SkillsCanada
Newfoundland and Labrador

PROJECT

#23 – Mobile Robotics

SECONDARY

Gold Mine Operation

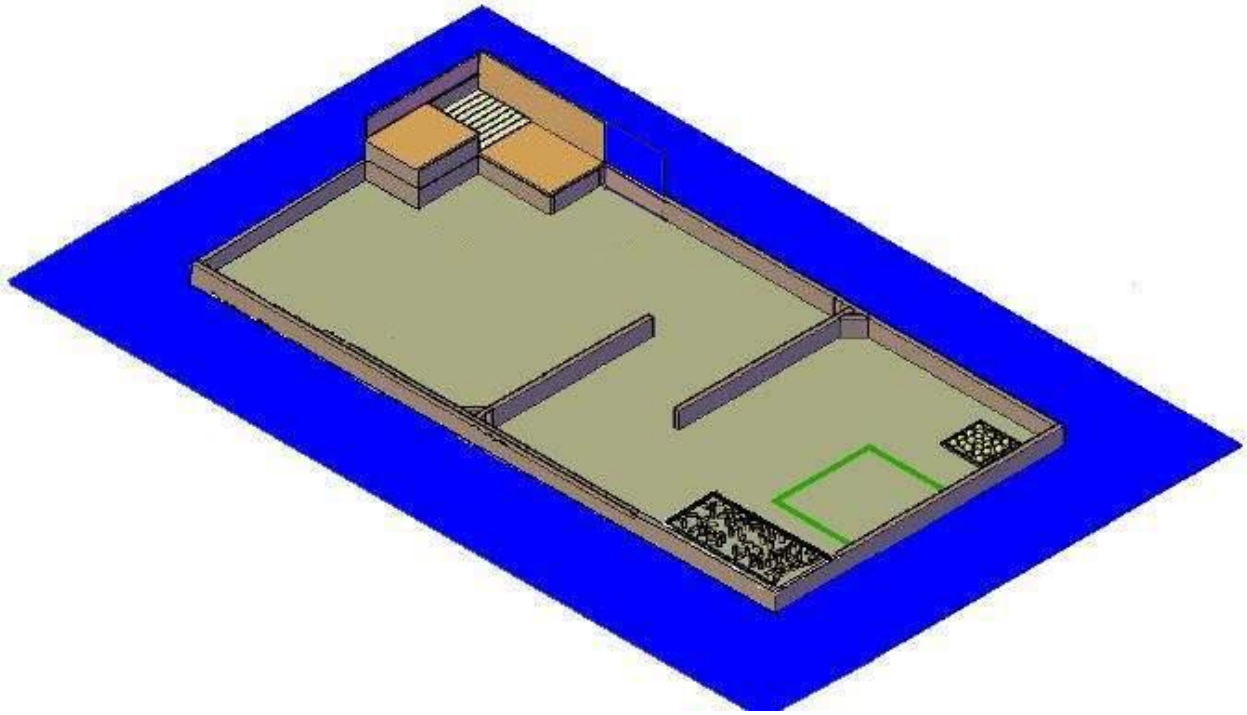

Figure 1: Overall Court

Date: April 9th, 2022

FURTHER COMMUNICATIONS

QUESTIONS FOR CLARIFICATION OF THE RULES CAN BE MADE TO YOUR PROVINCIAL TECHNICAL CHAIR, DAVE KEEFE.

SkillsCanada
Newfoundland and Labrador

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1. Definition of terms referenced in this document

a. 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.

b. Mobile Independent Autonomous Mobile Robot Elements are elements that at the start of a game have a competitor pressing their start button or enter on a computer keyboard as the only competitor to Independent Autonomous Mobile Robot Element communication during the entire game.

c. Stationary Independent Autonomous Elements are elements that have their power on at the start of games but have no direct contact with a competitor during game play. These units may interact with the team's tele-operated mobile robot with the actions of the tele-operated mobile robot triggering an active response by the Independent Autonomous Element which may be managed either by a mechanical based system (eg. A series of limit switches / no programmed elements) or a pre- programmed system (eg. Managed by an Arduino or other microprocessor) internal to the Independent Autonomous Element.

2. The Gold Mine Operation Teleoperation Game Overview

a. The core game situation requires a Robot or Robots to use the components provided in their Exclusive Use Court Space to (a) Mine the paydirt from the mine pit and (b) sort and deliver the tailings and gold into the appropriate zones.

3. Detailed Court Areas

3.1: Platform

a) At one corner of the court area there will be a two-level platform that surrounds the mining pit.
b) This platform has dimensions as shown in the figure below and in Appendix A.

