

DESIGN CHALLENGE PROJECT SPECIFICATION AND RULES 2026

IMechE DESIGN CHALLENGE

EXTERNAL PIPE CLIMBER



Project Specification and Rules for the 2026 External Pipe Climber Design Challenge

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Note: this specification must be read alongside the
"IMechE Design Challenge - General Specification 2026"
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
1.1	-	First release	13/06/2025
1.2	6; 9; 11; 12; 13; 15; 16; 18; 19; 20.	Sections: 1 amended; 2 amended; figure 7 replaced (typo); 4.4 amended; 4.8 amended; 4.11 to 4.13 added; 5 amended; 5.10 amended; 5.11 added; 5.12 amended; 6.12 amended; 6.13 added; 6.14 amended; 7.18 amended; Appendix 1 amended.	15/12/2025
1.3	16; 19; 20	Sections: 6.16 scoring amended; Appendix 1 amended.	20/2/2026

List of Major Changes Since 2025

- External pipe climber specification reviewed from legacy
 - Harmonised mission profile between different categories

Please report any errors to designchallenge@imeche.org so that corrections can be made.

1 Introduction

This year the challenge is to design, build and test a device to simulate a wire rope climbing robot, with the potential to perform unmanned non-destructive testing on suspended bridges ropes or depose optic fibre cables on existing over the ground lines. Examples are SKY Wire from Inspection GC, SkyWrap from AFL and others.



Figure 1 – Inspection GC SKY Wire Rope Climbing Robot (www.inspectiongc.com)



Figure 2 – Optic fibre cable installation AFL SkyWrap (www.aflglobal.com)

The competing device should be capable of undertaking a repeatable climbing movement externally to a commercial pipe fixed vertically, with an increasing load attached to it. 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.

The competing device can be based on any moving technology with contact with the vertical pipe, and it should:

- be started manually and perform the mission autonomously, without any other external support or control.
- be capable of performing on a real installation without requiring any post treatment or adjustment. Errors in vertical – plumb line may be present

and the substrate of the commercial 22mm copper pipe will be as in purchased condition - refer to BS EN 1057;

- start, return and / or stop on specific positions as specified in 5 or 6;
- engage with the top barrier as specified in 2 and 5 or 6;
- lift a changing load – delivered by a standardised chain;
- disengage the chain retention (clip) as specified in in 5 or 6.

Points will be awarded for the time device takes to return to the starting point, delay – maintaining the engagement with the top barrier; delay – maintaining engagement with intermediate target position (if applicable), accuracy on the intermediate target position (if applicable), releasing the load attached.

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 2026*" - section 4 for further guidance.

2 Main competition general description

The devices will move vertically on a pipe pre-assembled to a frame, connecting to it from a starting point above the ground level to a top barrier.

