

FIRST® Robotics Competition and *FIRST*® Tech Challenge

Safety Manual

FIRST® **is a global robotics community that prepares young people for the future.**

www.firstinspires.org

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1 Culture of Safety

Instilling a culture of safety is a value that every individual in the *FIRST*® community must embrace as we pursue the mission and vision of *FIRST*. Safety is a vital part of the *FIRST* culture, with a framework for safety leadership established in all aspects of the programs.

FIRST believes that teams that take the lead in developing safety programs and policies have a positive and lasting impact on each team member and mentor in addition to their communities and present and future workplaces. *FIRST* recognizes the teams that demonstrate safety throughout their programs and are deeply committed to developing a culture of safety.

1.1 Scope

This safety manual is a guide for important safety information and provides students with a basic set of requirements to maintain a safe environment during the build season and at competitions. It applies to anyone involved with *FIRST*, including all students, mentors, volunteers, and spectators.

This document serves to educate and provide guidelines for teams. For enforced rules at events, teams and staff/volunteers should refer to the relevant competition or game manuals.

2 Participant Responsibilities

Everyone is responsible for safety during team meetings and the design, build, travel, and event phases of the competition. Please read this entire manual for details on how to establish and maintain a culture of safety within *FIRST*. Below are the expectations for *FIRST* participants.

2.1 All Participants

- Be familiar with this manual and understand and follow established safety requirements applicable to your environment.
- Be familiar with any site restrictions linked in the 'Event Info' section of the *FIRST* Event Search page.
- Work in a safe and responsible manner.
- Use personal protective equipment (PPE) and other safety equipment as required.
- Identify and report any unsafe or hazardous conditions to a mentor. This includes work practices that may cause an accident.
- Encourage safe behaviors in everyone around you.

2.2 Mentors

- Lead by example. Practice the same safety behaviors that are expected from the students.
- Provide guidance and encouragement in a safe working environment.
- Provide leadership and guidance on matters of general safety, such as the use of PPE and lifting, handling, and transportation of robots.
- Encourage communication about safety. Utilize safety engineering principles with members to eliminate or minimize identified hazards.
- Collect and store Safety Data Sheets (SDSs) for any chemicals, chemical compounds, or chemical mixtures (e.g., in paint and batteries) used. SDS information may include instructions for safe use and potential hazards associated with a particular material or product. You can obtain SDS sheets from the manufacturer's web site or by calling the manufacturer directly. Become familiar with them and the related emergency procedures.

3 General Safety Requirements

3.1 Stored Energy

Plan the required activities when servicing or making repairs to the robot. Make sure all team members are aware that work is being done on the robot. Avoid working on an energized robot during repairs unless necessary. Address the following:

3.1.1 Electrical Energy:

- Disconnect the electric power source.
- *FIRST* Best Practice: Always de-energize the robot before working on it.
    - *FIRST* Robotics Competition: open the main circuit breaker ("re-set" lever is released) and unplug the battery.
    - *FIRST* Tech Challenge: turn off the main power switch and unplug the battery.

3.1.2 Pneumatic Energy (*FIRST* Robotics Competition Only):

- Always vent any compressed air to the atmosphere (this applies to all parts of the pneumatic system).
- Open the main vent valve and verify that all pressure gauges on the robot indicate zero pressure.

3.1.3 Miscellaneous Energy Sources:

- Relieve any compressed or stretched springs or tubing.
- Lower all raised robot mechanisms or devices that could drop down to a lower position on the robot.

3.2 Hand Tools

Constructing a robot will require the use of hand tools. Most people think of hand tools as wrenches, screwdrivers, chisels, and so forth, but the term also applies to any hand-held tool or implement used to accomplish a task. Always use the proper tool for the job.

3.2.1 Tool Rules

- Before using any tool, check to see if it is in good condition. Do not use defective, dull, or broken tools. If a tool is not in good condition, do not put it back on the shelf; remove it from service and notify a mentor so the tool can be replaced or sent for repair.
- When using a tool, place the work on a bench or hard surface rather than in your hand.
- When using knives/blades, direct your cutting strokes away from your hand and body and be aware of those around you. Always retract the blade into the stored position before putting it down.
- Ensure all guards and protective coverings are installed and working.
- Wear gloves as applicable.
    - For example, wear chemical-resistant gloves when handling chemicals, or avoid the use of gloves when using power tools like drill presses where the gloves can get caught in the tool.
- Wear Safety Glasses or Goggles. Eye Protection is crucial when using hand tools to shield your eyes from flying debris.

3.2.2 Tool Storage

- Store sharp-edged or pointed tools in a safe place.
- When carrying tools, cover the point or any sharp edges with shields.
- NEVER carry unshielded tools in your pocket.
- Do not leave tools on overhead work surfaces; they may fall and strike someone below.
- Store equipment in a location where it will not create a safety hazard or get damaged.

