



Surviving Inspection

Presented by

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Agenda

- Purpose and Goals
- Event Flow
- Inspection
- Final Thoughts



Priorities and Goals

- **Robot Inspectors are your friends**
- **Three Priorities**
 - Safety
 - Compliance
 - Fun
- **Goals**
 - **Get all teams on the field for *ALL* matches**
 - Teams must pass inspection to compete
 - Not being on the field hurts your own team and alliance partners
 - Help teams improve their robots

Pre-Inspections

- FIRST allows lead robot inspectors (LRIs) to conduct pre-inspections.
 - Opportunity for teams to discover potential problems and solve them during unbag time.
 - Do not impact inspections during events.
- FIRST Chesapeake will be doing pre-inspection events again on **February 23, 2019**.
 - **Manassas**
 - **Richmond**
 - **Newport News**
 - **Maryland (Location TBD)**
- Additional pre-inspections may occur if depending on team needs (e-mail me).

Pre-Inspections

- LRIs will be available during established times at each location.
- Students are not required for pre-inspections.
- Process:
 - Inspector greets you.
 - Robot is unbagged.
 - Inspector evaluates robot and provides recommendations.
 - Robot is bagged.
- Do not unbag the robot unless authorized.
- No work will be permitted on the robot during inspection.

District Event Flow

- Day 1 (6:00PM-10:00PM)
 - Pits Open: load-in and teams set-up pits
 - Bag & Tag Compliance checks and unbagging of robots
 - **Inspection can begin immediately!**
- Day 2 (Qualification matches start at 11:00AM)
 - Finish any last inspections (goal is to have none!)
 - “Random” inspections throughout the day
 - Re-inspections when asked
- Day 3
 - “Random” inspections and re-inspections
 - Re-inspection for playoff robots



Championship Event Flow

- Wednesday (5:00PM-9:00PM)
 - Pits Open and teams set-up pits
 - Bag & Tag Compliance checks and unbagging of robots
 - **Inspection can begin immediately!**
- Thursday
 - Finish any last inspections (goal is to have none!)
 - Practice matches (10:00AM-12:30PM)
 - Qualification Matches start at 2:00PM
- Friday & Saturday
 - “Random” inspections throughout the day
 - Re-inspections when asked
 - Weigh-in for playoff robots (Saturday)

Key Points

- **Start Inspection Early**

- Locate major problems early
- Easier to get improvements/changes re-inspected
- Once passed, can utilize standby practice line


- **Inspectors**

- *Help and guide* teams through the inspection process
- Want to speak primarily to students


- **Getting Started**

- Send a representative to the inspection station and ask to be inspected.
- Do not just bring your robot to be weighed

Bag-Tag Forms



ROBOT LOCKUP FORM
Please remember to bring this form to your events!



Team Number: _____
Team Name: _____
Home City: _____

Date	Time	Time Zone	Signature	Security Seal Number	Print Last Name, First Name	Cell Phone Number	(L) – Locked (U) – Unlocked	Explanation (reason for locking or unlocking)

1. By signing this form the signatory attests to the fact that they are 18 years of age or older, not a student member of a team, and that all rules and regulations regarding access periods and lock/unlock have been followed.
2. Cell phone numbers are required for verification in case inspectors at events have questions regarding the form.
3. Stop build day is **04:59 UTC on Wednesday, February 21, 2018** which is 11:59 pm Eastern on Tuesday February 20, 2018.
4. Teams attending two-day district events have access to a "Robot Access Period." Please see section 8.4 of the game manual for more detail.
5. To assist teams with their promotional and community relations activities, robots may be unbagged and operated **briefly** after "Stop Build Day" for display purposes only. Please see section 8.4 of the game manual for more detail on robot displays.
6. Teams may use up to three bags to Bag and Tag their robot.

V1.1

- **Take a picture of your lock-up form every time you bag the robot.**
- Inspectors are not required to physically hold or sign the form, only verify that your team followed procedures and that everything is properly documented.

Initial Inspection



Unbagging

- **DO NOT UNBAG YOUR ROBOT UNTIL AUTHORIZED**
 - You will be forced to stop and will likely have to wait several hours
- Make sure your bag-and-tag form is signed and ready as soon as you enter the pit
 - Inspectors will be eager to sign you out
 - Designate a team member as being responsible for the form
 - Take a picture of the form before you leave
 - Do not put the form inside the bag
- If you are found to be noncompliant, the LRI will have to get several signatures and this takes time.
- Repeat offenders will require that I notify FIRST HQ and establish penalties.
 - This can be up to losing an entire day of unbag time.

