WARMAN® Design & Build Competition

34th WARMAN DESIGN & BUILD COMPETITION 2021

ENGINEERS AUSTRALIA

SPONSORED BY WEIR

Project Neutralise

CONTEXT

Gondwana is a small planet orbiting a star on the outer fringes of the Milky Way. Rich in natural resources, the Gondwanans mine and distribute precious metals throughout the Galaxy. To separate the metals from the mined ore a highly acidic and toxic chemical is used. In case of a catastrophic failure of the chemical containment vessels, an emergency system for distributing neutralising pellets to various locations around the bunded processing plant, (Link to "bunded" definition), is required by the socially and environmentally conscious mining company. The acidic chemical will dissolve common engineering materials within seconds so the pellet deployment system must not touch the chemical surface. The accompanying release of toxic gases necessitates all personnel evacuate the plant so the deployment system must be autonomous.

The people of Earth have exhausted their economically viable source of a precious metal used in their fusion reactors. They are desperate for the Gondwanans to start supplying their refined metal but refining can't start until all health and safety concerns have been addressed. The method of deploying the neutralising pellets is the last hurdle that is baffling the Gondwanan engineers.

Stimulated by the desperate need for the metal, engineering students from Earth have risen to the challenge of developing a system to deliver the correct number of pellets to four silos that will release the pellet contents in the event of a chemical containment emergency. They will build and demonstrate a proof of concept autonomous system that will precisely deliver the correct number of pellets to four silos. Over the last 33 years, engineering students have rendered invaluable assistance with such engineering problems, and on this thirty-fourth occasion, the Gondwanans again seek help from these budding engineers to demonstrate a solution.

DILEMMA

For the Gondwanans to begin refining and shipping an essential precious metal all environmental and health and safety protection measures must be installed. The last system to implement is a means of autonomously deploying ten pellets of a chemical neutralising agent to four silos strategically located around the refining plant. Due to varying depth of chemical, each silo requires a different number of pellets. Rapid deployment will reduce damage to the plant equipment and the release of toxic gas. The deployment system must not contact the chemical surface within the bunded area and rapid return of the deployment system is essential to avoid irreparable damage.

CHALLENGE

Prototype a reduced scale proof of concept system that precisely delivers ten tennis balls that represent the neutralising pellets, into four vertical tubes of different heights that simulate the silos A, B, C and D, Figure 1. Higher tubes are representative of the higher quantity of neutralising agent required in that silo. The autonomous system will start from a safe area, defined by the Start/End zone, Figure 1. The system will be loaded with up to ten pellets by the team and when activated will deliver the appropriate number of pellets into each tube and return to the Start/End zone. The maximum time the deployment system can be over the chemical is 120 seconds after system activation so the system must have returned to the Start/End zone within that time. The system may

contact any surface within the Start/End zone and only the silos in the red Bunded zone, Figure 1. For extra stability, the system may be attached to the grey SHS sections in the Start/End zone, Figure 1.

OBJECTIVE

The objective is to design, build and demonstrate a proof of concept scaled prototype pellet deployment system in a laboratory environment. Points will be earned when your autonomous system starts entirely within the Start/End zone and delivers the pellets into each of four vertical tubes, Figure 1. The required number of pellets to be deposited in each tube is shown in Figure 1. Further points will be scored when the entire system returns to being fully to the Start/End zone side of the vivid black line, Figure 1, in less than 120 seconds, faster systems will be preferred. Preferably all ten pellets will be correctly deposited but fewer will earn points.

