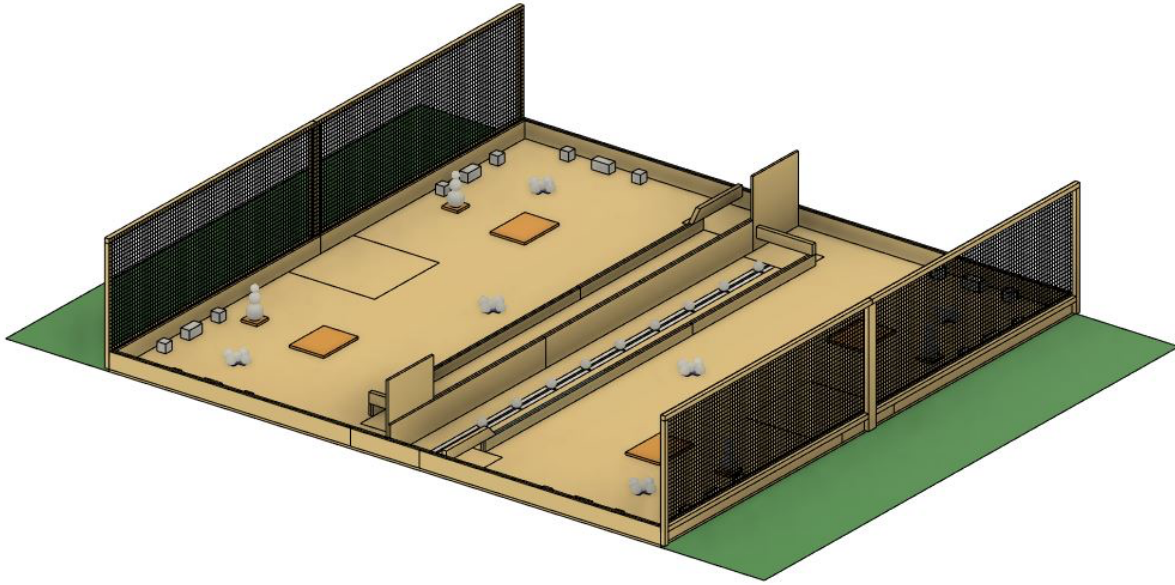




Project  
**Mobile Robotics**

SECONDARY

## Snowday!



Project Document  
23 - Mobile Robotics  
Secondary Level

1. Terms .....	3
2. Safety .....	4
3. Overview, Game Description, and Play .....	5
4. Team’s Area and Court Areas .....	11
5. Detailed Game Components .....	19
6. “Snowday!” Game Scoring Summary .....	22
7. Pit Area and Court Access .....	24
8. Robot Restrictions .....	25
9. Inspection .....	28
10. On-site Autonomous Robot Challenge Overview .....	30
11. Medal Awarding System .....	32
Appendix A: Court Dimensions and Details.....	33
See Attached.....	33
Appendix B: Tele-operated Main Game Score Sheet.....	33
See Attached.....	33
Appendix C: Sample Wiring Diagrams .....	33
See Attached.....	33
Appendix D: Approved Autonomous Challenge Chassis Optional Pre-build.....	33
See Attached.....	33
Appendix E: Safety Criteria and Scoresheet for Judging.....	33
See Attached.....	33
Appendix F: Inspection Sheet.....	33
See Attached.....	33

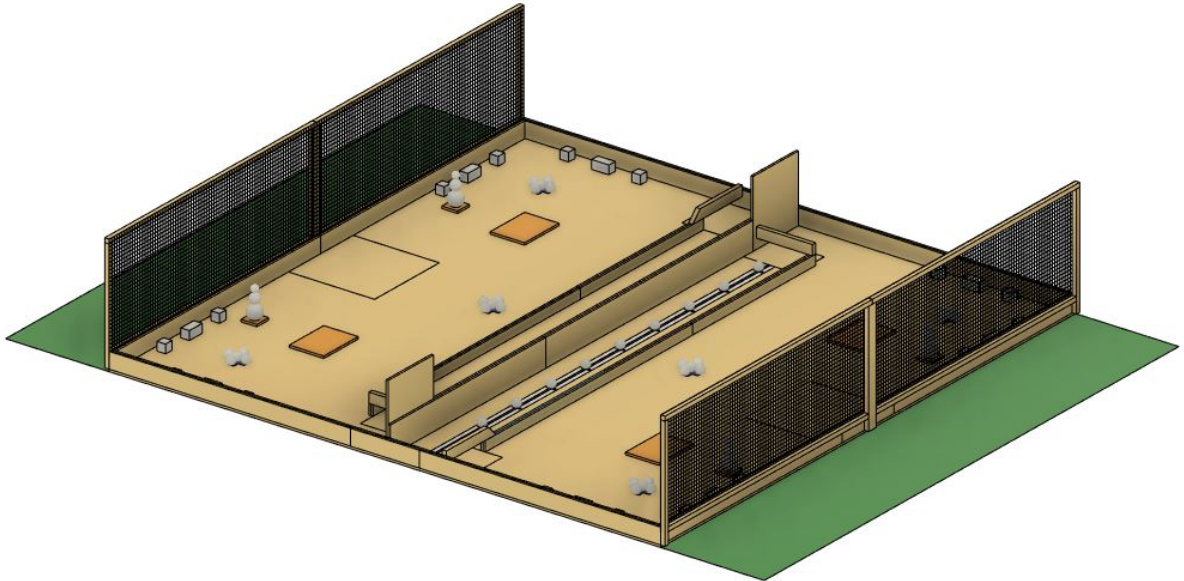
## 1. Terms

- 1.1. Tele-Operated Robot Elements are elements under the direct/active control of competitors during game play using one or two radios/game controllers held by the courtside competitors.
- 1.2. Independent Autonomous Elements are elements not under the direct control of competitors throughout gameplay.
  - 1.2.1. The only permitted direct competitor interaction with these elements is initiation of the autonomous device at the beginning of the game.
  - 1.2.2. Once the expiration of the time has been complete, these devices must be turned off safely. This may be done by the NTC/Judges.
  - 1.2.3. Mobile Independent Autonomous Elements are considered any autonomous element that moves about the court.
  - 1.2.4. Stationary Independent Autonomous Elements are considered any autonomous element that does not move about the court.
    - 1.2.4.1. This includes elements that have electrical components as well as elements that do not contain electrical components.
  - 1.2.5. Independent Autonomous Elements may interact with the team's tele-operated mobile robot.
    - 1.2.5.1. Tele-operated mobile robots may initiate an active response by the Independent Autonomous Element which may be managed by a mechanical based system or a pre-programmed system internal to the Independent Autonomous Element.

## 2. Safety

- 2.1. Safety is of paramount importance in all aspects of the competition.
  - 2.1.1. All individuals on site are expected to be mindful and ensure they act safely at all times.
- 2.2. Specific expectations with regards to the Robotics competition are as follows:
  - 2.2.1. All individuals are expected to wear eye protection at all times when they are in the competition area.
  - 2.2.2. Teams are expected to ensure their pit area is tidy.
  - 2.2.3. Teams are expected to have appropriate storage for their batteries when they are not on the robot.
    - 2.2.3.1. For Lithium based batteries, teams are to have a properly rated Lithium storage bag/container.
  - 2.2.4. All fabrication work involving material removal processes (grinding / cutting) must be completed in the designated “Grinding Booth” area.
  - 2.2.5. All competitors must ensure they are not wearing any jewelry that could be caught in something.
  - 2.2.6. All competitors must ensure their hair is tied back/not in their eyes, and not able to be caught in anything.
  - 2.2.7. All individuals are expected to ensure all trip hazards are reduced as much as possible.
    - 2.2.7.1. In situations where trip hazards cannot be eliminated, appropriate signage and notification must be made to everyone in the area.
  - 2.2.8. All individuals are expected to ensure they are wearing appropriate footwear.
    - 2.2.8.1. All footwear must be closed-toe shoes.
    - 2.2.8.2. All laces must be tied.
  - 2.2.9. All Robots must pass a safety inspection (details in Section 9).
- 2.3. Safety Scoring criteria details are available in Appendix E.

