

LiveWire Robotics

Safety Manual



FIRST Robotics
August 2013



SAFETY AND THE *FIRST* ROBOTICS COMPETITION (FRC)



Instilling a culture of safety is a value that every individual in the *FIRST* community must embrace as we pursue *FIRST*'s mission and vision. *FIRST* Robotics Competition (FRC) has adopted safety as a core value and has established the framework for safety leadership in all aspects of the program.

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

PURPOSE

This safety manual is an easy-to-use guide adapted from the *FIRST* Robotics Competition (FRC) Team Safety Manual for important safety information and provides LiveWire participants with a basic set of requirements to maintain a safe environment during the build season & competition events.

SCOPE

This manual applies to anyone involved with the *FIRST* Robotics Competition including all student team members, mentors, and support personnel.

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 be safe.

PARTICIPANTS

As an FRC participant, the 4-H LiveWire team is expected to:

- Be familiar with this manual as well as the safety-related requirements applicable to your work area.
- Be familiar with any site restrictions listed in the "Site Info" listed on the web regarding competition site location(s).
- Work in a safe and responsible manner.
- Understand and follow established safety requirements.
- Use personal protective equipment (PPE), safe guards, and other safety equipment when needed or as required.
- Identify and report any unsafe or hazardous conditions to the student safety captain.
- This includes work practices that may cause an accident. Encourage safe behaviors in everyone around you.



MENTORS

- Lead by example. Practice the same safety behaviors that we expect from the teams.
- Provide guidance and encouragement on a safe working environment.
- Provide leadership and guidance for proper tool usage and safety as outlined below in the hand tool section.
- Offer safety design considerations to the team so the robot itself is designed to eliminate or minimize hazards to an acceptable level.
- Familiarize yourself with relevant event safety and restrictions by reading the web-posted “At the Events” section of the FRC Administrative Manual and “Site Info” for your event(s). Go over it with the team and work with the safety captain to monitor safety behaviors.
- Coach the student safety captain to ensure that he/she understands and adequately fulfills the position’s responsibilities.
- Material Safety Data Sheets (MSDS): Collect and store one for any chemicals, paint, and batteries, etc. the team uses. You can usually obtain these sheets from the manufacturer’s web site or by calling the manufacturer directly.
- Become familiar with them and the related emergency procedures.
- Inform the safety captain of the MSDS storage location.



STUDENT SAFETY CAPTAINS

- Coordinate, deliver, and track safety training for the individual team members. Bring your training log to events and continue to make comments about infractions and/or continuing improvements.
- Ensure safe practices are in use at the event and that each pit area remains safe. For an example of a safety checklist see Appendix A.
- Provide support for any safety questions or concerns that may arise. Seek guidance, as appropriate, from your team mentors.
- Conduct safety inspections of the general work site, especially the robot construction area. This also applies to the Pit Station during competition events. (See Appendix A and B)
- Encourage your team to display positive safety behaviors at all times.
- Know where to find, and become familiar with the Material Safety Data Sheets (MSDS) and related emergency procedures. (See Appendix C)

INJURY REPORTING REQUIREMENT

Regardless of severity, report all accidents, injuries, and near misses to your team’s mentor and your team’s safety captain. Even injuries that you determine as minor may become serious if proper medical attention is not provided in a timely manner. Remember, each minor event can be a precursor to a major event.

When at *FIRST* events, report any injuries to the Pit Administration supervisor. He or she will document the injury or illness on an Incident Report sheet.

SAFETY INSPECTION

The safety captain should inspect the work areas on a routine basis. Determine and document the frequency of inspections by the potential risk in the work. Refer to Appendix A and B of this Manual for a sample checklist and a corrective actions page (These are guidelines and may be expanded upon). Where applicable, develop and close out corrective actions for identified deficiencies in a timely manner.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

The proper use of personal protective equipment (PPE) is an important element to help ensure FRC Participants are protected from hazards in the work area. The following describes the common PPE that you are required to wear as part of constructing a robot.



EYE AND FACE PROTECTION

There are several forms of eye/face protection available to provide protection from these hazards, including safety glasses with side shields, goggles, and face shields. Inspect equipment for damage each time it is worn. If you wear prescription glasses, and they are not approved safety glasses, you must wear approved safety goggles over them to achieve adequate protection.