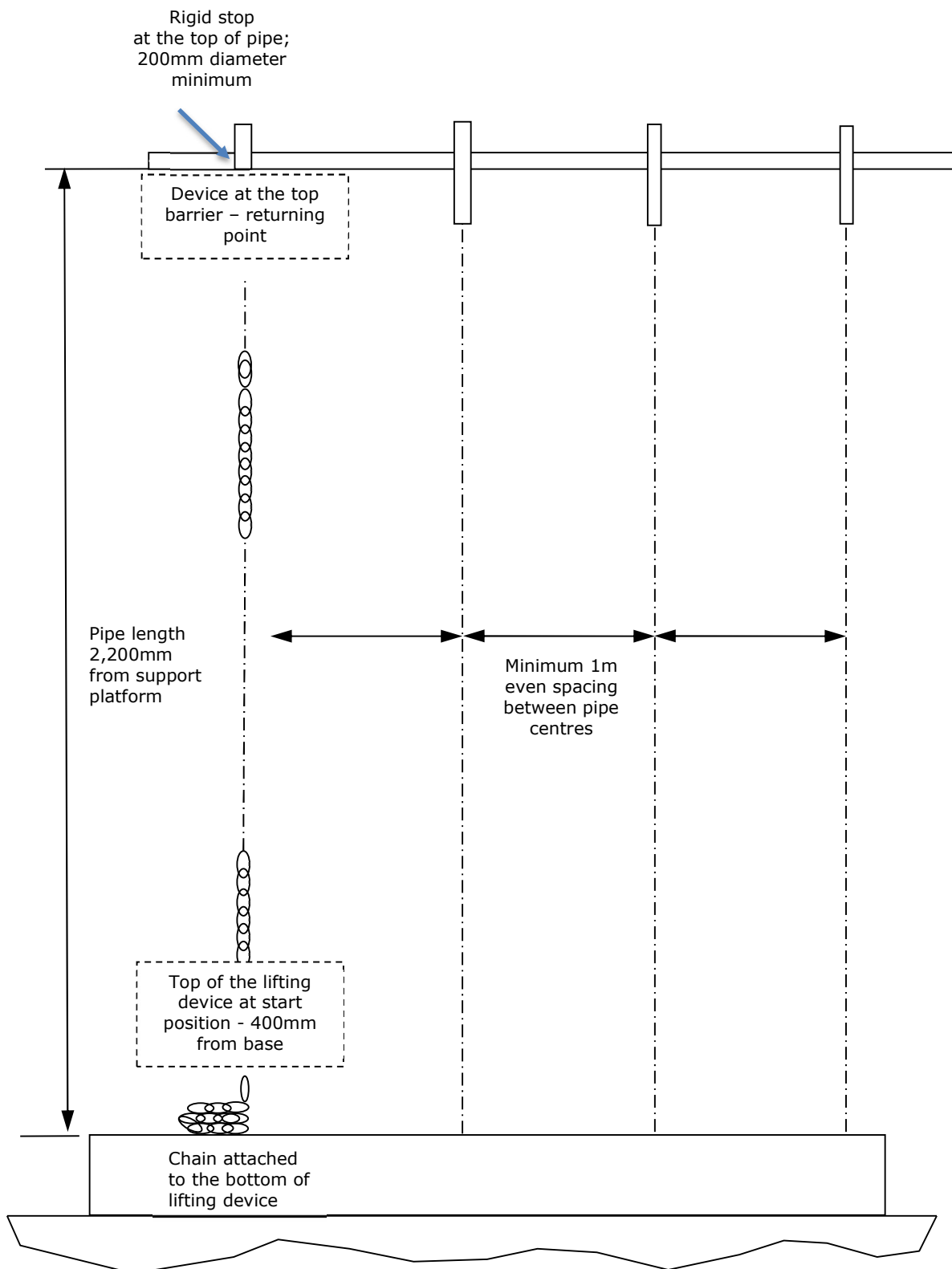


Figure 3 – Rig and device schematic

The device shall return to the ground level / pass the starting point without any human intervention, excluding the removal from the pipe. In all operations, no connection, disconnection or alteration of the pre-assembled rig is allowed.

Intermediate steps may differ between the competing categories.

Allowed rig tolerances and conditions:

- plumb error 8mm over 3m vertical;
- pipe diameter error $\pm 2\%$;
- pipe roundness error $\pm 2\%$;
- pipe max straightness error 4mm/2m;
- no paint, surface treatment, joints or other: pipe in as bought condition (except for targets marking – see below).

Lines on the vertical pipes shall be marked with a pipe cutter, leaving light marks of maximum 0.2mm wide, without cutting the pipe and without raising edges, see Figure 4. Distances from the bottom of the pipe and between lines with tolerance of $\pm 2\text{mm}$ will be considered equivalent.