### 3. Overview, Game Description, and Play



*Figure: Overall Team Court*

#### 3.1. General Overview

- 3.1.1. The core game situation requires a Robot or Robots to use the components provided in their Exclusive Use Court Space to:
  - 3.1.1.1. Build a snow fort out of snowblocks.
  - 3.1.1.2. Protect their snowmen.
  - 3.1.1.3. Collect and shoot snowballs at their opponents' snow forts and snowmen.
  - 3.1.1.4. Clear snowballs from their side of the court, including their autonomous zone.
- 3.1.2. The goal of this game is for Robot(s) to build “Snow forts” to protect their “Snowmen” while collecting and shooting “Snowballs” at their opponents.
- 3.1.3. Teams will earn points for:
  - 3.1.3.1. Snowmen standing at the end of the match.
  - 3.1.3.2. Fort/tower construction.
  - 3.1.3.3. Snowballs in their opponent's court.
  - 3.1.3.4. Returning to the starting area at the end of the match. Robots must leave the starting zone to get these points.
- 3.1.4. Teams are not permitted to intentionally remove game pieces from the court area.

### 3.2. Game Description

- 3.2.1. Games will involve two teams at a time.
- 3.2.2. Competitors must remain in their designated driver zone on their side of the court.
- 3.2.3. Teams can utilize a maximum of TWO tele-operated robots.
- 3.2.4. Teams may also use a maximum of ONE Independent Autonomous Element as part of their entry.
  - 3.2.4.1. This must start and remain in the designated autonomous zone.
- 3.2.5. Teams are not permitted to intentionally drop pieces off of any robot.
- 3.2.6. A team's Robots (Tele-operated or Autonomous) are not permitted to interact or interfere with their opponents or the robots of any other team.
  - 3.2.6.1. Intentional violations of this may result in disqualification.
- 3.2.7. Tele-operated Robots may NOT be in possession of any game components at the Start of a game.
- 3.2.8. Teams are not permitted to reach over any walls (exterior, interior, or the middle barrier).
- 3.2.9. NOTE: Competitors will participate in BOTH the "Snowday!" game and the separate "On-site Autonomous Robot Challenge" (See Section 10) during BOTH competition days.

### 3.3. Game Play

- 3.3.1. Games will be played between 2 teams.
  - 3.3.1.1. Games will last 4 minutes.
    - 3.3.1.1.1. The amount of time between matches will depend on the number of teams participating. This information will be provided to teams at the start of the competition.
    - 3.3.1.1.2. Games will start on time. Teams are responsible to know when their games are scheduled. Teams arriving late will be allowed to use the remainder of the time in the game.
      - 3.3.1.1.2.1. NTC judges may adjust the scheduled games as necessary for the purposes of ensuring fair game play.
    - 3.3.1.1.3. Between games, battery changes and repairs to robots may be completed at the team's assigned "Pit Area Worktable", with appropriate PPE and Safety.
  - 3.3.1.2. It is a team decision what roles team members will fill.
    - 3.3.1.2.1. Drivers are the competitors holding the robot controller(s) and asserting direct control over a Tele-Operated robot.
    - 3.3.1.2.2. The Spotter is the competitor providing navigational guidance to the driver.
    - 3.3.1.2.3. Competitors must remain in their designated driver zones at all times during a match.

- 3.3.1.2.4. Competitors may change roles while a game is in progress.
- 3.3.1.2.5. Competitors cannot enter onto the court surface or adjust their robot during a game.
- 3.3.2. Robots must remain in compliance with the rules in this document for the duration of the game.
  - 3.3.2.1. Robots must start in their designated starting area, and in their designated starting position.
    - 3.3.2.1.1. The designated starting position is the same configuration used during the volume calculation. (For more information about the volume calculation, please refer to sections 8 and 9.)
  - 3.3.2.2. Damaging the court area is prohibited. If a robot's design causes damage to the court elements, then it will not be allowed to compete until it can operate without causing damage.
    - 3.3.2.2.1. Games missed due to this situation will be forfeited.
    - 3.3.2.2.2. Damage will be defined as any action that causes the court or components to no longer be able to function as intended.
    - 3.3.2.2.3. "Snowmen" are an element of play in the court, they may be knocked over and do not count as damage to the court.
      - 3.3.2.2.3.1. Should a "Snowman" become damaged due to normal use, that will be considered a court defect, not damage.
    - 3.3.2.2.4. "Snowballs" are an element of play in the court. Robots are not permitted to intentionally damage these.
      - 3.3.2.2.4.1. Should a "Snowball" become damaged due to normal use, that will be considered a court defect, not damage.
      - 3.3.2.2.4.2. Should a "Snowball" become stuck within the mechanisms of a robot (through normal function of the robot) and become damaged, this will be considered court damage.
    - 3.3.2.2.5. It is expected that all court components will be fixed firmly in place so that the court is a Neutral Factor in the competition.
  - 3.3.2.3. If a robot is mal-functioning and represents a hazard to participants, the court, other robots or itself, in the opinion of the NTC/Judge, then, the NTC/Judge may authorize shutting off the robot during a game. Disabled robots or parts of robots not



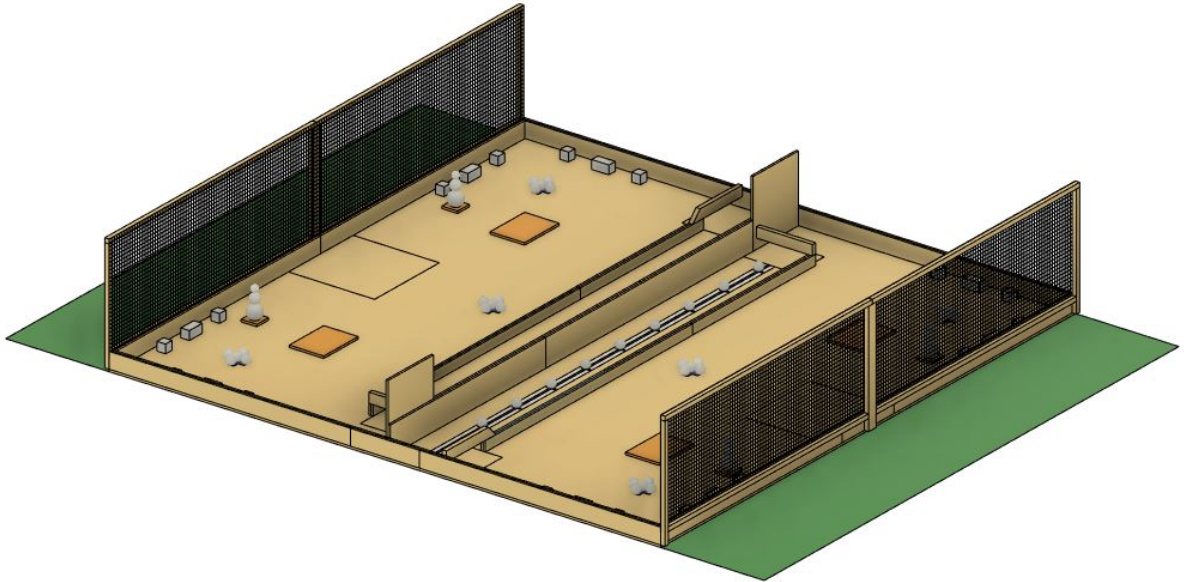
- generating any safety concerns will be left on the court until the game time expires.
- 3.3.2.4. Robots must not leave the contest court at any time during a game.
  - 3.3.2.5. No aerial (flying) robots are permitted.
  - 3.3.3. During game play, NTC/Judges will have ultimate authority over game rulings, and will have full authority over team conduct in the court area.
    - 3.3.3.1. It will be an NTC/Judge's ruling that decides if an 'End of the Game Component Placement' took place before or after the game-ending buzzer sounded.
    - 3.3.3.2. It will be an NTC/Judge's ruling that decides if a robot is in violation of the rules of the game.
      - 3.3.3.2.1. If any rule violations are noted during the competition, the following escalation pathway will be followed:
        - 3.3.3.2.1.1. During a match:
          - 1) 1st Warning. The team is given an in-match warning when a violation is first noticed.
          - 2) 2nd Warning. The team is given a second in-match warning when a second violation is noticed, and is clearly told that the next occurrence will mean disqualification.
          - 3) Disqualification of the team from the match. The team is disqualified and will then be subjected to a discussion with the judges. The team will have to prove the violation(s) is/are addressed before they are allowed to participate in another match. The opposing team will be granted the win in that match.
        - 3.3.3.2.1.2. Not during a match (Practice time, inspection, or other)
          - 1) The team will be subjected to a discussion with the judges.
          - 2) Teams will not be permitted to proceed until the judges are convinced the violation(s) is/are addressed.
        - 3.3.3.2.1.3. Note: Depending on the severity of a violation, warnings may be skipped.
- 3.3.4. Scoring will take place after the "End of Game" Buzzer.

