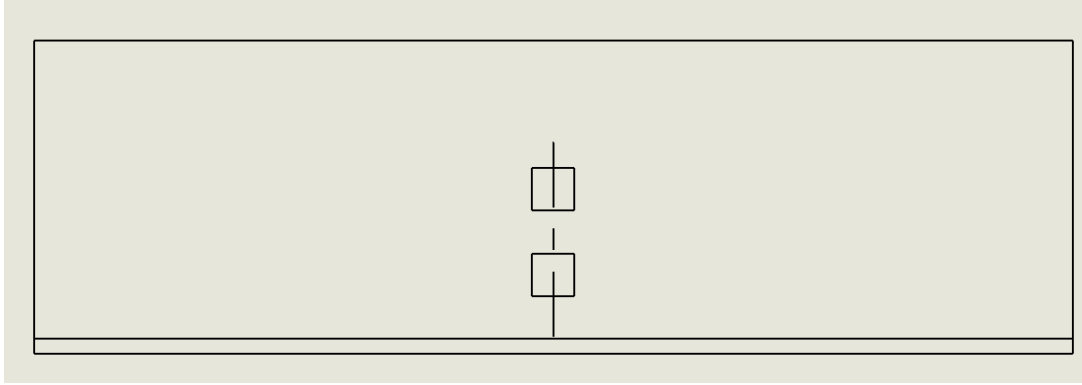


Figure 10 – Horizontal target area with suggested alignment marking



*Figure 11 – Vertical targets with centreline alignment*

No other numbers, marking or scheme shall be printed on the bands or on the white background area. No black line shall be printed between different colour bands.

Each university shall produce their own target according to the rules and verify it complies with sizes and shape as detailed in this document, see Figure 8 and Table 1.

## 6 Main competition conditions – single target

The aim of this competition is to design a device that could perform the mission described in less than 3 minutes in total, regardless of the distance. The mission description is: start with the reference datum pointer on the centre of the horizontal target, travel towards the wall, contact the plunge simulator on the vertical target (50mm from horizontal surface), remain in contact for up to 15 seconds, return with the same datum pointer as close as possible to the starting point and stop, see Figure 12.

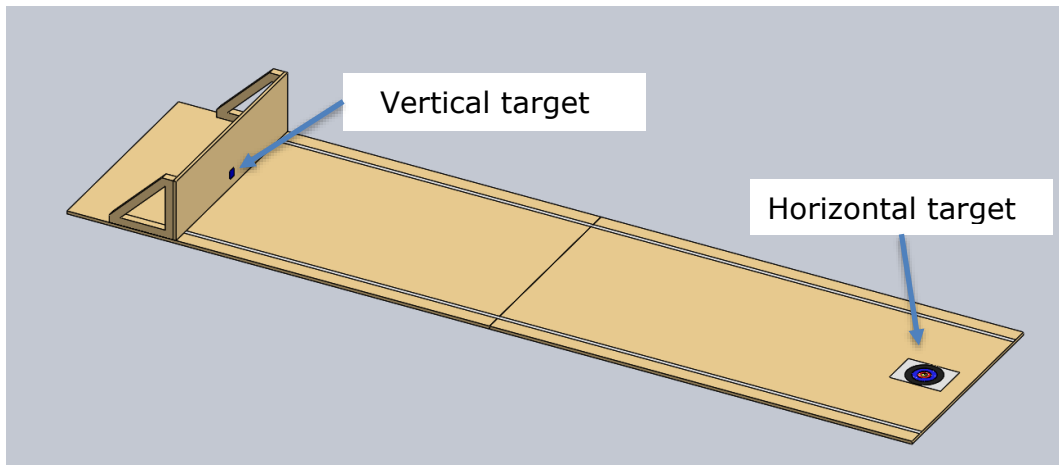


Figure 12 - Typical lane set-up for single target mission

The front plunger – plug simulator should contact the wall on the vertical target area, that should be identified via a sticker of the correct dimensions and position and in a colour – appearance different from the material the vertical barrier is made of, see Figure 12 and Figure 13.