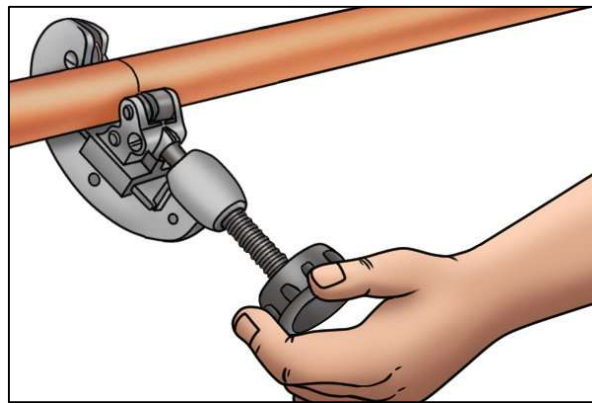


Figure 4 – Targets scoring

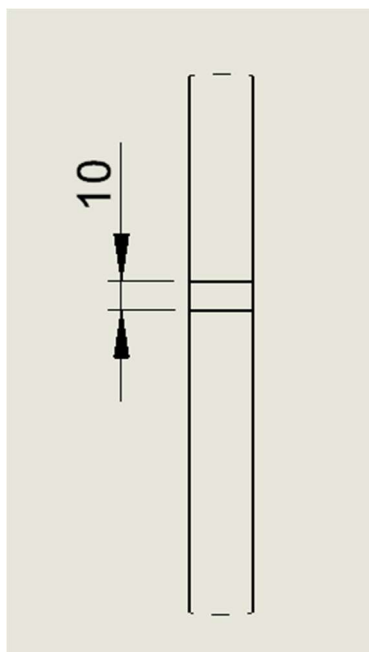


Figure 5 – Starting point – first target

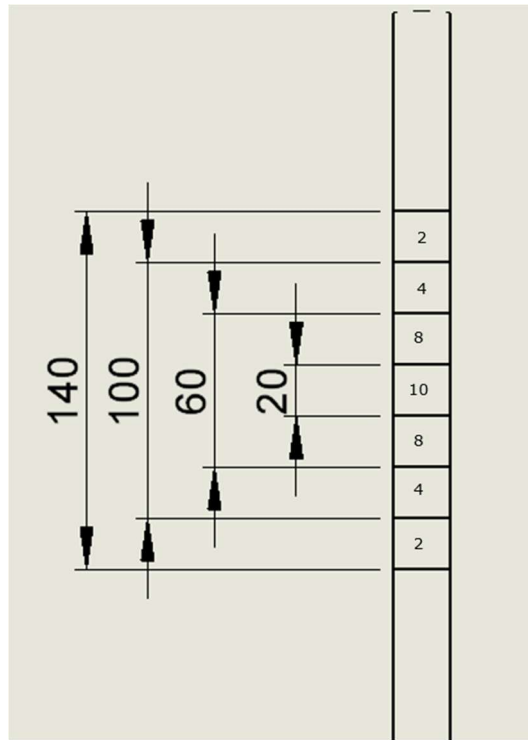


Figure 6 – Intermediate reference / target zone

The rig should be designed and manufactured such that two people can safely tilt it to retrieve a stuck device, eliminating the need for ladders or working-at-height equipment.

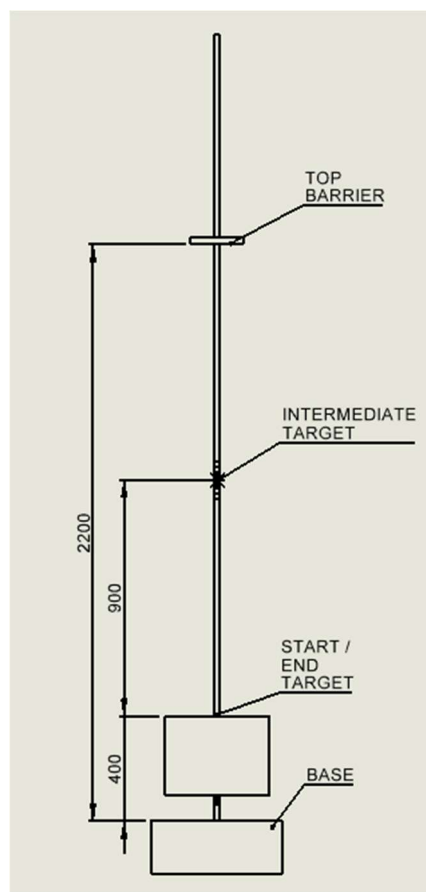


Figure 7 - Single pipe rig schematic – with dimensions

3 Device categories and competition conditions

Referring to "IMechE Design Challenge - General Specification 2026":

- the devices in category *Concept Challenge* (IMechE Design Challenge - General Specification 2026 – 4.13.1) shall be designed to perform as per 5 - Note: no physical device built, design elements only;
- the devices in category *Foundation Challenge* (IMechE Design Challenge - General Specification 2026 – 4.13.2) shall be designed and built to perform as per 5;
- the devices in category *Advanced Challenge* (IMechE Design Challenge - General Specification 2026 – 4.13.3) shall be designed and built to perform as per 6.

At the competition, the pipes 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 rig: all the pipes 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 are the major characteristics of the devices competing

- 4.1 The device can be of any type, but it must be completely self-contained and fit within a working envelope of 400mm diameter 300mm length maximum, excluding the automatic clip – see below *Figure 8*.