3.3 Mechanical Guards

Provide safety guards for power tools where required. Never use any equipment without safety guards in place. Notify your mentor of any broken or defective equipment and take it out of service (unplug the equipment, remove the key, post a sign, etc.) until repairs are made.

3.4 Respect for Electricity

Proper use and respect for electricity is paramount. The following are general guidelines for ensuring that basic electrical safety requirements are met:

- Inspect your equipment cords and extension cords routinely to ensure they are in good condition.
- Avoid the following electrical power supply setups to prevent overloading:
  - Extension cord plugged into another extension cord.
  - Extension cord plugged into a power strip.
  - Multi-device receptacle plugged into a power strip or extension cord (daisy chaining).

3.5 Battery Safety

CAUTION: *FIRST* Robotics Competition batteries contain acid. This substance, H_2SO_4, is a corrosive, colorless liquid that will burn eyes, skin, and clothing. *FIRST* Robotics Competition team mentors and/or student leads should post the Safety Data Sheet (SDS, see example in Appendix C) for the battery in use and train all team members about battery safety. You can find emergency handling and first aid procedures in the SDS, along with proper protection for handling cracked or damaged batteries, and information on disposal of batteries.

3.5.1 General Damaged Battery Information and Warnings

Any battery that is visibly damaged in any way is dangerous and unusable. Do not take a chance - do not use it! Reasons you should not use a damaged battery include:

- It contains stored electrical energy that could cause the battery to rapidly heat up due to an internal electrical short circuit and possibly explode.
- The 12V batteries *FIRST* typically provides in the *FIRST* Robotics Competition Kit of Parts contain sulfuric acid that will burn human tissue on contact.

Set aside a damaged battery and handle accordingly:

- Immediately flush any contacted skin with a large quantity of water.
- Seek medical treatment.
- Periodically inspect your batteries for any signs of damage or leaking electrolyte. Remember that a dropped battery may be cracked, but the crack may not be visible and might eventually leak electrolyte.

- Treat it as a hazardous material and process it in accordance with the battery's Safety Data Sheets (SDSs).

3.5.2 Necessary Safety Materials

FIRST recommends that teams keep the following items readily available whenever working with batteries:

- A box of sodium bicarbonate (baking soda) to neutralize any exposed acid electrolyte.
- A pair of acid-resistant rubber or plastic leak-proof gloves to wear when handling a leaking battery.
- A suitable non-metallic leak-proof container in which to place the defective battery.

3.5.3 Procedure for Handling a Leaking Lead Acid Battery

- When an electrolyte leak occurs:
  - Neutralize it by pouring sodium bicarbonate on all wet surfaces. The sodium bicarbonate itself is not dangerous and will react with the acid in the electrolyte, leaving a harmless residue that can be disposed of in a conventional manner such as rinsing with water.
  - Follow emergency handling instructions of the SDS and notify a mentor.
  - Put on safety glasses and gloves before handling the battery.
  - Place the battery in a leak-proof container for removal.
  - Be sure to neutralize any acid on the gloves before removing and storing them.
  - Properly dispose of the battery, which is now a hazardous material.
- At a *FIRST* event:
  - Immediately send the person in contact with acid to the First Aid Station/EMTs.
  - Report the incident to the Pit Administration Supervisor so they can fill out a Medical Incident. Provide your team number and available information.
  - Pit Administration will immediately contact Event Management for further instruction from event and venue authorities.

3.5.4 Battery Disposal

Be sure to dispose of all batteries properly and safely. Most retailers of automotive batteries will accept and properly dispose of them at no cost.

3.5.5 Charging and Handling

- Never carry or transport a battery by its power leads.
- Keep the battery charging area clean and orderly.
- Place your battery charger in an area where air can freely circulate around the charger. Battery chargers can fail without proper ventilation.
- Do not short the battery terminals. If metal tools/parts contact the terminals simultaneously, it will create a direct short circuit. This may cause high heat to develop in the battery terminal/part/tool area, and the battery could explode. To avoid the possibility of shorting out the battery terminals and creating a hazardous situation, it is required to cover all exposed battery terminals and connections with appropriate insulating material such as electrical tape or tubing.
- Do not charge a battery at greater than the manufacturer's maximum recommended rate.
- Never attempt to disassemble batteries or battery housing, which could cause accidental puncture.

- Never use tools to remove a stuck battery, as they may puncture the battery.

3.5.6 Ongoing Battery Inspection

- Periodically inspect your battery for any evidence of damage, such as a cracked case or leaking electrolyte.
- Bent terminals can also be a potential leak source.
- Inspect the battery before and after each round of competition.

