ENGINEERS AUSTRALIA

WARMAN®
Design & Build Competition

WEIR Minerals

36th Warman Design and Build Competition

Competition rules

WARMAN Design & Build Competition

36th WARMAN ESIGN & BUILD COMPETITION 2023

ENGINEERS AUSTRALIA

SPONSORED BY WEIR

Project REFUEL

CONTEXT

Gondwana is a small planet orbiting a star on the outer fringes of the Milky Way. The native Gondwanans utilise hybrid propulsion engines to launch rockets into orbit of their planet. These rocket engines utilise a liquid fuel and a liquid oxidiser which are mixed and combusted within the engine. Each liquid is stored under high pressure in spherical vessels and will self-ignite when mixed. Due to the different properties of these liquids and the ratios required for complete combustion, these storage vessels have different sizes for each liquid component. The spherical design and materials used to form these containers allows for good impact resistance and *usually* protects against the rough handling typically experienced during transportation from the refinery to the rocket launch location. A recent near-miss incident at the storage facility has highlighted potential risks with the handling and transport of these storage vessels, and the Gondwanans have asked for assistance from Earth's student engineers to improve their processes. Oxidiser and fuel vessels were found to be leaking in the previously shared storage drop zone, which could have resulted in a major explosion. The Gondwanans have redesigned their storage vessel drop zones where quad-copters deliver the vessels, so that now there is a distinct and separate area for each type of vessel, with an appropriate separation distance between these zones. Furthermore, they have committed to ensuring that vessels of different size should never come into direct contact with each other, be carried together in any loading or transport system, or be deposited into the incorrect storage vessel. Due to these more rigorous safety requirements the existing systems used to load the vessels into their respective storage silo have become obsolete, and require a clean-sheet redesign.

Your team of student engineers has been set the task of designing and building a scale, demonstration system which is capable of separately picking up three Fuel and three Oxidiser vessels and safely depositing them into their respective storage silos, which are typically located on small raised platforms. Over the last 35 years, Earth's engineering students have rendered invaluable assistance with such engineering problems, and we anticipate you will again be successful on this thirty-sixth occasion.

OBJECTIVE

Prototype a reduced scale, proof-of-concept transport system, later referred to as the "system", which will precisely deliver scale representations of the Propellant Fuel vessels and the Propellant Oxidiser vessels, from their respective drop zones to their respective storage silos. Referring to Figure 1, the team will have freedom to position the six spherical vessels (three fuel and three oxidiser) at your chosen location within the respective zone boundaries and the team will install the system within the boundaries of the Setup/Start Zone. The fuel vessels will be simulated using tennis balls. The oxidiser vessels will be simulated using squash balls. Your system must start in the Setup/Start Zone and be fully contained within an imaginary 400mm sided cube. When activated via a single starting action, your system will autonomously collect the vessels (in the order of your choice) and deliver them to their respective storage silos. Vessels containing the different fluids must not come into contact at any time, your system must not simultaneously carry (fully support) vessels containing the different fluids, and you must not deposit a vessel in the incorrect storage silo. Failure to comply with any of these three requirements will pose unacceptable risks. Your system should return to, and/or finish the run completely within the Setup/Start Zone. The maximum allowed time for the operation is 120 seconds.

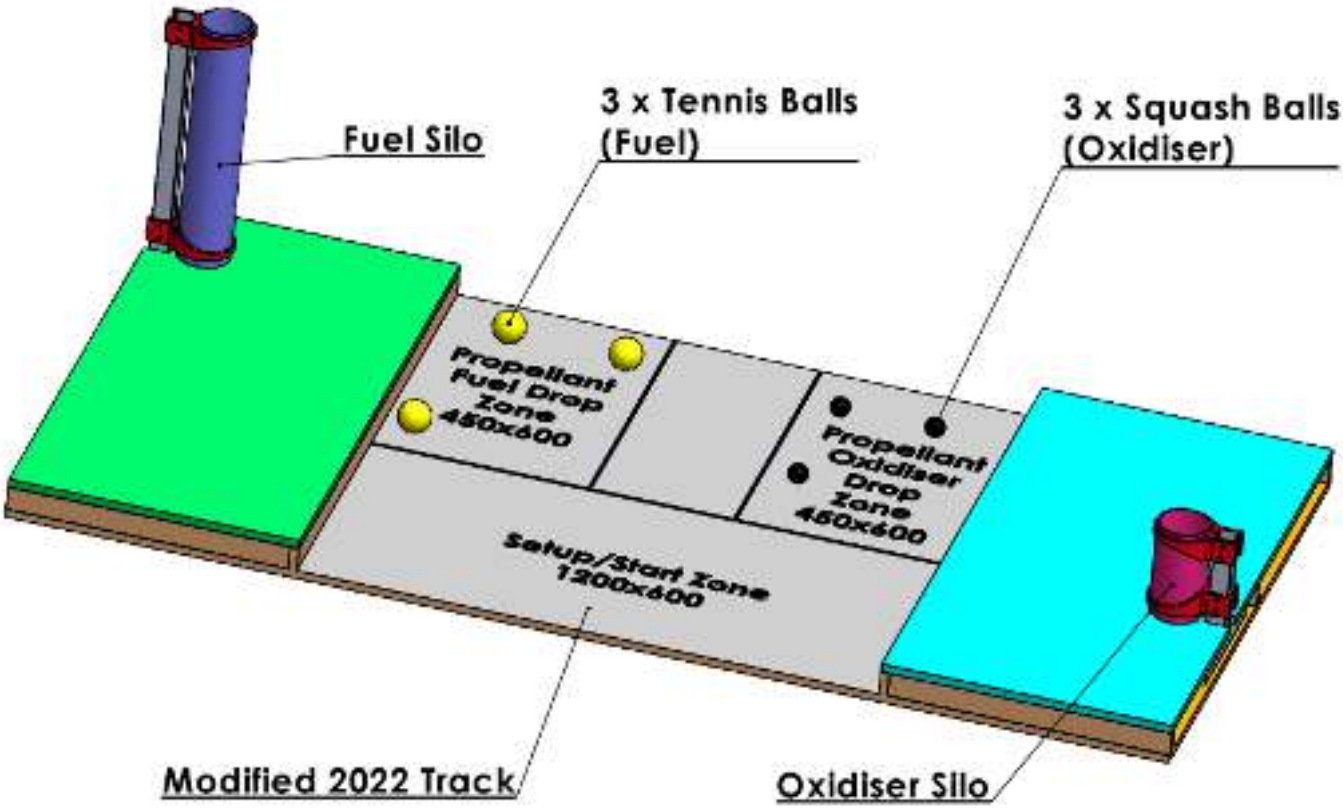

Figure 1. Schematic view of the Competition Track showing the system Setup/Start Zone, the Propellant Fuel Drop Zone, the Propellant Oxidiser Drop Zone, and on raised platforms the Fuel Storage Silo and the Oxidiser Storage Silo.