Eye and face protection is required when there is a risk of exposure to the following:

- Flying particles
- Chemical exposure (such as splashes, splatters, and sprays)

Wear non-shaded, ANSI-approved eye protection in the following areas:

- When doing any work on the robot including, grinding, drilling, soldering, cutting, welding, etc.

At *FIRST* events:

- Anywhere in the pit area, including walk ways and pit stations
- On the playing field
- On the practice field
- Any area posted with signs requiring the use of eye protection

HAND PROTECTION

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

Gloves

- FRC participants should work with the team mentor to ensure the selected glove is the correct one to use for each project. For example, chemical-resistant gloves afford some measure of chemical protection. Wear them when handling chemicals. Check your gloves for proper size, absence of cracks and holes, and good flexibility and grip before you wear them.

Mechanical Guards

- Provide safety guards for power tools where required.
- Never use any equipment without safety guards in place.
- Notify your Safety captain and mentor of any broken or defective equipment, and take it out of service until repairs are made.

HEARING PROTECTION

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

FOOT PROTECTION



When engaged in *FIRST* activities, all FRC participants must wear shoes that completely cover the entire foot. Shoes must have closed-toes and heels to protect against foot injuries, regardless of work location. Flip-Flops, Sandals, Mules, Crocs, etc. *are not acceptable* when working on or near the robot or while attending *FIRST* competitions.

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

OTHER PREVENTIVES

Ensure that team members or mentors are not wearing ties, loose clothing, jewelry, or hanging key chains when near or working on moving or rotating machinery. Tie hair back or cover it.

SAFETY REQUIREMENTS

The following are some areas, practices, and functions for which teams will be inspected and monitored for safety conformity and innovation. This list is not all-inclusive, and the Safety Advisors and your peers will observe and report any positive and negative safety practices. Horseplay is not permitted at any time.

GENERAL SAFETY

- Follow safe work practices, safe use of all tools, and maintain a healthy attitude regarding safety.
- Always walk and work in a controlled and thoughtful manner.
- Wear ANSI-approved non-shaded safety glasses. Rose, Blue, Amber tints are *FIRST* approved, but reflective lenses are not (eyes must be clearly visible by others).
- Wear closed-toe and closed heel shoes, gloves where needed, and use hearing protection if necessary.
- Keep full control of robot at all times with no one in the robot's path at any time.
- Assist other teams with safety issues. Display Gracious Professionalism and care enough to act with good, safe behavior at all times.
- Take special care when working at higher-than-normal height.
- Always fully open a ladder and never stand on a non-approved step.

COMPETITION SAFETY

- Use the buddy system when traveling and while at the event.
- Travel safely and carefully between the Pit and the playing field.
- Demonstrate safe behaviors in the heat of competition.
- Exhibit a planned, safe lifting procedure of the robot, including cart removal after the lift.
- Make sure the robot is properly secured if you must work underneath it or if the robot is on an unstable surface.

- Assist and mentor other teams with safety issues.

PIT AGE REQUIREMENT

Children twelve (12) and under must have a person eighteen (18) or older with them at all times. There will be child safety glasses available.

- Child strollers and baby carriages are not allowed within the individual pit station.

PIT STATION SAFETY

- Control access to your Pit area; visitors are required to comply with PPE rules.
- Keep your aisle clear for pedestrians and robot transit.
- When transporting your robot, politely keep pedestrians alert to your movement.
- Adhere to the specifics in the FRC Administrative Manual, “At the Events” section.
- Teams cannot build any structure to support people or items for storage above the work area in their team pit station.
- **NO** Team Station structures, signs, banners, or displays can be higher than 10 feet above the floor.
- Securely mount team pit station signs, banners, and displays to the structure.
- Be aware of your neighbors. Alert them if there is a hazard in your station or near theirs.
- Maintain a clean, neat, and orderly Pit Station at all times. Remember, there are inspections after teams leave so be sure to include:
 - The floor in and around your Pit Station
 - Proper tool storage
 - Proper care of batteries and battery chargers
 - Tidy storage of personal belongings and equipment

SOLDERING

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



- Use lead-free solder only and solder with electrically heated soldering iron/gun only.
- No torches or open flames of any kind are allowed in the buildings.
- Wear eye and face protection.
- Solder in well-ventilated areas.
- Never touch the iron/gun. It heats to extreme temperatures that will cause severe burns.
- Prevent burns: Wear cotton clothing that covers your arms and legs.
- 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 actually being used.
- Do not leave any hot tools, where someone can accidentally contact the hot element.

