ENGINEERS AUSTRALIA

WEIR Minerals

The planet of Gondwana needs another team of engineering heros.

Competition Rules 2018

WARMAN®

Design & Build Competition

WARMAN® Design & Build Competition	**31st WARMAN DESIGN & BUILD COMPETITION 2018**	ENGINEERS AUSTRALIA · SPONSORED BY WEIR

Project PRAISE –

Powerpack Relocation Avoiding Imminent Starvation and Enervation

CONTEXT

Gondwana is a small planet orbiting a sun on the outer fringes of our Galaxy. Gondwana's climate is changing due to the release of methane from its oceans, which is causing planet warming. They are in the midst of the worst drought in history and irrigation has dried up aquifers normally abundant with fresh water. Starvation is imminent unless essential water is found for their crops. Fortunately, teams of engineering students from Earth are about to visit Gondwana as part of their work experience programmes. Over the last 30 years, visiting engineering students have rendered invaluable assistance with such engineering problems, and on this thirty-first occasion, the Gondwanans again seek help from these budding engineers.

DILEMMA

Three water bores, each having a powerpack and pumping station, have been sucked dry but by using new satellite and geotechnical technology, the Gondwanans have located a plentiful aquifer. High flow pumps have been installed in the pump bunker but its powerpack was overloaded and it exploded. If they can move a powerpack from a dry well to the new aquifer a famine could be averted.

CHALLENGE

Situated on a plateau, a bunker has been made above the new aquifer and **ONE** of three powerpacks needs to be collected off a nearby well tower and placed in the bunker. Unfortunately, the largest powerpack that will drive the biggest pumps is in the most difficult location for collection and will also be the most difficult to place in the bunker. A garage providing protection near the location can be used as a workshop from which to deploy a system that will collect, transport and place the powerpack into the bunker. The challenge is to design and build a system to autonomously collect and place **ONE** powerpack assembly that comprises of three energy orbs, three cups and one MDF base. To avoid a catastrophic environmental disaster the energy orbs must not be dropped.

Objective

The objective is to design, build and demonstrate a prototype collection and placement system. Points will be scored when your autonomous system collects and places a powerpack, with all energy orbs, into the bunker as quickly as possible.

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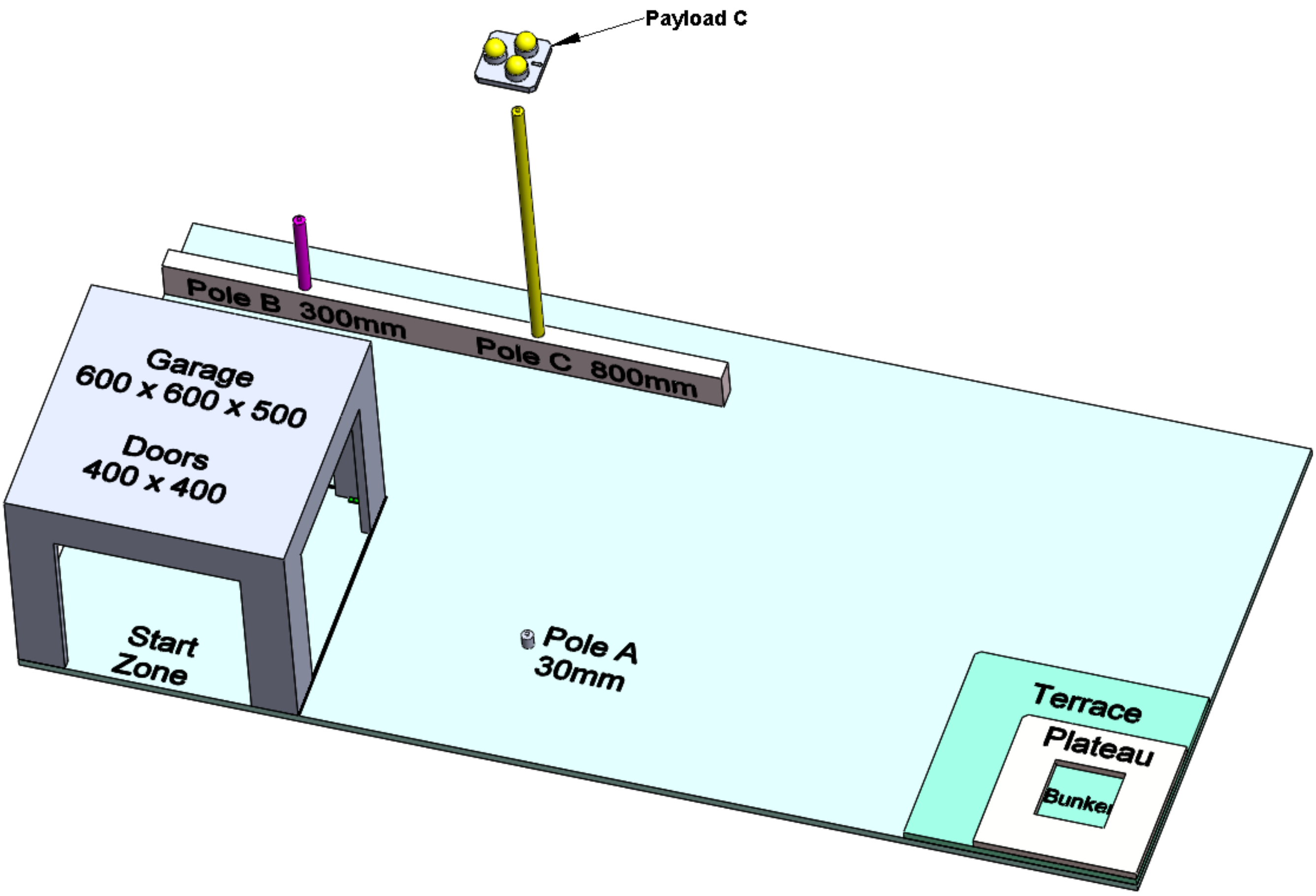

Figure 1. Schematic view of the Competition Track with payload C

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Details follow:

- Competition Guidelines
- Competition Rules
- Frequently Asked Questions
- Further Competition Details
- Spirit of the Competition
- Appendix A - General Arrangement and Detailed Drawings of Competition Track
- Appendix B - Other components and assembly details

Document Control:

Version: 1.0. Released 20 February 2018

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. "Payload" refers to a powerpack that includes a base board, three cups and three energy orbs.*

ELIGIBILITY

G 1. Teams that are eligible to represent their campus in the International Final will consist of students from a first or second year engineering design course/subject/unit in an Australasian (or other countries, by arrangement) mechanical-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, the International Competition Coordinators should be consulted to ensure that other teams are not unreasonably disadvantaged.

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 occurs 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 safe operation and produce risk assessment documentation in order to compete in either the campus heat or at the International Final.

G 5. This year the competition relies on collecting a payload from a raised position. Campus Organisers should encourage students to consider the risks associated with the elevated payload when completing their risk assessments.

G 6. Compressed gas systems may be used but students must gain Campus Organiser approval based on a safety assessment.

Such systems presented at the International *Final will be examined against the following principles and must 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 will 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 will not be permitted to run. For example, employing any form of combustion is considered hazardous.

COMPETITION TRACK, EQUIPMENT AND ENVIRONMENT

G 8. The 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 included as per Appendix A. The supporting frame for the sheet may be fabricated by any convenient method.

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 constructed from 2400 x 1200 mm sheets in accordance with Appendix A.*

G 9. The MDF sheet with relevant features attached SHALL be identified as the Competition Track as shown in Figure 1. The attached features include; the MDF panels defining the Garage walls and roof, the MDF terrace and MDF plateau creating the bunker, the steel 30mm high pole, the 300mm high wooden dowel pole, the 800mm high wooden dowel pole and a 90 x 45mm MGP10 Pine Timber Framing.

G 10. The upper surface of the MDF sheet of the Track SHALL define the competition base plane, which is nominally horizontal.

G 11. The competition base plane SHALL be no less than 300 mm above the supporting floor at the International Final.