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Details follow:

- Competition Guidelines
- Competition Rules
- Frequently Asked Questions
- Further Competition Details
- Spirit of the Competition
- Appendix A – Detailed Drawings of the Competition Track and Relevant Component Details

Document Control:

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Competition Guidelines

Wording: *The language of the guidelines is tiered. Those clauses expressed as "SHALL" are mandatory and failure to comply will attract penalties which in the extreme could lead to a zero RUNscore or disqualification at the International Final. Those expressed as "SHOULD" or "MAY" reflect some level of discretion and choice.*

ELIGIBILITY

G 1. Teams that are eligible to represent their campus in the International Final SHALL consist of students enrolled in the competition year in their first engineering design course/subject/unit in an Australasian (or other countries, by arrangement) mechanical or mechatronics-based BE or 3+2 ME programme. Teams SHALL consist of at least two students, with teams of three or four strongly recommended, but it is recognised that larger teams MAY be educationally appropriate at some universities. If an alternative team structure is envisaged, an International Competition Coordinator should be consulted to ensure that other teams are not unreasonably disadvantaged. While students may be required to participate in the Warman competition more than once at their campus level, students SHALL NOT compete at the International Final more than once.

In registering a team, the Campus Organiser attests to the eligibility of the team and teams found to be ineligible at the International Final SHALL NOT be eligible for an award.

SAFETY

G 2. Safety is of paramount importance when participating in this competition. All engineers SHOULD know that injury and damage to equipment and the environment occur when the control of energy (in any form - whether strain, potential, kinetic or thermal) in a system is lost.

G 3. As appropriate, protective clothing, footwear, safety glasses or full-face masks SHOULD be worn by students working on systems during construction, testing, and

competitions. Refer to your campus requirements. Appropriate, protective clothing, footwear, safety glasses or full-face masks SHALL be worn at the International Final.

G 4. Students are encouraged to carry out a risk assessment for their system prior to campus testing. Students are encouraged to embrace risk management in their own activities and MAY need to demonstrate the safe operation and produce risk assessment documentation in order to compete in either the campus heats or at the International Final.

G 5. Appropriate fuses SHALL be used for electrical systems.

G 6. Compressed gas systems MAY be used, but if used, students SHALL gain Campus Organiser approval based on a safety assessment.

Such systems presented at the International Final SHALL be examined against the following principles and in order to run SHALL be found to be acceptable to the International Competition Coordinators.

- Home fabricated pressure system components SHALL NOT be used.

- Commercial components SHALL be used (unions, vessels, cylinders, lines, etc).

- Evidence of proof testing of compressed gas systems SHALL be provided.

To avoid disappointment, students using compressed gas MAY consult with the International Competition Coordinators prior to arrival at the International Final. The International Competition Coordinators' approval decision SHALL be final after examination of the presented system and documentation at the International Final.

G 7. Systems that are deemed by the officials and judges to be hazardous SHALL NOT be permitted to run. For example, employing any form of combustion SHALL be considered hazardous.

COMPETITION TRACK, EQUIPMENT, AND ENVIRONMENT

G 8. The Competition Track base sheet SHALL reuse the 2022 track with minor modifications. It will be fabricated using primarily one sheet of Medium Density Fibreboard (MDF) or equivalent sheet material (MDF SHALL be used at the International Final), with nominal dimensions 2400 x 1200 x 18 mm, arranged as shown in Figure 1 and Appendix A Figure 2 and Drawings. A track supporting frame, not shown, for the sheet MAY be fabricated by any convenient method. The supporting frame SHALL NOT extend beyond the perimeter of the competition track.

NOTE: *MDF sheets as supplied may be slightly larger than the nominal 2400 x 1200 mm dimensions and are generally 2420 x 1210 mm. On request, all dimensions for the 2022 track SHALL be supplied. It is based on sheet sizes of 2400 x 1200 mm. Competition Tracks at the International Final SHALL be trimmed to be 2400 x 1200 mm sheets.*

Raised platforms SHALL be made from Medium Density Fibreboard (MDF) or equivalent sheet material (MDF will be used at the International Final), with nominal dimensions 600 x 1200 x 18 mm, arranged as shown in Figure 1 and Appendix A Figure 2 and Drawings.

G 9. Each platform, refer G9, SHALL have four supports that SHALL be made from 18mm thick Medium Density Fibreboard (MDF) or equivalent material (MDF will be used at the International Final), arranged as shown in Figure 1 and Appendix A Figure 2 and Drawings.

G 10. The target silos SHALL be made from Holman 100DN DWV PVC drain pipe and SHALL be attached to the pylons using 3D Printed brackets. The print files are supplied. Two identical brackets SHALL be used for each silo arranged as shown in Figure 1, and in Appendix A Figure 2.

G 11. All screw or fastener recesses on the horizontal surfaces of the track SHALL be filled and levelled.

G 12. The MDF track sheet with relevant features attached, not including the vessels, SHALL be identified as the Competition Track as shown in Figure 1. The features include; the central Zone which includes the Set-up/Start zone and two designated Drop Zones, the platforms at each side, the two support pylons, the two storage silo tubes and their mounting brackets with fittings.

G 13. The Setup/Start Zone SHALL be defined by the projected vertical planes of the track sheet edge, the vertical planes of the platforms at either side and the marked boundary, refer to Figure 1.

G 14. The lower surface track sheet, marked with the drop and setup/start zones, Figure 1, SHALL define the competition base plane, which is nominally horizontal. Lettering shown on the surface, Figure 1, are for clarity and SHALL NOT be applied to the track.

G 15. Permanent marker vivid pen lines with knife scribe lines, refer Appendix A Figure 2 and Drawings, SHALL define the boundaries of the Setup/Start Zone and the two Propellant Drop Zones.

G 16. The competition base plane SHALL be no less than 300 mm above the supporting floor at the International Final. The supporting table or frame is not shown in Figure 1.

G 17. Two pylons SHALL support the silos, these SHALL be welded and painted assemblies of 40x40x3 SHS steel, detailed drawing are available on request. For campus' recycling the 2022 track, the oxidiser storage pylon SHALL be cut 192 +/- 5mm above the blue platform surface, refer Figure 1 and Appendix A Figure 2. The height of the Fuel pylon is as per the 2022 track, no change required. The pylons MAY be cut and drilled in situ.

G 18. The two pylons shall be attached to the track base sheet using M8 bolts without washers under the bolt head and with washers between the nuts and track sheet.

