

Introduction

Safety is a fundamental principle every team must adhere to within the FIRST Tech Challenge. Building a robot involves working with various tools and materials; each process can present risks. This safety manual aims to guide teams in building their robots responsibly, minimizing risks, and ensuring the health and safety of all team members.

To maintain a professional and corporate approach to safety, teams should integrate structured safety protocols into their workflow. Regular safety training sessions should be conducted for rookie and veteran members to ensure everyone knows best practices and updated procedures. Establishing a culture of continuous learning and adherence to safety guidelines reduces risks and fosters a responsible and efficient working environment.

1. General safety rules

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1.1 Fundamental Rules

Before starting any robot construction activity, every team must understand and follow these fundamental safety rules:

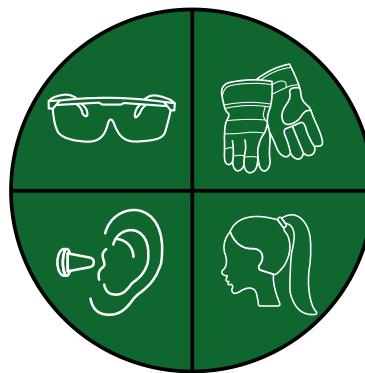
- 1 Follow all FTC and applicable local safety regulations.
- 2 Inspect tools for safety and suitability before use.
- 3 Store tools and materials safely to prevent accidents and injuries.
- 4 Stay aware of your surroundings and inform others of risks.
- 5 Work should only be conducted in properly lit areas to ensure visibility and prevent accidents.
- 6 Ensure all team members know emergency contacts.



1.2 Personal protective equipment (PPE)

Proper personal protective equipment is essential to prevent accidents:

- **Safety glasses:** Always wear safety glasses when using power tools or working with chemicals or objects that might release particles. (ANSI-approved, UL Listed, CE EN166 rated, AS/NZS certified, or CSA rated).
- **Protective gloves:** Protective gloves should be used primarily to prevent scratches, irritation, or contact with hazardous materials. However, there are situations where wearing gloves can be dangerous. For example, when operating a drill press or other rotating machinery, gloves should not be worn, as they can get caught in the moving parts and pull the user in, leading to serious injury. Always assess the task at hand and use gloves only when they enhance safety rather than create additional risks.
- **Hearing protection:** Use earplugs or protective earmuffs when operating loud tools (e.g. electric saws or drills).
- **Hair must be tied back** at all times to prevent entanglement in tools, machinery, or moving robot parts.



1.3 Safety at Competitions and on the Field

Safety extends beyond the workshop to competitions and field operations. Teams should implement the following measures:

- **Robot Safety Inspections:** Check the robot before every match.
- **Fasteners:** All bolts and nuts must be tight.
- **Structural Integrity:** All parts must be securely attached.
- **Entanglement Prevention:** Secure wires and moving parts.
- **Elimination of Sharp Edges:** Remove or cover sharp edges.
- **Accessible Power Controls:** Power button must be easy to reach.
- **Safe Operation Protocols:** Operate the robot safely at all times.
- **Projectile Restrictions:** The robot must not launch objects.
- **Extension Limits:** Do not extend parts dangerously outside the robot.



1.4. Working on the robot while it is powered on

It is necessary to follow safety protocols when working on the robot, particularly while it is powered on. **Never place your hand inside the robot while it is active.** Even if the robot appears to function normally, there is a risk of uncontrolled movement or malfunction that could cause accidents.

- **Check the robot's status:** If adjustments or component inspections are necessary, ensure the robot is completely powered off and disconnected from active energy sources (batteries, connected cables, etc.).
- **Secure the work area:** If performing work on the robot, ensure no team member activates the robot without confirming the area is safe. This will prevent accidents.
- **Team communication:** Maintain constant communication within the team when working on the robot to prevent miscommunication errors.

Key safety rules:



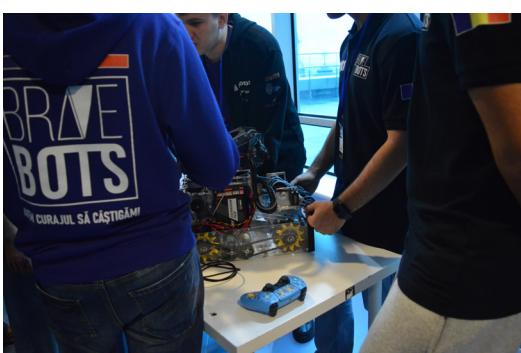
Avoid contact with unprotected cables to prevent electrical shock. Always ensure cables are properly insulated and secured before handling.



Use appropriate protective equipment. When working near moving parts or electrical components, wear the proper PPE (e.g., protective gloves) to minimize the risk of injury.



A clutter-free work area reduces the risk of accidents. To prevent tripping or falling, keep tools and spare parts organized and out of the way.