G 12. The shoulder height of the three poles, shown in Figure 1, above the base plane SHALL be 30mm, 300mm and 800mm +/- 2.0mm.

G 13. The Competition Track SHALL contain the Start Zone at one end, which is representative of a vehicle garage with four doors. This SHALL house the system prior to starting the run. Dimensions of the Garage are shown in Figure 1 and Appendix A. It SHALL be made from 18mm MDF sheet.

G 14. Four angle brackets with 50 mm leg length SHALL be used to secure the Garage to the Track as shown in Figure 1. Suitable angle brackets are pictured in Appendix B1. The angle brackets SHALL be attached to the internal walls of the Garage with the legs parallel to the vertical longitudinal plane of the track. See Appendix B2 for positioning.

G 15. The terraced Bunker SHALL be constructed from two 18mm thick MDF panels as shown in Figure 1 and Appendix A. These SHALL be attached to the Track as shown in Appendix A. The attachment method SHALL not damage the upper exposed surfaces of the terraces or Track and SHOULD allow replacement if necessary.

G 16. A 1.2m length of 90 x 45mm MGP10 Pine Timber Framing SHALL be used for supporting poles B and C. It SHALL be fixed to the Track as shown in Figure 1 and Appendix A from the underside using at least four wood screws of minimum length 75mm. The attachment method SHALL NOT damage the surfaces of the track or support. The poles SHALL be nominally vertical.

G 17. The MDF and timber surfaces of the Track excluding the poles SHALL be brush or roller coated with one coat of Wattyl Water Based Estapol Clear – Satin as a sealer followed by two coats of Wattyl Estapol Matt (in accordance with Wattyl's recommendations for use with MDF - Refer: http://demo.autospec.com.au/productmedia/wattyl_australia/new-images/espatol/polyureth-gloss-satin-matt.pdf). Recycled track surfaces SHOULD be lightly sanded and re-coated with two coats of Wattyl Estapol Matt.

G 18. Pole A SHALL be machined from mild steel or similar according to Appendix A. It SHALL be fixed to the Track using one M6 x 30 bolt and washer from the underside at the location shown in Figures 1 and Appendix A.

G 19. Poles B and C SHALL be made from diameter 25mm wooden dowel and SHALL be cut and truly faced on a lathe to 300 and 800mm +/- 2.0mm length respectively. Diameter 8mm steel pins SHALL be fitted and glued with an epoxy resin into holes drilled into the upper ends of poles B and C. 5mm of pin SHALL protrude from the surface as per Appendix A.

G 20. Poles B and C SHALL be a firm fit into the 90 x 45 wooden support. Two side screws from the far side of the pine timber framing from the Garage SHALL be used to secure each pole noting the fitting method SHOULD allow replacement of the poles if necessary. The poles SHALL be nominally vertical.

G 21. The payloads (powerpacks) A, B and C SHALL be made by using a 18mm thick MDF base to the relevant dimensions shown in Appendix A. Three modified 40 mm PVC pipe caps, see examples Appendix B3, SHALL be screwed with one countersunk head screw each to the base in the relevant pattern as shown in Appendix A and B3. Three energy orbs, table tennis balls for A, squash balls for B and golf balls for C SHALL be placed in the cups prior to the run. An arrow SHALL be clearly marked on the bases as shown in Appendix A.

NOTE:

(A) As defined under the Rules of Table Tennis, the ball shall be spherical, with a diameter of 40mm. The ball shall weigh 2.7g. The ball shall be made of celluloid or similar plastics material and shall be white or orange, and matt. Any colour table tennis balls may be used as per G21.

(B) As defined under the Rules of Squash, a squash ball weighs 24.0 ± 1.0 gram and has a diameter of 40.0 ±0.5 mm. Yellow dot squash balls (black in colour) shall be used as per G21.

(C) As defined under the Rules of Golf, a golf ball weighs no more than 1.620 oz (45.93 grams) and has a diameter not less than 1.680 in (42.67 mm). Any colour golf balls may be used as per G21.

G 22. Teams SHALL accept that the presence of bright lighting and photographic equipment including flash and infrared systems are part of the competition environment.

PROOF OF CONCEPT SYSTEM

G 23. The system SHALL collect and place **ONE** payload, including three energy orbs, on the defined competition track in accordance with the rules.

G 24. The system SHALL represent essentially a ground-based solution.

G 25. The system SHALL be initially positioned in the Start Zone and be fully supported by the base plane of the competition track.

G 26. Campus Organisers are free to 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.

COMPETITION RULES

R 1. The payload placed refers to **ONE** of three powerpack assemblies, A, B or C, each representing a different energy capacity and value to the Gondwanans. Collecting and placing each requires a different level of technical ingenuity and complexity. The team SHALL nominate only **ONE** payload that their system will collect and place and that SHALL be known as the payload.

R 2. The other alternative two payloads SHALL NOT be added to the Competition Track.

SYSTEM MATERIALS AND MANUFACTURE

R 3. Students SHALL manufacture and fabricate their "proof of concept" 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 4. In keeping with the spirit of the competition, teams SHALL NOT use LEGO ® Mindstorms ® 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".

PROCEDURE

R 7. The mass of the team's system SHALL be measured by an official. The system mass (i.e. without payload) 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 travelling to the International Finals who MAY wish to transport their system as carry on. Teams must appropriately satisfy the airlines restrictions/limitations for carry on and/or checked luggage, including restrictions for transporting batteries.*

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

R 9. The team SHALL nominate which payload their system will attempt to collect and place.

R 10. An official SHALL place the nominated payload onto the appropriate pole with the vertical planes of the payload base nominally parallel to the vertical planes of the Competition Track. The arrow on the bases SHALL face the bunker end of the competition track as shown in Figure 1.

R 11. The Team SHALL visually without contact confirm the correct placement of the payload and request adjustment by an official if necessary.

R 12. There SHALL be no contact by team members or their system with the Competition Track before setup commences.

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. In this time they are to set up their system in the Start Zone.

R 14. During setup, the team MAY use additional objects not considered part of the "system" to assist with setup.

R 15. 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 the internal faces of the Garage and the 18mm edges of the door. The internal surfaces of the Garage includes the internal faces of the MDF front and side walls, internal face of the MDF representing the roof, the 50 mm angle brackets, inside edges of the four 400 mm square openings, and the competition base plane bounded by the external faces of the front, back and side walls. This represents all internal surfaces bounded by a 600 x 600 square on the track noted as the "start zone" and the roof of the garage.

R 16. The Team SHALL indicate to the appropriate "official" when their setup is complete.

R 17. After setup, and prior to running, everything placed and left on the competition track SHALL be considered to be part of the system.

R 18. After setup, and prior to running, the system SHALL be subject to volume constraints. The system SHALL be wholly contained within the 600 x 600 x 500 start zone as defined by the outer sides of the Garage, i.e.; the height and projected plane of the external faces of the side walls, roof and the edges of the starting zone. The volume and positioning conditions SHALL be physically checked by an official.

R 19. After set up and prior to running, the system SHALL NOT be held or supported or contacted by anything other than the competition base plane and must be ready to start. The system SHALL NOT be in contact with or be restrained by the walls, brackets or roof of the Garage. The system SHALL NOT be restrained by personal contact by team members. The system SHALL be capable of remaining in the set up condition indefinitely.

R 20. On instruction and by a signal from the "official starter" the run SHALL commence.

R 21. The run SHALL finish within 100 seconds. This will be judged by an "official".

R 22. The system SHALL be started using a single action that does not impart motion or energy to the system.

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 score for the run. If team members choose to intervene to protect a system that is malfunctioning, a zero score for the run SHALL be recorded.

R 24. During the run the system SHALL NOT come into contact with anything below the competition base plane (defined in G10). The system MAY contact the Competition Track comprising the track, terraces, the garage, the poles, the base of the poles and the bunker. This rule SHALL NOT apply to lost energy orbs.

R 25. The system or payload MAY hang over the edges of the perimeter of the Competition Track during and at the end of the run.

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 can be executed.

R 27. The team 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 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 and payload SHALL NOT damage or contaminate the competition track. The run SHALL NOT contaminate or damage the payload. Teams presenting a system that damages or is deemed to have potential to damage the competition track or payload MAY be disqualified from the competition.