HAND TOOLS

Constructing a robot will sometimes 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 handheld tool or implement used to accomplish a task. This includes all sorts of things used to grasp, lift, push, pull, carry, or clean.

Always use the proper tool for the job.

Example: **DO NOT** use a wrench for a hammer or a screwdriver as a chisel.

TOOL RULES

- Before using any tool, check to see if it is in good condition. Don't use defective, dull, or broken tools. Don't put them back on the shelf; remove them from service and notify the Safety Captain and mentor so they can be replaced or sent for repair.
- When using a screwdriver or other tools, place the work on the bench or hard surface rather than in the palm of your hand.
- When using knives/blades, direct your cutting strokes away from your hand and body, and be aware of those around you.

TOOL STORAGE

- Store sharp-edged or pointed tools in a safe place. When carrying, cover the point or edges with shields. **NEVER** carry unshielded tools in your pocket.
- Don't 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.



STORED ENERGY

Plan out the required activities when servicing or making repairs to the robot. Make sure all teammates are aware that work is being done on the robot. Address the following:

Ensure no one is working on the robot when it will be energized during repairs.

Electrical Energy

- Disconnect the electric power source.
- Always de-energize the robot before working on it by unplugging batteries.
- Open the main circuit breaker ("reset" lever is released).

Pneumatic Energy

- 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.

Miscellaneous Energy Sources

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

BATTERY SAFETY



CAUTION: Batteries contain acid. This substance, H_2SO_4 , is a corrosive, colorless liquid that will burn your eyes, skin, and clothing. The team mentor and safety captain should post the Material Safety Data Sheet for the battery in use (MSDS, See sample in Appendix C) and train all team members about battery safety. You can find Emergency handling and first aid on the MSDS, proper protection for handling cracked or damaged batteries, and information on disposal of the battery.

(http://www.mkbattery.com/images/MSDS_smallsealed_line.pdf)

GENERAL DAMAGED BATTERY INFORMATION/WARNINGS

Any battery that is visibly damaged in any way is dangerous and unusable, and should be set aside and handled accordingly because:

- 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* provided in your Kit contain sulfuric acid that will burn human tissue on contact.
- 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.
- **Don't take a chance. Don't use it!**
- Treat it as a hazardous material and process it in accordance with the battery's MSDS.

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.

PROCEDURE FOR HANDLING A LEAKING BATTERY

When an Electrolyte Leak Occurs

- Neutralize it by pouring the sodium bicarbonate on all wetted surfaces. The bicarbonate of soda itself is not dangerous, and will react with the acid in the electrolyte leaving a safe residue that can be disposed of in a conventional manner such as rinsing with water.
- Put on the gloves before handling the battery.
- Place the battery in the leak-proof container for removal.
- Be sure to neutralize any acid on the gloves before removing and storing them.
- Follow emergency handling instructions of the MSDS, and notify mentor.
- Seek medical attention.
- 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 incident to the Pit Administration Supervisor so he/she can fill out an Incident Report. Provide team number and available information.
- Obtain sodium bicarbonate from the Pit Administration Supervisor and carefully sprinkle the sodium bicarbonate on the spill, then clean, and dispose of the now neutralized cleanup materials in the trash.
- Dispose of the battery properly. Read below.

BATTERY DISPOSAL

The Interstate Batteries Company (<http://www.interstatebatteries.com>) has volunteered to accept and properly dispose of any *FIRST* team's batteries and you can find a location near you from the above web site.

Most retailers of automotive batteries will accept and properly dispose of them at no cost.

CHARGING AND HANDLING

- When a battery is neither connected to the robot nor the battery charger, use the battery protector safety plugs *FIRST* provides in the Kit of Parts.
- Keep the battery charging area clean and orderly.
- Place your battery charger in an area where cooling air can freely circulate around the charger. Battery chargers can fail without proper ventilation.
- Do not short out 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.
- If a quick disconnect is not available and you must use tools to disconnect the battery, make sure metal tools don't contact both terminals at the same time.