G 19. The Storage Silos SHALL be made from Holman 100DN DWV PVC drain pipe. Refer to this page: Holman 100mm PVC Pipe. It SHALL be nominally OD110 x ID 104 and SHALL be positioned on the track at the locations shown in Figure 1 and Appendix. The oxidiser storage silo SHALL be 200mm +/- 5mm tall and the fuel 530mm +/- 5mm. Each silo SHALL be attached to the respective pylon using two, 3D printed brackets as detailed in Appendix A, Figure 2. *.stl are provided. The bracket material SHALL be PETG, nylon or ABS with solid infill. The brackets SHALL be attached to the pylons using two standard zinc plated M6 x 70mm bolts and nuts for each bracket. One standard washer SHALL be fitted beneath the head and nut. Bolt holes through the SHS SHALL be drilled through the pylon for the silo mounting the brackets. Note the bracket orientation, refer Appendix A Photo 1. The top bracket SHALL be flush with the top of the pylon and flat surface of the bottom bracket SHALL be 50mm off the

surface of the platform, refer Appendix A, Photo 1 and 2. The heads of the bolts SHALL be on the setup/start zone side of the track.

G 20. The flat horizontal, external surfaces of the track, and the vertical boundaries of the Chasm zone SHALL be brush or roller coated with one coat of ESTAPOL® Water-Based Xtra Clear – Satin as a sealer followed by two coats of Wattyl ESTAPOL® - Polyurethane Matt (in accordance with Wattyl's recommendations for use with MDF - Refer: Estapol Polyurethane Material Specification and Estapol Water-Based Clear Material Specification. Recycled track surfaces SHOULD be lightly sanded and re-coated with two coats of Wattyl ESTAPOL® - Polyurethane Matt. The vivid and scribed lines SHALL be applied following the last coat. If the MDF track from the 2022 competition is being recycled all the bolt holes and screw holes MAY be filled and the top surface levelled to match the general surface. At the International Final new or recycled 2022 tracks MAY be used but for recycled tracks the holes SHALL be filled and resurfaced according to G21.

G 21. The three vessels representing the Propellant Fuel vessels SHALL be simulated using Wilson Tour Competition Tennis Balls Wilson Tour Competition Balls. (These balls were used for the 2021 competition). One standard zinc plated M12 nut per vessel MAY be used to support each vessel.

G 22. The three vessels representing the Propellant Oxidiser SHALL be simulated using World Squash Federation Approved yellow dot squash balls. Yellow Dot Squash Balls. One standard zinc plated M12 nut per vessel MAY be used to support each vessel.

G 23. Teams SHALL accept that the presence of bright lighting and photographic equipment including flash and infrared systems MAY be part of the competition environment.

G 24. Teams SHALL accept that the presence of air conditioning/ventilation induced air movement MAY be part of the competition environment.

G 25. Teams SHALL accept track assembly, components, and the vessels are made within defined tolerances.

G 26. Campus Organisers MAY modify the rules and or competition track for their local competition but the guidelines and rules as stated SHALL be strictly adhered to at the International Final.

G 27. At the International Finals, video recording SHALL be used to determine placings if potential podium winning time scores are within 3 seconds.

PROOF OF CONCEPT SYSTEM

G 28. The system SHALL cease all operations within 120 seconds. The system MAY use an identifying signal, for example a LED or similar visual or audible signal, to indicate when all electrical and/or mechanical functions have ceased.

G 29. Untethered or tethered flying systems SHALL NOT be used, refer G2. The system SHALL be fully supported by the competition track at all times.

G 30. Prior to the start signal, the system SHALL contact the horizontal surface of the Setup/Start Zone. It MAY also contact the vertical walls at either side of the Setup/Start Zone. The system microelectronics MAY be initialised but SHALL not perform any functions. The overall system SHALL fit within a virtual 400mm cube with one surface of the cube parallel with the horizontal surface of the Setup/Start Zone.

G 31. To earn points for SUPPORTscore, DEPOSITscore, RETURNscore, and RUNTIMEscore the system SHALL complete the tasks as defined in the scoring formula (see SCORING).

G 32. The system MAY launch or throw the vessels into the storage silos.

G 33. The system SHALL NOT comprise multiple separate systems, or a system that separates into multiple, unconnected sub-systems.

G 34. To commence setup a track official SHALL call the team to the track and on the command of a track official the setup SHALL begin. The maximum setup time SHALL be 120 seconds. Teams SHALL set-up their system during this time and position the six vessels at their chosen location within the respective drop zone boundaries. Vessel locating items SHALL not be left on the track. Vessels MAY be supported by M12 nuts supplied by the track officials, refer Appendix A, Photo 3.

COMPETITION RULES

Objective

R 1. Points SHALL be awarded for achieving particular milestones including; the system fully supporting each of the vessels at some point in the run, the successful deposit of vessels in their correct storage silos, the system returning to (or staying within) the Setup/Start Zone at the end of the run, and the time taken to complete the run. The RETURNscore is contingent upon the successful deposit of at least one vessel in its correct storage silo. The RUNTIMEscore is contingent upon the successful deposit of all vessels and the system returning to the start zone.

R 2. Three conditions SHALL result in a zero RUNscore: Vessels of different types coming into contact at any time; the system simultaneously carrying (fully supporting) vessels of different types; depositing a vessel in the incorrect storage silo

System Design and Fabrication

Students SHALL manufacture and fabricate their “proof of concept prototype” system themselves using commonly available materials, components and methods.

R 3. NOTE: At the International Final Campus Organisers MAY be required to confirm that the system presented has been appropriately manufactured in keeping with the spirit of the competition. While students MAY purchase components “off-the-shelf”, it is not intended that they purchase systems / major subsystems as solutions directly.

R 4. In keeping with the spirit of the competition, teams SHALL NOT use LEGOMindstorm® or similar comprehensive kitted systems at the International Final.

R 5. In keeping with the spirit of the competition, teams MAY use Arduino or similar PIC based components.

R 6. In keeping with the spirit of the competition, teams MAY adapt / modify / integrate elements sourced “off-the-shelf”.

R 7. Systems using electric battery storage devices SHALL have an appropriately sized fuse connected to one of the battery leads.

Pre-Setup Scrutineering

R 8. As directed, teams MAY attempt two runs.

R 9. The system MAY be modified between runs.

R 10. The mass of the team’s system (SYSTEMmass) SHALL be measured and recorded by a track official. The system mass does not include the vessels, supporting M12 nuts, if used, and any positioning jigs or setup equipment used by the team but removed from the track before the run start. The SYSTEMmass SHALL NOT be greater than 6 kilograms.