R 30. One or more components of the system left on the competition track does not constitute contamination.

R 31. The system SHALL NOT restrain in any way the energy orbs from being lost from the payload. The system MAY make contact with all faces of the payload base and outer surfaces of the cups.

R 32. Points SHALL be deducted if the arrow of payload C is NOT facing the bunker end of the Competition Track at the completion of the run.

R 33. As directed, teams MAY attempt two runs.

R 34. 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.

R 35. Violations of procedural rules SHALL result in a zero run score being recorded.

R 36. The judges' decisions on all matters pertaining to the competition SHALL be final.

SCORING

R 37. Better systems will achieve the objectives of collecting and placing the payload in the bunker in the least time, whilst adhering to procedural, volume and positioning constraints.

R 38. The smaller powerpacks (payloads) A and B will deliver less water to the Gondwanans' crops so are of less value to them. The scoring reflects this by using a PAYLOADfactor, in addition to a non-zero TIMEscore for only powerpack (payload) C.

R 39. For a "clean" run, the run score SHALL be calculated using the following formula:

$$RUNscore = PAYLOADfactor\ x\ (COLLECTscore + PLACEscore + TIMEscore + PENALTY)$$

Calculated to one decimal place, where at the end of the run:

PAYLOADfactor = *1/3 for payload A (smallest on 30mm pole)*
2/3 for payload B (middle on 300mm pole)
1 for payload C (largest on 800mm pole)

COLLECTscore = The system demonstrates at the time of collection full support and control of the payload = 40 (the payload may move within the system or later lose contact with the system)

= 0 otherwise

PLACEscore = Following removal of the payload from the pole, and at the completion of the run, one of the following:

1. The payload is not in contact with the competition track = 0

2. The payload is in contact with and fully supported by the competition track base plane and/or garage and/or poles and/or the pole support = 15

3. The payload is supported by the competition track base plane and the terrace = 20

4. The payload is fully supported by only the terrace = 25

5. The payload is supported by the terrace and plateau = 30

5. The payload is fully supported by only the plateau = 35

6. The payload is supported by the bunker and the plateau = 40

7. The payload is placed in the bunker with its horizontal plane level = 45

8. For payload C only, the payload is placed in the bunker with its horizontal plane level and the orientation arrow points toward the bunker end of the competition track = 50

TIMEscore = 10 - RUNTIME/10 (relevant to payload C ONLY – see R38 and R41)

= 0 Otherwise

Notes: RUNTIME = Time for the complete run rounded up to the nearest whole second

(e.g. 15.2s becomes 16s)

If RUNTIME ≥ 100 seconds TIMEscore = 0

Penalties For EACH energy orb (ball) lost from its payload cup = -10

System and payload are contacting at the end of the run = -10

MASS = Net mass of system without the payload in grams

R 40. By design, the system SHALL NOT project the payload by airborne translation. The payload MAY be dropped but R29 and R31 must be considered.

R 41. The RUNtime SHALL be measured by officials as the time from when the start command being given, to the system AND payload ceasing translation on the competition track and being able to remain in this state indefinitely relative to the competition track. Mechanisms and items in the system and/or the energy orbs MAY continue to move but no further functions can be executed.

NOTE: *RUNtime is only used to calculate a TIMEscore when payload C is nominated.*

R 42. Each team MAY attempt two runs. The Competition Score shall be the higher RUNscore achieved from either run plus half the RUNscore achieved from the other run. The highest Competition Score shall be declared the winner. The system may be modified between runs but the procedural, mass, volume and time constraints must be satisfied for a run to achieve a non-zero run score.

R 43. If equal Competition Scores are recorded by teams, teams tied SHALL be ranked based on the RUNtime recorded for their higher scoring run, with faster systems preferred. Time will similarly define other minor placings as necessary. If potential podium teams remain tied, teams tied SHALL be ranked based on the MASS recorded for their higher scoring run, with lighter systems preferred.

Frequently Asked Questions

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

Yes. The scenario is for essentially a ground based system (see G24). The guidelines and rules do define what can be legally contacted (see G25, R15, R19, etc).

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 run score (R24). Parts of the system MAY be left on the Competition Track. Energy orbs MAY be lost off the track without additional penalty to that of being lost from the payload cup.

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

Yes. The system can lie partly outside the track during or at the completion of the run and not be penalised provided volume and positioning constraints of the system are met prior to running (see R25).

4. When is a system deemed to be stationary at the completion of the run?

The stop instant will be interpreted as the later of when the payload is stationary on the track or when the contact points of the system and the competition track come to rest and when the functions being performed are observed to have ceased. It must be clear that the system could remain in the end state indefinitely. Energy orbs on or off the payload may continue to move.

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 and fit within the start volumes. No remote-to-the-track control systems of any sort can be used (manual or pre-programmed, hard wired or wireless) – see 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.

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. Is there a requirement on the end state of the system at the completion of the run?

No. However R41 defines the state of the system that satisfies a completed run.

10. If the vertical faces of the powerpack are in contact with other vertical faces of the terrace or plateau does that constitute supporting?

No. Support of the payload only refers to the payload sitting flat on a surface or bridging two horizontal surfaces.

Further Competition Details

INTERNATIONAL FINAL

It is planned that the Warman International Final will be held in late September to mid-October 2018 in Sydney at a location to be determined. The competition has traditionally been run Friday to Sunday but maybe run Thursday to Saturday or even Wednesday to Friday.

Prizes for Campus Winners and International Podium Places will be awarded at the International Final. An International Final "Judges' Prize" and an NCED "Design Prize" may also be awarded.

The planned format will have students gathering on the morning of Day 1 in Sydney. Lunch, followed by a tour of Weir Minerals Ltd will follow. Scrutineering and additional judging will be conducted on Day 2 and there will be briefings, presentations and practice sessions held on Day 2. The actual running of the International Final and the Awards Ceremony will be on Day 3.

A team registration form will be available – please submit it to Engineers Australia (EA) as early as possible. Travel arrangements are coordinated by EA. Team details are required early August at the latest (unless otherwise advised).

Teams registering and accepting the invitation and sponsorship to participate at the Final also accept that their names and photographs and video of them can be used for publicity purposes by EA and Weir Minerals. All team members and attending Campus Organisers will be required to sign an appropriate authority in relation to this use.

In meeting costs, the competition sponsorship has in past years funded two students per team. It is hoped that this will be possible again in 2018. Depending on funding, it is hoped that Campus Organisers will also be funded. Campuses will be billed for additional students and for other people for whom arrangements are made whether or not they actually attend the Warman weekend.

SPIRIT OF THE COMPETITION

Although the rules may look rigid you will find that they have been written in a way which 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.