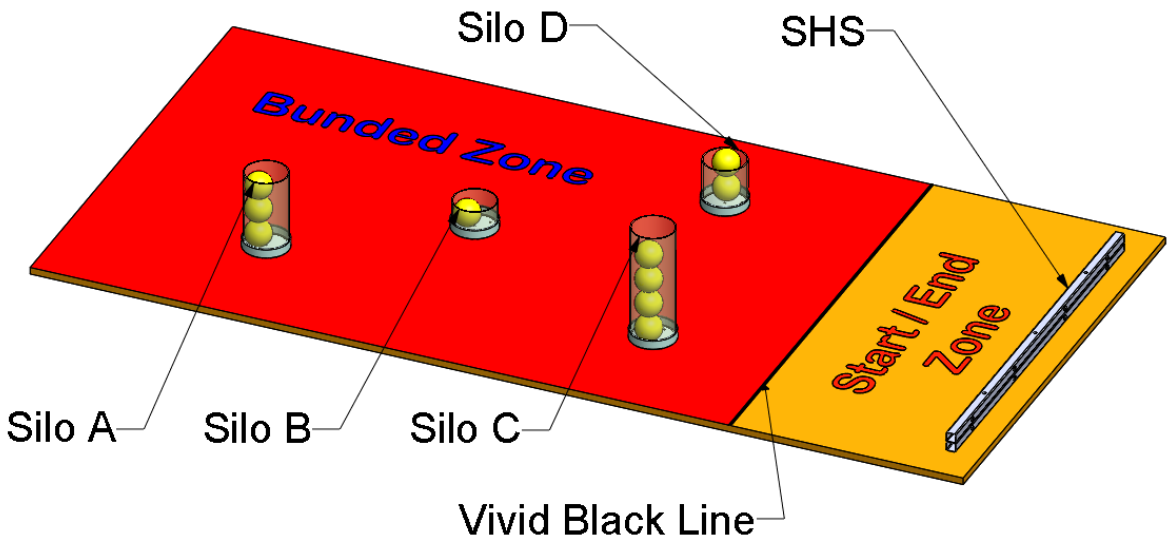

Figure 1. Schematic view of the Competition Track showing silo tube location and the number of pellets targetted to be in each tube at the completion of the run. Tubes (silos) are shown transparent for clarity.

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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 Components

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 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.

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 heat 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 SHALL be fabricated using primarily one sheet of Medium Density Fibreboard (MDF), with nominal dimensions 2400 x 1200 x 18 mm, arranged as shown in Figure 1 and detailed drawings in Appendix A. The 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. All dimensions shown in Appendix A are 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 in accordance with Appendix A.*

G 9. The MDF Track Sheet with relevant features attached, not including the ten pellets, SHALL be identified as the Competition Track as shown in Figure 1. The attached features include; the Start/End zone defined by a black vivid pen line and the track edge, four nominal 100mm diameter vertical DWV PVC pipes (OD110xID104) supported by PVC end caps, screws to attach the PVC caps to the Track Sheet, two 1000mm lengths of 25x25x1.5 SHS within the Start/End zone, and three standard M8 bolts with six M8 x 17 washers and three M8 nuts to restrain the RHS length. The washers SHALL be used top and bottom and bolt heads SHALL be on the upper face. Refer G13.

G 10. The upper surface of the Track Sheet SHALL define the competition base plane, which is nominally horizontal. Lettering shown on the competition base plane in all figures are for clarity and SHALL NOT be applied to the track.

G 11. 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 12. The Competition Track SHALL contain the Start/End Zone area bounded by the edges of the Track Sheet and a black vivid line across the Track Sheet. The black vivid line SHALL be applied before the track surface sealer, refer G16. Prior to starting, the system SHALL be fully contained within the Start/End zone virtual vertical planes defined by the vivid line and the track edges.

G 13. Within the track Start/End zone, two 25x25 SHS sections SHALL be stacked and fixed to the Track Sheet using three M8 bolts with washers top and bottom. M8 x 17 Washer Example . (Allows recycling the 2020 SHS sections, note the added 13mm holes in each and increased bolt hole size). Bolt heads SHALL be on the upper surface. The SHS shall be positioned as shown in Figure 1 and Appendix A. It SHALL be made from galvanised unpainted Steel SHS 1000mm in length. 25 x 25 SHS Material Specification

G 14. If the MDF track from the 2020 competition is being recycled the 6mm bolt holes and screw holes MAY be filled and the top surface finished to match the general surface. At the International Final new or recycled MDF tracks MAY be used but for recycled tracks the holes will be filled and resurfaced according to G16.

G 15. Four delivery target tubes made from 100DN DWV PVC PIPE drain pipe. Refer to this page for an example material: 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 A by gluing into 100mm PVC push-on caps screwed to the track sheet. Example PVC Cement. Refer to this page for an example push-on cap: Holman Push-On Cap. The cut length of the tubes SHALL be: A=200, B=70, C=300, D=120 with tolerances of +/-5mm. The tubes SHALL be fully inserted into the cap that is screwed to the track using seven wood screws per cap. The centre screw hole in the four push caps SHALL align with the four location pilot holes shown in Appendix A. The tubes SHALL be nominally vertical.

Note: There are other manufacturers of the 100mm PVC push caps and pipe that MAY be used. The Holman brand will be used on the International Final tracks.

G 16. The surface of the track sheet 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 black vivid line defining the Start/End zone SHALL be applied prior to the final coat.

G 17. The ten pellets SHOULD be modelled using Wilson Tour Competition Tennis Balls Wilson Tour Competition Balls. Up to ten balls SHALL be loaded into/onto the system by the team during the 120 second setup time.

Note: There are various suppliers of tennis balls and various grades. The Wilson Tour Competition balls SHALL be used at the International Final.

G 18. 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 19. Teams SHALL accept that the presence of air conditioning/ventilation induced air movement MAY be part of the competition environment.

PROOF OF CONCEPT SYSTEM

G 20. The system, initially located fully within the Start/End zone and be no more than 500 x 500 x 500 (w x d x h), SHOULD deliver **TEN** pellets and return to be fully to the Start/End zone side of a vertical plane boundary between the Bunded and Start/End zones, identified by "vivid black line", Figure 1, within 120 seconds. After the start of the run, the system MAY overhang the edges of the competition track. The system does not need to comply with the 500 x 500 x 500mm constraint upon its return to the Start/End zone at the conclusion of the run.