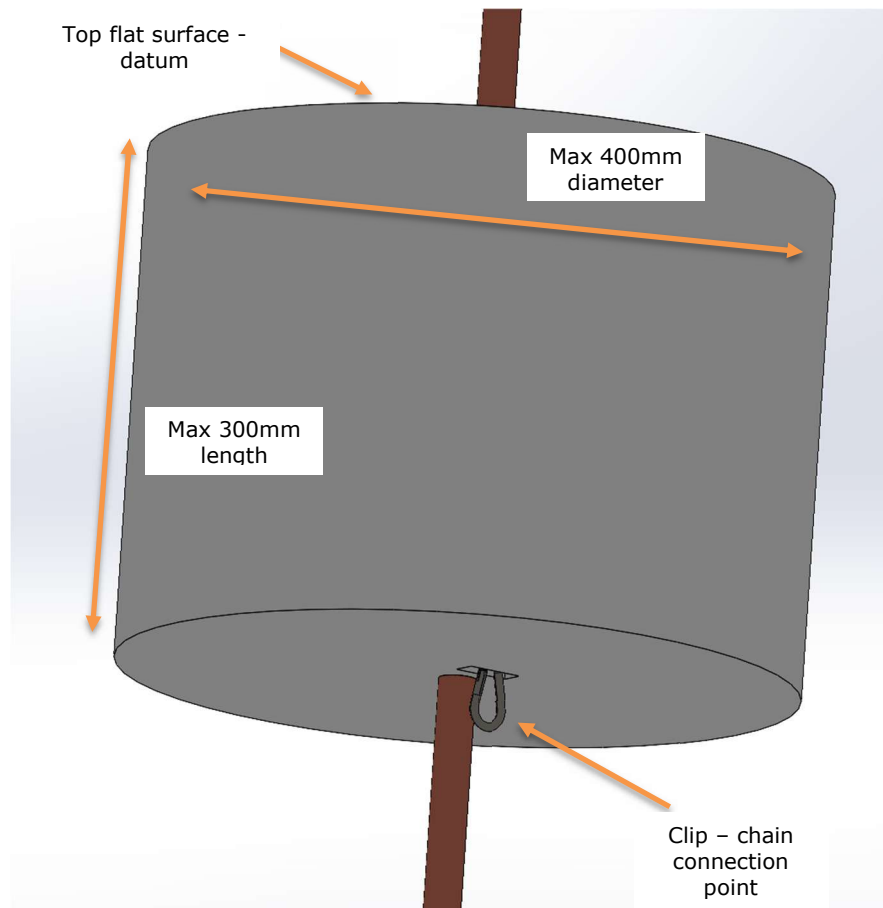


Figure 8 – Maximum envelope, pipe and standard connecting clip

- 4.2 The device must always fit within the maximum working envelope during competition.
- 4.3 The top (opposite to chain connection) shall be flat and even, functioning as datum reference and inversion switch – command, without any protrusion (including screws and connections).
- 4.4 Any plunger, switch or element at the top of the device necessary to contact the top barrier and command the reversing movement shall fit within the maximum envelope and not alter the top flat reference surface - datum. Similarly, any switch or tether to operate the device shall fit within the given envelope and travel with the device.
- 4.5 The device should not contaminate with fluids or lubricant the tube or, similarly, create dents, scratches or modify the surface of the tube.
- 4.6 The device will climb over 22mm commercial copper pipes, without junctions, similar to www.diy.com product code 5034579002535

- 4.7 The device shall include a single 50mm automatic clip – carabineer similar to www.screwfix.com 334FE as attachment of the load chain. This shall be included in BoM and considered as part of the vehicle, for both mass and cost considerations. The clip can protrude outside the maximum envelope, see *Figure 8*.
- 4.8 The progressively changing load will be simulated by a 2.5mm x 2.5m chain, similar to see www.diy.com product code 3663602920335, with a specific mass between 115 and 155 g/m (grams per linear meter).
 - 4.8.1 For the purpose of the project, any chain with a specific mass as listed in 4.8 will be considered equivalent. The chains will be left by an individual vertical pipe though the whole duration of the event.
- 4.9 The device should have a visible green light, that remains lit for the duration of the run.
- 4.10 An additional visible red light and a sound (buzzer or similar) shall be on during some elements of the competition, see 5 or 6.
- 4.11 Only the competing device can be connected to the pipe or the rigs, no other elements can be used to secure, support, lift or position the device on the rig: any removable support, stand or similar is not allowed.
- 4.12 The device must be self-retaining on the pipe once positioned and for the whole duration of the run, until manual intervention by the device controller.
- 4.13 A single device controller is allowed to install, remove, connect chains and operate the device during the heats or the final.