3.5.7 Lithium-Ion Batteries

Lithium-ion batteries are used in a variety of equipment and require attention to minimize hazards. Misuse, physical abuse, or improper handling can force lithium-ion batteries into a failure mode called thermal runaway, which can result in fires or explosions. Below are safety tips to avoid causing a lithium-ion battery to malfunction:

- Use batteries or battery packs that are certified.
- Purchase batteries (including replacement batteries) from the original equipment manufacturer or from a reputable source. Purchasing batteries over the internet from unknown sources at exceptionally discounted prices can be an indication that the product is not authentic. Avoid products with minimal packaging, no branding, or no documentation.
- Avoid crushing, bending or severe impact to lithium-ion batteries, battery packs and battery-operated devices. Avoid excessive vibration of lithium-ion batteries.
- Do not expose lithium-ion batteries to high temperatures.
- Always use the correct, compatible charger to safely charge your batteries.
- Avoid excessive or prolonged charging. Inappropriately charging a battery can lead to irreversible changes that may reduce battery life or lead to failure. It is best to recharge a battery only when it has a low state of charge and then fully charge it to 100%.
- Do not use or charge battery-operated devices if they are surrounded by materials that prevent normal air flow.
- Special care should be taken with spare batteries during storage and transport. Loose batteries or the terminals on battery packs can contact metallic items such as spiral notebook binders and cause a short circuit.
- Keep batteries out of the reach of small children. Button or coin cells can be ingested by small children and cause serious internal injuries from chemical burns.
- Have a Class C fire extinguisher on hand in case of lithium fires. Note that lithium fires can produce toxic smoke, and extinguishing such fires should not be attempted unless the fire is very small, and the person is trained in the use of a fire extinguisher. Reach out to local emergency authorities if the fire is not small or the person is not trained in the use of a fire extinguisher.

3.6 Chemical Safety

- Keep chemical containers in good condition.
- Make sure all chemical containers have labels placed by the manufacturer.
- Ensure that all labels are legible.
- Become familiar with the chemicals you may use as part of *FIRST*. Read safety precautions and instructions for use located on the chemical label.
- Store all chemicals in an orderly way and store incompatible chemicals separately from each other. Obtain Safety Data Sheets (SDSs) for the chemicals your team uses. These sheets provide information on the correct handling of spills or injuries.

- Store any flammable chemicals when not in use in non-flammable storage locations and away from flammable materials.
- If you are exposed to a chemical, notify your student lead and mentor immediately and consult the SDS if necessary.

3.7 Soldering

Soldering can be dangerous because of the heat from the iron and the chemical fumes and vapors released from the solder and flux. When soldering, observe the following points:

- Using lead-free solder is highly recommended for safety purposes, and solder with an electrically heated soldering iron/gun only. Be aware that even lead-free can still contain toxic ingredients, wash hands after handling.
- Wear eye and face protection.
- Solder in well-ventilated areas.
- Never touch the iron/gun. It heats to extreme temperatures that can cause severe burns.
- Prevent burns by wearing cotton clothing that covers your arms and legs.
- No food or drink should be present in the specific soldering area to prevent cross-contamination.
- Always wash your hands with soap and water after handling solder.
- Work on a fire-resistant surface.
- Keep your soldering iron in its protective holder when not in use.
- Do not leave any hot tools where someone can accidentally touch the hot element.
- Dispose of solder waste appropriately, even if using lead-free solder, it may contain other parts that are considered hazardous waste.

4 Personal Protective Equipment (PPE)

The proper use of personal protective equipment (PPE) is an essential element in helping to protect *FIRST* participants from hazards in the work area. The following describes the common PPE that you are required to wear as part of constructing, using, maintaining, and transporting of a robot. All PPE must be ANSI-approved, UL Listed, CE EN166-rated, AS/NZS-certified or CSA-rated, as applicable. Generally, all PPE should be kept clean and inspected prior to use for any defects. Defective PPE should be discarded and replaced.

4.1 Eye and Face Protection

There are several forms of protection available to protect against hazards, including safety glasses with side shields, goggles, face shields, and face masks. Inspect equipment for damage each time you wear it.

4.1.1 Use and Application

- Wear eye protection in the following situations:
  - When performing any work on the robot, including grinding, drilling, soldering, cutting, welding, etc.
  - When there is a risk of exposure to flying particles or chemical exposure (such as splashes, splatters, and sprays).
- At *FIRST* Robotics Competition events, wear eye protection:
  - Anywhere in the pits, including walkways and team pits.
  - Near the arena, including the playing field.
  - Near the practice/test areas.
  - Any area posted with signs requiring the use of eye protection (such as the machine shop).
- At *FIRST* Tech Challenge events, wear eye protection:
  - in team pit areas where work is being performed
  - in the immediate vicinity of competition fields and practice fields with active robots.