G 21. The system SHALL cease operation within 120 seconds.

G 22. The system SHALL represent essentially a ground-based solution. Untethered flying systems SHALL NOT be used, refer G2.

G 23. The system SHALL be initially positioned in the Start/End zone and be fully supported by the competition track. The system MAY contact or be connected to the two 25x25 SHS within the Start/End zone. The system fasteners, if used, SHALL not damage the 25x25 SHS. Fastening the system to the SHS SHALL be performed during the setup time.

G 24. 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 25. The system MAY contact the PVC pipes and caps (silos).

G 26. The system MAY not contact the track surface identified as the Bunded zone (shown in red), Figure 1.

COMPETITION RULES

R 1. A pellet refers to **ONE** of **TEN** tennis balls being transferred from the Start/End zone to a delivery target tube A, B, C or D. Points SHALL be awarded for delivering pellets into the delivery target tubes (silos). Bonus points SHALL be awarded when the system delivers at least one pellet and returns to be fully to the Start/End zone side of the boundary between the Bunded and Start/End zones, identified by the vivid black line, Figure 1. In the end state, the system MAY hang over/extend beyond the competition track edges of the Start/End zone but SHALL NOT be in contact with surfaces below the competition track base plane. A penalty SHALL be applied to the RUNscore if the system touches the Bunded zone track surface at any time during the RUNtime.

SYSTEM MATERIALS AND MANUFACTURE

R 2. Students SHALL manufacture and fabricate their "proof of concept prototype" system themselves using commonly available materials, components and methods.

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 3. In keeping with the spirit of the competition, teams SHALL NOT use LEGO ® Mindstorms ® or similar comprehensive kitted systems at the International Final.

R 4. In keeping with the spirit of the competition, teams MAY use Arduino or similar PIC based components.

R 5. In keeping with the spirit of the competition, teams MAY adapt / modify / integrate elements sourced "off-the-shelf".

R 6. Systems using electric battery storage devices SHALL have an appropriately sized fuse connected to one of the battery leads.

COMPETITION PROCEDURE

R 7. The mass of the team's system (SYSTEMmass) SHALL be measured by an official. The system mass, not including pellets and device positioning equipment, 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.*

R 8. The team SHALL then be called to the trackside.

R 9. There SHALL be no contact by team members or their system with the Competition Track before setup commences.

R 10. When ready, an official will signal that the setup SHALL commence. The team SHALL be allowed a maximum of 120 seconds for setup. In this time they are to set up their system in the Start/End Zone.

R 11. 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 during setup. The mass of these additional objects SHALL NOT be included in the SYSTEMmass.

R 12. During setup, physical contact SHALL NOT be made by team members, their system, or any additional objects used to assist with setup, with any portion of the competition track other than surfaces bounded by the perimeter of the Start/End zone. Contact with the track edges below the track base plane of the Start/End zone is permitted. Refer to Figure 1 and Appendix A.

R 13. During the setup, the team SHALL load up to **TEN** pellets into/onto their system. Pellets not loaded SHALL be retained by the track officials.

R 14. During the setup, the team MAY attach the system to one or both of the 25x25 SHSs with suitable fasteners that SHALL not damage the SHS.

R 15. The Team SHALL indicate to the appropriate "official" when their setup is complete.

R 16. After setup, and prior to running, everything placed and left on the competition track SHALL be considered to be part of the system.

R 17. After setup, and prior to running, the system SHALL be subject to volume constraints. The system and pellets SHALL be wholly within a virtual cube of 500 x 500 x 500 (w x d x h) and wholly within the Start/End zone vertical planes of the vivid black line and the track edges. The lower face of the virtual cube SHALL be coincident with the competition track base plane. The volume and positioning conditions SHALL be physically checked by an official. The system MAY have multiple unconnected components but the combination of components SHALL satisfy this rule.

R 18. After setup and prior to running, the system SHALL be held or supported only by the competition track Start/End zone base plane and/or the Start/End zone SHSs and must be ready to start. The system SHALL NOT be restrained by personal contact by team members. The system SHALL be capable of remaining in the setup condition for at least 240 seconds prior to starting. Electronics MAY be powered up but there SHALL NOT be any component motion.

R 19. On instruction by a clapper board type signal from the "official starter," the run SHALL commence. The start SHALL be counted 3-2-1-clap at nominally one-second intervals.

R 20. The system SHALL be started using a single action of a team member that does not impart motion or energy to the system. Attaching wires or fitting electrical terminals or fitting plugs SHALL NOT be used.