- 3.3.5. If a piece falls out of the court, it may not be retrieved and will be considered out of the game for the remainder of the game time.
- 3.3.6. Should any game pieces fall into the opponent's court area, those pieces shall remain in play and be usable by the opposing team.
  - 3.3.6.1. This applies to all game pieces which may count for points.
  - 3.3.6.2. Should a larger game piece fall into the opposing team's court, it may be removed at the Judge's/NTC discretion.
- 3.4. Teams will participate in a "Round Robin" followed by a "Seeded Double Elimination Playoff Tournament".
- 3.5. Teams will play an equal number of "Round Robin" games.
  - 3.5.1. Round Robin games will be played between 2 teams.
  - 3.5.2. Overall final placement of teams in the Round Robin will be determined using the win-loss-tie record.
    - 3.5.2.1. Match wins will be awarded 2 points.
    - 3.5.2.2. Match loses will be awarded 0 points.
    - 3.5.2.3. Match ties will be awarded 1 point.
      - 3.5.2.3.1. A tie is defined as a situation where 2 teams score identical points in a match.
    - 3.5.2.4. Round Robin ranking tie breaker will be determined by the following criteria:
      - 3.5.2.4.1. First tie-breaker for Round Robin ranking will be the record of the tied teams against each other.
      - 3.5.2.4.2. Second tie breaker for Round Robin ranking will be the total in-game points scored by the tied teams in all their matches.
      - 3.5.2.4.3. Third tie breaker for Round Robin ranking will be a "Shootout". Teams will be given in turn a single shot from their starting zone towards their opponent's zone, with 2 standing snowmen in their starting locations. The team with the highest scored shot will be awarded the win.
        - 3.5.2.4.3.1. Should both teams make an equal value shot, they will repeat the "Shootout" round until a winner has been determined.
  - 3.5.3. The "Snowballs", "Snowblocks", and "Snowmen" in the court will be located as designated in the "Court Description" Appendix A.

- 3.6. All teams will qualify for the “Seeded Double Elimination Playoff Tournament”.
  - 3.6.1. Playoff Tournament seeding will be based on the results of the Round Robin.
  - 3.6.2. Should a match result in a “Tie” during the tournament, the following “tie-breaker” will be used to decide the match winner.
    - 3.6.2.1. First tie-breaker for a tournament match will be the number of balls in your opponent’s autonomous zone. Whichever team has the higher number of snowballs in their opponent’s autonomous zone will be awarded the win.
    - 3.6.2.2. Should the first tie-breaker remain in a tie, the second tie-breaker for a tournament match will be the “Snowfort” height. Whichever team has the taller snowfort will be awarded the win.
    - 3.6.2.3. Should the second tie-breaker remain in a tie, the third tie-breaker for a tournament match will be the number of snowmen standing on a team’s court side. Whichever team has the most standing snowmen will be awarded the win.
    - 3.6.2.4. Should the third tie-breaker remain in a tie, the fourth and final tie-breaker for a tournament match will be a “Shootout”. Teams will be given in turn a single shot from their starting zone towards their opponent’s zone, with 2 standing snowmen in their starting locations. The team with the highest scored shot will be awarded the win.
      - 3.6.2.4.1. Should both teams make an equal value shot, they will repeat the “Shootout” round until a winner has been determined.

## 4. Team's Area and Court Areas

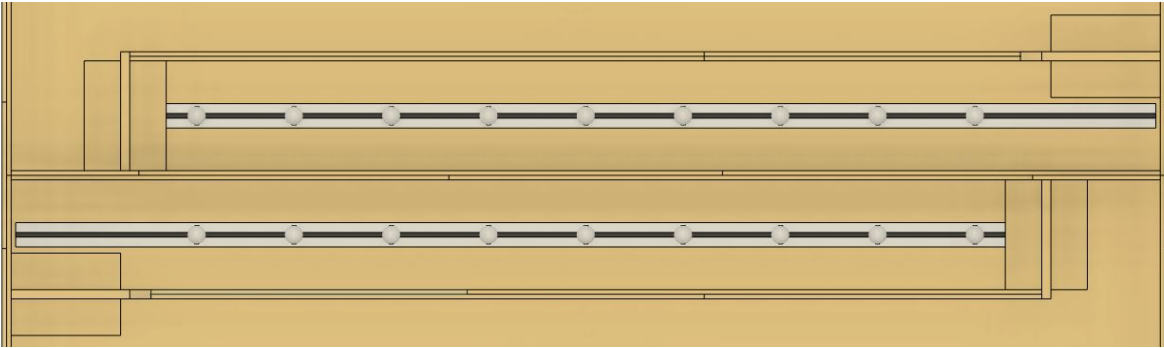
4.1. The overall court playing surface will be a 16' by 16' square.



*Figure: Overall Court*

- 4.1.1. Exclusive use team spaces are 8' by 16' rectangles.
- 4.1.2. Perimeter court walls will be made using  $\frac{3}{4}$ " plywood, resulting in a 5.5" tall by 1.5" thick wall.
- 4.1.3. The court surface may vary between melamine, concrete, hardboard, plywood, or the facility floor.
- 4.1.4. Detailed court information has been included in the Appendix section of this document.
  - 4.1.4.1. Although great efforts will be made to keep the court in compliance with the drawings, some inaccuracies in construction may occur. Please make your robot designs allowing for a possible  $\frac{1}{2}$  inch tolerance.

## 4.2. “Ice Area” - Autonomous Zone

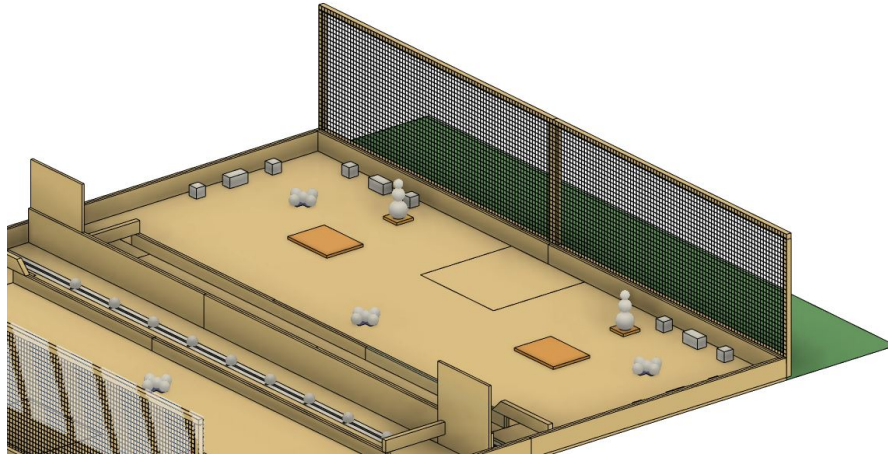


*Figure: Ice Area*

- 4.2.1. Located along the shared middle wall of the court surface will be the “Ice Area”.
  - 4.2.1.1. This area will be 169.5” in length and 18” in width (internal dimensions).
- 4.2.2. This area will be the dedicated “Autonomous Zone” for this competition.
- 4.2.3. The “Ice Area” will contain the following:
  - 4.2.3.1. 9 Snowballs will begin in this area, at the predefined locations (See Appendix A).
  - 4.2.3.2. A team’s optional autonomous element.
  - 4.2.3.3. A middle line running throughout the autonomous zone as described in Appendix A.
    - 4.2.3.3.1. This middle line will be composed of a 4” wide white duct tape line plus a ¾” black electrical tape line taped down the middle of it.
    - 4.2.3.3.2. It will extend from the exterior wall, the length of the autonomous zone to 6 inches away from the passageway (touching the “delivery zone”).
    - 4.2.3.3.3. 9 strips of 3” long black electrical tape perpendicular to this line will mark the starting locations of the snowballs.
- 4.2.4. The barrier to this area will be as described:
  - 4.2.4.1. The shared middle wall will be a solid portion 9.5 inches in height, 1.5 inches in width.
    - 4.2.4.1.1. This shared middle wall will be constructed using plywood, as described in Appendix A.
  - 4.2.4.2. The barrier wall in the teams' zone will be 3.5 inches in height, 1.5 inches in width.
    - 4.2.4.2.1. This barrier wall will be constructed using plywood, as described in Appendix A.
  - 4.2.4.3. At the end of the “Ice Area” there will be “delivery zones” which snowballs are permitted to be passed through.