NOTE: *A maximum system mass of 6 kg has been selected to reflect carry on allowances by Jetstar and Virgin airlines so as not to disadvantage interstate and international teams traveling to the International Final who MAY wish to transport their system as carry on. Teams must appropriately satisfy the airline's restrictions/limitations for carry on and/or checked luggage, including restrictions for transporting dangerous goods such as batteries.*

Pre-run System Setup

R 11. The team SHALL then be called to the trackside.

R 12. There SHALL be no contact by team members or their system/vessels with the Competition Track before setup time commences, at the direction of the organisers.

R 13. When ready, an official will signal that the setup SHALL commence. The team SHALL be allowed a maximum of 120 seconds for setup. During this time they are to set up their system in the Setup/Start Zone and position all six of the vessels in their correct drop zones.

R 14. During setup, the team MAY use additional objects not considered part of the “system” to assist with setup. Any additional objects used SHALL be removed from the competition track at the conclusion of the setup time. The mass of these additional objects SHALL NOT be included in the SYSTEMmass.

R 15. After setup, the plan projection of the system SHALL lie fully contained within and supported by any surface(s) within the Setup/Start Zone, including the vertical walls of the zone at either end. The system SHALL NOT be in contact with the horizontal surfaces of the raised platforms at either end of the competition track.

R 16. The installed system SHALL be fully contained within a virtual cube with 400mm sides inside the Setup/Start zone, refer R15. One face of the cube SHALL be adjacent to the

track surface. This SHALL be checked using C shaped gauges, with a 400mm square internal cavity.

R 17. During setup, the vessels SHALL be placed by the team anywhere, such that their plan projection is within the Drop Zone boundaries defined by projected vertical planes of these zones, the edge of the track, and the vertical faces at each end, refer Figure 1. The vessels may be in contact with the vertical faces of the platforms. The vessels SHALL NOT cross the virtual boundaries defined by the zone markings or the edge of the track. Each vessel MAY be supported by one M12 nut supplied by a track official.

R 18. The Team SHALL indicate to the appropriate competition official when their setup is complete.

R 19. After setup, and prior to running, everything placed and left on the competition track, except the vessels and optional M12 nuts, SHALL be considered to be part of the system.

R 20. Officials SHALL inspect the team's setup of their system and vessels, using the gauges, rulers and large square edges. If the setup is found to be in violation of any of the system starting location and size, vessel location requirements or any unintended or unintentional movement of the vessels has deemed to have occurred, at the discretion of the competition officials, the system and vessels MAY ONE TIME ONLY for each run be removed from the track and the setup process IMMEDIATELY repeated. If after the second setup the system or vessels are in violation of the setup rules a zero RUNscore SHALL be recorded.

Run Process and Timing

R 21. On instruction by a clapper board type signal from a track official the run SHALL commence. The start SHALL be counted 3-2-1-clap at nominally one-second intervals.

R 22. The system SHALL be started by a single team member, using a single hand, via a single action, that does not impart any motion or energy to the system. Attaching wires, fitting electrical terminals, or fitting plugs SHALL NOT be considered a single action. Teams should install a reliable and easily accessible switch or mechanical trigger to ensure safe and consistent starting.

R 23. If the team member accidentally or prematurely starts the system, at the discretion of the competition officials, the system MAY ONE TIME ONLY for each run be removed from the track and IMMEDIATELY reset and started again after repeating the setup procedure. Rules R2 to R21 SHALL be adhered to. This rule SHALL NOT be used to extend the setup time.

R 24. After performing the single action start, team members SHALL NOT control or touch the system in any way during the run. Wireless control SHALL not be used. Team members SHALL NOT interfere with the system. The team SHALL wait for a track official's approval to touch the system after the run has started. If team members choose to intervene to protect a system that is malfunctioning, a zero RUNscore SHALL be recorded.

R 25. During the run, the system MAY contact the upper horizontal surfaces of both platforms, the storage silos (inside and outside faces), the pylons and the pylon clamps, in addition to all horizontal and vertical surfaces in the Setup/Start Zone, the two Drop Zones and the intermediate space and the vertical surfaces at each end of the zones.

R 26. The system SHALL NOT contact any of the external vertical faces of the track, or any track or ground surface below the Start Zone surface, refer G13. Such contact SHALL result in a zero RUNscore being recorded.

R 27. During the run the system and vessels MAY extend or pass beyond the edges of the perimeter of the competition track.

R 28. The run SHALL be designed to finish within 120 seconds. For timing, the run SHALL be deemed to be complete when all functions of the system have ceased. An LED or similar visual or audible signal MAY be used to indicate when the micro controller program has ended.

R 29. At the completion of the run, all parts of the system SHALL cease controlled or powered translation or rotation, and remain in this state indefinitely relative to the competition base plane. Mechanisms and items within the system MAY continue to move (i.e. to swing, sway or vibrate) but no further functions may be executed.

R 30. The team or system MAY indicate to the timekeepers when they declare their run to be complete. However, the track officials SHALL make the final judgment as to when the system ceases translation and all functions have ceased and the recorded time MAY exceed the team's or system's declaration.

R 31. To ensure that judging has been completed teams SHALL NOT retrieve their system or assist in gathering other items until directed by a track official.

R 32. A RUNtime SHALL be recorded and rounded up to the nearest half second.

Run Scoring

R 33. The relevant SUPPORTscore SHALL be awarded for any vessels which are completely supported (i.e. collected) by the system, at any time during the run. To qualify for this score the vessel may only be in contact with the system (and potentially other spheres of the same type), but not with any of the competition track surfaces. Depositing, discarding or loss of these vessels later in the run SHALL NOT affect this score. A vessel MAY be supported multiple times but the SUPPORTscore SHALL be given only once for that vessel.

R 34. The SUPPORTscore for each Oxidiser Vessel (squash ball) SHALL be 5 points.

R 35. The SUPPORTscore for each Fuel Vessel (tennis ball) SHALL be 10 points.

R 36. The relevant DEPOSITscore SHALL be awarded for vessels which are deposited into the correct storage silo, and are completely below the plane made by the circular silo opening. The vessel SHALL NOT be supported by the system.

R 37. The DEPOSITscore for each Oxidiser Vessel (squash ball) SHALL be 15 points.

R 38. The DEPOSITscore for each Fuel Vessel (tennis ball) SHALL be 30 points.

R 39. At the conclusion of the run, vessels MAY be left in their initial drop zones, lost or discarded off track, or retained within the system, however they SHALL NOT earn a DEPOSITscore.

R 40. IF at least one vessel (of either) type is successfully deposited into the correct storage silo, the run SHALL attract a RETURN score of 20 points IF the system plan projection is fully contained within the Setup/Start zone at the conclusion of the run. The system MAY remain in this zone during the run.