R 21. If the vertical boundary between the Bunded Zone and the Start/End Zone is not penetrated by the system or the team member prematurely starts the system, by the instruction of the official starter the system MAY ONE TIME ONLY for each run be removed from the track and IMMEDIATELY reset and started again after 120 seconds setup time. Rules R9 to R18 SHALL be adhered to. This rule SHALL NOT be used to extend the setup time. This rule SHALL NOT apply to systems that do not comply with the volume constraints.

R 22. The run SHALL be designed to finish within 120 seconds.

R 23. After performing the single action start, team members SHALL NOT control or touch the system in any way during the run. Wireless control is specifically prohibited. Any interference by team members SHALL result in a zero RUNscore. If team members choose to intervene to protect a system that is malfunctioning, a zero RUNscore SHALL be recorded.

R 24. During the run, the system SHALL NOT come into contact with anything below the competition base plane including the track vertical edges, refer G10. This SHALL NOT apply to pellets. The system MAY contact the Start/End zone of the Competition Track surface, either of the steel SHS lengths and the vertical tube assemblies. The system MAY not contact the Bunded zone surface of the competition track, Figure 1.

R 25. The system or pellets MAY hang over/extend beyond the edges of the perimeter of the Competition Track during the run and at completion.

R 26. At the completion of the run, all parts of the system SHALL cease translation on the Competition Track and remain in this state indefinitely relative to the competition base plane. Mechanisms and items within the system MAY continue to move but no further functions SHALL be executed.

R 27. The team or system MAY indicate to the timekeepers when they declare their run to be complete. However, the timekeepers 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 28. To ensure that judging has been completed teams SHALL NOT retrieve their system or assist in gathering other items until directed by an official.

R 29. The system SHALL NOT damage or contaminate the competition track. The run SHALL NOT contaminate or damage the pellets. Teams presenting a system that damages or is deemed to have the potential to damage the competition track or pellets MAY be disqualified from the competition.

R 30. Each target tube requires a different quantity of pellets as defined in R42 and shown in Figure 1. Pellets deposited that exceed the specified quantity for a tube SHALL NOT receive a DEPOSITscore. For example, if 4 pellets are deposited in tube A, which requires 3 pellets, the recorded DEPOSITscore is 3.

R 31. By design, pellets still in contact with the system and/or not fully deposited SHALL NOT receive a DEPOSITscore. For example, a pellet with a holder detached from the system and in contact with a pellet at the end of the run SHALL NOT constitute a deposited pellet. A detached pellet holder, for example, remains part of the system when considering the RETURNscore.

R 32. For the RETURNscore bonus at least one pellet SHALL be correctly deposited, the entire system and any pellets still held by the system SHALL be to the Start/End zone side of the boundary

between the Start/End and Bunded zones, Figure 1, and the RUNtime SHALL be less than 120 seconds.

R 33. One or more components of the system left on the competition track SHALL NOT constitute contamination. Systems that leave parts fully or partially on the competition track outside the Start/End zone SHALL NOT receive the RETURNscore bonus. System parts SHALL NOT contact delivered pellets, refer R31.

R 34. As directed, teams MAY attempt two runs.

R 35. The system MAY be modified between runs but the mass, volume and time constraints must be satisfied for a run to achieve a valid non-zero score. SYSTEMmass SHALL be recorded before each run.

R 36. Violations of procedural rules SHALL result in a zero RUNscore being recorded.

R 37. The judges' decisions on all matters pertaining to the competition SHALL be final.

SCORING

R 38. Within 120 seconds the system SHALL cease all operations. Pellets deposited after 120 seconds SHALL NOT receive a DEPOSITscore. Systems that have not fully returned to the Start/End zone within 120 seconds SHALL NOT receive the RETURNscore.

R 39. Better systems will achieve the objective of depositing the correct number of pellets in each delivery target tube and the system fully returning to the Start/End side of the boundary between the Bunded Zone and the Start/End Zone within 120 seconds, whilst adhering to procedural, volume and positioning constraints.

R 40. At the International Finals, video recording SHALL be used if potential podium winning time scores are within 5 seconds.

R 41. If two or more teams have equal COMPETITIONscores the team competition placing SHALL be determined by the SYSTEMmass of the run achieving the highest RUNscore. The lower SYSTEMmass will be preferred.

R 42. The COMPETITIONscore SHALL be calculated using the following:

$$RUNscore = \big((DEPOSITscoreA + DEPOSITscoreB + DEPOSITscoreC + DEPOSITscore\ D)\ x\ 10 + RETURNscore\ + (120 - RUNtime)\ x\ 0.5\big)\ x\ TOUCHpenalty$$

DEPOSITscore = Number of deposited pellets up to the maximum defined below. Deposited pellets SHALL not be in contact with the system.

DEPOSITscoreA: zero to three pellets (0, 1, 2, 3)

DEPOSITscoreB: zero or one pellets (0, 1)

DEPOSITscoreC: zero to four pellets (0, 1, 2, 3, 4)

DEPOSITscoreD: zero to three pellets (0, 1, 2)

Pellets deposited that exceed the maximum defined above are a wasted resource and SHALL receive no DEPOSITscore.