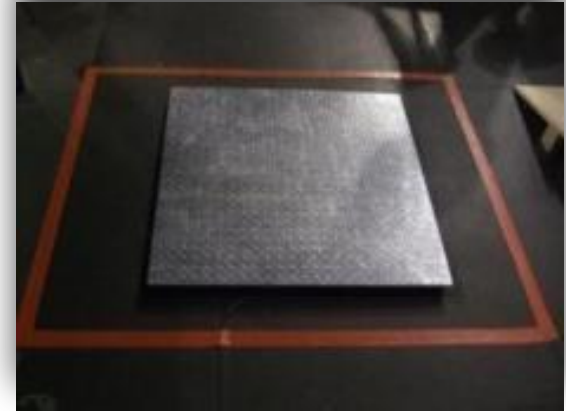
Initial Inspection

- **Weight**

- Robot
 - Remove battery and bumpers
 - Include all robot mechanisms
- Bumpers
 - Weigh each set individually
 - Include all mounting hardware
- Team places items on scale
- **DO NOT STEP ON SCALE**

- **Size**

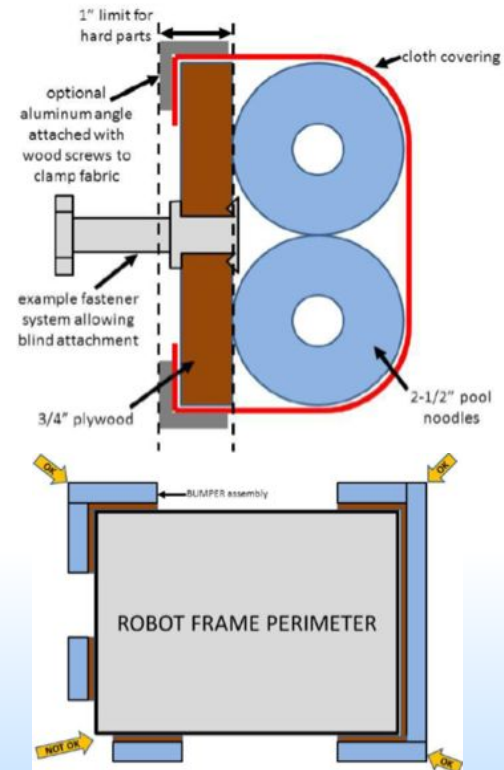
- Remove bumpers
- Inspection method varies over years



- **Continue in Pit**
 - Minimize representatives in pit
 - Prefer 2 key students
 - Ensure all stored energy in lowest energy state
 - Turn off robot
 - Relieve pressures (i.e., air in storage tanks)
 - Release springs / surgical tubing / bungee cords, etc.
 - Team must prove robot is safe

Bumpers

- **Bumpers (Red & Blue)**
 - Construction
 - Proper plywood backing
 - Pool noodles
 - Durable fabric cover
 - Proper display of team number
 - Mounting
 - Securely fastened
 - Ease of removal
 - Pay particular attention to gaps
 - No gaps in corners
 - Minimum corner coverage