4.1.2 Safety Glasses and Protective Eyewear

Safety glasses and protective eyewear are designed to provide a shield around the entire eye to protect against hazards such as splashes of liquids, burns from steam, compressed air, and flying wood or metal debris.

To prevent injury, all individuals near robots that are running or being worked on, as well as any areas designated in the *FIRST* Robotics Competition Game Manual or *FIRST* Tech Challenge Competition Manual (Located in the Event Rules section), must wear safety glasses or protective eyewear that is ANSI-approved, UL Listed, CE EN166-rated, AS/NZS-certified or CSA-rated. Reflective lenses are prohibited; your eyes must be clearly visible to others; however, tinted safety glasses are allowed for general use without need for permission or accommodation.

The use of anything other than ANSI-approved, UL Listed, CE EN166-rated, AS/NZS-certified, or CSA-rated eye protection is prohibited.

4.1.3 Prescription Glasses

If you wear prescription glasses that do not have a marked safety rating, you must wear rated safety goggles over them to achieve adequate protection.

If you wear marked safety-rated glasses, you may use ANSI-approved, UL Listed, CE EN166-rated, AS/NZS-certified, or CSA-rated side shields.

Safety-rated glasses, side shields and frames can be identified by markings stating the standard to which they are rated to, e.g., Z87.1.

4.2 Hand Protection

Hand protection is designed to protect against heat, electrical, chemical, laceration, and mechanical hazards. Use proper gloves and mechanical tool guards for the application.

FIRST participants should work with their mentor to ensure that the selected glove is the correct one to use for each activity. For example, wear chemical-resistant gloves when handling chemicals, or avoid the use of gloves when using power tools like drill presses where the gloves can get caught in the tool. Check your gloves for proper size, absence of cracks and holes, and good flexibility and grip before you wear them.

4.3 Hearing Protection

Make hearing protection devices available, such as earplugs, where there are objectionable/questionable sound levels. Hearing protection is often available at pit administration. A mentor can provide assistance in evaluating high-noise tasks and determining appropriate hearing protection devices.

4.4 Foot Protection

4.4.1 Participants

When engaged in *FIRST* activities, *FIRST* participants must wear shoes that completely cover the entire foot. Shoes must be substantial and have closed toes and heels to protect against foot injuries, regardless of work location. Flip-flops, sandals, mules, Crocs, lightweight slippers, etc. are not acceptable when working on or near the robot.

In some cases, safety shoes or toe guards are appropriate for areas where heavy objects can fall on your feet. Notify your mentor if you encounter such situations and determine the safest way to perform the task.

4.4.2 Spectators

Spectators attending *FIRST* competitions should follow the same footwear rules as participants in designated areas as specified by event guidelines. Spectators who do not meet the footwear requirement for participants as described above are not allowed inside individual team pits or in any locations where robots are being worked on.

Please note that loose sandals (like flip-flops) or bare feet are not permitted in the pits under any circumstances.

4.5 Other Preventatives

Ensure that team members or mentors have removed or secured all loose articles when near or working on moving or rotating machinery to avoid the potential risk of drawing such articles into rotating parts.

5 Safe Robot Lifting, Handling and Transportation

Take a few moments to ensure that your team knows how to lift your robot properly and safely. Practice the procedures prior to beginning the season so everyone has the same method and goals at the events.

5.1 General

It is generally best practice to disable or power off the robot during transport, including when moving to and from your pit, waiting in queue, and moving the robot on and off the field. Robots which are powered on, but not enabled, require minimal additional precautions to move the robot.

Robots are permitted to be powered on while in queue. Robots which are powered on, but not enabled, such as to deploy code, require minimal additional precautions. Teams enabling their robot, such as to charge pneumatics or test system functions, should ensure that they are maintaining safe space for any mechanism on the robot to move unexpectedly to its full extent.

5.2 Robot Carts

In the *FIRST* Robotics Competition, to protect team members from muscle strains and other injuries as they transport the robot between the pits and the competition area, we strongly recommend that team members use a cart.

In the *FIRST* Tech Challenge, teams are encouraged to think about how their drive team will safely transport their robot when designing it but should be aware that carts are not always allowed in all areas of all venues.

Please keep the following in mind:

- Carts must remain in the team pit area when not in use for robot transportation.
- All carts should fit through a standard 30-inch door.
- Wheels on the cart must not damage site flooring.
- Do not add music or other sound-generating devices to the cart.
- Put your team number on your cart so it can be identified by field personnel.
- Some venues have specific rules regarding where carts can/cannot be used. Always pay attention to specific event rules.