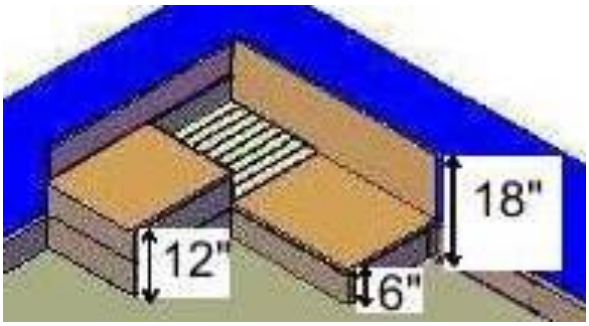


Figure 2: Platform

3.2: Mine Pit

a) The space between the Upper Platform level and the Lower Platform level forms the Mine Pit.
b) This pit extends from the top of the lower platform down to the court floor, to a depth of 6 inches.
c) Along the exterior wall and the opposite side of the pit (next to the upper level platform), there is a 1.5 inch wide ledge, extending from the floor to 6 inches above the court level (to be level with the top of the Lower Platform).
d) At the start of the game, this pit will contain 35 pieces of “Paydirt”.
    i) 30 pieces will be “Tailing” pieces.
    ii) 5 pieces will be “Low Quality Gold” pieces.
    iii) Pieces will be randomly placed, as described in Section 3.5.
e) At the start of the game, this pit will be covered with 8 “Overburden” pieces.
    i) Overburden pieces are 2 inch wide, 17.5 inch long strips of ¼ inch thick corrugated plastic.
    ii) They are a solid color, not transparent.
    iii) They are placed with a 1.5 inch overhang on each end.
    iv) They are to be placed with a ¼ inch space between them.
f) The pit dimensions are 6 inches deep, 15 inches wide, and 18 inches long.

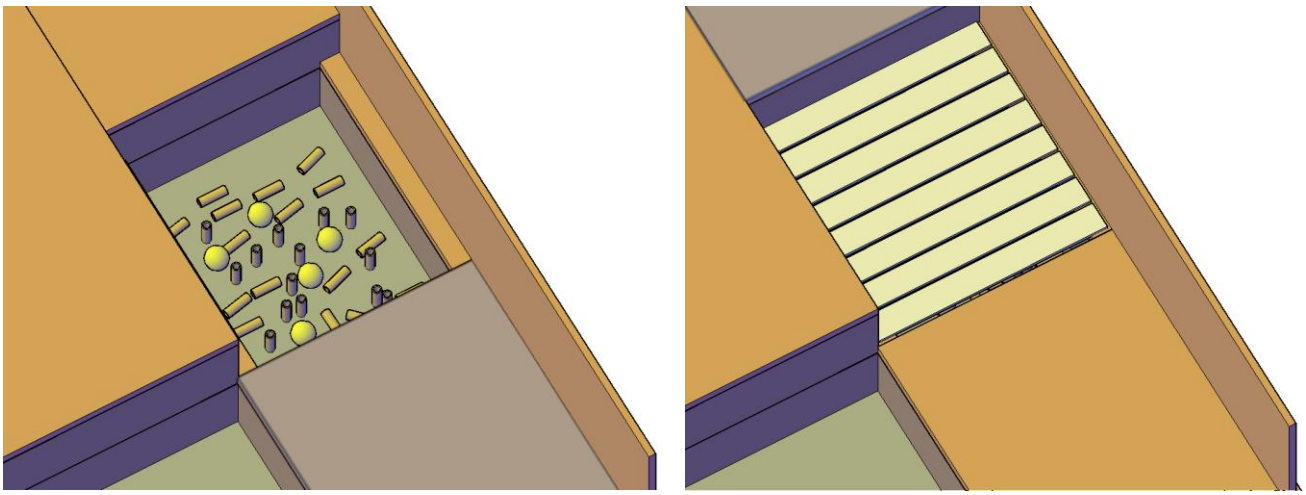


Figure 3:Mine Pit (without and with Overburden)

3.3: Drop Off Zones

a) The area on the opposite end of the court to the platform is the sorting area.
b) Contained in this area are the drop off zones.
    i) The “Tailing Drop Off Zone” is located in the corner of the exterior wall. It measures 18 inches by 36 inches (internal dimensions).
    ii) The “Gold Drop Off Zone” is located 6 inches from the corner of the 2 exterior walls. It measures 12 inches by 12 inches (internal dimensions).
    iii) The drop off zones are lined by 0.5 inch wide, 0.5 inch tall borders.
c) The “Tailing” pieces are to be placed in the “Tailing Drop Off Zone”.
d) The “Gold” pieces are to be placed in the “Gold Drop Off Zone”.
e) The pathway between the “Platforms” and the “Sorting Area” is a winding pathway, with a minimum width of 30 inches.