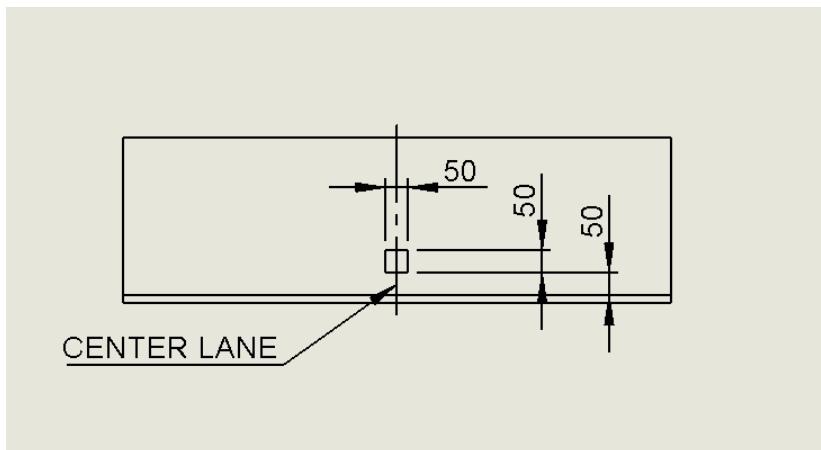


Figure 13 – Wall vertical single target with dimensions and position from the horizontal surface of the track.  
Dimensions in mm

The mission will be repeated on different distances, see Figure 3. Each individual mission – run shall be performed without human intervention, except for the start and final switch on and off operations.



### Competition steps:

- 1) Position the device with the rear datum pointer aligned to the centre of the horizontal target;
- 2) (after the judges says "Go!") Switch on the device – make the device operative and green light visible;
- 3) The device will start moving forwards, towards the vertical barrier hitting with the front plunge the socket simulator the vertical target (positioned at 50mm from the horizontal – track surface);
- 4) At contact, produce red light and sound. Remain in contact with the wall up to 15 seconds;
- 5) Leave the vertical barrier, red light and sound off – only green light visible, return to the starting point with the vehicle datum pointer as close as possible to the starting point within 3 minutes.

In a regional or national final the vertical wall could have a single or both targets pre applied, see 7: this should not affect the performances of the devices listed in this section 6.

## 7 Main competition conditions – multiple targets

The aim of this competition is to design a device that could perform the mission described in less than 3 minutes in total, regardless of the distance. The mission description is: start with the reference datum pointer on the centre of the horizontal target, travel towards the wall, contact the plunge simulator on the first vertical target (150mm from horizontal surface), remain in contact for up to 15 seconds, return with the same datum pointer as close as possible to the starting point, travel towards the wall for the second time, contact the plunge simulator on the second vertical target (50mm from horizontal surface), remain in contact for up to 15 seconds, move backwards and stop on the second horizontal target positioned at a distance intermediate between the first one and the wall.

During the first and the second phase of this competition, the device should be able to adjust automatically the vertical position of the plunger to contact the second vertical target.