NOTE: Carts must be safe. They must be easy to control and maneuver and pose no risk to bystanders. *FIRST* Robotics Competition team carts identified as unsafe by the FTA must be made safe before they can be used.

Always follow recommended practices for lifting, handling, and transporting robots. By practicing these safety techniques, your team members will also develop a quick, fluid routine.

5.3 Pre-Lift and Lifting Safety

While proper safety while lifting is important for all FIRST participants, the recommendations below primarily apply to the *FIRST* Robotics Competition and may not be applicable to *FIRST* Tech Challenge teams.

5.3.1 Pre-Lift

- Ensure that all transporters wear appropriate PPE.
- Make sure the robot is safe to move:

    - Are all parts of the robot secured? (e.g., the arm won't fall and hit someone)
    - Is anyone still working on the robot?
    - Are there enough people to perform the lift safely? Two people are preferred.
- Before lifting, hold a brief discussion to determine the direction and path you will be lifting.
- Ensure that the areas and paths are clear of debris and hazards.

5.3.2 During the Lift

- Appoint someone to coordinate the lift to make sure you are all ready to begin.
- Each lifter should place his/her feet close to the robot and adopt a balanced position.
- All persons should lift at the same time using proper body mechanics. These include:
    - Lift with your legs, keeping your back straight.
    - Do not twist your body: use your feet to turn your entire frame if you need to turn.
    - Use proper hand holds to grasp the robot and make sure you have a safe, secure lift point before starting the lift.
    - Bend your knees to a comfortable degree and get a good handhold. Maintain normal spinal curves.
    - Tighten your stomach muscles and commence lifting the robot, using your leg muscles if you are lifting the robot up from the floor.
    - Keep the robot close to your body and coordinate the lift speed with the others.
- Make sure the cart is stable and will not roll. Coordinate correct placement of the robot on the cart.
- For *FIRST* Robotics Competition, use the gate opening to enter the playing field. Climbing over the railing is prohibited.

5.4 Transporting Procedures

- Make sure the robot is stable on the cart before transporting.
- Always keep the cart under control, especially when removing or placing the robot.
- Lead the cart with a team member who can ensure the safety of those in the path of the travel area.
- Use patience and control when moving the robot, especially in crowded areas. Do not run.
- Ensure that the cart will not roll away or pose a hazard, especially upon robot removal. Use a chock block or lock the wheels.
- For *FIRST* Robotics Competition, use the gate opening when entering/exiting the playing field.

5.5 Post-Match Procedures

- Relieve all stored energy and open the main circuit breaker/power switch on the robot. There are many forms of stored energy that can be hazardous, including electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other sources in machines and equipment.
- Ensure that the robot is made safe prior to lifting it off the playing field, no dangling parts, etc.
- Remove debris from the playing field.
- Use the above "Pre-Lift" and "During the Lift" procedures.
- For *FIRST* Robotics Competition, use the gate opening to exit the playing field.

6 Safety in Your Workspaces

We recommend that teams implement a safety program to deliver on ensuring a culture of safety for the team throughout the season covering all aspects of the program. You will find a Safety Checklist in Appendix A, which can serve as minimum guidelines.

We recommend that teams implement a checklist of their own to monitor their unique work facility safety considerations.

- Are stacked items at least 18 inches below sprinkler heads?
- No other overhead materials or structures blocking sprinkler heads
- Are stacks stable and secure against sliding and collapse?
- Are heavy or bulky items stored below shoulder level?
- Are floors free of slipping and tripping hazards?
- Are all light fixtures functional?
- Is the illumination level sufficient for the detail of work performed?

Review your workspace, take notes, and make improvements to the safety of the environment and those working there. Mentors and students should constantly monitor team safety and the conditions at the work facility, so the area is secure from injury, danger, risk, or liability.

6.1 General Safety Practices

The following are some general safety practices your team should keep in mind. This list is not exhaustive.

- Follow safe work practices, including safe use of all tools and personal protective equipment (safety glasses, shoes, gloves, hearing protection, etc.).
- Maintain a healthy attitude regarding safety.
- Always walk and work in a controlled and thoughtful manner. Always keep full control of the robot.
- Be especially careful around high-speed rotating components, both on and off the robot. If you are putting a high-speed rotating component on the robot, make sure the component is designed to be used the way you intend to use it.
- Take special care when working above normal height or at ground level.
- Always fully open a ladder and never stand on a non-approved step.
    - Inspect all ladders before use for broken rungs, missing feet, and safety labels.
    - Do not use a ladder that fails an inspection, report it to team leadership and be sure to remove it from service.
- Be careful using tools that generate heat, such as heat guns and soldering irons. Be aware of objects that may be in the vicinity of the heat source and may catch fire. Also, be aware that these tools often retain heat after being shut off and should be set down only on appropriate surfaces.
- Do not use gloves when using shop equipment such as band saws and drill presses because gloves can be accidentally drawn into the rotating machinery of the equipment. Secure all loose articles of clothing, jewelry, hair, etc. when using shop equipment. Ensure that shop equipment users have both the knowledge and experience to operate shop equipment safely.
- Participants must be behind shielding or in a marked-off safety area when robots are actively operating to prevent accidental collision or contact with an active robot.