R 41. IF all six vessels are successfully deposited into the correct storage silo (full SUPPORTscores and DEPOSITscores) AND the system fully returns to the Setup/Start Zone (RETURNscore) then the run SHALL attract a RUNTIMEscore, based on the time taken to complete the run (the RUNTIME). A RUNTIMEscore SHALL NOT be awarded for runs that do not deposit all vessels and return to the start zone, refer R40.

R 42. Each team's overall COMPETITIONscore SHALL be calculated based on their maximum RUNscore plus 50% of their minimum RUNscore gained from a separate run.

R 43. If two or more teams have equal COMPETITIONscores the competition placing SHALL be determined by the SYSTEMmass of these teams. The lower SYSTEMmass SHALL be preferred and will be calculated based on the average recorded SYSTEMmass from both runs.

Conditions Determining Zero RUNscores

R 44. If vessels of different types are simultaneously ***fully*** supported by the system at any time, this SHALL result in a zero RUNscore.

R 45. If at any time during the run, or at its conclusion, any part of the system is lost or discarded off track, or is on-track but is separate (not maintaining physical contact with) the rest of the system, a zero RUNscore SHALL be recorded. At the discretion of the officials, trivial connections that are deployed to circumvent this rule, like string, ropes, wires or chains SHALL NOT be considered sufficient to maintain physical contact between otherwise physically separate sub-systems.

R 46. Vessels of different types which make direct contact with each other whilst within the boundaries of the track perimeter SHALL result in a zero RUNscore.

R 47. Vessels of different types which make direct contact with each other, once outside or below the boundaries of the track perimeter SHALL NOT result in a zero RUNscore.

R 48. Vessels deposited into the incorrect storage silo SHALL result in a zero RUNscore.

R 49. The system SHALL NOT damage or contaminate the competition track. The setup or run SHALL NOT contaminate or damage the vessels. Teams presenting a system that damages or is deemed to have the potential to damage the competition track or vessels MAY be disqualified from the competition. IF damage or contamination is deemed to

have occurred to the track or vessels a zero RUNscore MAY be awarded at the discretion of the competition officials.

R 50. Violations of procedural rules SHALL result in a zero RUNscore being recorded.

R 51. The competition organisers' decisions on all matters pertaining to the competition SHALL be final.

SCORING

The COMPETITIONscore SHALL be calculated using the following:

COMPETITIONscore = Max RUNscore + Min RUNscore/2 $RUNscore = \left((SUPPORTscore + DESPOSITscore + RETURNscore + RUNtimescore)\right)$
SUPPORTscore: 5 for each Oxidiser Vessel the system fully supports. *10 for each Fuel Vessel the system fully supports.* *DEPOSITscore: 15 for each Oxidiser Vessel deposited in the Oxidiser Storage silo.* *30 for each Fuel vessel deposited in the Fuel Storage silo.* *The following scoring is contingent upon the run achieving ANY DEPOSITscore:* *RETURNscore: 20 if the system is fully contained within the Setup/Start Zone at the conclusion of the run. At least one vessel Shall have been correctly deposited, Refer R41* *RUNtimescore: RUNtime = time in seconds for a run that correctly deposits all vessels and the system fully RETURNS to the Setup/Start zone within 120 seconds, refer RETURNscore. Points are calculated based on the RUNtime and according to the following formula RUNtimescore =* $(120 - RUNtime)\ x\ 0.5$ *with a minimum RUNTIMEscore = 0*
Notes: RUNtime is measured from the 'Start Clap' command until the system has ceased functions. The system MAY sway but there SHALL NOT be translational motion relative to the competition track. *RUNtime SHALL be rounded up to the nearest half-second. For example, 15.2s becomes 15.5s and 15.7s becomes 16s* *SYSTEMmass = the net mass, in grams, of the system. Excludes the vessels, nuts and setup tools.*
Example score calculation: *The system supports all three fuel vessels but fails to deposit them and they are lost off the track. It then supports one Oxidiser vessel and deposits it. The system fully returns to the Setup/Start Zone:* *5+5+5 +10 +30 +20 = 75*

FREQUENTLY ASKED QUESTIONS

1. **Can part of a system be "discarded" off the competition track without penalty?**
   No. If the system, or part of the system, is discarded off the competition track this would lead to a zero RUNscore (R49).

2. **Can part of the system overhang the extremities of the competition track without penalty when negotiating the track?**
   Yes, (see R27). After the run commences the system or vessels MAY extend beyond the edges of the perimeter of the Competition Track. Contact between the system and anything below the track base plane is not permitted at any time.

3. **Autonomous – does this mean that the system on the competition track cannot receive input or instructions from a Subsystem off the track (such as a computer)? Or does it mean that the system on the competition track can receive input from a Subsystem off the track (such as a computer) but that Subsystem (computer) cannot be manipulated by a team member during the run? An example of the second would be if the system was controlled by motors that ran to a pre-programmed route transmitted from the computer.**
   Autonomous in this competition implies every control system for the system is to be part of the system on the competition track that fits within the start volume. No remote-to-the-track control systems of any sort can be used (manual or pre-programmed, hard-wired or wireless).

4. **Are programmable chips or microcontrollers allowed?**
   Yes. You can use a programmable chip or microcontroller, but there is to be no remote communication during the run. However, LEGO ® Mindstorms ® or similarly kitted systems are not allowed (see R3, R4, R5).

5. **What is the allowable voltage and power of any employed electrical systems?**
   There are no restrictions this year but it needs to be risk assessed as safe. Refer G4 and R7.

6. **Can off-the-shelf items be used?**
   Commonly available components such as toy and machine parts are able to be used, however full kits or systems such as LEGO ® Mindstorms ® are not allowed. The spirit of the competition is that students manufacture and fabricate their system themselves, meaning that professionals are not engaged to do it for them. It is possible for some assistance to be obtained (e.g.; for a weld) but this should be minimal or where possible be done by the students themselves. The production of major components should not be outsourced.

Further Competition Details

INTERNATIONAL COMPETITION FINAL
We are working on the international competition dates and event format and more information will be posted to teams and competition organisers as soon as it is available.

Competition sponsors Weir Minerals Australia will offer the following prizes and cash awards for participants in the International Final.

Overall Winning Team: **AUD$3,000**
Second Place Team: **AUD$2,000**
Third Place Team: **AUD$1,000**

Weir Minerals' Prize: **AUD$400**
NCED Best Design Prize: **AUD$400**

Campus Champion Prize **AUD$200**
(awarded to all competitors in the international final)

SPIRIT OF THE COMPETITION
Although the rules may look rigid you will find that they have been written in a way that allows, and in fact encourages creative and innovative solutions. This is not always the case in real-world engineering projects. In this project and competition, the rules are there because we have tried to be very clear on points which will be important when student groups come together for the International Final. For this reason, it is essential to work with your Campus Organiser from an early stage, and for the campus organiser to verify decisions with the International Competition Coordinators so that everyone has the same understanding of the meaning of the rules.