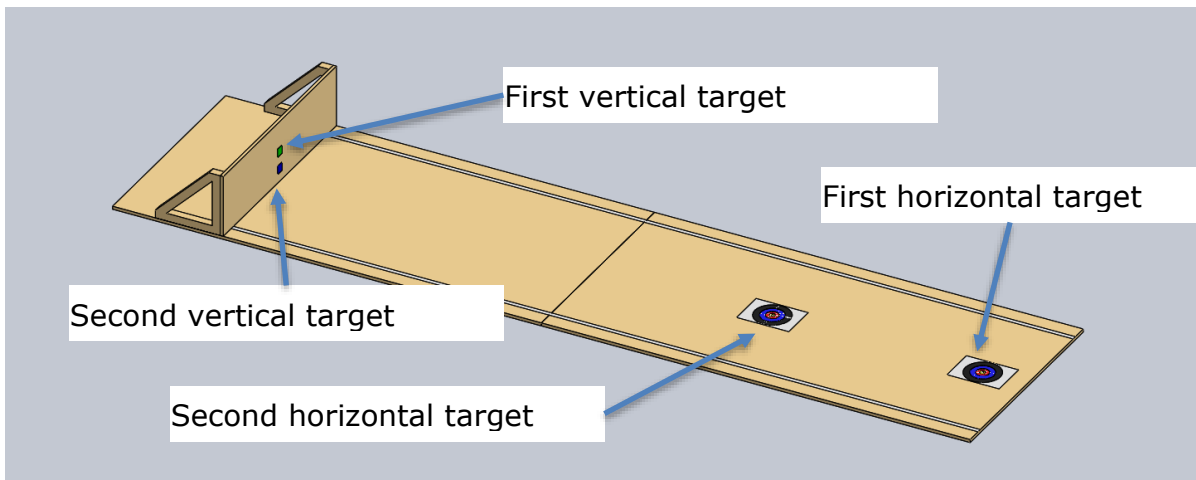


Figure 14 Typical lane set-up for double target mission

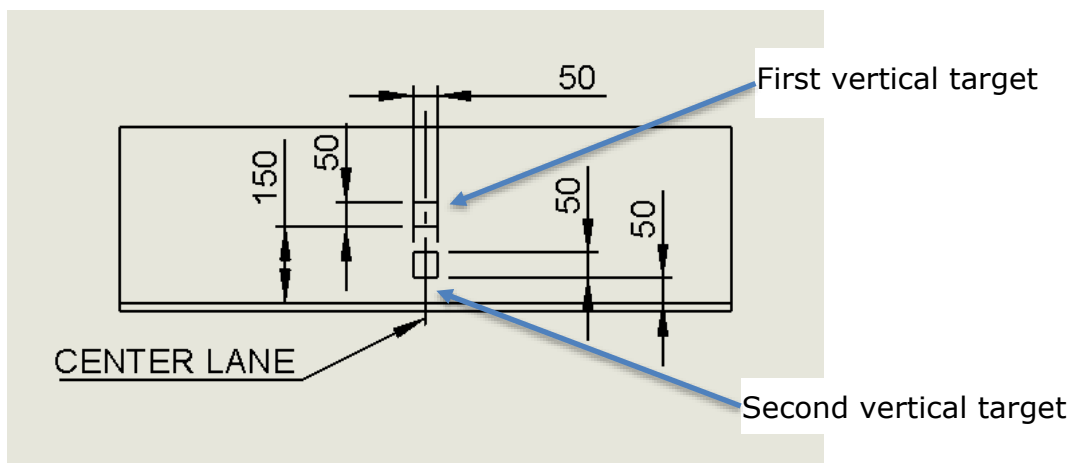
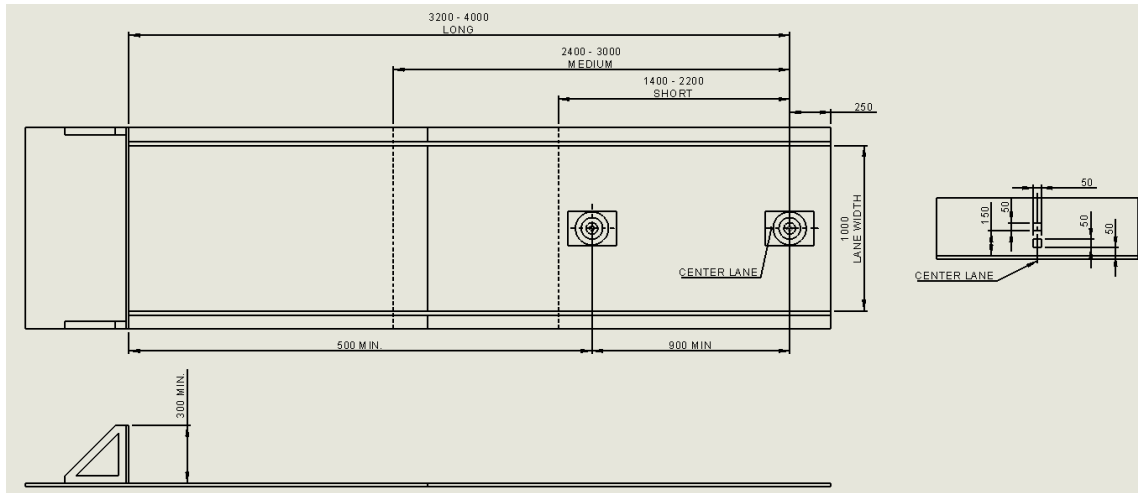