- 4.2.4.3.1. At one end, the “delivery zone” will be perpendicular to the shared middle wall. Down the middle of this delivery zone, a 2x4 piece will be placed to form an arch spanning the distance from the shared middle wall to the barrier wall in the team's zone. This will result in the construction of a passageway with a height of 3.5” and a width of 18”.
- 4.2.4.3.2. At the opposite end, the “delivery zone” will be parallel to the shared middle wall. Down the middle of this delivery zone, a 2x4 piece will be placed to form an arch spanning the distance from the barrier wall in the team's zone to the outside court wall, resulting in the construction of a passageway with a height of 3.5” and a width of 18”. These “delivery zones” will be an open area underneath the 2x4 spanning the specified gap.
- 4.2.4.3.3. These “delivery zones” will have an area stretching 6” into the tele-op zone and 6” into the autonomous zone.
  - 4.2.4.3.3.1. The autonomous robots are permitted to reach into this delivery area.
  - 4.2.4.3.3.2. The autonomous robot will not be permitted to reach beyond this area.
  - 4.2.4.3.3.3. The tele-op robots are permitted to reach into this delivery area under the passageways (may not reach over the walls).
  - 4.2.4.3.3.4. The tele-op robot is not permitted to reach beyond the delivery area into the autonomous zone.
  - 4.2.4.3.3.5. This area will be considered a mutual tele-op and autonomous zone.
  - 4.2.4.3.3.6. This area will be delineated by the vertical plane formed by tape marked on the floor.
- 4.2.4.3.4. These passageways will be constructed as described in Appendix A.
- 4.2.5. A team's optional autonomous element may be used to clear the “Ice Area” of the snowballs.
  - 4.2.5.1. The optional autonomous element is permitted to toss the snowballs over the barriers or slide them through the passageways as described.
  - 4.2.5.2. Tele-op robots are not permitted inside the “Ice Area” (autonomous zone). This includes driving or reaching. The only exception to this is the “delivery zone”, as per Section 4.2.4.3.4.
  - 4.2.5.3. Autonomous elements cannot break the vertical plane formed by the inside wall of the autonomous zone. The only exception to this is the “delivery zone”, as per Section 4.2.4.3.4.

#### 4.3. Snowman Area - Tele-op Zone

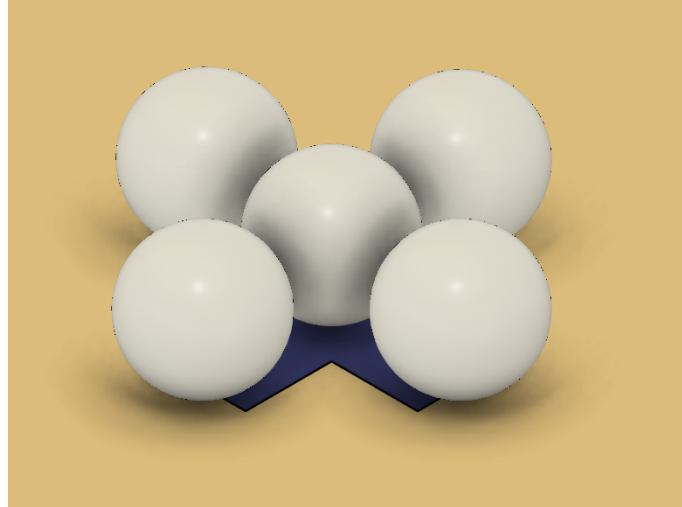


*Figure: Snowman Area – Tele-op Zone*

- 4.3.1. Each team will have exclusive use of an area defined as the “Snowman Area – Tele-op Zone”.
  - 4.3.1.1. This area will extend from the barrier of the “Ice Surface” zone to the exterior walls.
  - 4.3.1.2. Tele-operated robots must remain within this area at all times during the match.
- 4.3.2. This area will contain:
  - 4.3.2.1. 2 Snow Fort Platforms
  - 4.3.2.2. 2 Snowman Platforms
  - 4.3.2.3. 3 Snowball Starting Locations, each with 5 snowballs.
  - 4.3.2.4. 4 Snowblock Starting Locations, each with 3 snowblocks
  - 4.3.2.5. Tele-operated Robot Starting Area
  - 4.3.2.6. Details on each item are listed below.
- 4.3.3. Along the back exterior wall there will be a mesh fence. The purpose of this fence is to prevent the snowballs from leaving the court area.
  - 4.3.3.1. The fence will be 34 ½” inches in height from the top of the exterior wall.
  - 4.3.3.2. The fence will extend the entire length of the back exterior wall.
  - 4.3.3.3. The fence will be constructed using the designated mesh, as described in Appendix A.
- 4.3.4. Snow fort building platforms will be located in the Snowman Area – Tele-op Zone.
  - 4.3.4.1. There will be 2 building platforms.
    - 4.3.4.1.1. Both platforms will be 30” from the back exterior wall of the court surface.

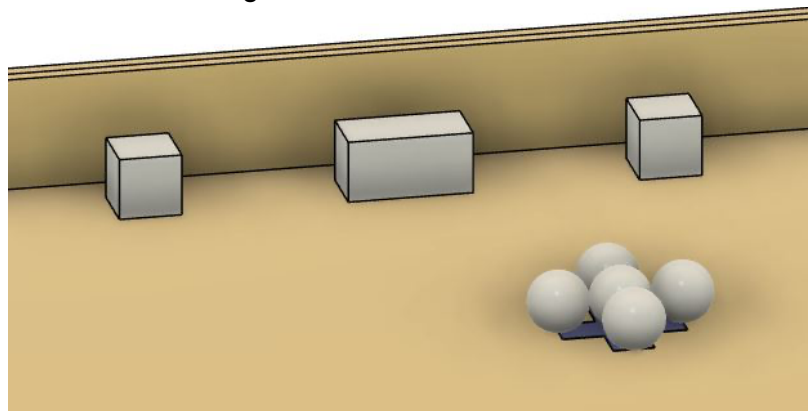
- 4.3.4.1.2. Each platform will be 40" from each exterior side wall of the court surface.
- 4.3.4.2. The platforms will be 12" x 16", constructed out of ¾" plywood.
- 4.3.5. Located behind the snow fort building platforms will be the snowman platforms.
  - 4.3.5.1. Each snowman will be located behind their own building platform, between the platform and the back exterior wall.
  - 4.3.5.2. Each snowman will start the match in the standing position.
  - 4.3.5.3. Each snowman will be standing on their dedicated platform.
    - 4.3.5.3.1. Each platform is a 5.5 inch square piece of ¾" plywood, as described in Appendix A.
    - 4.3.5.3.2. A snowman will be considered standing if it is upright and is being supported entirely by the platform.
      - 4.3.5.3.2.1. Upright is defined as being entirely supported by the flat surface on the bottom of the snowman.
      - 4.3.5.3.3. If a snowman is touching any surface that is not the platform, it will be considered knocked down.
        - 4.3.5.3.3.1. This includes being in contact with a robot.
        - 4.3.5.3.3.2. The snowman must be freestanding, and at rest to qualify for points at the end of the match (as per Section 6.4).
- 4.3.6. Tele-op Snowball Starting Locations
  - 4.3.6.1. Within the Snowman Area – Tele-op zone, there will be 3 snowball starting locations.
    - 4.3.6.1.1. One snowball starting location will be located 60" from the back wall, centered side to side.
    - 4.3.6.1.2. Two snowball starting locations will be located in the back corner of the Tele-op zone, 24" from the back wall, 24" from the side wall.
  - 4.3.6.2. Each snowball starting location will contain 5 snowballs.
  - 4.3.6.3. The snowballs will be arranged in the following formation in each starting location:





*Figure: Snowball Starting Formation*

#### 4.3.7. Snowblock Starting Locations



*Figure: Snowblock Starting Formation*

- 4.3.7.1. Within the Snowman Area – Tele-op zone, there will be 4 snowblock starting locations.
  - 4.3.7.1.1. Two snowblock starting locations will be along the back wall.
  - 4.3.7.1.2. One snowblock starting location will be along each side wall (resulting in a total of two snowblock starting locations on the side walls).
- 4.3.7.2. Each snowblock starting location will contain 3 blocks.
  - 4.3.7.2.1. 16" from the corner, there will be a 3 inch block.
  - 4.3.7.2.2. 8" from the 3 inch block, there will be a 6" block.
  - 4.3.7.2.3. 8" from the 6 inch block, on the opposite side to the first 3 inch block, there will be a 3 inch block.

4.3.7.2.4. All blocks are located 2” from the exterior walls.

4.3.8. Robot Starting Areas

4.3.8.1. Robots must start within the designated starting area. The “Tele-operated Robot Starting Area” is a 30 inch square located in the “Snowman Area – Tele-op Zone”.