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.
- After each competition round, inspect the battery.
- Check your battery prior to competing in each round.

CHEMICAL SAFETY

- Keep chemical containers in good condition.
- Make sure all chemical containers have labels placed by the manufacturer and that they are legible.
- Become familiar with the chemicals you may use as part of the FRC. Read safety precautions and instructions for use located on the chemical's label.
- Store all chemicals in an orderly way. Obtain Material Safety Data Sheets (MSDS) for the chemicals your team uses. These sheets provide information on the correct handling of a spill or injury.
- If you are exposed to a chemical, notify your safety captain and team mentor immediately and consult the MSDS if necessary.
- Don't use any highly flammable materials, such as cleaning solutions, at *FIRST* events

RESPECT OF ELECTRICITY

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

- Inspect your equipment cords and extension cords routinely to ensure they are in good condition.
- DO NOT overload electrical fixtures and/or receptacles.
- Avoid the following electrical power supply setups to prevent overloading.
- Power strip plugged into another power strip.
- 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.

AT THE EVENTS

Follow the following safety considerations when constructing the Pit station at the FRC Event(s):

- **Registration** An adult will register your team and may be asked to sign a safety statement.
- Safety glasses are required *everywhere* in the Pit.
- To gain entrance to the Pit, every person will have to wear a pair of safety glasses.
- Don't ship all glasses and goggles in the crate or you won't be able to enter the Pit.
- Use safe lifting techniques
- **Age Requirement** Children twelve (12) and under must have a person eighteen (18) or older with them at all times. There will be child-sized safety glasses.

SETTING UP THE TEAM PIT STATION

- Bring and use work gloves for uncrating and re-crating.
- Design and set up your Pit Station safely and properly use ladders - don't climb on items not meant for the task such as tables and chairs.
- Observe the ten-foot height limit for all portions of your pit station.
- Small, bench-top band saws and drill presses, with appropriate guards, are allowed in team pit stations.
- Use proper tools to safely hang banners. Banners must also adhere to the ten-foot height limit.



WORKING IN THE PIT

- Properly use power strips; don't daisy chain, for example.
- Keep the work area neat and orderly.
- Participants should be wearing personal protective equipment, PPE, in the Pit at all times, including:
 - ANSI-approved, non-shaded safety glasses with approved side shields. Rose, Blue, and
 - Amber tints are *FIRST* approved, but reflective lenses are not. (eyes must be clearly visible by others)
 - Safety goggles over prescription glasses

- Appropriate footwear - no open-toe or open heel shoes or sandals

USING THE PRACTICE AREA/FIELD

If your event has a practice field/area, be sure to obey the rules for maintaining an “exclusion zone” around the area. This zone will help ensure that robots and moving parts will not exceed the practice area. It will help prevent accidents to those persons viewing the sessions or traveling nearby who may not be aware of the movement of the robots.

Of course, be sure to wear safety glasses and use safe lifting practices. Make sure the field is clear of debris, and be gracious by picking up any foreign materials. The designated volunteers are there to help maintain a safe area. Please cooperate with them.

SAFE ROBOT LIFTING, HANDLING, AND TRANSPORTING

Take a few moments to ensure 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.

PRE-LIFT

- Ensure all transporters are wearing PPE.
- Make sure the robot is safe to move:
- Are all parts of the robot secured?
- Is the robot powered off?
- Is anyone still working on the robot?
- Have a pre-lift briefing to determine direction and path.
- Ensure that the areas and paths are clear of debris and hazards.
- Are there enough people to perform the lift safely? Two to four people are preferred.

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 the legs, keeping your back straight
- Do not twist your body. Use your feet 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 lift speed with the others.
- Make sure the cart is stable and will not roll. Coordinate correct placement on the cart.

POST-MATCH

- Relieve all stored energy and open the main circuit breaker on the robot.
- 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.

- Use the gate opening to exit the playing field. Don't climb over the railing.