Robot inspection at Zilele Robotice #4



2. Safety when using tools & equipment

2.1 Hand Tools

Hand tools (**screwdrivers, hammers, wrenches, saws**) are essential for assembling the robot but can cause accidents if not used correctly.

Safety measures:

- **Inspect tools** before use to ensure they are not damaged or worn out.
- **Store tools** in a **safe** and **organized** manner to prevent accidents.
- Use tools **correctly** for their **designated purpose**. For example, use the appropriate-sized screwdriver and avoid using a hammer to tighten screws.
- Avoid **sudden** or **uncontrolled** movements that could lead to accidental injuries.



Our hand tools at our hub

2.2 Power Tools

Power tools, such as drills, saws, grinders, or milling machines, present higher risks during robot construction.

Safety measures:

- **Inspect** power tools before use to ensure they are in good condition and free of defects.
- Follow the manufacturer's **instructions** for each tool.
- **Be aware** of the direction of moving parts (e.g., saws and grinders can project debris in unintended directions).
- Do not leave power tools unattended. Ensure they are **disconnected** from the power source when not in use.
- Keep hands and clothing away from moving parts.
- **Never** operate power tools alone - there should always be at least two people present, with one person not engaging in any hazardous activity. This ensures that someone is available to assist or call for help in case of an emergency.



3. Electrical Safety

In the FIRST Tech Challenge, teams work with various electrical components, including batteries, circuits, and motors, which pose risks of electrocution, fires, or equipment damage.

3.1 Using Batteries

Batteries are essential for powering the robot but can be hazardous if used or charged improperly. For safe storage of NiMH batteries, they should be kept in a dry, cool, and well-ventilated area, away from heat sources, and ideally stored in a dedicated container to prevent accidental contact between terminals and short circuits.

Safety measures:

- Ensure that the battery is **properly installed in the robot**, but the robot should be powered off during inspection.
- Inspect batteries before use to ensure they are not **damaged** (visual check for cracks, dents, or leaks, check for corrosion on terminals, inspect for bulging or swelling, ensure secure and clean connections, test voltage with a multimeter, look for signs of leakage.)
- Store batteries in a **dry location away from heat sources** or open flames.
- Avoid overcharging batteries and follow the manufacturer's charging instructions: Overcharging a battery typically occurs when it is charged beyond its maximum rated voltage for a prolonged period. For NiMH (Nickel-Metal Hydride) batteries, this generally means charging **beyond 12V**, 3000mAh NiMH battery which is constructed using Sub-C cells, each with a **nominal voltage of 1.2V**. To achieve a total voltage of 12V, 10 Sub-C cells are connected in series.
- **Prevent short-circuiting batteries** and avoid contact with metallic objects.



*Our batteries
charging*



3.2 Cables and Circuits

Working with electrical circuits requires caution to prevent short circuits or electrocution.

Properly insulate wires and connectors

Ensure all wires and connectors are properly insulated to prevent short circuits and electrical hazards.

Avoid circuit overload

Do not overload circuits, and always verify that the batteries are appropriately sized for the intended load to avoid overheating or failure.

Protect from moisture

Keep all electrical components dry and shielded from moisture, as water can cause short circuits and damage to sensitive parts.

Power off before handling electrical components

Always disconnect the power source before working on any electrical components to avoid accidental shocks or damage.

Ensure proper grounding

Make sure the robot's electrical system is grounded correctly to minimize the risk of electrical shock or equipment damage.

4. Chemical Safety

During robot construction, teams may use various chemicals (e.g., solvents, adhesives, oils) that can be hazardous if mishandled.

4.1 Chemicals

- Read Safety Data Sheets (SDS) for each chemical used.
- Work in a well-ventilated area when using chemicals to avoid inhaling fumes.
- Wear gloves and safety glasses when handling hazardous chemicals.
- Store chemicals in appropriate, labelled containers, away from heat sources or flames.



5. Emergency preparedness

Teams must be prepared for emergencies, including accidents or fires.

5.1. Emergency Equipment

- Regularly check the **location of emergency equipment** (fire extinguishers, first aid kits, emergency exits) and ensure they are easily accessible.
- Familiarize yourself with **emergency procedures**, and ensure all team members know what to do in case of a fire or accident.
- Learn basic first aid:** At least one team member should be trained in first aid.



6. Tutorials

6.1 How to solder correctly

Soldering helps connect electronic components on the robot by creating stable and safe electrical connections.

Materials needed:



Steps:

Prepare the workspace - Work in a well-ventilated area. Verify that the soldering iron is clean and functioning correctly.

Use a wire stripper to carefully remove the insulation from the wire, exposing the underlying conductor without damaging the wire itself.

Heat the soldering iron - Place the soldering iron in a stand and allow it to heat to approximately 400°C.



Apply solder - Add a small amount of solder to the tip of the iron to aid heat transfer.

Position the soldering iron tip on the **connection area**. The solder will melt and flow around the connection.

Cool the connection- Remove the soldering iron and let the joint cool for a few seconds.