Appendix A - General Arrangement and Detailed Drawings of Competition Track

Sheet 1 – General Arrangement View

Sheet 2 – Track Details

Sheet 3 – Garage Details

Sheet 4 – Poles B and C Support Details

Sheet 5 – Plateau Details

Sheet 6 – Terrace Details

Sheet 7 – Pole A Details

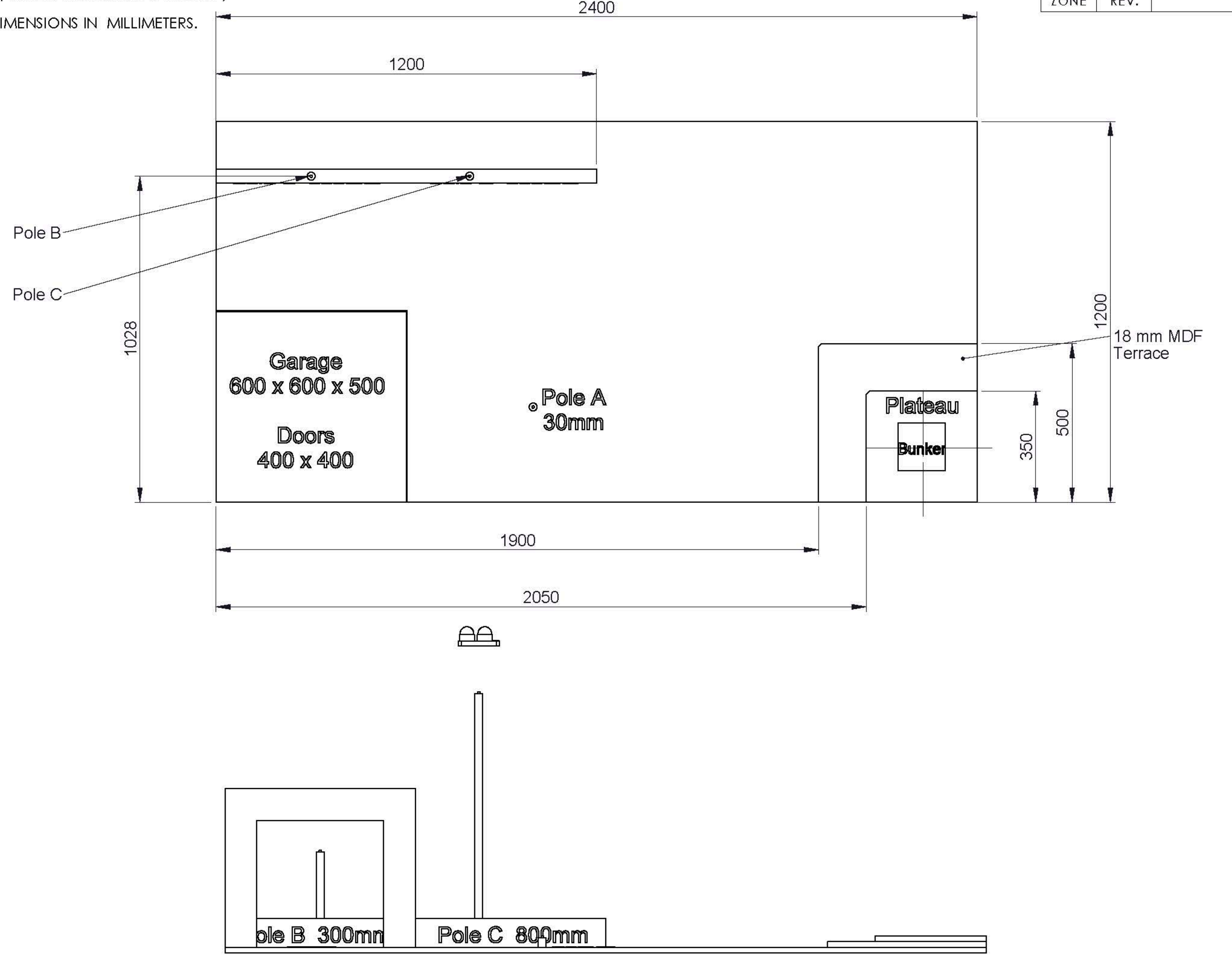
Sheet 8 – Poles B and C Details

Sheet 9 – Powerpacks A, B and C details

NOTES - (UNLESS OTHERWISE SPECIFIED)

1. ALL DIMENSIONS IN MILLIMETERS.

REVISIONS					
ZONE	REV.	DESCRIPTION	ECO	APPROVED	DATE



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MATERIAL: SEE PART DRAWINGS		General Assembly	
FINISH: SEE PART DRAWINGS		DESIGN	DWG NO. Sheet 1 / REV 0
TOLERANCE (UNLESS OTHERWISE SPECIFIED) DECIMAL mm		DRAWN DMC	PROJECT Weir Warman 2018
.X ± .1 .XX ± .03 .XXX ± .010 ANG. ± 1°		SUPERVISOR	ISSUE DATE 20 Feb 2018 / DRAWING NOT TO SCALE / SHEET 1 OF 9

NOTES - (UNLESS OTHERWISE SPECIFIED)

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

REVISIONS					
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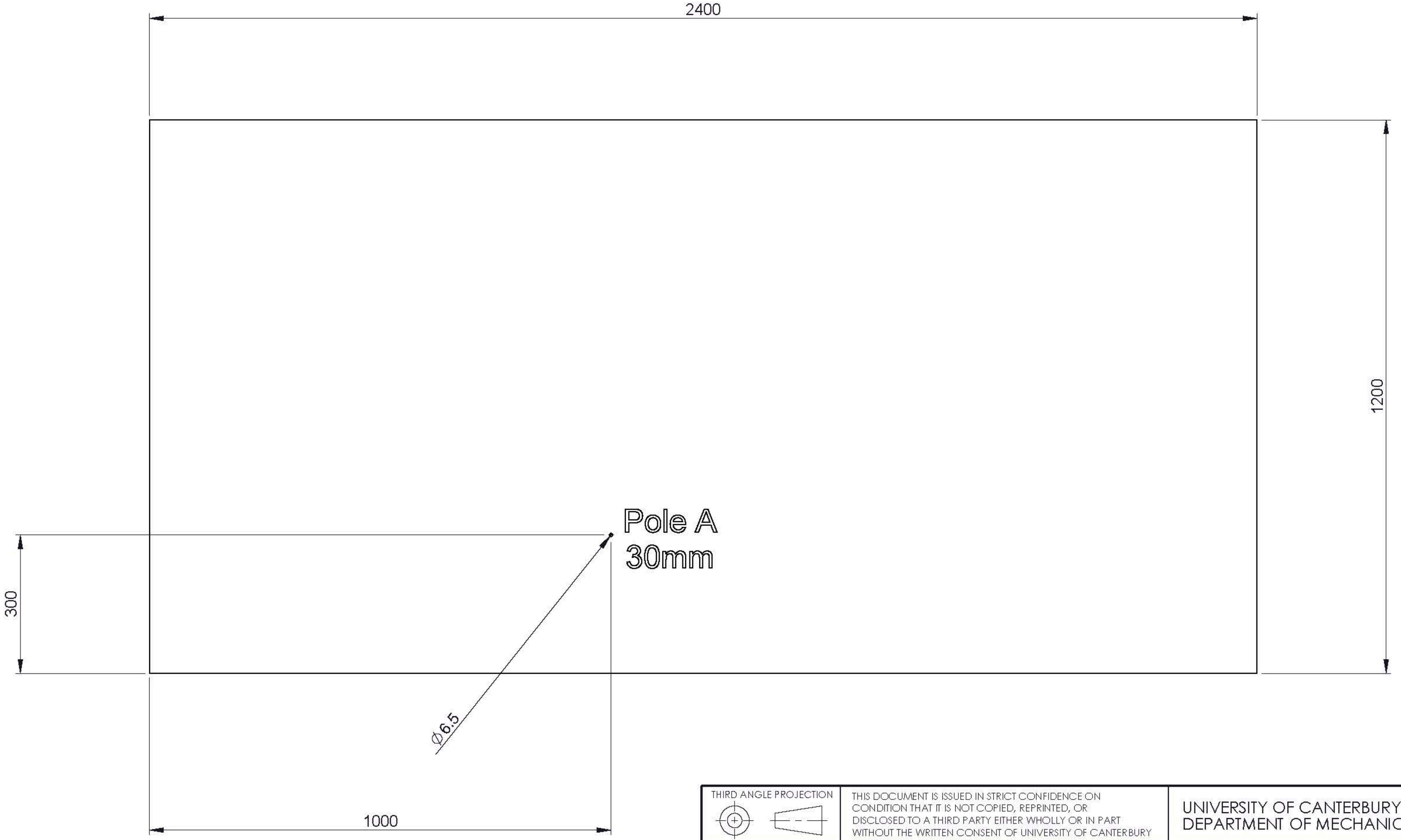

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MATERIAL: 18mm MDF		Track
FINISH: Wattyl Estapol Matt		DESIGN; DWG NO. Sheet 2; REV 0
TOLERANCE (UNLESS OTHERWISE SPECIFIED)		DRAWN: DMC; PROJECT: Weir Warman 2018
DECIMAL mm ± 5mm		SUPERVISOR; ISSUE DATE: 20 Feb 2018; DRAWING NOT TO SCALE; SHEET: 2 of 9