Pellets not deposited that are still held by the system or are dropped are wasted resource and SHALL receive no DEPOSITscore.

RETURNscore = 20 for the system fully to the Start/End zone side of the START/END and BUNDED zones boundary, Figure 1, at the end of the RUNtime, AND at least one pellet has been deposited, Refer R1.

RUNtime = time in seconds for runs that correctly deposit all ten pellets within 120 seconds AND fully return to the Start/End zone as defined in R32.

Otherwise = 120

TOUCHpenalty = one or 0.5 if the system touches the bunded (red) zone at any time during the run. For this rule, until the pellets are deposited or lost they are part of the system.

Notes: RUNtime measured from the 'Start Clap' command until the system has stopped 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 placed onto the track, excluding pellets and setup tools, which achieved the highest RUNscore.

COMPETITIONscore = Max RUNscore + Min RUNscore/2

Note: Teams are allowed to make two (2) scoring attempts (nominally one in Round 1 and one in Round 2)

Frequently Asked Questions

1. Does the system have to stay in contact with the competition track at all times?

Yes. The scenario requires a ground-based system (see G22). The guidelines and rules do define what can be legally contacted. Pellets MAY NOT be in contact with the system or competition track at all times.

2. 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 (R22). Parts of the system MAY be left on the Competition Track. The entire system SHALL return to the Start/End zone to receive the RETURNscore. Pellets MAY be discarded off the track without penalty or disqualification.

3. Can part of the system overhang the extremities of the competition track without penalty when negotiating the track?

Yes, (see R23). The system can exist in space beyond the projected extremities of the plan of the track during the run. It MAY also overhang the extremity of the Start/End zone beyond and Start/End side of the boundary between the Start/End and Bunded zone at the end of the run Refer R32. Contact between the system and anything below the track base plane is not permitted at any time.

5. 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) refer R23. Such configurations would be considered to be part of the system and violate position and volume constraints (see R18).

6. Are programmable chips allowed?

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

7. What is the allowable voltage and power of any employed electrical systems?

There are no restrictions this year but it clearly needs to be safe. Refer G2.

8. Can off-the-shelf items be used?

Commonly available components such as toy and machine parts are able to be used. 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.

9. To receive the RETURNscore, can the system be larger than 500 x 500 x 500 and in multiple pieces when the run is completed?

Yes, but the entire system must be on the Start/End Zone side of the common boundary between the Start/End Zone and bunded area. The system MAY have multiple unconnected parts when the run is completed.

Further Competition Details

INTERNATIONAL COMPETITION FINAL

It is the intention of the International Competition organisers and sponsors to hold a 2021 International Competition Final in Sydney.

Travel and social distancing rules may prevent an 'in person' Sydney 2021 International Competition Final. Should this occur, a virtual competition final may be held using a video link.

Details of either option will be announced to campus organisers.

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, both at the Campus Competitions 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 organiser's 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 - Detailed Drawings of Competition Track

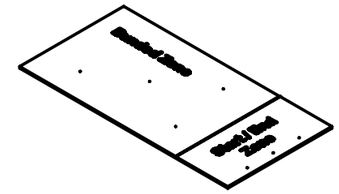
Sheet 1 – Drawing 1 of 3. Competition Track MDF Sheet