TRANSPORTING

- Make sure the robot is secured to the cart.
- Keep the cart under control at all times, especially when removing or placing the robot.
- Use Gracious Professionalism around others to prevent damage or injury. Do not include music on your robot transporter.
- Use patience and control when moving the robot, especially in crowded areas. Walk; don't run.
- Ensure that the cart will not roll away or pose a hazard, especially upon robot removal. Use a chock block if necessary.
- Use the gate opening when entering/exiting the playing field. Don't climb over the railing.

SAFETY AWARENESS AND RECOGNITION PROGRAM

KEY OBJECTIVES

The key objectives of the Safety Awareness and Recognition Program are:

- a. Ensure participants, staff and the public have injury-free competitions
- b. Motivate participants to learn and follow safe individual and group practices as a life skill
- c. Select the winning team for the UL Industrial Safety Award

The Safety Advisors and FRC participants will rate safe performance in three key areas:

1. Safe Behaviors
2. Physical Conditions
3. Personal Protective Equipment, PPE Usage

The Program uses coaching and positive reinforcement to meet its objectives. The Safety Advisors with input from FRC participants will select the team that best meets the Program objectives. Please read below for a description of the expected "safe" activities that advisors and FRC participants will assess over the course of a typical Regional competition or the Championship.

SAFETY ADVISORY PROCESS

Prior to the competition, team mentors should coach participants on working together and show the students how to use equipment and construct and operate the robot safely.

Throughout the competition, the easily recognizable, green-shirted Safety Advisors will observe activities in the Pit, practice field, queue line, and playing fields to identify the safety habits of the teams. This includes observing the uncrating of robots and transporting them between the Pit and playing fields. Do not hesitate to talk with the Safety Advisors and ask questions

The Safety Advisors will:

1. Provide positive verbal feedback for safe behaviors and conditions
2. Correct non-safe behaviors and coach or mentor to correct behaviors
3. The Safety Advisors, with input from the FRC participants, will select the three hard hat pin award teams and designate the "Star of the Day" person to a mentor or student.

SAFETY RECOGNITIONS AND AWARDS

The Safety Awareness and Recognition program rewards teams and individuals for their exceptional dedication to safe working methods and considerations by providing the awards below.

Top 3 Safe Teams

Using input from event participants, the Safety Advisors will determine one winner in each of the following hard hat pin categories:

1. Community Outreach
2. Safety Initiatives (at the event)
3. Program Presentations (Safety Program Development)

NOTE: The winner of the UL Industrial Safety Award is not eligible to receive these pins because that team will receive a separate pin during the awards ceremony.

Star of the Day Award

The Safety Advisors, with input from FRC participants, will select the “Star of the Day” on Thursday and Friday. On the following day(s), you will be able to see the winner’s name and team affiliation on a poster near the Pit Administration Station. This will be visible for the duration of that competition. This individual is presented with a small token of appreciation.

This award can go to any student, mentor or volunteer who, in the opinion of the Safety Advisors and FRC participants, has made a noteworthy contribution to promoting a culture of safety and is a person that the rest of the *FIRST* community should emulate.

UL Industrial Safety Award

This award celebrates the team that progresses beyond safety fundamentals by using innovative ways to eliminate or protect against hazards. The winning team consistently demonstrates excellence in industrial safety performance that shines throughout the competition from uncrating to re-pack.

Safety Advisors are volunteers who will observe all the teams and with input from FRC participants, select the one that best meets the criteria for the UL Industrial Safety Award.

SAFETY IN YOUR WORK SPACES

We recommend that teams implement a safety program. You will find an inspection sheet in the Appendix, which will be a guideline at the events. Safety Advisors will be on site to mentor and coach teams on proper safety practices.

We recommend that teams implement a checklist of their own to monitor their unique work facility safety situations. The following are examples of things that may occur in a less than perfect area. Check for items such as:

- Are stacked items at least 18" below 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?
- Are illumination levels sufficient for the detail of work performed?

Review your workspace and notice and make any improvements to the safety of the environment and those working there. The mentors and safety captain should constantly monitor team safety and the conditions at the work facility so the area is secure from liability, injury, danger, or risk. New for 2011: During the early part of the regionals, each safety captain will have an opportunity to informally present their safety program within a five minute timeframe to a designated Safety Advisor. The Safety Advisor Team will use the information presented to evaluate each FRC team and provide coaching and mentoring throughout the competition.

Revised 8-2013

Good Luck and Be Safe!!!