If you think you see a loophole, clear it with your Campus Organiser before you rely on it in the competition. Even if it is accepted at the local level, you might be in for a shock at the International Final where the interpretation might be different. Provision will be made for confidentiality, so your idea will not be passed on to other students.

It is highly recommended that all students communicate with their Campus Organiser and that if a ruling is required by the International Competition Coordinators, this is sought by the Campus Organiser. Students SHOULD NOT contact the International Competition Coordinators directly for an individual ruling.

The competition tracks, at the Campus Competitions, State/Country semi-finals and the International Final, will be made with reasonable care but because it is a real engineering object it may well be "wrong" in various small ways. For example, the competition base plane might have a slight longitudinal slope. Your team is expected to consider these possibilities in your design and develop a system that can function even if the competition track has slight imperfections and inaccuracies. In other words, you are not allowed to blame failure of your system on some minor imperfection with the competition track.

A FINAL COMMENT ON SAFETY

Please be aware that in 2003 during a campus competition, a student was lucky to escape serious eye injury when a Subsystem went off unexpectedly. While Campus Organisers run their own competitions independently, they are strongly encouraged to consider all aspects of safety in relation to the conduct of their competition.

Personal Protective Equipment, PPE, required for the competition is determined by campus organisers for the campus heats. For the International final, it will be the International Final organisers.

*All participants **SHALL** use appropriate PPE during the building and development of their system. Refer to campus organisers for campus requirements.*