Verify that the solder is solid and **free of excess material** that could cause short circuits.

Clean the iron- Use a wet sponge to clean the soldering iron tip after each use.

⚠ SAFETY PRECAUTIONS

- **Avoid inhaling fumes.** Work in a well-ventilated area or use a fan to direct smoke away.
- Wear **safety glasses** to prevent accidents with molten solder.

6.2 How to use a metal drill correctly

Materials needed:



Steps:

Prepare the workpiece - Secure the workpiece in a clamp to prevent it from moving.

Choose the drill bit- Select an appropriate drill bit for the desired hole size.

Begin drilling- Start at low speed, applying light pressure. Gradually increase speed and pressure as needed.

Clean the drill bit- Periodically stop and clean debris from the drill bit.

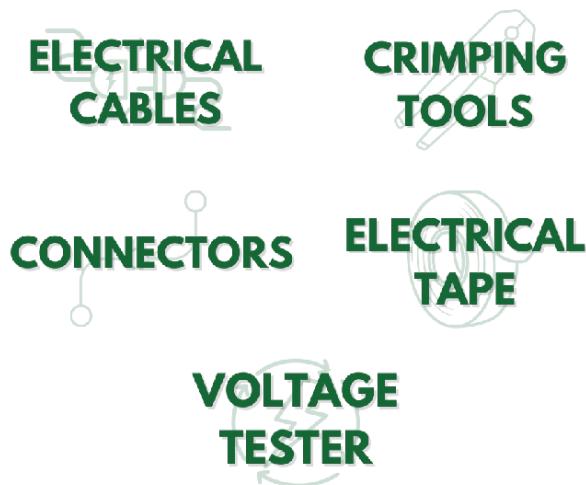


!! SAFETY PRECAUTIONS

- Wear safety glasses to protect against flying debris.
- Keep hands away from the drill bit.

6.3 How to properly connect an electrical cable

Materials needed:



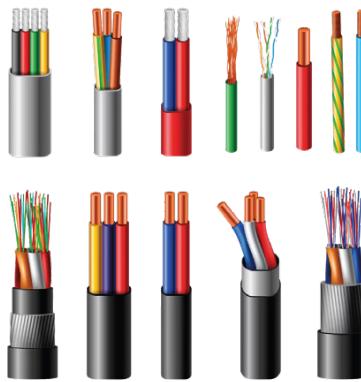
Steps:

- **Prepare the cable**- Measure and cut the cable to the desired length. Strip **1-2 cm of insulation** from the ends.
- **Attach connectors**- Place the stripped cable into the connector and use a crimping tool to secure it.
- **Test the connection**- Use a voltage tester to ensure the connection works correctly.

!! SAFETY PRECAUTIONS

- **Test for voltage** before connecting cables to avoid electrocution.
- Ensure all exposed connections are **properly insulated**.





Examples of electrical cables

6.4 How to properly use an angle grinder

Materials needed:



Steps:

- **Prepare the tool**- Inspect the flex to ensure it is in good condition, with the correct disc installed and the guard securely in place.
- **Secure the workpiece**- Use clamps to firmly hold the material you're working on to prevent movement during operation.
- **Power on the angle grinder** - Turn on the tool and allow the disc to reach full speed before making contact with the material.
- **Use the angle grinder**- Hold the tool with both hands, applying light pressure as you move it steadily across the material.
- **Turn off the tool** - Once the job is complete, turn off the flex and allow it to cool before storing.



!! SAFETY PRECAUTIONS

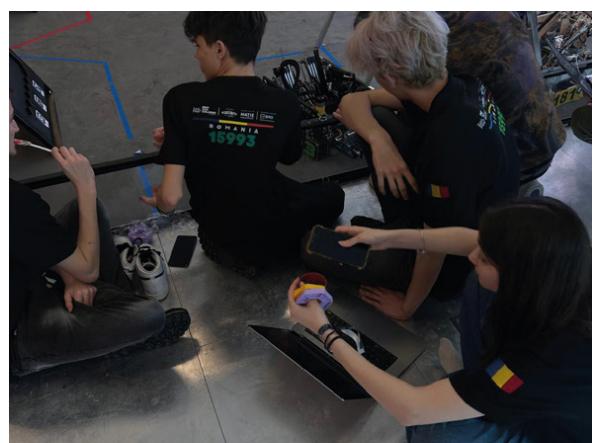
- Wear **protective gear**: always wear gloves, goggles, hearing protection, and a dust mask to protect from sparks, debris, and noise.
- Check the tool: **ensure the flex and its disc are in good working condition** before use.
- **Never use the tool alone**: always have someone nearby in case of emergency.
- Keep a **safe distance**: avoid placing your body in line with the rotating disc and keep your hands away from the blade.
- **Disconnect power when not in use**: always unplug the tool when changing the disc or when it's not in use to avoid accidents.

Photos of our team working safely



Our team at a League Meet

Our programmers working on the autonomous



7. Impressions