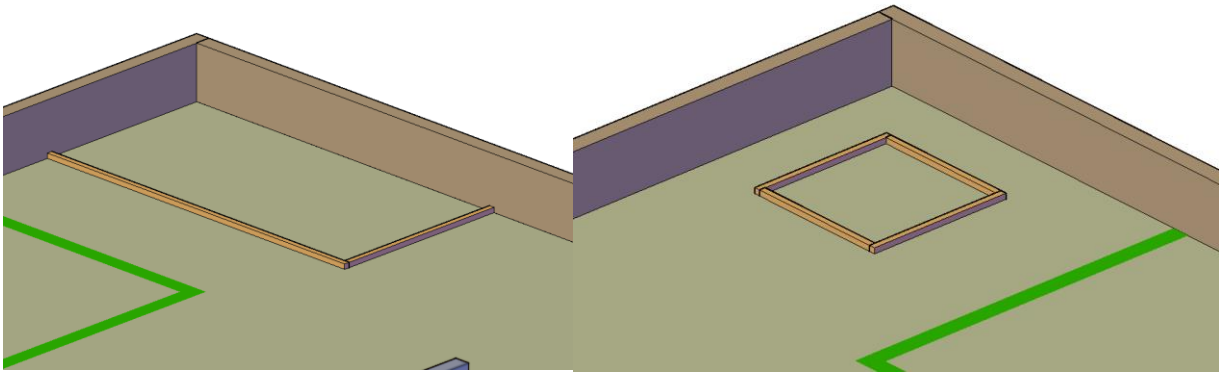


Figure 4: Drop Off Zones (Tailing and Gold)

3.4: Starting Zone

a) Located in between the drop off zones, the “Starting Zone” measures 30 inches by 30 inches.
b) It is located along the short exterior wall (opposite the platforms) 32.25 inches from the long exterior wall.
c) At the beginning of the game, a team’s entire robot entry must be within this zone, not breaking the vertical plane formed at the edge of the 30 inch square.

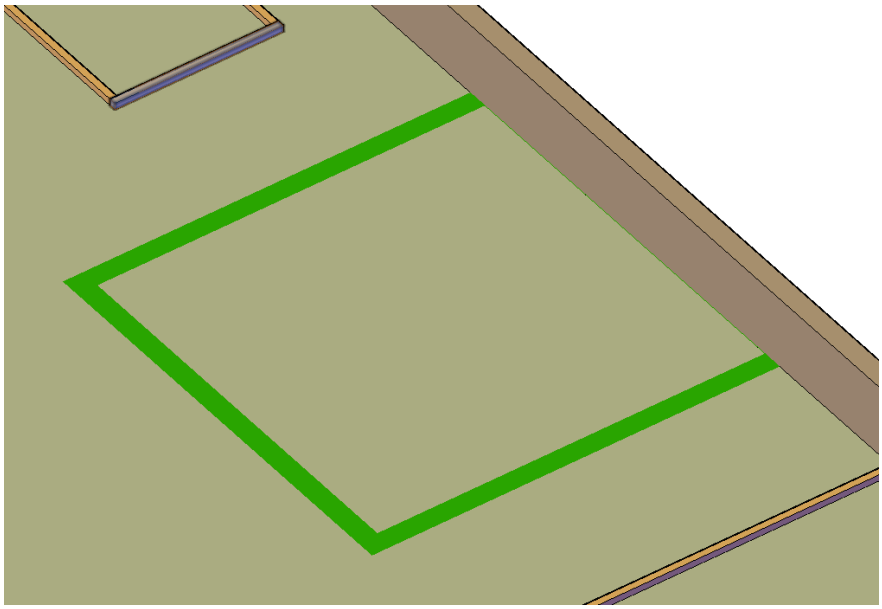


Figure 5: Starting Zone

3.5: Game Pieces

a) There are 3 types of game pieces which will be used for scoring points.
   i) “Tailing” pieces are 2 inch long sections of 0.5 inch Copper Type M pipe.
   ii) “Low Quality Gold” pieces are yellow foam golf balls, measuring 1.68 inches in diameter.
   iii) “High Quality Gold” pieces are 1 inch diameter steel balls.

b) The Mine Pit will contain 35 pieces at the beginning of each game. 25 “Tailing” pieces, 5 "High Quality Gold" Pieces, and 5 “Low Quality Gold” pieces.

c) The pieces for the pit will be randomly placed.
   i) The pieces for the pit will be placed in a container and mixed.
   ii) Once mixed, the pieces will be poured from the container into each pit. They will be poured into the pit from the central side of the pit (the side closest to the center of the court).
   iii) Once the pieces are placed in the pit, the pit will be covered with the “Overburden” pieces.
   iv) Team members are not allowed to watch the pieces being poured!