5 Main competition conditions – single movement

The aim of this competition is to design a device that could perform the mission described below in less than 3 minutes in total.

The device shall have the top surface – datum aligned between the target lines, see *Figure 8*, *Figure 7* and *Figure 5*.

The aim of the competition is to perform the mission in the shortest time possible.

Competition steps - single movement competition:

- 5.1 Position the device with the top datum surface between the starting target lines (*Figure 5*).
- 5.2 (after the judges says "Go!") Switch on the device – make the device operative and green light visible.
- 5.3 The device will start moving upwards, hitting the top barrier with the top datum surface.
- 5.4 It must remain in contact with the barrier up to 15 seconds, it should produce a red light and sound (buzzer).
- 5.5 Leave the top barrier, red light and sound switches off – only green light visible, return towards the starting point – first target.
- 5.6 Between the intermediate target (*Figure 6*) and the starting point – first target (*Figure 5*) release the automatic clip (see 4.7) and the chain connected to it (see 4.8).
- 5.7 Progress movements towards the starting point – first target (*Figure 5*), time count is stopped at top surface passing it.
- 5.8 Stop autonomously or by contacting the ground without any operator intervention to complete the challenge.
- 5.9 Swap onto a different climbing area and setup in 2 minutes maximum.

Scoring - single movement competition:

- 5.10 The maximum score for the fastest time per run is 30 points – excluding any time it remains in contact with the vertical barrier. The slowest team in the heats or final completing the mission within the maximum allowed time will be awarded 10 points. Other teams will be awarded points on a linear pro rata basis, rounded down.
- 5.11 The mission time will be rounded up to the nearest 5 seconds; it means that valid mission times will be 5s, 10s, 15s, 20s and so on.
 - 5.11.1 Device competing and achieving the same rounded up time will be awarded the same score: for example, a device completing the mission successfully in 11s and another in 14s will be both recorded as in 15s.
- 5.12 Bonus points for holding the position before the start without operator support: 5 points.
 - 5.12.1 To be considered self-retained and holding the position without operator, the device shall not touch the ground directly.

- 5.13 Bonus points for engagement with top barrier by emitting sound and visible light (see 5.4): 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.
- 5.14 Bonus points for releasing chain after passing the intermediate target (*Figure 6*) and before reaching the starting point – first target (*Figure 5*): 10 points.
- 5.15 Bonus points are awarded only if the device continue or attempts to continue the mission to the following step.
- 5.16 A total of maximum 55 points is available per heat or run.
- 5.17 Points will be normalised to 100 for final scoring summary.
- 5.18 Example score calculations are shown in Appendix 1 – Scoring examples.

6 Main competition conditions – multiple movements

The aim of this competition is to design a device that could perform the mission described below in less than 3 minutes in total.

The device shall have the top surface – datum aligned between the target lines, *see Figure 8, Figure 7 and Figure 5.*

Competition steps - multiple movement competition:

- 6.1 Position the device with the top datum surface between the starting target lines – *see Figure 5.*
- 6.2 (after the judges says “Go!”) Switch on the device – make the device operative and green light visible.
- 6.3 The device will start moving upwards, hitting the top barrier with the top datum surface (no stop on the intermediate target).
- 6.4 Remain in contact with the barrier up to 15 seconds, produce red light and sound (buzzer).
- 6.5 Leave the top barrier, red light and sound switches off – only green light visible, return towards the starting point – first target (no stop on the intermediate target).
- 6.6 Remain in position over the first target up to 5 seconds, produce red light and sound (buzzer).
- 6.7 Move upwards toward the intermediate target.
- 6.8 Between the starting point – first target and the intermediate target release the automatic clip (see 4.7) and the chain connected to it (see 4.8).
- 6.9 Remain in position over the intermediate target up to 5 seconds, produce red light and sound (buzzer).
- 6.10 Switch off red light and sound, hold position on the intermediate target to complete the challenge.
- 6.11 Swap onto a different climbing area and setup in 2 minutes maximum.