Figure 15 – Wall vertical double target with dimensions and position from the horizontal surface of the track. Dimensions in mm

The mission will be repeated on different distances, with the location of the second target centre will be no closer than 0.5m to the wall and at least 0.9m from the first target, see Figure 16: in other words, the second target position

does not have to be in the same range as the wall. Each individual mission – run shall be performed without human intervention, except for the start and final switch on and off operations.



*Figure 16 - Typical lane set-up with double targets (double start / stop and double charging port simulator).  
Dimensions in mm*

The distance between the first and second target points could be different for each range and may be different between heats and finals. It will be agreed and verified by the judging panel present at the competition.

Competition steps:

- 1) Position the device with the rear datum pointer aligned to the centre of the first horizontal target;
- 2) (after the judges says "Go!") Switch on the device – make the device operative and green light visible;
- 3) The device will start moving forwards, towards the vertical barrier hitting with the front plunge the socket simulator the first vertical target (positioned at 150mm from the horizontal – track surface);
- 4) At contact, produce red light and sound. Remain in contact with the wall up to 15 seconds;
- 5) Leave the vertical barrier, red light and sound off – only green light visible, return to the starting point with the vehicle datum pointer as close as possible to the centre of the first horizontal target (starting point)
- 6) Remain on the starting point for 5 to 10 seconds;
- 7) The device will start moving forwards, towards the vertical barrier hitting with the front plunge the socket simulator the second vertical target (positioned at 50mm from the horizontal – track surface);
- 8) At contact, produce red light and sound. Remain in contact with the wall up to 15 seconds;
- 9) Leave the vertical barrier, red light and sound off – only green light visible, move backwards to stop with the vehicle datum pointer as close as possible to the centre of the second horizontal target, within 3 minutes.

## 8 Rules for the Main Competition

- 8.1 The devices shall not be modified between scrutineering and runs, in any form that may invalidate the features evaluated during the scrutineering process.
- 8.2 No practice runs are permitted on the lanes. The competition organisers will provide dedicated areas for setup activities.
- 8.3 Clear instruction on the running order for the heats and finals will be given at the event.
- 8.4 All teams must display an A4 sheet detailing the teams name and college or university. This must be clearly displayed as instructed during any run in which the team is taking part.
- 8.5 There will be multiple competition lanes in the main competition, set at same or different wall distances depending on how the event will be organised.
- 8.6 The wall distances will be the same for all teams, but will not be known in advance, and will be determined on the day.
- 8.7 Organisers will not announce the target distances during the competition and teams are not allowed to measure the distance using a tape or any other means. The organisers will show the equivalence between different lanes, by showing the measurements taken. The teams cannot make a note of it and use it for any physical adjustment or software input in the device.
- 8.8 Teams will compete head-to-head in heats for a place in the final. The relative performance will be determined by teams' scores.
- 8.9 A heat or final will involve running on different lanes, as selected by the judging panel.
- 8.10 Heats may consist of multiple teams' devices running in parallel on different lanes.
- 8.11 Participating teams will have a maximum of 3 minutes before a heat to prepare and position their device on the target centre.
- 8.12 Teams not ready within the allotted time before a run will forfeit that attempt.
- 8.13 The time limit for runs in the heats and final will be 3 minutes. Time will start from the end of the timekeeper's starting countdown. Devices that don't complete the mission within the limit time will forfeit that attempt.
- 8.14 In each a run, the device will have one attempt only to perform the mission. The run is scored on accuracy and time of engagement with the vertical barrier.
- 8.15 Each team must appoint a 'Device Controller' who will be the only person to attend to the device during the preparation and start of each run. This includes any form of repair, tuning or alteration.