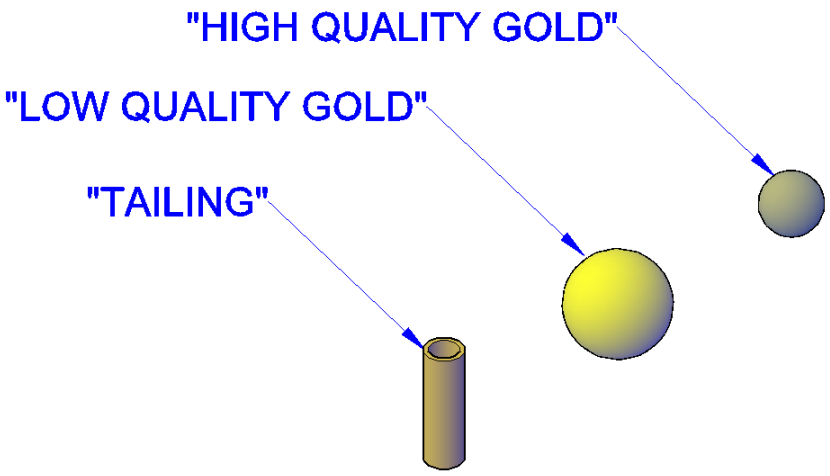


Figure 6: Game Pieces

3.6 Additional Notes

a) Should any piece fall outside of the competitors playing area, the piece will be considered out of play for the remainder of the match.

b) At no time are teams allowed to throw any of the game pieces (no throwing, tossing, projecting, etc.) in the interest of fairness and safety.

i) Throwing would be considered an act of propelling something through the air with a robot generated force by means of:

- A wheel based shooting mechanism
- Straight arm throwing mechanism
- An air pressure shooting mechanism
- A flicking system where the angle is above the horizontal axis

ii) Actions not considered throwing:

- Dropping of pieces, where the force of movement is gravity, and the movement direction is equal to or below the horizontal axis of the mechanism
- Bouncing of pieces off robots, as long as the robot is not adding a propulsion force

iii) For any other examples not explicitly stated, it is up to the Judges' discretion if a Robot is considered to be throwing a piece, with the interest of overall safety in mind. If a robot is deemed unsafe by a Judge, the team utilizing this robot platform will not be allowed to compete in the competition until the Judge decides that the mechanism can be proven safe.

4. Each Team's Exclusive Use Area is approximately 8 ft. by 16 ft.

a. Teams have Exclusive Use of a 30 in. wide passageway along all four sides of their assigned court area.

b. Both Team Members can be active in and move throughout this entire team passageway space during game play.

c. It is a Team Responsibility to define the tasks assigned to each competitor.

d. If a Team has a Two Robot Entry, then:

   i. Both competitors can be Robot Drivers
   ii. Both competitors can also be Spotters for their partner driver

e. If a Team has a One Robot Entry, then:

   i. One competitor can be the Robot Driver and One competitor can be a Spotter for their partner driver

5. Each Team's Area includes:

5.1: Starting Area

a) Each team's robots will start in the "Starting Square"
b) The "Starting Square" measures 30 inches by 30 inches.
c) This is located directly against the exterior wall, in the middle of the short wall, opposite the platforms.
d) The team's entire entry must begin each match fully within the starting square.
   i) The entire entry must not break the vertical plane formed by the edge of the starting square.

5.2: Mining Area

a) Each team will have exclusive access to their mining area, located along the opposite end of the court as the starting area and the “Drop Off Zones”.