Scoring - multiple movement competition:

- 6.12 The maximum score for the fastest time per run is 30 points– excluding any time it remains in contact with the vertical barrier and holding position on the starting target. The slowest team in the heats or final completing the mission within the maximum allowed time will be awarded 10 points. Other teams will be awarded points on a linear pro rata basis, rounded down.
- 6.13 The mission time will be rounded up to the nearest 5 seconds; it means that valid mission times will be 5s, 10s, 15s, 20s and following.
- 6.13.1 Device competing and achieving the same rounded up time will be awarded the same score: for example, a device completing the mission successfully in 11s and another in 14s will be both recorded as in 15s.
- 6.14 Bonus for holding the position before the start without operator support: 5 points.

- 6.14.1 To be considered self-retained and holding the position without operator, the device shall not touch the ground directly.
- 6.15 Bonus points for engagement with top barrier by emitting sound and visible light (see 6.4): 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.
- 6.16 Bonus points for maintaining the position over the starting point - first target by emitting sound and visible light (see 6.4): 1 point for an engagement of 2 seconds or less, 5 points for engagement of 3 to 5 seconds, 0 points for engagement longer than 15 seconds.
- 6.17 Bonus points for releasing chain after leaving the starting point – first target (see *Figure 5*) and before reaching the intermediate target (see *Figure 6*): 10 points.
- 6.18 Bonus points for position over the intermediate target – see *Figure 6*;
- 6.19 Bonus points are awarded only if the device continue or attempts to continue the mission to the following step.
- 6.20 A total of maximum 70 points is available per heat or run.
- 6.21 Points will be normalised to 100 for final scoring summary.
- 6.22 Example scores calculations are shown in Appendix 1 – Scoring examples.

7 Notes and penalties

Additional notes:

- 7.1 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.
- 7.2 The teams must swap rig location within the allowed time, without moving the chains from the locations.
- 7.3 At the national final only, points from the heats will be carried forward into the final for overall scoring.
- 7.4 PPE – eye protection (minimum) is required for all the device controllers.

Re-Run Procedure

- 7.5 In the event of a tie affecting qualification to the final, the tied devices will be retested in selected lanes. Points will be scored as in the heats.
- 7.6 If a winner cannot be determined after a tie re-run, there will be a head-to-head repeat until a device scores higher points.

Zero Points

A team will score zero points in the attempt if:

- 7.7 The device doesn't hit the top barrier before reversing direction
- 7.8 The device has not come to a stop after 3 minutes.
- 7.9 The device operator has touched the device outside the time window allowed.
- 7.10 The device operator has caught the device on the descent.
- 7.11 The device does not have a red light and emit a sound when indicated by the competition (see 5 or 6) – zero bonus points.

Penalties

- 7.12 If the top barrier is not flat and has some protrusions a 25% penalty will be applied on all scoring relative to the competition.
- 7.13 Penalties listed in the General Specification can be cumulated with the ones in 7.12.

Disqualifications

- 7.14 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, multiple energy sources, device not fitting in the maximum envelope, risk of finger trapping in movable elements such as gears or belts.

- 7.15 A team member or the device operator that touches the device outside the allowed time on more than one occasion.
- 7.16 The device not fitting in the given envelope at any time of the competition, see 4.1.
- 7.17 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.
- 7.18 The judging panel decision on penalties and / or disqualifications will be final.