- 8.16 During each phase of the finals, all other team members must be outside the test area. A judge will be allocated to each test area to ensure the correct procedure is followed.
- 8.17 If a device is started before the starter's order, it will forfeit that attempt.
- 8.18 If a device fails to start within 10 seconds of the START command during a run it will score 0 points for that attempt.
- 8.19 Repairs and minor alterations are allowed to the device between each run within a 2-minute time limit. Re programming is not allowed between runs, both in the heats or in a final.
- 8.20 The device attempt will be considered null – without any point cumulated - if any portion of the device exits the lanes as defined or the run exceeds the allowed time.
- 8.21 The device should be left independently to operate in each attempt and no operator shall touch the device at any point. If the device controller touches the device before all the teams are allowed to do so, that attempt will be considered null.
- 8.22 If the device controller fails twice as described in 8.21 or any other team member touches the device during the competition, the team will be disqualified from the competition.

## 9 Main Competition Run Procedure

- 9.1 Team Device Controllers put devices in the test area with the device aligned and the datum point over the target centre.
- 9.2 Allocated lane judges check position of datum point and device readiness.
- 9.3 Device Controllers will raise their hand clearly to show readiness within the three-minute period. If all the teams are ready, a run can commence.
- 9.4 Allocated recording devices are ready and can be started.
- 9.5 When teams are ready or when the preparation time has lapsed, the 'Timekeeper' will indicate the start by voice order: "3,2,1 Go".
- 9.6 The Device Controller will start the device manually and then stand clear of the test lane.

For single target competition:

- 9.7 Judges will verify the contact of the plunger – plug simulator within the vertical target area and record any valid scoring.
- 9.8 Judges will check the position of the datum point relative to the target and record the score for that run.
- 9.9 The device cannot be touched until the judge signifies that the run is complete. This means that the device cannot be switched off manually until this point.
- 9.10 Lane judge will verify the duration of engagement with the vertical barrier and record the scoring.
- 9.11 The attempt ends when all the devices have stopped or when the 3-minute run time has lapsed.
- 9.12 The Device Controllers will collect their devices when authorised by the judges. Minor repairs and adjustments can be made at this stage – see 8.19.
- 9.13 The run procedure is repeated on different lanes of three different distances to complete a heat.

For multiple target competition (steps following from 9.6 above):

- 9.14 Judges will verify the contact of the plunger – plug simulator within the first vertical target area and record any valid scoring.
- 9.15 Lane judge will verify the duration of the first engagement with the vertical barrier and record the scoring.
- 9.16 Judges will check the position of the datum point relative to the first target, verify the time of engagement and record the score for that run.
- 9.17 Judges will verify the contact of the plunger – plug simulator within the second vertical target area and record any valid scoring.

- 9.18 Lane judge will verify the duration of the second engagement with the vertical barrier and record the scoring.
- 9.19 The attempt ends when all the devices have stopped or when the 3-minute run time has lapsed.
- 9.20 The Device Controllers will collect their devices when authorised by the judges. Minor repairs and adjustments can be made at this stage – see 8.19.
- 9.21 The run procedure is repeated on different lanes to complete a heat.

## 10 Scoring and penalties

The scoring for each run is cumulative of any valid event and engagement with the targets and the barriers.