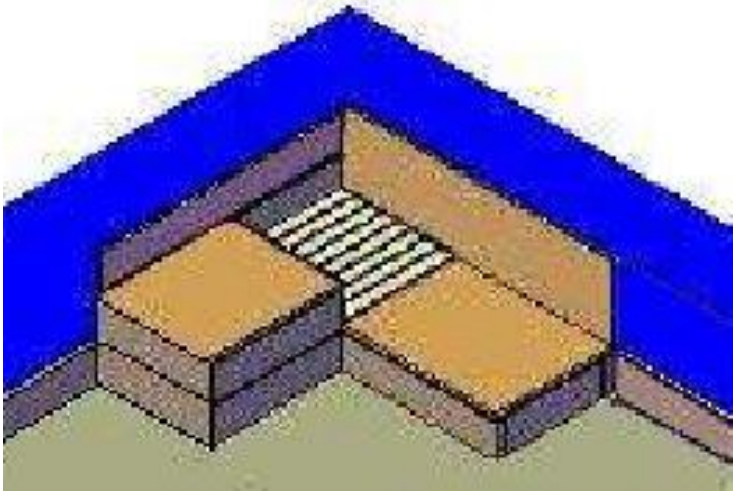


Figure 7: Mining Area

5.3: Sorting and Delivery Area

a) The area on the opposite end of the court to the platforms is the sorting area.
b) Contained in this area are the drop off zones.
c) The “Tailing” pieces are to be placed in the “Tailing Drop Off Zone”.
d) The “Gold” pieces are to be placed in the “Gold Drop Off Zone”.
e) The pathway between the “Platforms” and the “Sorting Area” is a winding pathway, with a minimum width of 30 inches

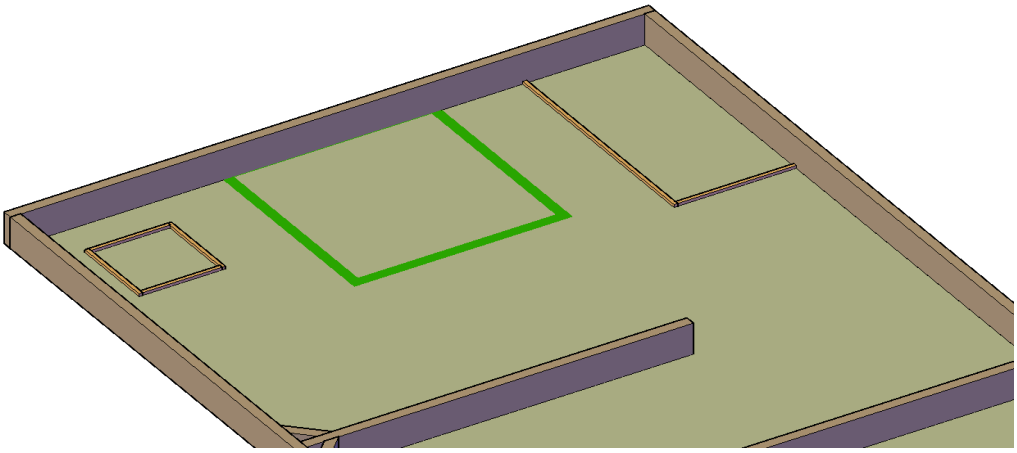


Figure 8: Sorting and Mining Area

6. Gold Mine Operation Game Description

a. Games will involve One Team at a time.

b. Both Competitors are allowed unrestricted movement around the perimeter of the Court Area.

c. Teams can utilize a Maximum of TWO Tele-operated Robots.

d. Teams may also use ONE Independent Autonomous Element as part of their entry (which must fit into the overall size limitation at the beginning of the game).

e. Teams may also use an Unlimited Number of Independent Elements as part of their entry (which must fit into the overall size limitation at the beginning of the game).

- These Independent Elements cannot be Independently Electronically controlled (cannot be Autonomous)
- These must be easily cleaned up at the end of the match

f. Teleoperated Robots may NOT be in possession of any Tailing or Gold components at the Start of a game.

g. Each marked game match will be recorded on the competition day and submitted to the Provincial Technical Committee in accordance with the schedule developed.

h. Only 3 game matches must be submitted to the PTC on the competition day. The match videos must include a time stamp, and must be recorded on the competition day. Specifics on format and method of submission will be provided in a later amendment (once it has been determined).

7. Scoring Summary

Scoring will be done at the end of each 4 min. match:

7.1: Mining Points

a) Teams will earn points for successfully removing pieces from the pit.
b) 1 point will be awarded for each successfully mined “Tailing” piece.
c) 2 points will be awarded for each successfully mined “Gold” piece.
d) A successfully mined piece will be defined as a piece that has been fully removed from the pit.
    i) Any piece that is removed from the pit and then returns to the pit will not be considered a successfully mined piece.
    ii) Any piece that remains on a robot that remains inside the pit will not be considered a successfully mined piece.
e) Mining points will be tallied at the end of the 4 minute match.
    i) Mining points will be determined by counting the remaining pieces within the pit, and subtracting that number from the starting total amount.
    ii) For example, if 20 “Tailing” pieces remain in the pit at the end of the match:

        25 - 20 = 5 successfully mined “Tailing” pieces.

f) Maximum available Mining pieces and points:

    25 “Tailing” pieces - 25 mining points

    10 “Gold” pieces - 20 mining points

7.2: Sorting Points

a) Teams will earn points for successfully sorting the mined pieces and placing them into the proper sorting area.
b) Pieces must be deposited into the designated area.
    i) Robots must release the pieces for them to be considered successfully deposited. Any piece remaining on a robot will not be considered successfully deposited.
    ii) Pieces must be freely standing within the delivery area to be successfully deposited. This means pieces contained within a bag or container are not considered successfully delivered.
    iii) Pieces must be within the sorting area and not touching the floor outside of the area to be considered successfully deposited. Pieces balanced on the barrier of the sorting area would count as deposited as long as it does not touch the court floor outside of the sorting zone.
c) 1 point will be awarded for each successfully sorted and deposited “Tailing” piece into the “Tailing Drop-off Zone”.
d) 2 points will be awarded for each successfully sorted and deposited “Low Quality Gold” pieces into the “Gold Drop-off Zone”.
e) 4 points will be awarded for each successfully sorted and deposited “High Quality Gold” pieces into the “Gold Drop-off Zone”.
f) Any pieces not deposited into the correct drop-off zone will not be awarded “Sorting Points”.
    i) Should a gold piece be placed in the “Tailing Drop-off Zone”, it will be awarded no “Sorting Points”
    ii) Should a tailing piece be placed in the “Gold Drop-off Zone”, it will be awarded no “Sorting Points”

8. Marking Sheet

2022 Skills Canada NL Robotics								
Mining Operation Scoring Sheet								
Match #:								
Mining Points	# of Pieces Mined	Points per Piece	Mining Score		Sorting Points	# of Pieces Sorted	Points per Piece	Sorting Score
Tailing Pieces		x1 Pt			Tailing Pieces		x1 Pt	
Gold Pieces		x2 Pt			Low Quality Gold		x2 Pt	
Total Mining Points:					High Quality Gold		x4 Pt	
					Total Sorting Points:			
					Total Score:			
School Name:					Signature:			

9. Pit Area and Court Access

A pit area is expected to be available so that students may make repairs and improvements to their robots between games. This is to be monitored by the designated proctor for safety and to ensure students are the only ones working on their robots.

10. Game Play

a. Teams will record and submit 3 full 4 minute game runs. In the recording, the video must be recorded from a specified angle, and include the starting position of the robots.

b. At the end of each match, teams are to fill out their own score sheet, and show all of the score based components on the recording which is submitted to the PTC.

c. Gold Mine Operation Tournament Standing will be based on the total number of points scored in all games played by each team.

d. Tournament games will last 4 minutes.

e. Teams will be provided a deadline by which they must have their 3 match recording(s) submitted. Failure to have them submitted by this time may result in the match(es) not being counted. If uploading issues are present, please ensure to notify the PTC.

f. Recordings must be submitted with the name of the school in the file name.

g. Time will become the tie-breaker during the Tournament matches. The team to sort their final piece first will be declared the winner of the match.

h. Between tournament games, battery changes and repairs to robots may be completed at the team's assigned Pit Area Worktable.

i. During the competition, protective safety glasses are expected to be worn while performing material removal tasks (cutting, drilling, etc.).

j. During game play, the proctor/PTC designate will have ultimate authority over game rulings, and will have full authority over team conduct in the court area.

k. 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. Games missed due to this situation will be forfeited. NOTE: Damage involves BREAKING court components.

Robots bumping into court components and causing them to shift position without breaking any court element will NOT be viewed as damaging the court. It is expected that all court components will be fixed firmly in place so that the court is a Neutral Factor in the competition.

i. *Note: The corrugated plastic overburden pieces are not considered parts of the court when considering damages.

l. Competitors cannot enter onto the court surface or adjust their robot during a game. Doing so will result in the match being suspended at the time which they enter.

m. If a robot is mal-functioning and represents a hazard to participants, other robots or itself in the opinion of the proctor/PTC designate, then, the proctor/PTC designate may stop the clock, and may authorize the 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.

n. It is a Team Decision what roles team members will fill. Drivers are the competitors holding the robot controller(s) and asserting direct control over a Tele-operated robot.

o. The Spotter would be the competitor providing navigational guidance to the driver.

p. Competitors may change roles while a game is in progress.

q. Competitors (Driver/s and/or Spotters) can move freely in their Assigned Courtside Team Area throughout the game.

r. At the start of a game, robots are expected to be in their Designated Starting Position.

s. Robots must not leave the contest court at any time during a game.

t. It will be the PTC's ruling that decides if an 'End of the Game Component Placement' took place before or after the game-ending buzzer sounded. This ruling will happen after video submission and review by the PTC.

u. If a Gold or Tailing 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.

v. Scoring will take place after the End of the Game Buzzer

w. No aerial (flying) robots are allowed.