NOTES - (UNLESS OTHERWISE SPECIFIED)

1. ALL DIMENSIONS IN MILLIMETERS.
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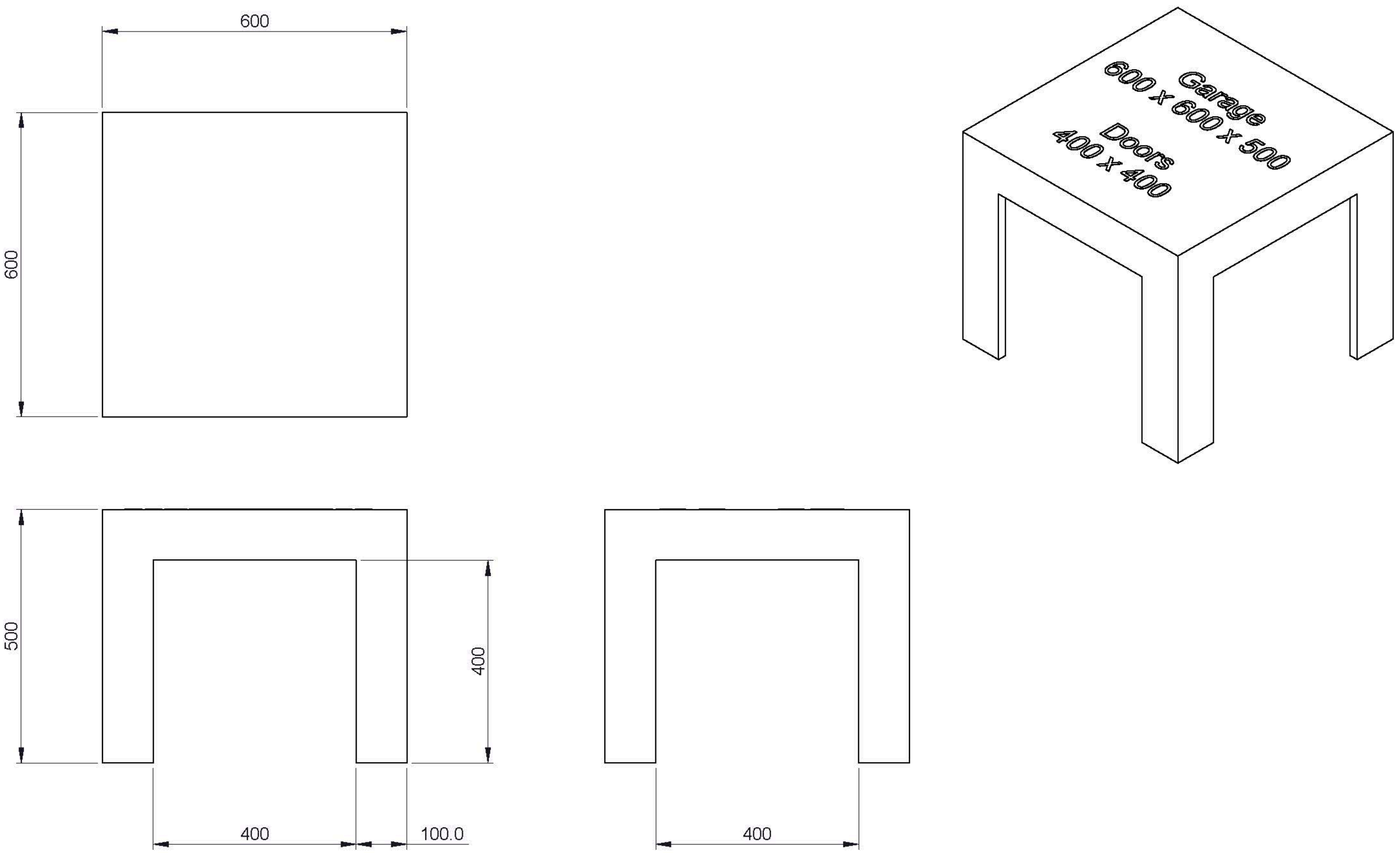
REVISIONS					
ZONE	REV.	DESCRIPTION	ECO	APPROVED	DATE



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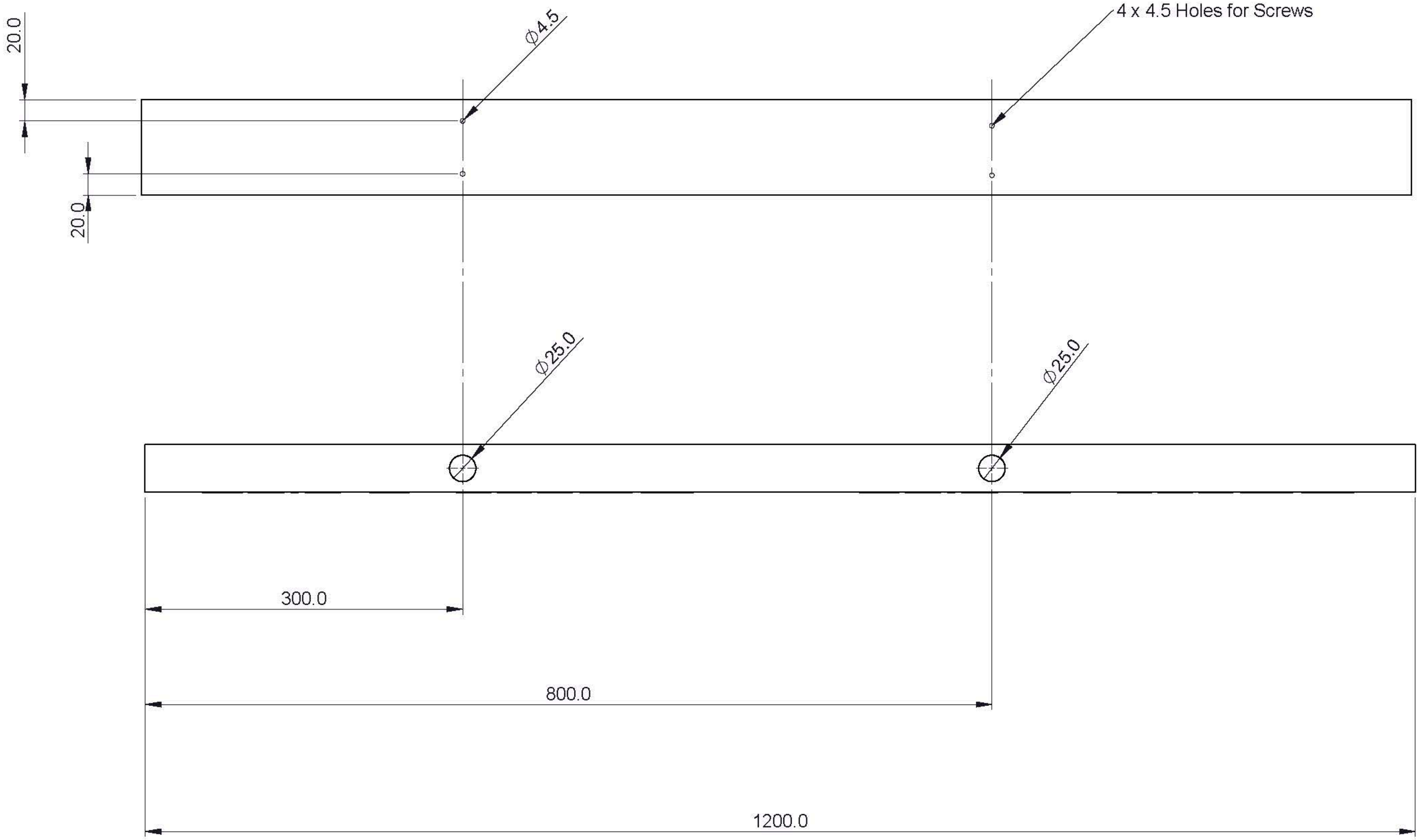
MATERIAL 18mm Thick MDF		Garage
FINISH As Supplied		DESIGN / DWG NO. Sheet 3 / REV 0
TOLERANCE (UNLESS OTHERWISE SPECIFIED)		DRAWN DMC / PROJECT Weir Warman 2018
DECIMAL mm +/- 5		SUPERVISOR / ISSUE DATE 20 Feb 2018 / DRAWING NOT TO SCALE / SHEET 3 of 9