4.3.8.1.1. The “Tele-operated Robot Starting Area” is located along the back exterior wall, centered from side to side.

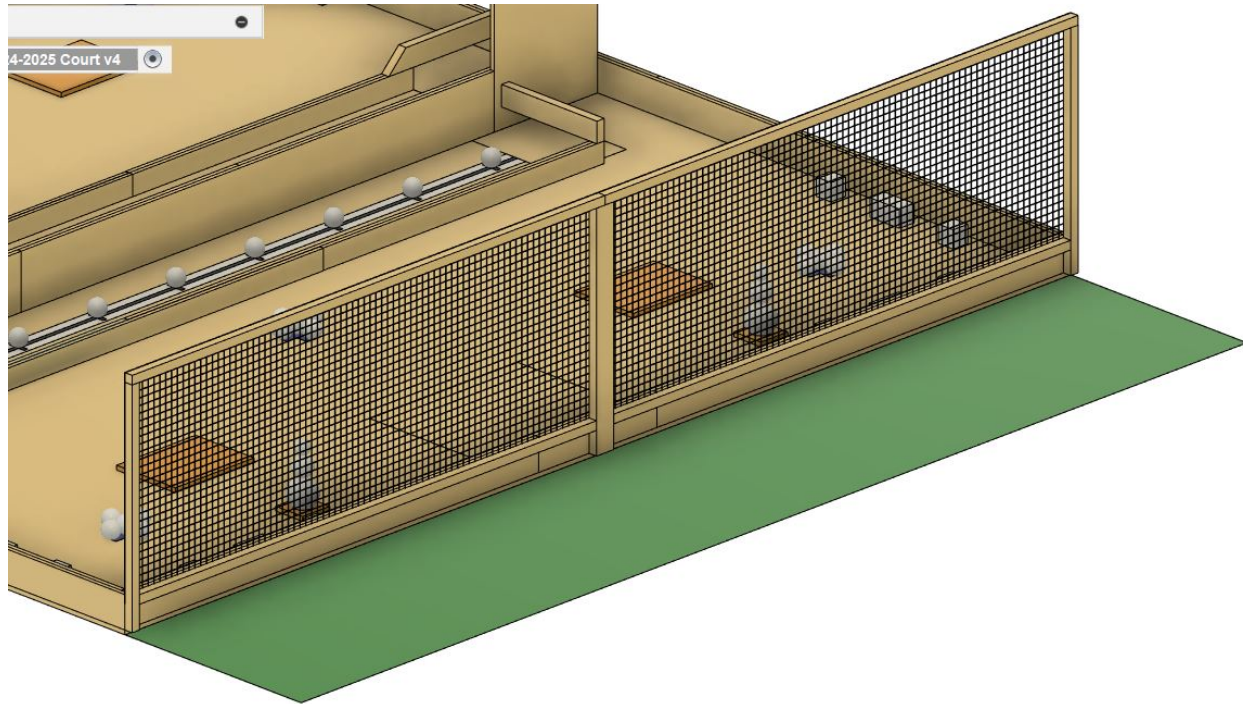
4.3.8.2. The Optional Autonomous Element must start (and remain) within the “Autonomous Zone”.

4.3.8.2.1. The Autonomous Element must remain stationary until the match begins.

4.3.8.2.2. Teams will be permitted to start the Autonomous robot 10 seconds prior to the match beginning, but it must remain stationary until the beginning of the match.

4.3.8.3. All details for starting areas can be found in Appendix A.

#### 4.4. Driver Zones

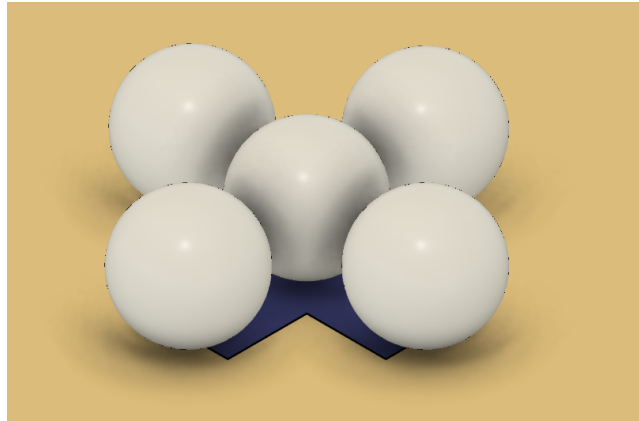


*Figure: Driver Zone*

- 4.4.1. Each driver and spotter must remain in their designated driver zone.
- 4.4.2. Both competitors may occupy any space within the driver zone.
- 4.4.3. Driver zones are located on the exterior ends of the court, directly behind the "Snow Fence".
- 4.4.4. Each team has 1 designated driver zone that is 36" wide.
- 4.4.5. No other competitors are permitted within 6' of the court.
- 4.4.6. See "Court Dimensions" in Appendix A for detailed dimensions.

## 5. Detailed Game Components

### 5.1. Snowballs

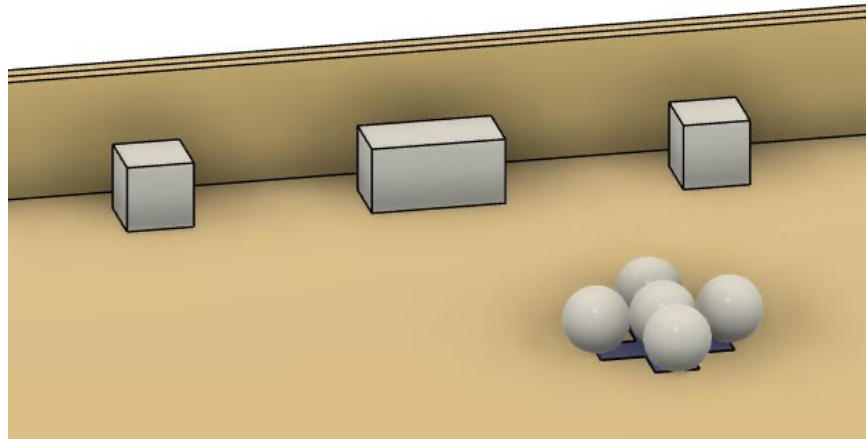


*Figure: Snowballs*

- 5.1.1. Indoor snowballs will be the snowballs used by teams to throw at their opponents.
  - 5.1.1.1. The specific snowballs are: Indoor Plush Snowballs White Fake Snowball 50 Pcs 7cm Imitation Snowball. Specific link in Appendix A parts list.
  - 5.1.1.2. They are 7 cm (2.76”) in diameter.
- 5.1.2. Snowballs will start in specific locations on the court.
  - 5.1.2.1. Autonomous snowball locations are described in 4.2.3.1
  - 5.1.2.2. Tele-op snowball locations are described in section 4.3.6
  - 5.1.2.3. There will be a total of 48 Snowballs in play during each match.
    - 5.1.2.3.1. 24 will start in each team’s area.
      - 5.1.2.3.1.1. 9 of these will start in each team’s autonomous zone.
      - 5.1.2.3.1.2. 15 of these will start in each team’s tele-op zone,
- 5.1.3. Snowballs are permitted to be thrown into the opponent’s zone.
  - 5.1.3.1. Snowballs are the only thing permitted to be thrown into the opponent zone.
  - 5.1.3.2. Snowballs are the only way a team can interact with their opponent.
    - 5.1.3.2.1. Teams using any air-based throwing systems are responsible for ensuring that byproducts (air from the system) do not affect the other team. This will be tested during robot inspection.
    - 5.1.3.2.2. Snowballs must remain separated and free. They cannot be joined together with another object or thrown in another object like a bag.

- 5.1.3.2.2.1. If snowballs stick to other snowballs (without any added substances involved), that is permitted.

## 5.2. Snowblocks



*Figure: Snowblocks*

- 5.2.1. Each team area will start with 12 snowblocks.
- 5.2.1.1. 8 snowblocks will measure 3"x3"x3"
  - 5.2.1.2. 4 snowblocks will measure 3"x3"x6"
  - 5.2.1.3. Snowblocks will be constructed of rigid foam covered in white duct tape (as described in Appendix A).
- 5.2.2. Snowblocks will start in set locations.
- 5.2.2.1. See section 4.3.7 for details.
- 5.2.3. These snowblocks are to remain within the team's exclusive use area.
- 5.2.3.1. The intent of these snowblocks is to be used to construct a fort to defend the snowmen.