11. Court Layout

a. Please note: Although great pains 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 ½ inch tolerance.**

   i. The open court surface will consist of the good side of Plywood Sheets **OR** the facility floor **OR** the smooth side of Masonite Sheeting.

   ii. Detailed court information has been included in the Appendix Section of this document.

12. The Robot(s) Restrictions

a. All tele-operated Robots must pass a pre-competition inspection for compliance with the safety and design rules before they will be allowed to participate in tournament games.

b. **Note**: 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.

13. Start of the Game Robot Status

a. When a 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:

   i. Robots must be stationary.

b. Robots must be in their designated Starting Location.

c. If Team Entries involve multiple Robots / Mechanisms, then all of them must fit within starting location and must be positioned to not exceed the allowed total 5 cu ft. volume per Team.

d. All systems may be ON.

e. Air System Circuits may be fully charged to 100 PSI maximum and their compressors can be ON.

14. Overall Team Robot Entry Size

a. Complete Team Entries must fit within the 30 by 30 inch starting area at the start of each game, as defined by the vertical plane of the starting area.

b. Complete Team Entries must not exceed an overall size of 5 cubic feet (8,640 cubic inches) at the start of each game.

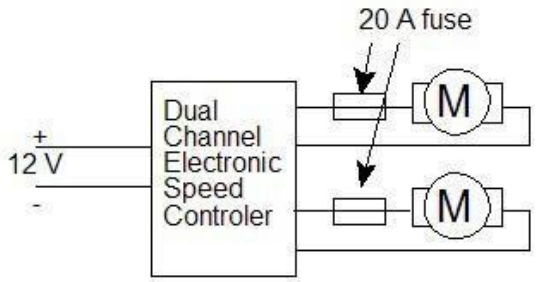
c. Team Entries may expand to a larger size once a game has started.

15. Power Sources / Management

a. The total voltage in any individual circuit cannot exceed 24 Volts.

b. The maximum continuous power rating allowed in any circuit branch is 240 W, which will be limited by voltage and fuse selection. A larger main fuse can be used to provide protection for motor controllers. To calculate power in any given circuit, use the following formula: Power (Watts) = Voltage (Volts) x Current (Amps)

***Acceptable* Circuit Protection: (ESC is NOT protected by fuse)**



***Recommended* Circuit Protection: (ESC *IS* protected by fuse)**

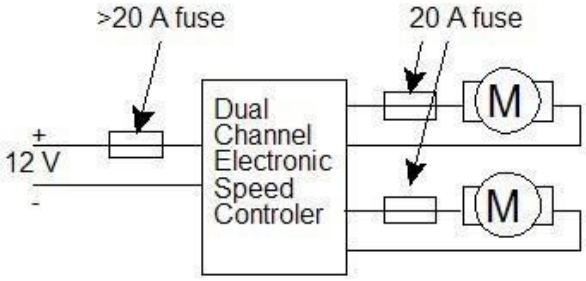


Figure 9: Circuit Protection

c. Teams are reminded that it is the purpose of a fuse to protect the students themselves and the equipment in their circuits. Teams must develop circuit diagrams and calculate the appropriate values for all circuits on their robot. Teams must submit a wiring diagram of their robot's circuits.

d. 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.

    i. Devices with a known, dedicated internal fuse (based on manufacturer's documentation) are considered to have this requirement met, assuming the fuse rating is appropriate.

e. Batteries must be complete sealed commercial battery packs.

    i. Competitors must have the Material Safety Data Sheets for their batteries.

f. ALL Robots must be able to be turned off with a single motion.

g. Robot Controller receivers may be in an independent circuit.

h. No explosive materials of any kind may be used (ether, gunpowder, acetylene etc.)

16. Non-Electrical (Battery) Energy Sources

a. Pressure based energy sources (air or other) may be pre-charged to a maximum of 100-PSI pressure in their reservoirs (cylinders) at the start of each game.

b. Air pressure systems using Competitor-made or modified air pressure hardware are NOT permitted.

c. All pressurized tanks on robots must have a pressure gauge to indicate the stored pressure and a form of automatic overpressure safety relief system.

d. The pressure tanks and related gauges / controls must be shielded from damage due to collisions or flying target objects.

e. The stored pressure in the tank must not exceed a maximum of 100 PSI at any time.

f. 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.

g. Laser devices are prohibited.

17. Recommended Robot Controllers

a. It is recommended (not required) that all teams use 2.4 GHz “non-crystal” control systems on Tele-operated Robots.

b. Teams are allowed the use of an unlimited number of channels, but only two separate tele-operated robots. Teams assume full responsibility if any interference is to occur with their respective communication systems that could render the robot(s) useless.

c. Tele-operated Robots may not transmit audio/visual information to off the robot devices. (Ex: Having a camera transmit images real time to a computer near the driver, etc.)