NOTES - (UNLESS OTHERWISE SPECIFIED)

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



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MATERIAL: 90 x 45mm MGP10 Pine Timber Framing		Pole B and C Support	
FINISH: Wattyl Estapol Matt		DESIGN: XXX	DWG NO. Sheet 4 — REV 0
TOLERANCE (UNLESS OTHERWISE SPECIFIED) DECIMAL mm		DRAWN: DMC	PROJECT: Weir Warman 2018
.X ± .1 .XX ± .05 .XXX ± .010 ANG. ± 1°		SUPERVISOR	ISSUE DATE 20 Feb 2018 — DRAWING NOT TO SCALE — SHEET 4 of 9

ZONE	REV.	DESCRIPTION	ECO	APPROVED	DATE

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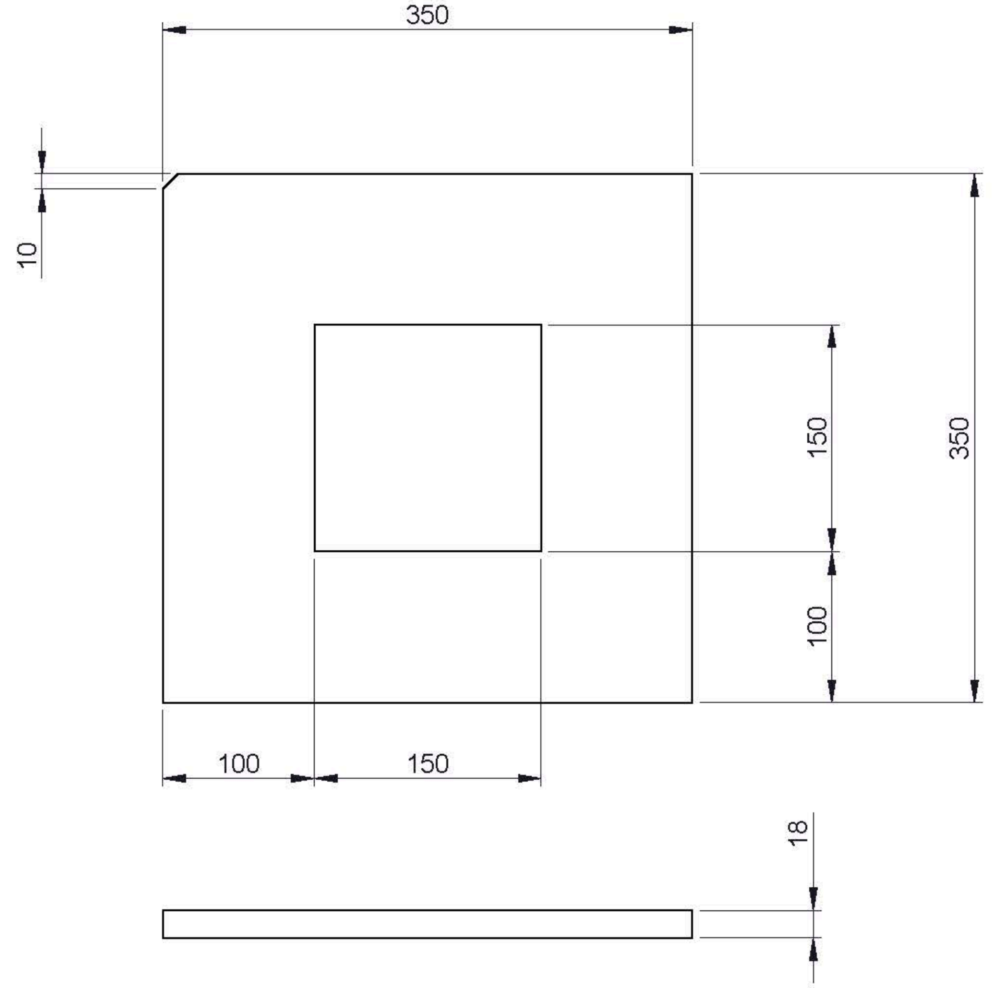
2. GD&T AS PER ISO1101-2004.

ZONE	REV.	DESCRIPTION	ECO	APPROVED	DATE

REVISIONS



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MATERIAL: 18mm MDF		Plateau	
FINISH: Wattyl Estapol Matt		DESIGN: XXX	DWG NO. Sheet 5 / REV 0
TOLERANCE (UNLESS OTHERWISE SPECIFIED) DECIMAL mm		DRAWN: DMC	PROJECT: Weir Warman 2018
.X ± .1 .XX ± .05 .XXX ± .010 ANG. ± 1°		SUPERVISOR	ISSUE DATE: 20 Feb 2018 / DRAWING NOT TO SCALE / SHEET 5 of 9

NOTES - (UNLESS OTHERWISE SPECIFIED)

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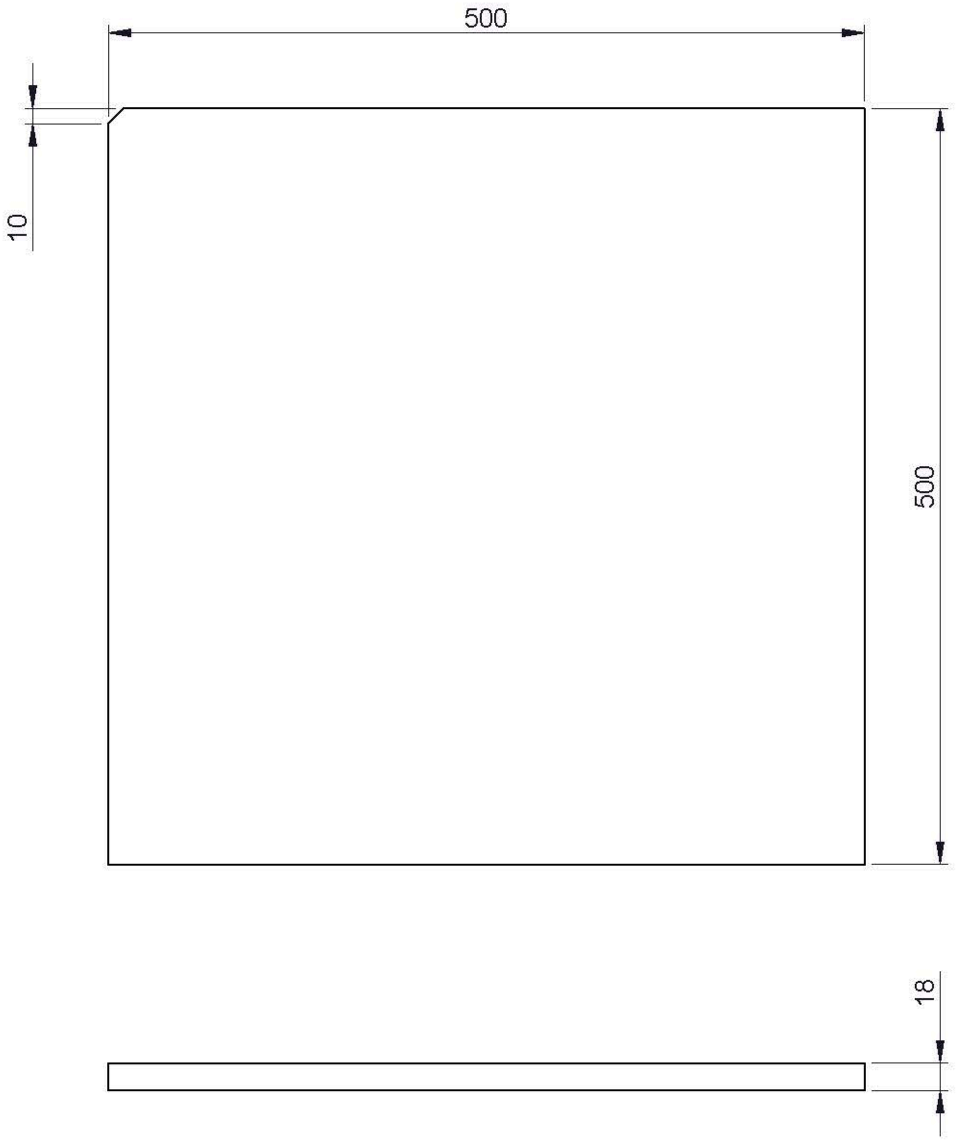