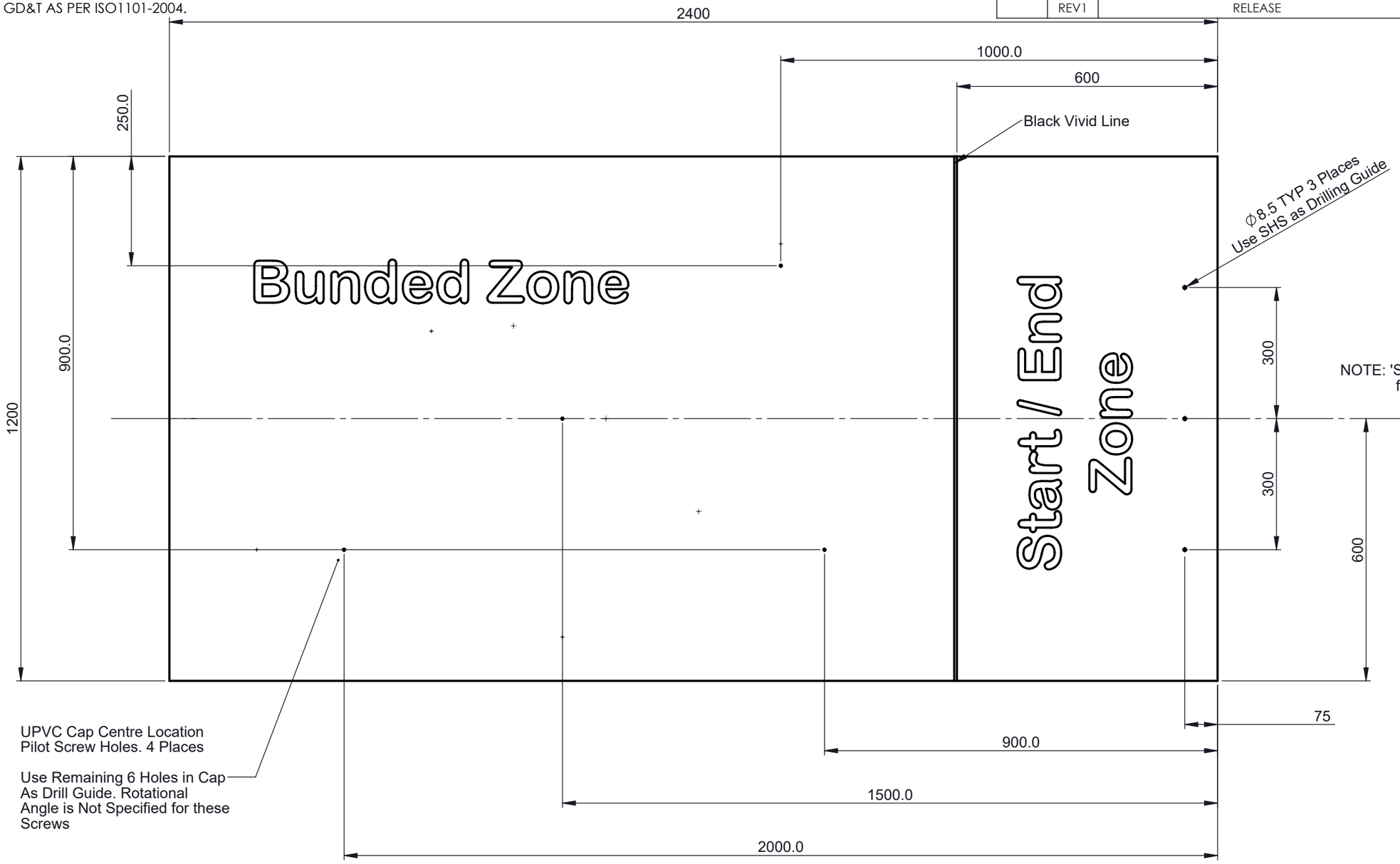
Sheet 2 – Drawing 2 of 3. 100mm PVC End CAP Drilling Details

Sheet 3 – Drawing 3 of 3. 25x25 SHS

NOTES - (UNLESS OTHERWISE SPECIFIED)
1. ALL DIMENSIONS IN MILLIMETERS.
2. GD&T AS PER ISO1101-2004.

REVISIONS					
ZONE	REV.	DESCRIPTION	ECO	APPROVED	DATE
	REV1	RELEASE		XXX	01JAN13





NOTE: 'Start/End Zone' words are shown for clarity, do not include.

THIRD ANGLE PROJECTION

MATERIAL: 1200 x 2400 x18 MDF Sheet

FINISH: Top Surface Coated as per Instructions

TOLERANCE (UNLESS OTHERWISE SPECIFIED)
DECIMAL mm
Tolerance +/- 5mm unless stated