### 5.3. Snowmen



*Figure: Snowman*

- 5.3.1. Each team area will start with 2 snowmen standing on their dedicated platforms.
  - 5.3.2. Each snowman will be constructed of 3 styrofoam balls.
    - 5.3.2.1. The base ball will be a 5" diameter ball with a 3" flattened section.
    - 5.3.2.2. The middle ball will be a 3 ½" diameter ball.
    - 5.3.2.3. The top ball will be a 2 ½" diameter ball.
    - 5.3.2.4. There will be a 10" long ¼" dowel extending vertically through the middle of the balls to form the snowman.
    - 5.3.2.5. Detailed construction information is available in Appendix A.
  - 5.3.3. Snowmen will start the match in the upright standing position.
    - 5.3.3.1. If a snowman is knocked over, teams are permitted to stand them up again.
      - 5.3.3.1.1. Snowmen will only be considered standing if they are supported entirely by their dedicated platform.
      - 5.3.3.1.2. Snowmen must be entirely supported by their flat base to be considered upright and standing.
  - 5.3.4. Snowmen are to remain within the team's exclusive use area.
- 5.4. Additional Notes
- 5.4.1. At no time are teams permitted to intentionally reach over any wall.
    - 5.4.1.1. Teams are not permitted to cross the middle barrier.
    - 5.4.1.2. Teams are not permitted to cross the exterior walls.
    - 5.4.1.3. Teams are not permitted to cross any interior walls.
  - 5.4.2. Any game pieces which fall outside of the court area are no longer in play.
  - 5.4.3. Should any game pieces fall into the opponent's court area, those pieces shall remain in play and usable by the opposing team.
    - 5.4.3.1. This applies to all game pieces which may count for points.

- 5.4.3.2. Should a larger game piece fall into the opposing team's court, it may be removed at the Judge's/NTC discretion.

## 6. "Snowday!" Game Scoring Summary

- 6.1. All scoring will take place at the end of each 4 minute match.
  - 6.1.1. Scoring will be based on the location of play elements at the end of each match.
- 6.2. Snowball scoring.
  - 6.2.1. Teams will earn one point for every snowball located in their opponent's court at the end of the match.
    - 6.2.1.1. Balls on robots at the end of the match are considered within the court area, and will be counted as such.
  - 6.2.2. Each snowball must be completely within the opponent's court area to be awarded points.
    - 6.2.2.1. Snowballs that have been removed from the court area will not be counted.
      - 6.2.2.1.1. Snowballs are not permitted to be intentionally removed from the court area. Doing so will be considered a violation of the game, and will be treated as such.
      - 6.2.2.1.2. Snowballs are considered outside of the court area if they are fully outside the vertical plane formed by the inside of the outside wall.
      - 6.2.2.1.3. Snowballs which are stuck in the back fence are considered outside of the court area.
    - 6.2.2.2. Snowballs that are on top of the middle wall will not be counted.
    - 6.2.2.3. Snowballs on the autonomous zone barrier wall are considered within the court playing area and will be scored as such.
    - 6.2.2.4. Balls in the air at the end of the game can come to rest before scoring is completed.
- 6.3. Snowfort scoring
  - 6.3.1. Snowforts will be scored based on the number of blocks on the snowfort platform and the maximum height of the snowfort on the platform.
    - 6.3.1.1. Each block on the platform will be counted as 1 block point, to a maximum of 6.
      - 6.3.1.1.1. Teams may put more than 6 blocks on a platform, but a maximum of 6 block points will be awarded.
      - 6.3.1.1.2. To clarify: Extra blocks could be used to get a higher multiplier (see section 6.3.1.3), but wouldn't count for block points
      - 6.3.1.1.3. Only snow blocks are permitted to be part of the snowfort.

- 6.3.1.1.3.1. Snowforts must be freestanding.
  - 6.3.1.1.3.1.1. If a robot is touching the snowfort at the end of the match, the snowfort will not be awarded snowfort points.
  - 6.3.1.1.3.2. If a snowfort contains a mixture of blocks and something else, points will be awarded as follows:
    - 6.3.1.1.3.2.1. Snowblocks will count for block points if it is fully supported by the platform or fully supported by another block that counts for block points.
    - 6.3.1.1.3.2.2. The height will be measured to the highest point of the highest block that counts for block points.

- 6.3.1.2. The height of the snowfort will be measured from the court floor.
- 6.3.1.3. The maximum height of the snowfort on the platform will determine the “Block Point Multiplier” based on the following table:

Max Height	0<=h<=6”	6<h<=12”	12<h<=18”	18” < h
Multiplier	x1	x2	x3	x4

- 6.3.1.4. Total Snowfort scoring for each platform will be the number of block points multiplied by the multiplier, using the following formula:

$$\text{Snowfort "A" points} = (\text{Platform "A" Block Points}) \times (\text{Multiplier})$$

- 6.3.1.4.1. Each snowfort platform will have their own snowfort points.
- 6.4. Snowman Points
  - 6.4.1. Snowmen within a team’s zone which are standing on their platform at the end of the match will be awarded 10 points each.
  - 6.4.2. A snowman will be considered standing if it is upright and being supported entirely by the platform.
    - 6.4.2.1. If a snowman is touching any surface that is not the platform, it will be considered knocked down.
    - 6.4.2.2. If the snowman is supported by any surface that is not its bottom flat surface, it will not be considered upright.
- 6.5. End of Match Location
  - 6.5.1. Teams will be awarded 2 points if their tele-operated robots return to the starting zone.



- 6.5.1.1. Robots must have fully left the starting zone at some point throughout the game to receive these points.
- 6.5.1.2. Robots must be fully within the starting zone at the end of the match to receive these points.
  - 6.5.1.2.1. This means the robots must not break the vertical plane at the edge of the starting zone to gain these points.

## 7. Pit Area and Court Access

- 7.1. Competitors **MUST** wear safety glasses when doing fabrication work involving material removal or adding processes (grinding, cutting, soldering, etc.).
- 7.2. Only registered competitors are permitted in the contest space.
- 7.3. Designated teacher/industry team advisors are permitted in the pit area only to inspect the worktable setup of their team prior to the start of the tournament.
  - 7.3.1. Designated teacher/industry team advisors are not permitted in the competition area during the competition.
  - 7.3.2. Teachers and industry advisors are not permitted to handle tools or robot parts.
  - 7.3.3. Students must effect all repairs and modifications on their robot.
- 7.4. A pit area is provided so that students may make repairs and improvements to their robots between games.
  - 7.4.1. Teams will be provided with a pit area workspace on a standard project table. Depending on the number of teams and availability of space, teams may have to share a 60 by 30-inch table.
  - 7.4.2. Teams must have a purpose-built tabletop robot stand, designed to keep the robot wheels off the ground/tabletop surface regardless of orientation.
    - 7.4.2.1. This stand or these stands should hold the robot(s) securely and be capable of preventing the robot(s) from driving on or off the table in the case of either deliberate motor testing during repairs or due to random, unexpected motor activity.
  - 7.4.3. A team's pit area must be kept safe at all times.
    - 7.4.3.1. This specifically means:
      - 7.4.3.1.1. Robots must be on the stand at all times when a battery is installed and connected to the robot
      - 7.4.3.1.2. Pit areas must be kept clean, tidy and free of all tripping hazards. Extension cords and power bars must all be taped, ziptied or velcro tied as per industry standards (minimum of 1 tie every 8 inches, must place 1 tie before and after every corner)
- 7.5. Teams **MUST** bring their robots, tools, and supplies into the skill area at Orientation. Teams are **NOT** allowed to remove their robots (or any part of their

robots) from the skill area during the overnight periods between Orientation Day, Competition Day 1, and Competition Day 2 of the contest.

- 7.6. Laptops may be removed overnight by competitors.
- 7.7. Competitors are not permitted to be in the competition area during times which are not scheduled as competition times.
  - 7.7.1. This includes before the competition day begins, after the competition day ends, and during lunch.
  - 7.7.2. At no time is a competitor permitted to be in the competition area if NTC members are not present.