7 Safety at *FIRST* Events

7.1 Safety Considerations

At events, the anticipation and excitement can sometimes overshadow common sense and safety fundamentals. One safety area that teams sometimes overlook is the need to wear appropriate clothing when working on or being around robots. In addition to the ANSI-approved, UL Listed, CE EN166-rated, AS/NZS-certified or CSA-rated safety glasses required for eye protection, *FIRST* highly recommends team members and mentors:

- Refrain from wearing dangling jewelry or loose, baggy clothing near the robots.
- Secure any loose items when working on the robot or machinery so that it will not get caught in the robot or other machinery.
- Take appropriate measures to protect hands and fingers when handling the robot; finger injuries are one of the most common injuries at events.

The following safety considerations apply at all *FIRST* events:

- To gain entrance to the pit, every person will have to wear a pair of safety glasses or safety-rated prescription glasses with side shields.
    - Do not leave all safety glasses or side shields in the pit. Be sure to bring a few pairs with you so someone from your team can enter the pit and get the safety glasses for all the other members.
    - Teams can enter the pits without safety glasses for the first 10 minutes of a team's load-in and the first 10 minutes of pits opening each day, UNTIL they start working on the robot or setting up their pit.
- Always use safe lifting, handling, and transportation techniques around robots.
- Do not use skateboards, hoverboards, or drones at events.
- Do not bring bottled gas tanks (e.g., helium) to events.
- Do not throw objects (such as paper airplanes) from the stands/bleachers.

7.2 Competition Safety

- Use the "Buddy System" or 2-Person Rule when traveling and while at the event.
- Note that event volunteers and key personnel often have nametags. Make sure your team understands who to talk to in the event of an emergency.
- Stay aware of your surroundings.
- Always demonstrate safe behaviors, even in the heat of competition.
- Establish a planned, safe lifting procedure for the robot, including cart removal after the lift.
- Make sure the robot is properly secured if you must work underneath it. Never work on the robot on an unstable surface.

7.3 Pit Station

7.3.1 Setting Up the Team Pit Station

- Bring and use work gloves for uncrating and re-crating if a crate is in use.
- Design and set up your pit station safely and use proper tools to construct any components (displays, shelves, banners, etc.).
- Use ladders; do not climb on items not meant for the task, such as tables and chairs.
- Observe the height limit for all portions of your pit station, including banners as defined in the Competition Manual.

- Small, bench-top band saws and drill presses, with appropriate guards, are allowed in the team pit station (this varies for *FIRST* Tech Challenge, depending on the venue and event).

7.3.2 Pit Station Safety

- Children 12 and under must always have a person 18 or older with them.
- Control access to your pit station.
- Keep the work area neat and orderly.
- Properly use power strips. Do not “daisy chain” (plugging power strips into one another) or overload the rated capacity of the power strip.
- Keep the aisle immediately outside your pit station clear for pedestrians and robot transit.
- Participants and spectators should be wearing approved personal protective equipment in the pit at all times.
- Teams may not build any structure to support people or items for storage over the top of the work area in their team pit station.
- Team structures, signs, banners, or displays cannot be higher than the maximum limit defined in the Competition Manual.
- Securely mount all structures, such as toolboxes, team pit station signs, and displays.
- Be aware of your neighbors. Alert them if there is a hazard in your pit or near theirs. Maintain a clean, neat, and orderly pit station at all times. Before your team leaves, be sure to do the following:
    - Clean the floor in and around your pit station.
    - Properly store all tools.
    - Properly take care of batteries and battery chargers.
    - Tidily store personal belongings and equipment.

7.4 Using the Practice Field

If your event has a Practice/Test area, be sure to maintain enough open space between humans and robots. This space will help ensure that robots and moving parts will not contact people within the practice area. It will also help prevent accidents involving those people viewing the sessions or traveling nearby who may not be aware of the movement of the robots.

Be sure to wear proper personal protective equipment (PPE) and use safe lifting practices. Make sure the practice area is clear of debris and be gracious by picking up any foreign materials. If the event has designated volunteers for the areas, they are there to help maintain a safe area. Please cooperate with them.

8 Appendix A: Safety Checklist

Teams should review the condition of the inspected area per the criteria in the checklist below. Assess each item and answer the question by placing a check mark in the appropriate column. For any questions answered "no" below, complete a Corrective Action Plan (see next page).