Weir Warman Competiton ©

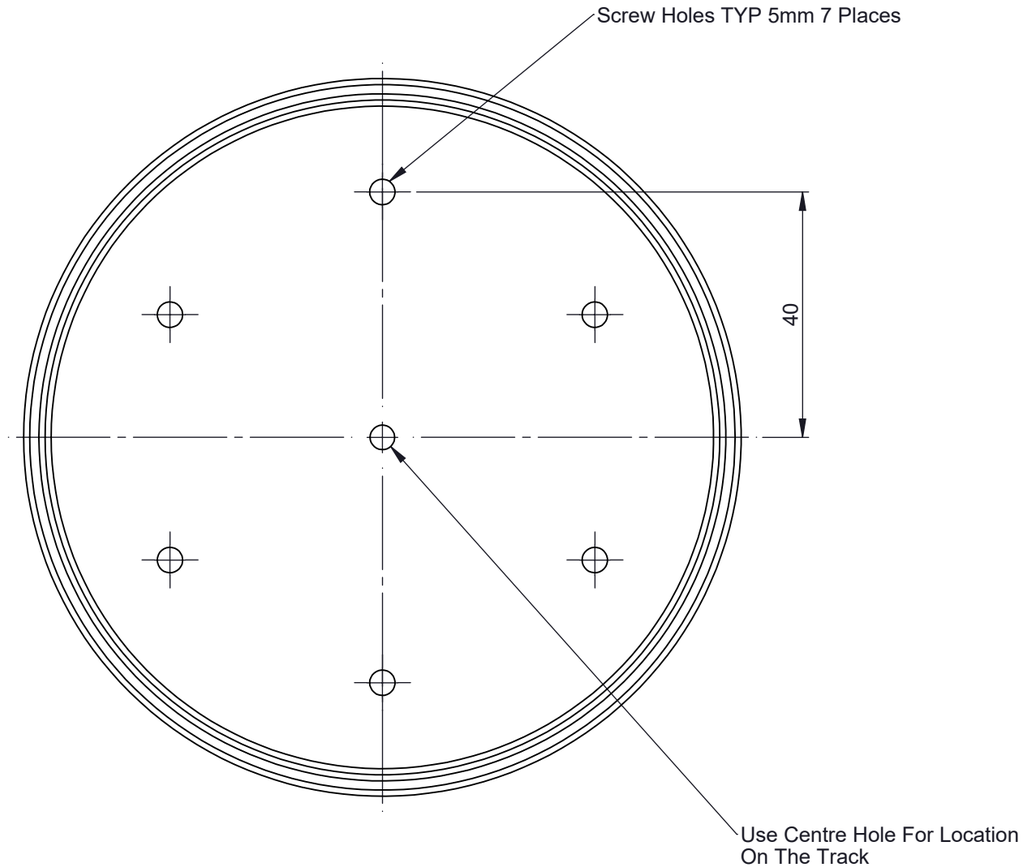
Competition Track MDF Sheet

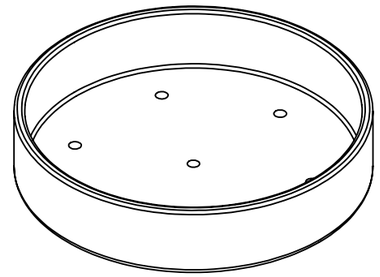
DESIGN	DWG NO.	REV
D M Clucas	1 of 3	1.0
DRAWN: D M Clucas	PROJECT: 2021 Weir Warman Competition	
	ISSUE DATE: 30/1/2021 — DRAWING NOT TO SCALE — SHEET: 1 OF 3	

NOTES - (UNLESS OTHERWISE SPECIFIED)

1. ALL DIMENSIONS IN MILLIMETERS.
2. GD&T AS PER ISO1101-2004.

REVISIONS					
ZONE	REV.	DESCRIPTION	ECO	APPROVED	DATE
	REV1	RELEASE		XXX	01JAN13





Attach to the Track Using
7 Wood Screws

4 Parts

THIRD ANGLE PROJECTION	THIS DOCUMENT IS ISSUED IN STRICT CONFIDENCE ON CONDITION THAT IT IS NOT COPIED, REPRINTED, OR DISCLOSED TO A THIRD PARTY EITHER WHOLLY OR IN PART WITHOUT THE WRITTEN CONSENT OF UNIVERSITY OF CANTERBURY	Weir Warman Competiton ©	
MATERIAL: 100mm PVC Push CAP		100mm PVC End CAP Drilling Details	
FINISH: As Supplied		DESIGN: D M Clucas	DWG NO.: 2 of 3 / REV: 1.0
TOLERANCE (UNLESS OTHERWISE SPECIFIED) DECIMAL mm: Tolerance +/- 2mm unless stated		DRAWN: D M Clucas	PROJECT: 2021 Weir Warman Competition
			ISSUE DATE: 30/1/2021 / DRAWING NOT TO SCALE / SHEET: 2 of 3