## 8. Robot Restrictions

- 8.1. Robots must remain in compliance with these rules throughout the competition. If teams fall out of compliance with these rules, then they will not be permitted to compete and will forfeit all their scheduled games until they have corrected the problem.
- 8.2. Start of Game Status
  - 8.2.1. Team Tele-op Entries must not exceed an overall size of 4 cubic feet (6912 cubic inches) at the start of each game.
    - 8.2.1.1. Total volume will be measured of the combined Tele-operated robots (in their starting position).
    - 8.2.1.2. Team entries may expand to a larger size once a game has started, up to a maximum size not exceeding a 30 inch square in the horizontal plane.
      - 8.2.1.2.1. Tele-op robots are permitted to expand to any height.
  - 8.2.2. Team Autonomous Elements must not exceed an overall size of 1 cubic foot (1728 cubic inches) at the start of each game.
    - 8.2.2.1. Total volume will be measured of the Autonomous Elements in their match starting position
      - 8.2.2.1.1. Their match starting volume is defined as the volume of the Autonomous Element at the beginning of the 4 minute match.
      - 8.2.2.1.2. Refer to section 4.3.8.3.1 for Autonomous starting details.
    - 8.2.2.2. Autonomous Elements may expand to a larger size once a game has started, up to a maximum size not exceeding a 24 inch cube.
    - 8.2.2.3. Autonomous Element volume will be measured and recorded independent from the Tele-op volume.
  - 8.2.3. Robots must start within their designated starting area.
    - 8.2.3.1. Tele-operated Robots must start together completely within the “Tele-operated Robot Starting Area”, as described in Section 4.5

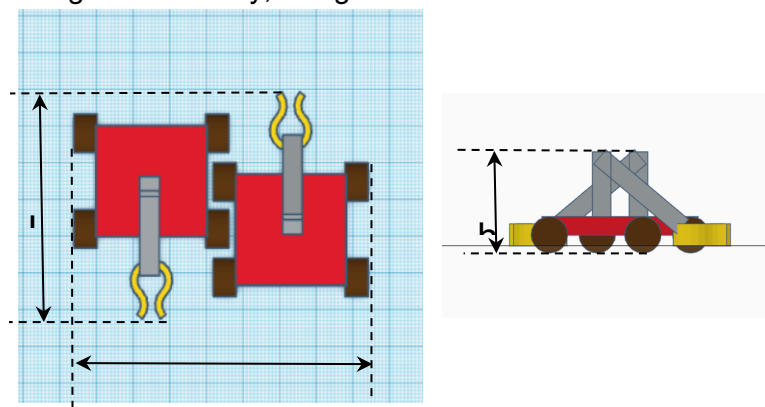
- 8.2.3.2. The optional Independent Autonomous Element may start in the “Designated Autonomous zone”, as described in Section 4.5
- 8.2.4. When a Tele-operated Robot’s main power is turned on prior to the start of a game, the robot must be in an overall “Idle State”, and the following conditions must exist:
  - 8.2.4.1. They must be stationary
  - 8.2.4.2. They must not be in possession of any game pieces
- 8.2.5. All systems may be turned ON
- 8.2.6. Air System Circuits may be fully charged to 100 PSI, and their compressors can be ON
- 8.3. During Game Status
  - 8.3.1. Robots may expand beyond the starting volume once the game begins.
  - 8.3.2. A team’s Robots must remain in their designated areas for the duration of the game.
    - 8.3.2.1. All Robots must remain in their own team’s court.
    - 8.3.2.2. All Tele-operated Robots are permitted to access any area within the team’s exclusive use area (in compliance with all other rules).
    - 8.3.2.3. The team’s Optional Autonomous Element must remain in the “Designated Autonomous Zone” for the duration of the game.
  - 8.3.3. Strategies aimed at preventing the opponent from playing the game are not permitted, as they are not in the spirit of fair play, and will not be permitted.
- 8.4. Each team’s optional Autonomous Element must not have any direct interaction with the competitors.
- 8.5. All Robots must conform to all of the following safety requirements.
  - 8.5.1. All Robots (Tele-operated and Autonomous) must be able to be shut off with a single motion.
    - 8.5.1.1. The “Kill Switch” must be easily accessible.
    - 8.5.1.2. The “Kill Switch” must be securely mounted.
    - 8.5.1.3. Robot controller receivers may be in an independent circuit.
  - 8.5.2. Robot power sources and circuits must follow the following requirements:
    - 8.5.2.1. The maximum continuous power rating allowed in any circuit branch is 256 Watts, which will be limited by voltage and fuse selection.
      - 8.5.2.1.1. To calculate power in any given circuit, use the following formula:  $\text{Power (Watts)} = \text{Voltage (Volts)} \times \text{Current (Amps)}$
    - 8.5.2.2. The total voltage in any individual circuit cannot exceed 24 Volts.
    - 8.5.2.3. Each current branch path from the battery must include either an in-line fuse, resettable fuse, circuit breaker, or be connected to a dedicated fuse in a rack.

- 8.5.2.3.1. Systems which utilize a built-in fuse will be considered to have this requirement met, as long as:
  - 8.5.2.3.1.1. It is a known and documented system. If the system is unknown to the NTC, teams may be required to produce this documentation.
  - 8.5.2.3.1.2. There are no modifications made to the system.
  - 8.5.2.3.1.3. There are no external circuits which do not contain a fused circuit. Proper fuses are required for modified circuits
- 8.5.2.4. Batteries must meet the following requirements:
  - 8.5.2.4.1. All batteries must be a complete sealed commercial battery pack.
  - 8.5.2.4.2. All batteries must be securely mounted to the robot.
  - 8.5.2.4.3. Batteries wired in series should be the same amp hour rating (ex. both 1500 mAh) and batteries in parallel must be the same voltage (ex. both 12 volts).
- 8.5.3. Robots utilizing non-electrical energy sources must meet the following requirements:
  - 8.5.3.1. Pneumatic systems are permitted, with the following restrictions:
    - 8.5.3.1.1. Pneumatic based energy sources may be pre-charged to a maximum of 100-PSI pressure in their reservoirs (cylinders) at the start of each game.
    - 8.5.3.1.2. Pneumatic systems using Competitor-made or modified air pressure hardware are NOT permitted.
    - 8.5.3.1.3. All pressurized tanks on robots must have a pressure gauge to indicate the stored pressure and a form of automatic overpressure safety relief system.
    - 8.5.3.1.4. The pressure tanks and related gauges / controls must be shielded from damage due to collisions or flying target objects.
    - 8.5.3.1.5. The stored pressure in the tank must not exceed a maximum of 100 PSI at any time.
  - 8.5.3.2. Tension-based energy sources (elastics, springs or other) may be in either a relaxed at rest state or in a tense / compressed state at the start of each game.
- 8.5.4. The following devices are not permitted:
  - 8.5.4.1. No explosive materials of any kind may be used (ether, gunpowder, acetylene etc.).
  - 8.5.4.2. Laser devices are not permitted.
  - 8.5.4.3. Hydraulic fluid systems are not permitted.
- 8.6. Teams must use an appropriate Robot Controller.

- 8.6.1. It is recommended (not required) that all teams use 2.4 GHz “non-crystal” control systems on Tele-operated Robots.
- 8.6.2. Teams are allowed the use of an unlimited number of channels, but only two separate tele-operated robots.
  - 8.6.2.1. Teams assume full responsibility if any interference is to occur with their respective communication systems that could render the robot(s) useless.
- 8.6.3. Robots may not transmit audio/visual information to off-the-robot devices, including anything directly observable by the driver(s) or spotter(s). (Ex: Having a camera transmit images real time to a computer near the driver, etc.)

## 9. Inspection

- 9.1. All Robots must pass a pre-competition inspection for compliance with the safety and design rules before they will be allowed to participate in games.
  - 9.1.1. If any modifications are made on a Robot during the competition, the Robots may be subjected to an additional inspection for compliance before being permitted to participate in games.
  - 9.1.2. All robots must be inspected, including the Tele-operated robots and Autonomous robot in a team’s entry.
- 9.2. It is the purpose of the inspection to ensure teams, and all robots are in compliance with the rules and restrictions described in this document.
- 9.3. Team entries will be measured for total combined volume.
  - 9.3.1. All robots will be measured in their starting positions.
    - 9.3.1.1. Tele-op robots must start together and will be measured together.
    - 9.3.1.2. Optional Autonomous element will be measured separately, in their starting position.
  - 9.3.2. Volume of the robots will be calculated using the maximum length, width, and height of the entry, using the formula  $V = LWH$



*Figure: Volume Measurement*

- 9.4. Teams will be required to demonstrate the operation of their robots as part of the inspection.
  - 9.4.1. A demonstration of a team's robot entry (or entries) must show the functionality of the robot to play the game.
  - 9.4.2. All robots must be shown to be in full compliance with the rules of the game, as described in this document.
    - 9.4.2.1. Should any clarification document be made, it will also be considered as part of this document.
  