Key: Y = Yes N = No NA = Not applicable

ITEM	Y	N	NA	LOCATION/NOTES
HAND AND PORTABLE TOOLS				
Are powered tools in good condition, with no evidence of damage?				
Are tools properly stored when not in use?				
Are guards and safety devices in place and operational?				
CHEMICALS				
Are chemical containers properly labeled and in good condition, with no sign of damage?				
Are Safety Data Sheets posted/readily available and team members aware of them?				
ELECTRICAL				
Are cords and plugs free of broken insulation and exposed wiring, and provided with grounded connections, or double insulated?				
Are electrical outlets overloaded (more than one power strip per outlet)?				
Is the battery charger situated so there is air circulating around it?				
Are the batteries in visibly good condition, terminals not bent, and no cracks in the case?				
TEAM PIT				
Is team equipment within the designated space? Is the aisle clear?				
Is the area free of slipping and tripping hazards?				
Is storage of materials orderly?				

ITEM	Y	N	NA	LOCATION/NOTES
Does the area conform to the 10-foot height restriction? This includes banners, signs, and all construction.				
Are the work surfaces neat and uncluttered?				
APPROVED PERSONAL PROTECTIVE EQUIPMENT (PPE)				
Is PPE available for *FIRST* participants and their visitors?				
Is PPE worn by team members where required/posted?				
Is PPE properly maintained and stored?				
RESPECT FOR STORED ENERGY DANGERS				
After competing, does the team relieve electrical and miscellaneous energy before moving the robot off the field?				
In the pit, does the team ensure that no one is working on the robot while it is energized?				

9 Appendix B: Corrective and Preventative Action Plan

Use this Preventative and Corrective Action Plan to monitor changes your mentor, or the event Safety Manager (*FIRST* Robotics Competition Only) recommends.

ID	DESCRIPTION AND ACTION	INITIATED	CLOSED	RESPONSIBLE
0.1	(Example) Unsafe placement of shelf in pit Shelf placed while standing on stacked crates to be able to reach mount area. Action: Team implemented procedure to use small ladder when assembling and dismantling pit.	01/15/20xx	03/01/20xx	Joan Builder

Comments:

10 Appendix C: Safety Data Sheets

Each team is responsible for collecting and storing Safety Data Sheets (SDSs) for any chemicals, chemical compounds or chemical mixtures used by the team. SDS information may include instructions for safe use and potential hazards associated with a particular material or product. You can obtain SDSs from the manufacturer's website or by calling the manufacturer directly.

Please note the following links to sample SDSs.

- Battery Non-Spillable 49 CFR 173.159a (SDS)
- Scotch-Weld Plastic and Rubber Instant Adhesive (Gel) (Clear) (SDS)

Examples of other common materials:

- Loctite (Various)
- WD 40 (SDS)

11 Appendix D: Additional Components for *FIRST* Robotics Competition

The following section contains information that is applicable to only *FIRST* Robotics Competition teams.

11.1 Key Objectives of the Safety Program

The key objectives of the Safety Program are to:

- Help ensure that participants, volunteers, and spectators have injury-free competitions.
- Motivate participants to learn and follow safe individual and group practices using a positive coaching approach as a life skill.
- Empower all participants to be proactive participants in creating a safe environment for *FIRST* Robotics Competition participation.
- Publicly recognize teams and individuals for safe practices.
- Coordinate, deliver, and track safety training for the individual team members as well as team-wide safety procedures.
    - It is suggested that teams bring their training log and procedures to events and continue to make comments about infractions and/or areas of continuing improvement.

To be eligible for any *FIRST* Robotics Competition award, teams will now be required to show how they espouse *FIRST* Core Values and a culture of safety in addition to demonstrating *Gracious Professionalism*®.

11.2 Student Safety Captains

FIRST Robotics Competition encourages teams to designate a student safety captain for events. Teams are encouraged to identify safety captains as part of their team organization so they can help promote safety where you meet, build, and work.

- Work with a mentor to learn about common safety risks which might occur when building or competing with *FIRST* Robotics Competition robots and how to mitigate those risks.
- Help identify and escalate safety concerns to ensure that participants, volunteers, and spectators have injury-free competitions.
- Work with their team to develop and document a team safety program that outlines your team's safety culture with consideration for the elements in this manual.
- Find ways to promote the importance of working safely every day as part of your team culture and processes.
- Provide support for any safety questions or concerns that may arise. Seek guidance from mentors as appropriate.
- Conduct safety inspections of the general work site, especially the robot construction area. This also applies to the pit station during competition events (see the Safety Checklist and Corrective and Preventative Action Plan Appendices for examples).
- Know where to find and become familiar with Safety Data Sheets (SDSs) and related emergency procedures.
- At *FIRST* events:
    - Lead the *FIRST* culture of safety as an event safety ambassador by maintaining Safety at *FIRST* Events for your team, volunteers, and spectators. Advise those around you of safe practices in line with these procedures and escalate to your

mentor if you require support. The Safety Manager(s) will also be available for escalation as appropriate.
    - Ensure compliance with safety practices and event requirements during load-in and tear-down.
    - Have a safety plan for each event so in the event of an emergency, all team members know the procedures to follow to ensure everyone's safety. This includes identifying a meeting spot to gather as well as a list of participants so you can confirm everyone is safe.