### For single target competition:

- 10.1 Precision in contacting the wall with the front plunge in the vertical target area: 0 point for contacting the wall outside the target area, 5 points for contacting the wall within the target area
- 10.2 Duration of the engagement with the wall: 1 point for an engagement of 2 seconds or less, 5 points for engagement of 3 to 9 seconds, 10 points for engagement of 10 seconds or more, 0 points for engagement longer than 15 seconds. Points will be valid only if the device continue the mission to return towards the starting point / attempt to continue the mission.
- 10.3 Precision in returning to the starting point, with reference to the datum pointer relative to the horizontal target: 0 to 10 points available, see target in Figure 8.
- 10.4 If the judging panel agree a device stops with the datum pointer falling on the boundary between two different zones, the highest score between the two zones will be recorded for that run.
- 10.5 After the three single runs on different lane lengths, the three scores recorded in the heat will be added together. A maximum of 25 points are available per each run.

### For multiple target competition:

- 10.6 Precision in contacting the wall with the front plunge on the first vertical target area: 0 points for contacting the wall outside the target area, 5 points for contacting the wall within the target area.
- 10.7 Duration of the engagement with the wall at the first contact: 1 point for an engagement of 2 seconds or less, 5 points for engagement of 3 to 9 seconds, 10 points for engagement of 10 seconds or more, 0 points for engagement longer than 15 seconds. Points will be valid only if the device continue the mission to return towards the starting point / attempt to continue the mission.
- 10.8 Precision in returning to the first horizontal target - starting point, with reference to the datum pointer relative to the horizontal target: 0 to 10 points available, see target in Figure 8.
- 10.9 Precision in contacting the wall with the front plunge on the second vertical target area: 0 point for contacting the wall outside the target area, 5 points for contacting the wall within the target area.
- 10.10 Duration of the engagement with the wall at the second contact: 1 point for an engagement of 2 seconds or less, 5 points for engagement of 3 to 9 seconds, 10 points for engagement of 10 seconds or more, 0 points for engagement longer than 15 seconds. Points will be valid only if the device



continue the mission to return towards the starting point / attempt to continue the mission.

- 10.11 Precision in returning to the second horizontal target, with reference to the datum pointer relative to the horizontal target: 0 to 10 points available, see target in Figure 8.
- 10.12 If the judging panel agree a device stops with the datum pointer falling on the boundary between two different zones, the highest score between the two zones will be recorded for that run.
- 10.13 After the three single runs on different lane lengths, the three scores recorded in the heat will be added together. A maximum of 50 points are available per each run.

#### Regional Finals - Foundation Challenge

- 10.14 A maximum of 75 points is available in the heats, with the same procedure as described in 10.1 - 10.5. The top three teams in the heats returning the highest scores will progress to the final.
- 10.15 Points from the heats will not be carried forward.
- 10.16 A maximum of 75 points is available in the Regional Final, with the same procedure as described in 10.1 - 10.5. The winner will be the team achieving the highest score in the final.
- 10.17 Points will be normalised to 100 for comparison and ranking in the overall winner scoring
- 10.18 In the event of a tie in the Regional Final, a re-run between the tied teams will take place as detailed in sections 10.33 - 10.35.

#### Regional Finals - Advanced Challenge

- 10.19 A maximum of 150 points is available in the heats, with the same procedure as described in 10.6 - 10.13. The top three teams in the heats returning the highest scores will progress to the final.
- 10.20 Points from the heats will not be carried forward.
- 10.21 A maximum of 150 points is available in the Regional Final, with the same procedure as described in 10.6 - 10.13. The winner will be the team achieving the highest score in the final.
- 10.22 In the event of a tie in the Regional Final, a re-run between the tied teams will take place as detailed in sections 10.33 - 10.35.