- 9.5. All teams and robots must abide by all safety requirements.
  - 9.5.1. All robots must have a wiring diagram.
    - 9.5.1.1. Acceptable examples of wiring diagrams are available in Appendix C.
  - 9.5.2. All robots must have a method of shutting the robot with a single motion. For the purposes of this document, this will be called a “kill switch”.
    - 9.5.2.1. The “kill switch” must be easily accessible.
    - 9.5.2.2. The robots must be able to be safely turned off, without risk to anyone.
  - 9.5.3. All teams must have a Safety Data Sheet available (physically on hand) for all chemical based components.
    - 9.5.3.1. This includes all batteries, as well as any other component that may be chemical based.
  - 9.5.4. All batteries must be in good working condition.
    - 9.5.4.1. Batteries must be complete sealed commercial battery packs.
    - 9.5.4.2. Batteries must be securely mounted.
      - 9.5.4.2.1. Securely mounted is defined as not able to be knocked off of the robot in any manner of regular gameplay.
    - 9.5.4.3. Batteries wired in series should be the same amp hour rating.
    - 9.5.4.4. Batteries wired in parallel should be the same voltage.
  - 9.5.5. All teams must have a tabletop robot stand for their robots.
    - 9.5.5.1. This stand or these stands should hold the robot(s) securely and be capable of preventing the robot(s) from driving on or off the table in the case of either deliberate motor testing during repairs or due to random, unexpected motor activity.
  - 9.5.6. All robots will be inspected to ensure all parts are permitted parts.
    - 9.5.6.1. Should any non-permitted part be detected, teams will be required to remove them before being allowed to compete.
  - 9.5.7. The maximum continuous power rating allowed in any circuit branch is 256 Watts, which will be limited by voltage and fuse selection. Power will be calculated using the formula  $\text{Power} = \text{Voltage} \times \text{Current}$ 
    - 9.5.7.1. The total voltage in any circuit cannot exceed 24 Volts.

- 9.5.7.2. Each current branch path from the battery must include either an in-line fuse, resettable fuse, circuit breaker, or be connected to a dedicated fuse in a rack.
  - 9.5.7.2.1. It is the purpose of a fuse/breaker to protect competitors and the equipment in their circuits.
  - 9.5.7.2.2. Systems which utilize a built-in fuse will be considered to have this requirement met, as long as:
    - 9.5.7.2.2.1. It is a known and documented system. If the system is unknown to the NTC, teams may be required to produce this documentation.
    - 9.5.7.2.2.2. There are no modifications made to the system.
    - 9.5.7.2.2.3. There are no external circuits which do not contain a fused circuit.
- 9.5.8. Any teams using pressure-based systems must ensure:
  - 9.5.8.1. No Competitor-made or modified air pressure hardware is being used.
  - 9.5.8.2. Only commercially manufactured pressure tanks (cylinders) can be used.
  - 9.5.8.3. Pressure in tanks does not exceed 100 PSI
  - 9.5.8.4. Systems have an over-pressure safety valve
  - 9.5.8.5. Pressure tanks and related gauges and controls are shielded from damage due to collisions
  - 9.5.8.6. Pressure system circuit diagram is provided
- 9.5.9. All teams must have eye protection available.
- 9.5.10. All teams must wear eye protection when working on their robots.
- 9.5.11. All teams' pit areas must be kept tidy and free from safety concerns.

## 10. On-site Autonomous Robot Challenge Overview

- 10.1. Competitors will be provided, at no cost to the teams, with an Autonomous Kit distributed to them through their Provincial/Territorial office.
- 10.2. The designated autonomous robot chassis (see Appendix D) may be pre-built.
  - 10.2.1. All other autonomous components must be disassembled upon the beginning of Competition Day 1.
  - 10.2.2. Teams choosing not to use the designated autonomous robot chassis may do so. However, the only chassis permitted to be pre-built is the designated autonomous robot chassis, as chosen and approved by the NTC.
- 10.3. A description of the Autonomous Component Collection will be posted on the Skills/Compétences Canada Website.

- 10.4. Competitors will demonstrate their autonomous robot's performance at the Skill competition area.
- 10.5. At the orientation meeting, Competitors will be told the specific Robot Behaviors their Built On-Site Robots need to complete.
  - 10.5.1. During this time, teams will also be informed of the Autonomous Challenge marking system.
- 10.6. The suggested performance items listed below reflect the type of core isolated robot performance elements competitor robots will need to complete
  - 10.6.1. Follow wall perimeter,
  - 10.6.2. Navigate a maze,
  - 10.6.3. Navigate around obstacles,
  - 10.6.4. Follow a colored tape line on the floor,
  - 10.6.5. Locate and touch an object
  - 10.6.6. Pick up a small object and move it to a new location
- 10.7. Competitors MUST understand the list above represents Samples ONLY and does not present a final or complete list of the potential robot behaviors they might be asked to create.
- 10.8. Teams need to develop an understanding of the performance capabilities of ALL components in the Competition Collection and prepare to be able to use any of these components effectively.
- 10.9. Competitors need to be prepared to go beyond the initial single stage performance requirements to multi-stage performance requirements as the culminating end of the competition experience.
- 10.10. Build On-Site Autonomous Tasks Equipment:
  - 10.10.1. Competitors will be required to build their autonomous robot solutions using ONLY the contents of the kit provided.
  - 10.10.2. If a Robot Component is not provided in the common to all "Box of Component's" then it cannot be installed on the Competitor's Autonomous Robot.
  - 10.10.3. Exception List to "Only what is in the box"
    - 10.10.3.1. Laptop/Computer, mouse, and keyboard, power cord, usb cable, software drivers
    - 10.10.3.2. Sample code, Arduino IDE or similar program
    - 10.10.3.3. Measuring tape, Allen keys, small wrench or pliers
    - 10.10.3.4. Paper, pen, pencil, calculator to record measurement
    - 10.10.3.5. Replacement parts for the originals (ie. Cable ties)
    - 10.10.3.6. Large and/or small storage containers
    - 10.10.3.7. Tele-op controllers and /or modules are not permitted to be used at any time on the robot.
      - 10.10.3.7.1. This includes during marked attempts and practice.



- 10.11. Teams will have time periods where they have shared access to the various Autonomous Performance Court Environments to conduct their Task Solution / Preparation Activities
- 10.12. Teams will have a select number of Marked Attempts at each of the Autonomous Performance Tasks as time permits. The number of attempts will be predetermined at the start of the competition.
- 10.13. Marked Autonomous Task Attempts will be conducted on a "By the request of the Teams Basis" with a requirement that Teams complete ALL Autonomous Task Preparation Activities by an announced at the start of the competition Fixed Time: (*Example: All Autonomous Task Preparation Activities must end by 3:00 PM on Competition Day 2*).

## 11. Medal Awarding System

- 11.1. Medals will be awarded based on the results of the Tele-operated Game Round Robin and Playoff Tournament Autonomous Challenge, and Safety.
- 11.2. The overall score will be determined by combining the points awarded in each section of the competition.
  - 11.2.1. Tele-operated Round Robin points will be awarded based on overall standing during the Round Robin.
    - 11.2.1.1. Round Robin points will be awarded in the following manner:

Place	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th
Points	24	22	20	18	16	14	12	10	8	6	4	2	0

- 11.2.2. Tele-operated Playoff Tournament points will be awarded based on final tournament placement.
  - 11.2.2.1. Tele-operated Playoff Tournament points will be awarded in the following manner:

Place	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th
Points	25	22	19	16	13	11	9	7	6	5	4	3	2

- 11.2.3. Autonomous Task points will be awarded based on the Autonomous Challenge.
- 11.2.4. Safety points will be awarded based on the safety criteria listed in Appendix E
- 11.3. Overall score will be 49% Tele-operated game performance, 49% Autonomous task performance, and 2% Safety score.
- 11.4. Medals will be awarded based on the overall team scores. The Gold Medal will go to the team with the highest overall score, the Silver to the next highest overall score, and the Bronze to the next highest after that.

- 11.4.1. In the case that a tie occurs in the Overall Team Scores, the medal will go to the team with the higher Autonomous Task Score.

## Appendix A: Court Dimensions and Details

See Attached.

## Appendix B: Tele-operated Main Game Score Sheet

See Attached.

## Appendix C: Sample Wiring Diagrams

See Attached.

## Appendix D: Approved Autonomous Challenge Chassis Optional Pre-build

See Attached.

## Appendix E: Safety Criteria and Scoresheet for Judging

See Attached.

## Appendix F: Inspection Sheet

See Attached.