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MATERIAL	18mm MDF	Terrace
FINISH	Wattyl Estapol Matt	DESIGN XXX / DWG NO. Sheet 6 / REV 0
TOLERANCE (UNLESS OTHERWISE SPECIFIED) DECIMAL mm	.X ± .1 .XX ± .05 .XXX ± .010 ANG. ± 1°	DRAWN DMC / PROJECT Weir Warman 2018 Project
		SUPERVISOR / ISSUE DATE 20 Feb 2018 / DRAWING NOT TO SCALE / SHEET 6 of 9

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1. ALL DIMENSIONS IN MILLIMETERS.
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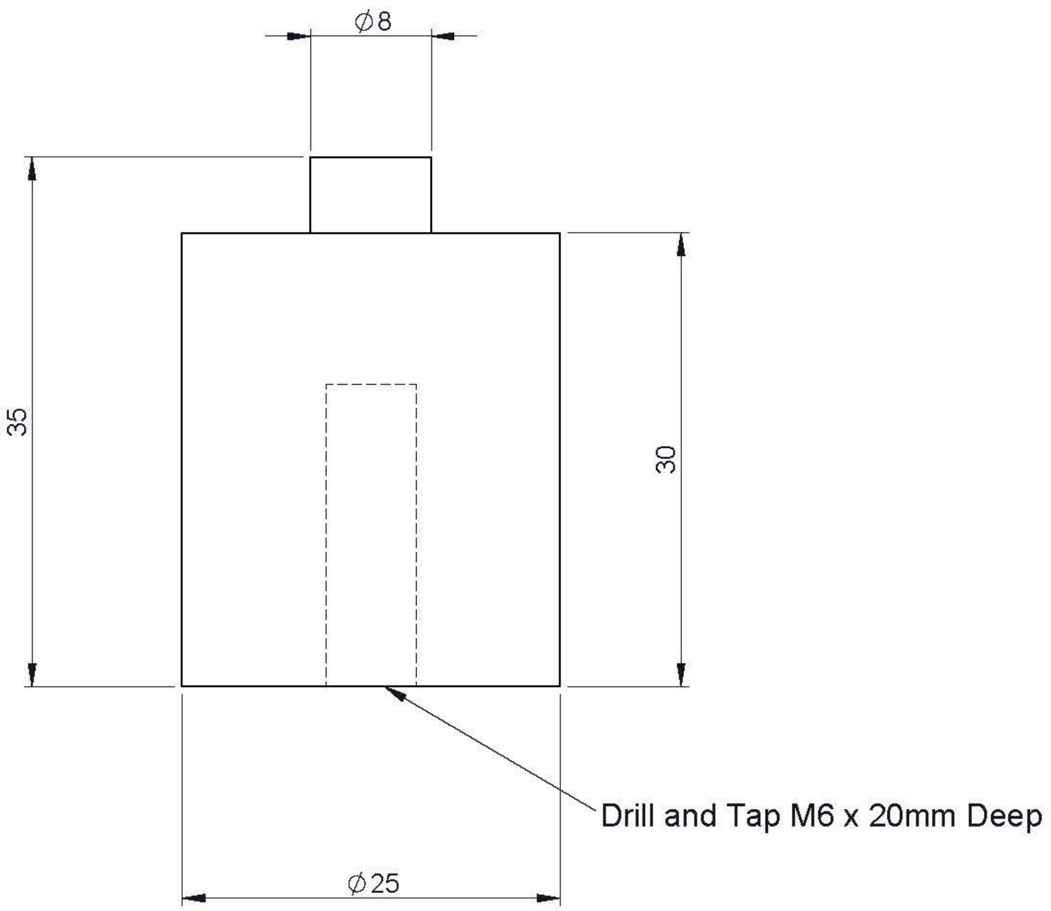
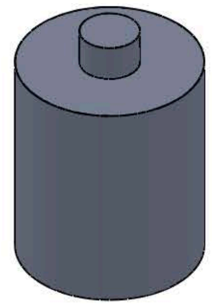
REVISIONS					
ZONE	REV.	DESCRIPTION	ECO	APPROVED	DATE





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MATERIAL Steel		Pole A	
FINISH Cold Rolled or Turned		DESIGN XXX	DWG NO. Sheet 7 / REV 0
TOLERANCE (UNLESS OTHERWISE SPECIFIED) DECIMAL mm		DRAWN DMC	PROJECT Weir Warman 2018
.X ± .1 .XX ± .05 .XXX ± .010 ANG. ± 1°		SUPERVISOR	ISSUE DATE 20 Feb 2018 / DRAWING NOT TO SCALE / SHEET 7 of 9

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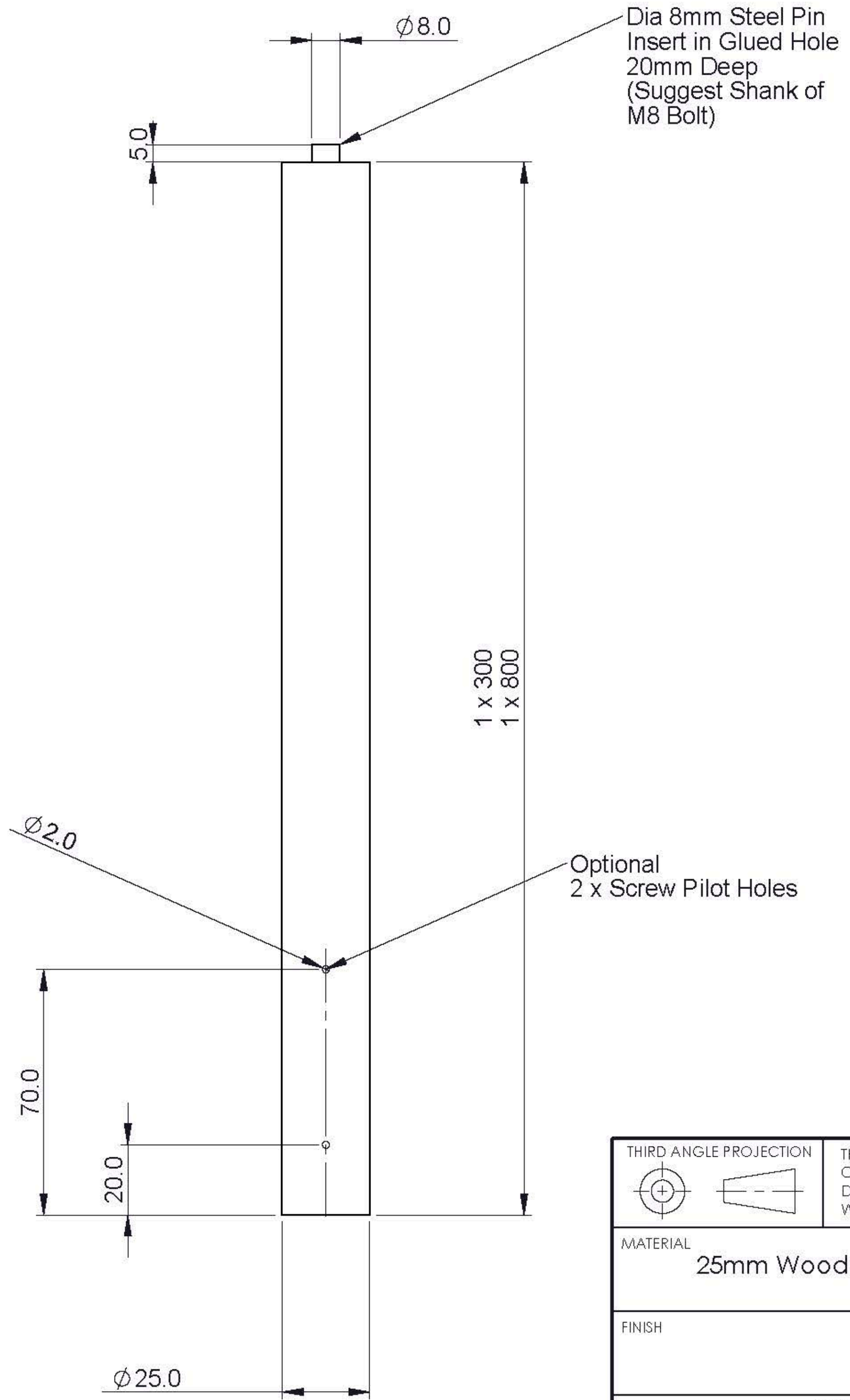