11.3 Safety All Star

Creating a culture of safety is exemplified by the work and dedication of Safety Captains. Throughout the competition, teams are encouraged to spend time talking to other teams' Safety Captains to learn what they are doing to create and build a culture of safety. To recognize those individuals who go above and beyond to drive a culture of safety, each team will be provided with *Safety All Star Cards.* The *Safety All Star Cards* are used to vote for the safety captain they believe exemplifies leadership, possesses extensive safety knowledge, and demonstrates excellence.

This information will be used to assess candidates for safety recognition and awards. Safety Managers, with input from *FIRST* Robotics Competition participants, will select the Safety All Star on the primary competition day(s) at each event. Each day's Safety All Star will be presented with a small token of appreciation.

Safety All Star Cards will be provided to teams on non-playoff round days of each event. The cards should be completed and submitted to pit administration prior to the end of the day they are received.

11.4 Event Safety Reminders

The following information will be reviewed at the first safety captain's meeting at each event, but all team members should be aware of these event safety reminders:

- Be Safe, Be Kind, Be Gracious. Instilling a culture of safety throughout the season, including at *FIRST* events, is a fundamental goal of *FIRST*.
- The Safety Managers are here to help promote safety with you during these events and in the heat of competition. We would love to hear about your team's approach to safety!
- Please pick up a Safety Captain's Button from Pit Admin if you would like one.
- Serve as a safety ambassador for *FIRST* at the event and be a proponent for the *FIRST* culture of safety. Escalation of safety matters should be made through your mentor or, as appropriate, with the Safety Manager(s).
- **Pits** include your individual pit and all adjacent aisles. The pit area begins when you enter the designated area, usually near the pit administration desk or safety glasses station.
    - Safety glasses are required at all times in the pit area and on the competition field. *FIRST* needs your help to enforce this rule. Please ask your team members and spectators to wear their safety glasses. Wear ANSI-approved, UL Listed, CE EN166-rated, AS/NZS-certified, or CSA-rated safety glasses.
        - If you wear non-safety rated prescription glasses, you must wear approved safety goggles over them to achieve adequate protection. If you wear safety rated glasses, you may use ANSI-approved, UL Solutions-Listed, CE EN166 rated, AS/NZS certified, or CSA rated side shields.

        - Reflective safety glasses lenses are not allowed (your eyes must be clearly visible to others); however, tinted safety glasses are allowed for general use without need for permission or accommodation.
    - Wear shoes that completely cover the entire foot. Shoes must be substantial and have closed toes and heels to protect against foot injuries, regardless of work location. Flip-flops, sandals, mules, Crocs, lightweight slippers, etc. are not acceptable.
    - A 10-foot height limit for equipment and displays in the pits will be enforced.
    - Children 12 and under must always have a person 18 or older with them.
- Practice safe robot transportation principles.
- Open flames are not allowed in the arena venue, except by authorized personnel and in approved locations (such as the machine shop).
- Report all injuries and illnesses to the EMT stationed near the pit administration desk.
- Teams should remember to review the Event Rules, found in Section 13 of the *FIRST* Robotics Competition Game Manual, prior to the event.
- Safety All Star input cards are to be filled out by each team and turned in each day to pit administration. Safety Managers, with input from *FIRST* Robotics Competition participants, will select the Safety All Star on the primary competition day(s) at each event.

11.5 Safety Managers

FIRST Robotics Competition Safety Managers are volunteers who work with teams to ensure that they understand, comply with, and practice the fundamentals of safety to ensure the safety of all *FIRST* event participants. Throughout the event, teams' safety practices will be observed in the pit, practice field, queue line, and playing field. This includes observing the transport of robots between the pit and playing fields. The culture of safety demonstrated by individual teams at the event will be assessed.

- The program uses:
    - Coaching, positive reinforcement, and public recognition to meet its objectives.
    - Positive verbal feedback for safe behavior and conditions.
    - Identification of unsafe behavior and coaching to correct unsafe behavior.
- Teams should not hesitate to talk with the Safety Manager(s) and ask questions.