18. Pit Area

a. Competitors MUST wear safety glasses when doing fabrication work involving material removal processes (grinding / cutting).

b. Only registered competitors are permitted in the contest space.

c. 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.

d. Designated teacher/industry team advisors are not allowed in the pit area during tournament play.

e. Teachers and industry advisors are not permitted to handle tools or robot parts. Students must affect all repairs and modifications on their robot.

f. It is required that teams fabricate a tabletop stand for holding their robot(s) in the pit area. 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.

19. Overall Court Description:

a. The Court Playing Surface will be an 8’ by 16’ rectangle.

b. The Perimeter Court Walls will be made using 2 by 4-inch planks.

c. This wall will as a result will be approximately 3.5 inches tall.

d. The court surface may vary between melamine, concrete, hardboard, or plywood.

20. Pre-inspection for Compliance with Safety and Design Rules

- ❑ Mandatory Wiring Diagram provided.
- ❑ Tabletop Robot Stand
- ❑ Overall volume ≤ 5 ft^3 or 8,640 in^3
- ❑ No explosives/combustibles
- ❑ No lasers
- ❑ All batteries are sealed commercial batteries in good physical condition
- ❑ Batteries wired in series should be the same amp hour rating (ex. both 1500 mAh) and batteries in parallel are of same voltage (ex. both 12 volts).
- ❑ Batteries securely mounted
- ❑ Material Safety Data Sheets available for all batteries.
- ❑ Total voltage in any individual circuit does not exceed 24V
- ❑ No circuit **branch** exceeds 240W (Voltage x Fuse Current Rating, easily accessible)
- ❑ All circuits have a fuse or breaker (breakers must have **DC rating**) and all Fuses / Breakers must be readily accessible.
- ❑ Mandatory Pressure System Circuit Diagram provided.
- ❑ No Competitor-made or modified air pressure hardware being used.
- ❑ Only commercially manufactured Pressure Tanks (cylinders) can be used.
- ❑ Pressure indicator
- ❑ Pressure in tanks does not exceed 100 psi
- ❑ Over-pressure safety valve
- ❑ Pressure tanks and related gauges and controls are shielded from damage due to collisions
- ❑ **Robot can be turned off with a single motion**. Radio receivers / Logic circuits may be independent of the kill switch.
- ❑ Control unit to support operator to robot communication are being used.
- ❑ Demonstration of robot functionality

Additional concerns: _____

Robot Evaluator Signature	Team Representative Signature

21. Autonomous Competition Overview:

IMPORTANT NOTE: The information in this section does NOT pertain to the NL Provincial Skills Competition. The information is provided to give insight into the Autonomous component of the National Skills Competition.

a. Competitors will be provided, at no cost to the teams, with a kit distributed to them through their provincial/Territorial office.

b. The autonomous robots must be disassembled on arrival.

c. A description of the Competition Component Collection will be posted on the Skills/Compétences Canada Website.

d. Competitors will demonstrate their robot's performance in a court to be defined at the Skill area.

e. At the orientation meeting, Competitors will be told the specific Robot Behaviors their Built On-Site Robots need to complete.

f. The suggested performance items listed below reflect the type of core isolated robot performance elements competitor robots will need to complete

   i. Follow wall perimeter,
   ii. Navigate a maze,
   iii. Navigate around obstacles,
   iv. Follow a colored tape line on the floor,
   v. Locate and touch an object
   vi. Pick up a small object and move it to a new location

g. 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.

h. 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.

i. 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.

j. Build On-Site Autonomous Tasks Equipment: Competitors will be required to build their autonomous robot solutions using ONLY the contents of the provided to all teams 2021 Skills Canada Component Collection. 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.

k. Teams will have time periods where they have shared access to the various Autonomous Performance Court Environments to conduct their Task Solution / Preparation Activities

l. 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.

m. 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 3:45 PM on Competition Day 2.

n. Team Marks will be based on their Best Performance out of their attempts.

21.1 Exception List to "Only what is in the box"

a. Laptop/Computer, mouse, and keyboard, power cord, usb cable, software drivers

b. Sample code, Arduino IDE or similar program

c. Measuring tape, allen keys, small wrench or pliers

d. Paper, pen, pencil, calculator to record measurement

e. Replacement parts for the originals ie. Cable ties

f. Large and/or small storage containers

22. YouTube Link

Refer to YouTube link about advice from our technical members on this competition category

https://youtu.be/qiqFb41mQek

https://youtu.be/bahp2A2TM4k

Appendix A: Court Area Dimensions and Details