#### National Finals - Foundation Challenge

- 10.23 A maximum of 75 points is available in the heats, with the same procedure as described in 10.1 - 10.5. The top three teams in the heats returning the highest scores will progress to the final.
- 10.24 Points from the heats will be carried forward. 75 points are available in the final, with the same procedure as described in 10.1 - 10.5, meaning a maximum of 150 points is possible for the Main Competition.

- 10.25 Points will be normalised to 100 for comparison and ranking in the overall winner scoring.
- 10.26 In the event of a tie of overall points in the National Final, the team with the highest points in the Main Competition will be the winner.
- 10.27 In the event of a further tie on points, a re-run between the tied teams will take place as detailed in sections 10.33 - 10.35.

#### National Finals - Advanced Challenge

- 10.28 A maximum of 150 points is available in the heats, with the same procedure as described in 10.6 - 10.13. The top three teams in the heats returning the highest scores will progress to the final.
- 10.29 Points from the heats will be carried forward. 150 points are available in the final, with the same procedure as described in 10.6 - 10.13, meaning a maximum of 300 points is possible for the Main Competition.
- 10.30 Points will be normalised to 100 for comparison and ranking in the overall winner scoring.
- 10.31 In the event of a tie of overall points in the National Final, the team with the highest points in the Main Competition will be the winner.
- 10.32 In the event of a further tie on points, a re-run between the tied teams will take place as detailed in sections 10.33 - 10.35.

#### Re-Run Procedure

- 10.33 In the event of a tie affecting qualification to the final, the tied devices will be retested in the selected lanes. Points will be scored accumulated as in the heats or finals, according to the regional or national final regulations, see 10.14 to 10.32.
- 10.34 If a winner cannot be determined after the tie re-run, there will be a head-to-head run off on the longest distance lane for a single score.
- 10.35 If this does not determine a winner on points the distance to the datum point will be measured and the device with the shortest distance will be the winner of the tie.

#### Zero Points and disqualification

- 10.36 A team will score zero points in the attempt if:
- 10.36.1 The device doesn't hit the wall before reversing direction
  - 10.36.2 The device leaves temporarily or permanently the marked area on the lanes, including not stopping after the end of the board as described in Figure 3 and / or Figure 16.
  - 10.36.3 The device has not come to a stop after 3 minutes.
  - 10.36.4 The device controller has touched the device outside the time window allowed. The device will be disqualified from this run but can compete and cumulate points in the other runs.

## Penalties

- 10.37 If the datum pointer is too high from the ground, a 25% penalty will be applied on all scoring relative to the horizontal target.
- 10.38 If the front plunger is larger than allowed, will lead to 50% penalty on all scoring relative to the vertical target.
- 10.39 If the front plunger cannot realign between the two vertical targets (*Advanced Challenge* - IMechE Design Challenge - General Specification 2025 – 4.15.3 and 7), will lead to 50% penalty on all scoring relative to the vertical target.
- 10.40 Penalties can be cumulated.

## Disqualifications

- 10.41 If a device is considered unsafe at any point of the competition or scrutineering, it will be disqualified from the physical competition. This includes but is not limited to exposed electrical connections, absence of a main fuse, device not fitting in the maximum envelope, datum pointer not installed – present, risk of finger trapping in movable elements such as gears or belts.
- 10.42 A device that leaves the running lane for more than one event, potentially affecting the competition of other devices.
- 10.43 A team member or the device controller that touches the device outside the allowed time for more than one event.
- 10.44 If the device is programmed via wireless connection within the runs, including inputting lanes – distances for target in the code between runs (*Advanced Challenge* - IMechE Design Challenge - General Specification 2025 – 4.15.3 and 7).
- 10.45 The device not fitting in the given envelope at any time of the competition, see 4.1.1.
- 10.46 If a device, or its team, does not comply with the competition rules, it will be disqualified from the Main Competition.
- 10.47 A device disqualified from the physical element of the competition will not cumulate points for the overall winner – will not be eligible as overall winner.
- 10.48 The judging panel decision on disqualifying a team will be final.