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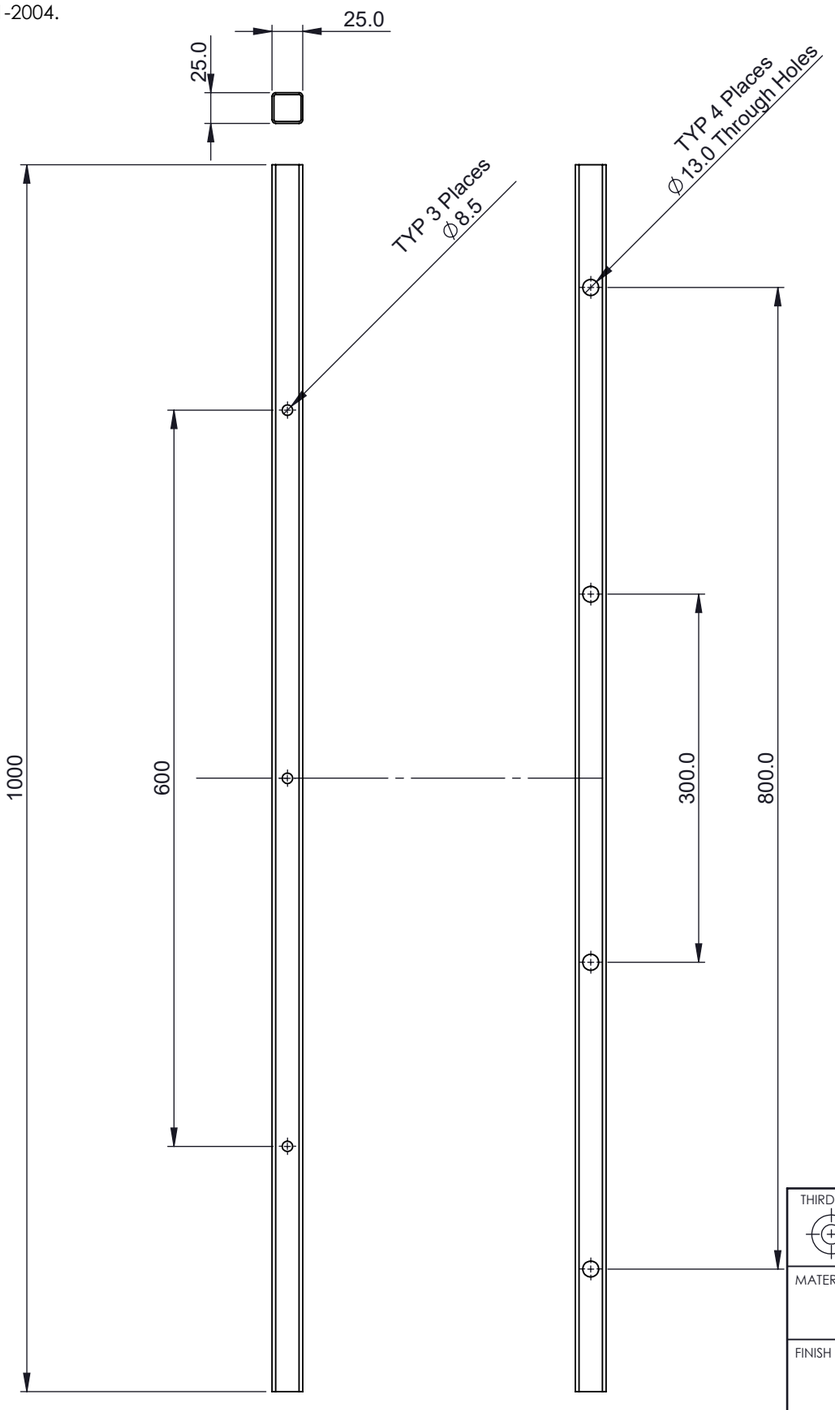
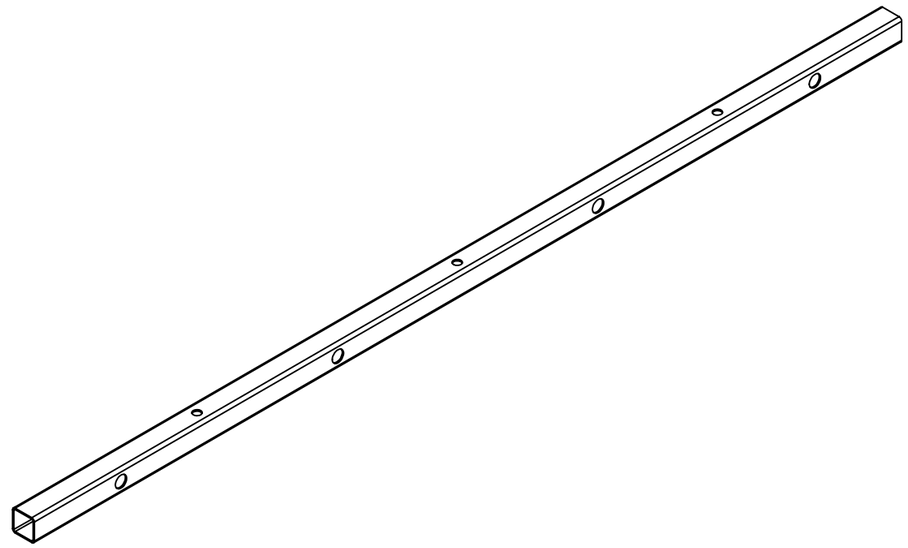
REVISIONS					
ZONE	REV.	DESCRIPTION	ECO	APPROVED	DATE
	REV1	RELEASE		XXX	01JAN13





2 Parts Required

THIRD ANGLE PROJECTION

MATERIAL: Galvanised 25 x 25 x 1.6 Mild Steel SHS

FINISH: As supplied, galvanised not painted

TOLERANCE (UNLESS OTHERWISE SPECIFIED)
DECIMAL mm
Tolerance +/- 5mm unless stated

Weir Warman Competiton ©

25 x 25 SHS FOR THE START END ZONE

DESIGN	DWG NO.	REV
D M Clucas	3 of 3	1.0
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	ISSUE DATE: 30/1/2021	DRAWING NOT TO SCALE	SHEET: 3 OF 3