Appendix 1 – Scoring examples

Competition scoring examples

Table 1 - Foundation competition heats scoring - worked example

Heat / Final			Uni 1	Uni 2	UTC 1
			Team A	Team B	Team C
1 st run	Holding position without operator (5pt) – Bonus (Sect. 5.12)	pt	5	0	0
	Overall run time	s	104.3	98	115
	Duration of engagement with top: 1p 2s or less, 5 p 3 to 9 s, 10 p 10 s or more, 0 p longer than 15 seconds (Sect. 5.13)	s	12	1	14
		pt	10	1	10
	Net run time - rounded	s	95	100	105
	Run time score (Sect. 5.10 & 5.11)	pt	30	20	10
	Releasing the chain between mid and end in the descend (Sect. 5.14)	pt	10	0	0
	Run total	pt	55	21	20
2 nd run	Holding position without operator (5pt) – Bonus (Sect. 5.12)	pt	5	0	0
	Overall run time	s	101.2	94	100
	Duration of engagement with top: 1p 2s or less, 5 p 3 to 9 s, 10 p 10 s or more, 0 p longer than 15 seconds (Sect. 5.13)	s	12	8	12
		pt	10	1	10
	Net run time - rounded	s	90	90	90
	Run time score (Sect. 5.10 & 5.11)	pt	30	30	30
	Releasing the chain between mid and end in the descend (Sect. 5.14)	pt	0	0	0
	Run total	pt	45	31	40
3 rd run	Holding position without operator (5pt) – Bonus (Sect. 5.12)	pt	5	0	0
	Overall run time	s	98.5	92.8	115
	Duration of engagement with top: 1p 2s or less, 5 p 3 to 9 s, 10 p 10 s or more, 0 p longer than 15 seconds (Sect. 5.13)	s	1	1	14
		pt	10	1	10
	Net run time - rounded	s	100	95	105
	Run time score (Sect. 5.10 & 5.11)	pt	20	30	10
	Releasing the chain between mid and end in the descend (Sect. 5.14)	pt	10	0	0
	Run total	pt	45	31	20
Penalties [no penalty = 100%]			75%	100%	75%
			Project specification 7.12	N.A.	Project specification 7.12
Total points - time only (including any penalty):			109	83	60
Ranking - final:			1	2	3

Table 2 - Advanced competition heats scoring - worked example

Heat / Final			Uni 9	Uni 10	UTC 5
			Team X	Team Y	Team Z
1 st run	Holding position without operator (5pt) – Bonus (Sect. 6.14)	pt	5	0	0
	Overall run time	s	95	45	115
	Duration of engagement with top: 1p 2s or less, 5 p 3 to 9 s, 10 p 10 s or more, 0 p longer than 15 seconds (Sect. 6.15)	s	12	1	14
		pt	10	1	10
	Duration of engagement with start point: 1p 2s or less, 5 p 3 to 9 s, 10 p 10 s or more, 0 p longer than 15 seconds	s	12	1	14
		pt	10	1	10
	Net run time - rounded	s	75	45	90
	Run time score (Sect. 6.12 & 6.13)	pt	17	30	10
	Releasing the chain between start and mid at second climb (Sect. 6.17)	pt	10	0	0
	Bonus points for position over the intermediate target (Sect. 6.18)	pt	2	0	10
	Run total	pt	54	32	40
2 nd run	Holding position without operator (5pt) – Bonus (Sect. 6.14)	pt	5	0	0
	Overall run time	s	90	55	100
	Duration of engagement with top: 1p 2s or less, 5 p 3 to 9 s, 10 p 10 s or more, 0 p longer than 15 seconds (Sect. 6.15)	s	12	1	14
		pt	10	1	10
	Duration of engagement with start point: 1p 2s or less, 5 p 3 to 9 s, 10 p 10 s or more, 0 p longer than 15 seconds	s	12	1	14
		pt	10	1	10
	Net run time - rounded	s	70	55	75
	Run time score (Sect. 6.12 & 6.13)	pt	15	30	10
	Releasing the chain between start and mid at second climb (Sect. 6.17)	pt	0	10	10
	Bonus points for position over the intermediate target (Sect. 6.18)	pt	6	0	10
	Run total	pt	46	42	50
2 nd run	Holding position without operator (5pt) – Bonus (Sect. 6.14)	pt	5	0	0
	Overall run time	s	85	65	95
	Duration of engagement with top: 1p 2s or less, 5 p 3 to 9 s, 10 p 10 s or more, 0 p longer than 15 seconds (Sect. 6.15)	s	12	1	14
		pt	10	1	10
	Duration of engagement with start point: 1p 2s or less, 5 p 3 to 9 s, 10 p 10 s or more, 0 p longer than 15 seconds	s	12	1	14
		pt	10	1	10
	Net run time - rounded	s	65	65	70
	Run time score (Sect. 6.12 & 6.13)	pt	30	30	10
	Releasing the chain between start and mid at second climb (Sect. 6.17)	pt	10	0	0
	Bonus points for position over the intermediate target (Sect. 6.18)	pt	2	6	10
	Run total	pt	67	38	40
Penalties [no penalty = 100%]			50%	100%	80%
			General specification 15.25.3	N.A.	General specification 15.25.1
Total points:			84	112	104
Ranking:			3	1	2