Appendix A –

- **Track Drawings 1-5**
- **Figure 2**
- **Photos 1-4**

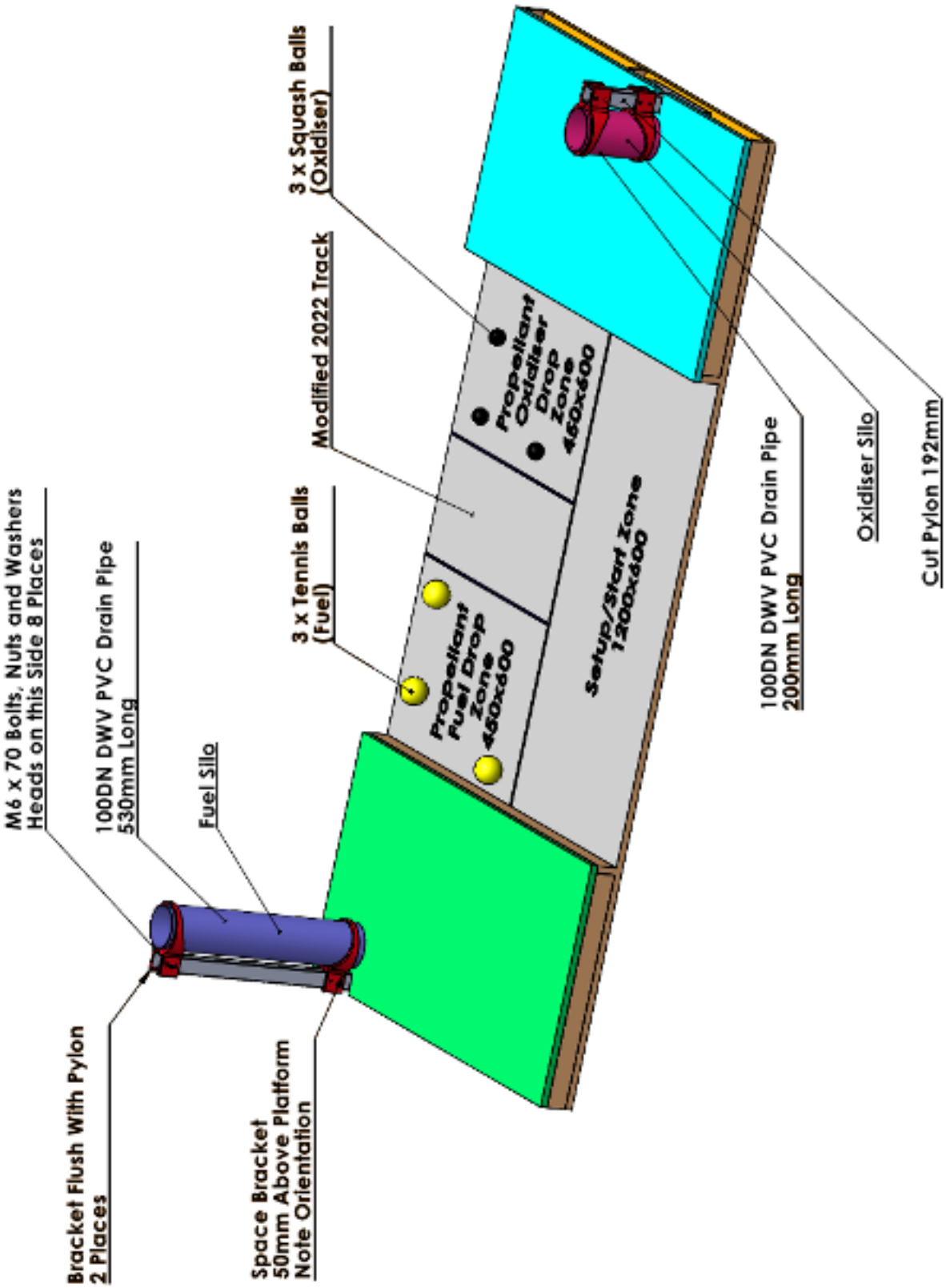


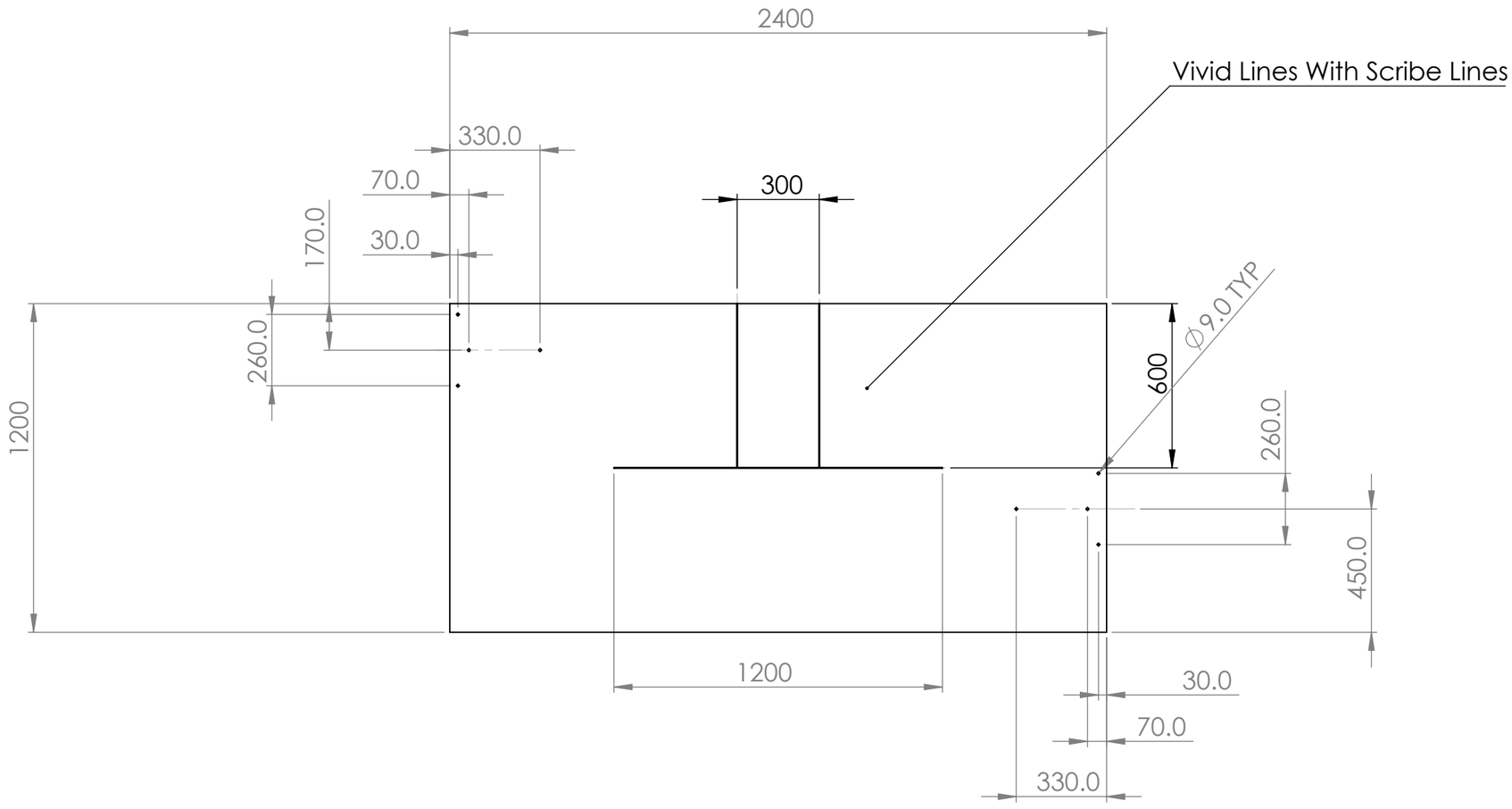
Figure 2. Track layout and modifications to the 2022 competition track

Photo 1. Lower silo bracket mounting location and orientation.

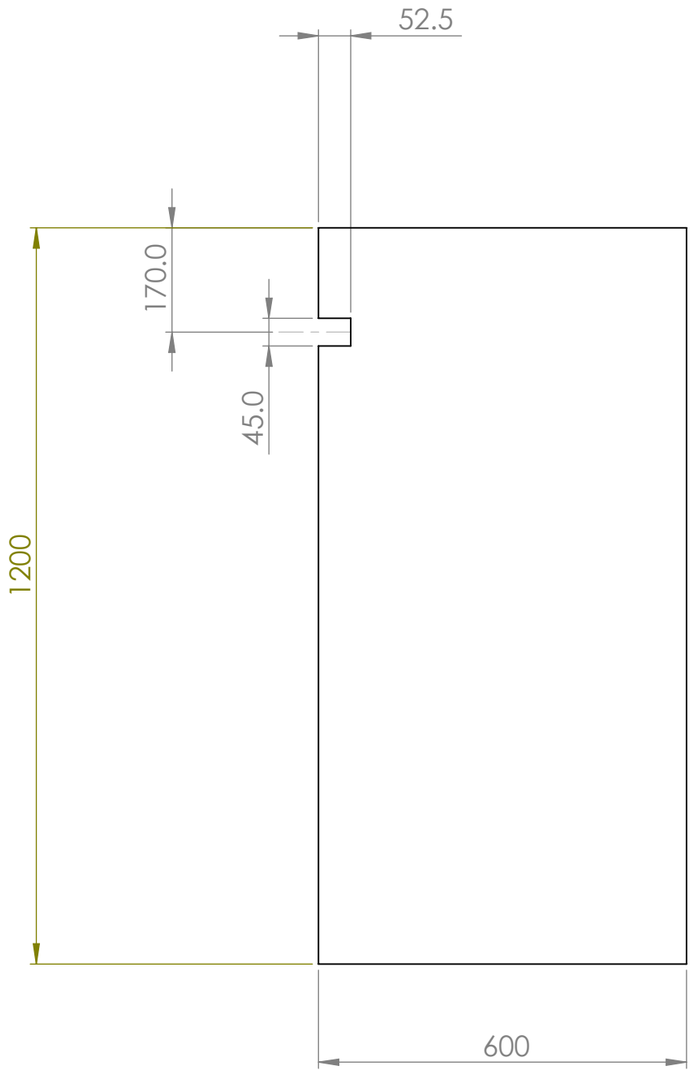
Photo 2. Pylon, bracket and silo assembly.

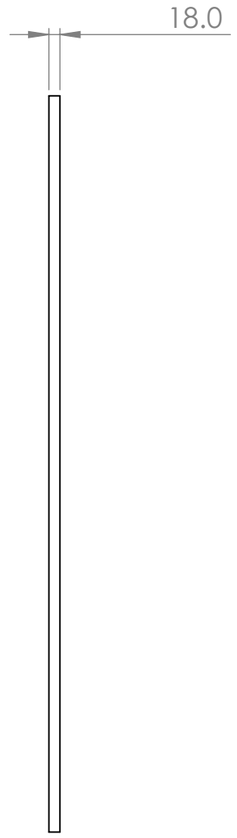
Photo 3. Optional use of an M12 nut to support a vessel.

Photo 4. Modified 2022 track. Zone lines not shown.