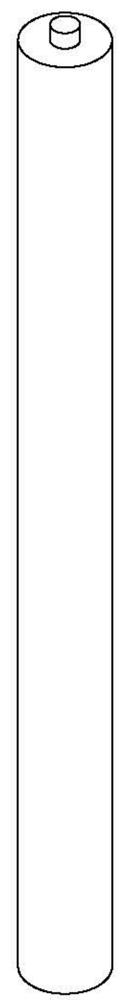

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MATERIAL: 25mm Wooden Dowel and Dia 8mm Steel Pin		Poles B and C		
FINISH: As supplied		DESIGN: XXX	DWG NO. Sheet 8	REV 0
TOLERANCE (UNLESS OTHERWISE SPECIFIED) DECIMAL mm		DRAWN: DMC	PROJECT: Weir Warman 2018 Project	
.X ± .1 .XX ± .05 .XXX ± .010 ANG. ± 1°		SUPERVISOR	ISSUE DATE: 20 Feb 2018	DRAWING NOT TO SCALE SHEET 8 of 9

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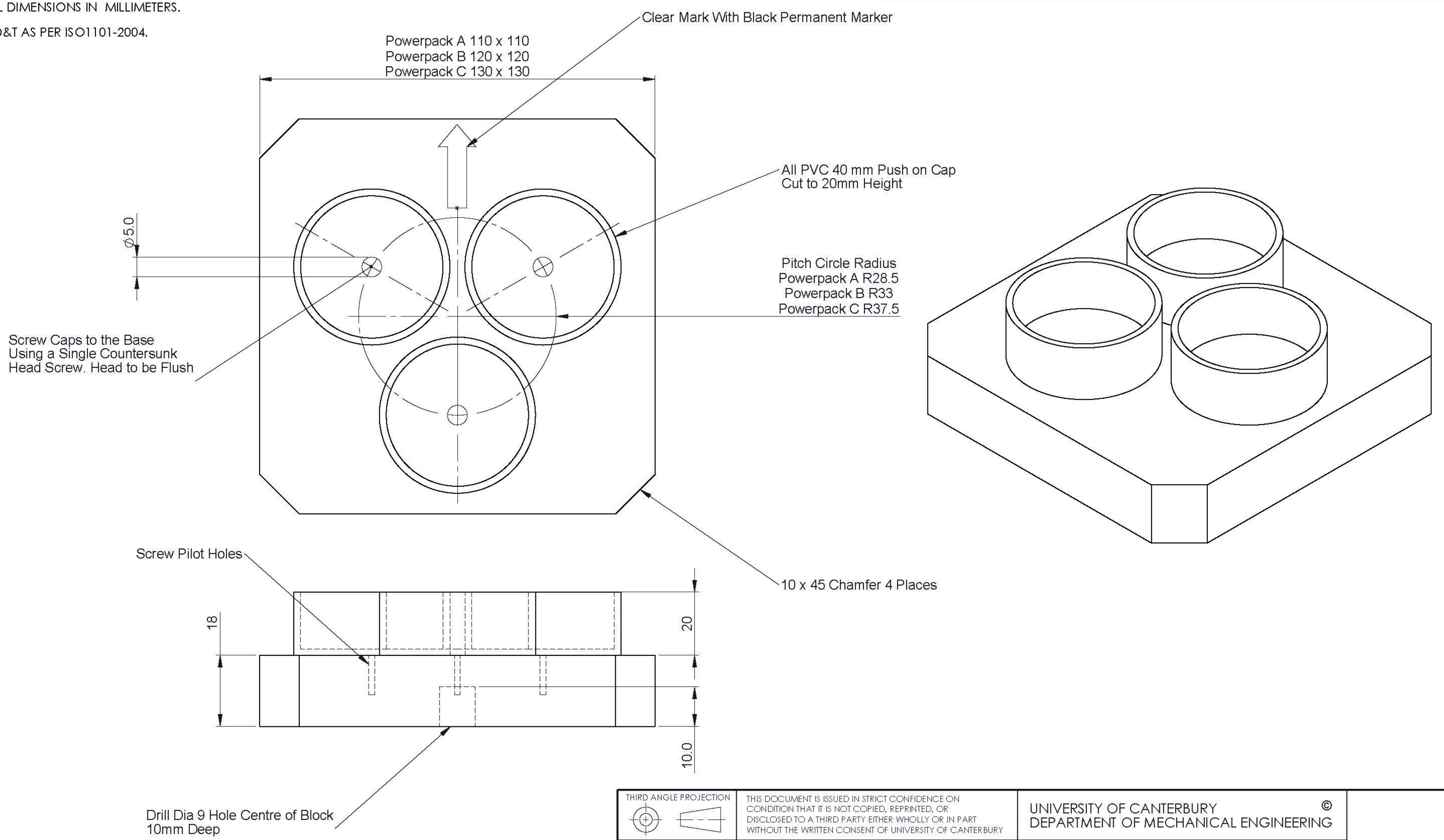
ZONE	REV.	DESCRIPTION	ECO	APPROVED	DATE



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DEPARTMENT OF MECHANICAL ENGINEERING

MATERIAL: MDF and Holman 40mm Push on PVC Caps

Powerpack Assem A, B,C

FINISH: Various

TOLERANCE (UNLESS OTHERWISE SPECIFIED)
DECIMAL mm
General Tolerance +/- 1.0 **ANG.** ± 1°

DESIGN: XXX
DWG NO. Sheet 9
REV 0
DRAWN: DMC
PROJECT: 2018 Weir Warman
SUPERVISOR:
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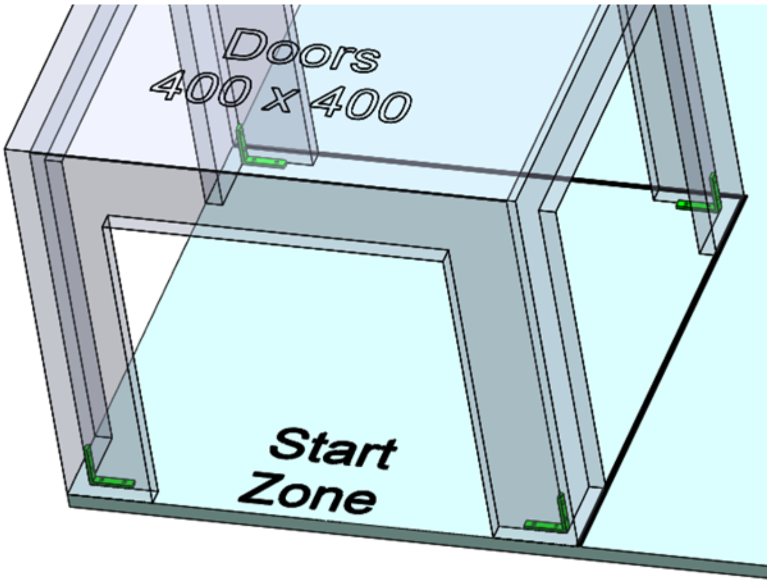
SHEET 9 of 9

Appendix B

Appendix B1 Angle Brackets for Garage/Track Connection



Appendix B2 Angle bracket locations for Garage/Track connection

Figure B3 Example of a powerpack assembly

Figure B4 Example of the pole b and c support assembly