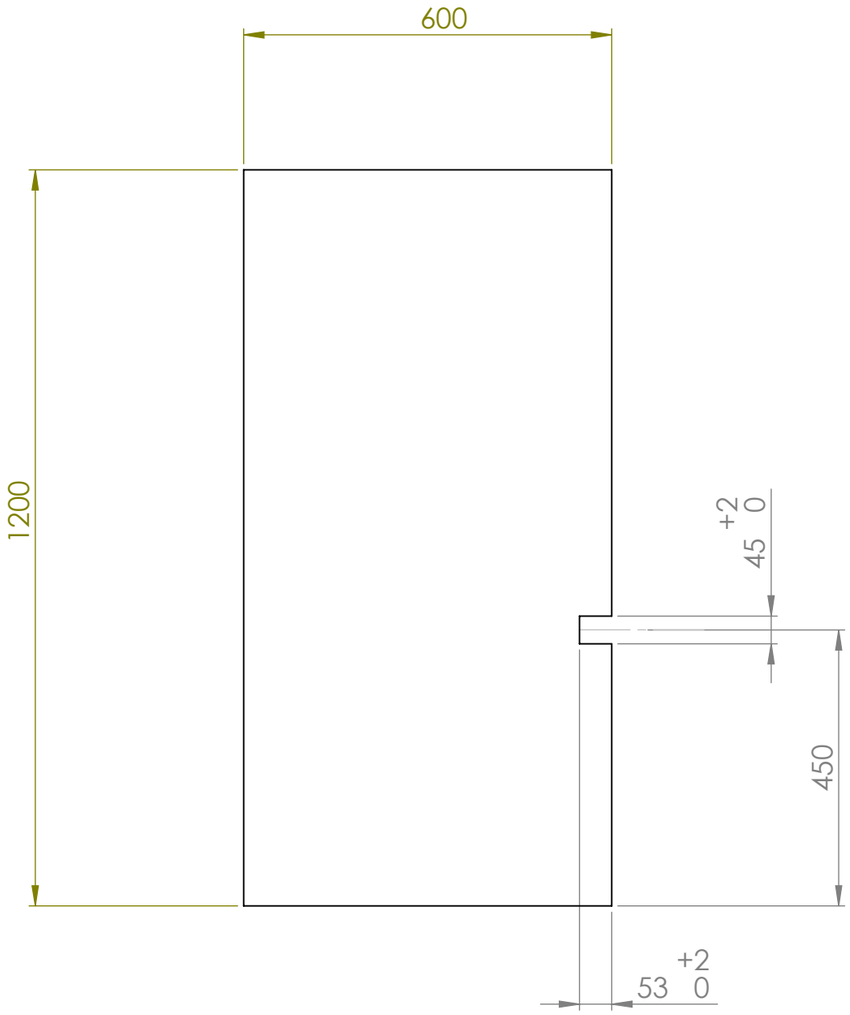


UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: ANGULAR:	FINISH: FINISH				DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE			TITLE: 2023 Warman Competition Track Base	
DRAWN							
CHK'D							
APPV'D							
MFG							
Q.A				MATERIAL: 18mm MDF		DWG NO. 1 of 5	A3
				WEIGHT:		SCALE:1:20	SHEET 1 OF 1

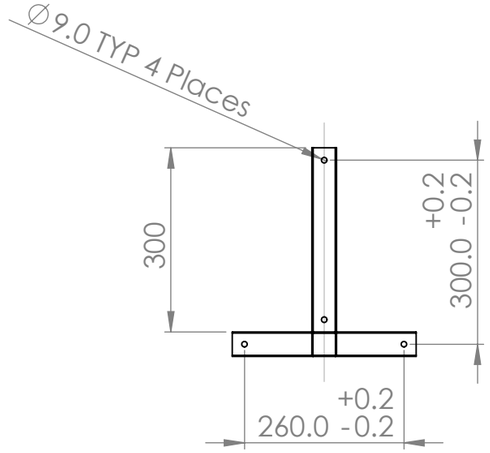




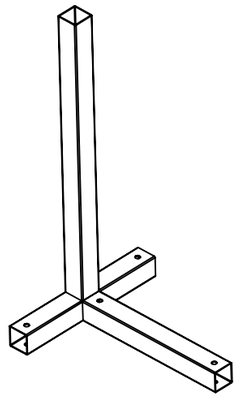
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: ANGULAR:	FINISH: As Per Rules					DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING / REVISION
	NAME	SIGNATURE	DATE				TITLE: 2023 Warman Competition Oxidiser Platform
DRAWN							
CHK'D							
APPV'D							
MFG							
Q.A				MATERIAL: 18mm MDF			DWG NO. 2 of 5 / A3
				WEIGHT:			SCALE:1:10 / SHEET 1 OF 1

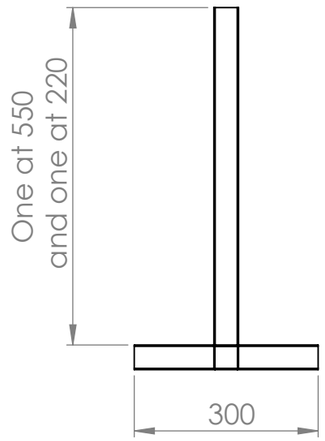


UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: +/- 2mm Unless Stated ANGULAR:	FINISH: Refer to Guidelines		DEBURR AND BREAK SHARP EDGES		DO NOT SCALE DRAWING	REVISION	
	NAME	SIGNATURE	DATE				TITLE: 2023 Warman Competition Fuel Platform
DRAWN							
CHK'D							
APPV'D							
MFG							
Q.A				MATERIAL: 18mm MDF			DWG NO. 3 of 5
							A3
				WEIGHT:	SCALE:1:10	SHEET 1 OF 1	

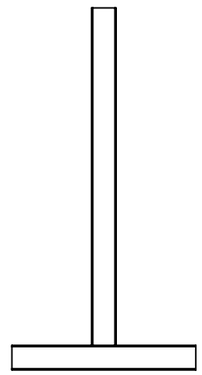


Plan





Elevation



End Elevation

2 Off

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: +/- 2mm Unless Stated ANGULAR:	FINISH: Enamel Gloss Paint		DEBURR AND BREAK SHARP EDGES		DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE			TITLE: 2023 Warman Competition Pylon
DRAWN						
CHK'D						
APPV'D						
MFG						
Q.A				MATERIAL: 40 x 40 x 3 Mild Steel SHS		DWG NO. 4 of 5 A3
				WEIGHT:	SCALE:1:10	SHEET 1 OF 1

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: +/- 2 Unless Stated ANGULAR:	FINISH: Refer to Guidelines				DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE			TITLE: 2023 Warman Competition Platform Packers	
DRAWN							
CHK'D							
APPV'D							
MFG							
Q.A				MATERIAL: 18mm MDF or Equivalent		DWG NO. 5 of 5	A3
				WEIGHT:		SCALE:1:10	SHEET 1 OF 1