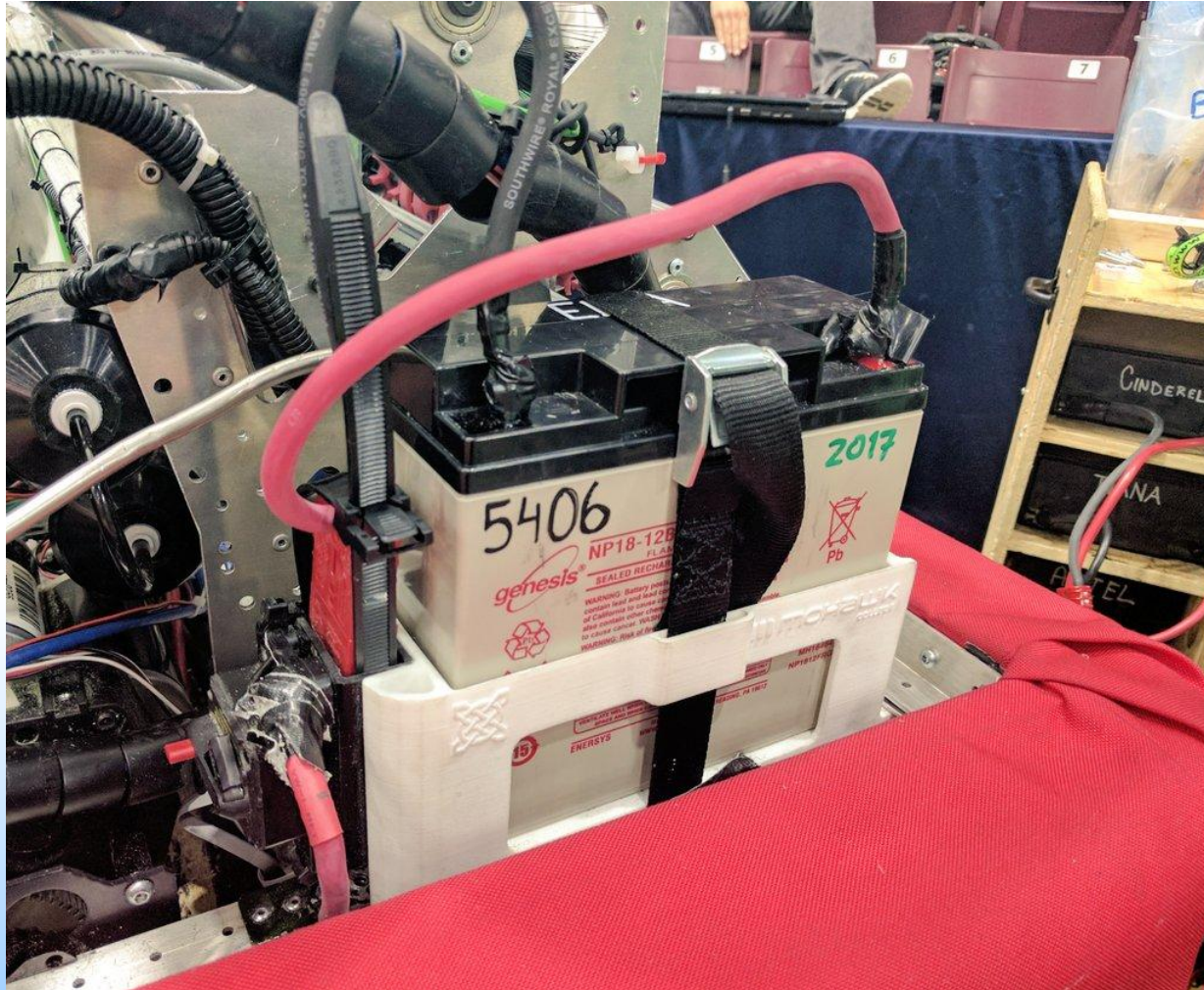


Bumpers

- Bumpers are not an afterthought!
 - They are a mandatory part of the robot
 - Bumpers can easily disqualify a robot if not robustly constructed
- Design and build early in the build period
 - Robust design that can withstand impact
 - Easy and intuitive mounting system
 - Double-check corners for no gaps
- Avoid bumper covers or convertible bumpers



Mechanical Inspection



- **Bill of Materials (BOM)**
 - Please have one ready
 - Total cost of materials \leq limit
 - Total cost of any one component \leq limit
 - KOP components excluded
 - Typically a lower limit for excludable components
 - Cost = Material + Labor
 - Labor from team members and recognized team sponsors are excluded
 - Can be provided in **printed or electronic form**
 - **Put a copy on Google Drive or take a picture**

- **Sharp Edges and Protrusions**
 - Hazard to personnel or field
 - Leading edges of the robot (surface area of at least 1 in²)
 - Edges (minimum radius of 0.030)
 - Points and corners (minimum radius of 1/8-inch)
 - Undersides
 - Improperly cut tie-wraps
 - Areas of concern
 - Robot parts that interact with game pieces
 - Near 120 amp breaker
 - Near battery connections

Mechanical Inspection

- **Safe Energy Storage**

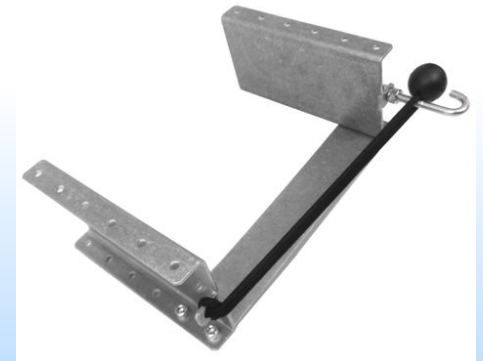
- One approved battery
 - 2018 rules allowed certain USB power packs.
- Springs, surgical tubing, bungee cords, etc.
- Pressurized air in storage tanks
- Stored mechanical energy must be safe to be around
 - Consider who will be working around the devices
 - Teams must prove that their designs are safe

- **Securing Batteries**

- Battery must be secure (turn the robot upside down and shake it)
- 2” cinch strap (left) works well
- Recommend avoiding the use of electrical energy storage that could stay charged after the robot is shut down (supercaps)



2” Cinch Strap (Amazon)



**Battery Tray for AM14U Series
(am-2939)**

Mechanical Inspection

- **Pneumatic Storage**

- Storage tanks must be rigidly secured
 - Please avoid cable ties or tape
 - Cable ties are legal but rarely secure tanks well and can stretch over time
 - Tape is illegal on pneumatic components
 - Avoid using banding that could cut into the storage device
- Preferred method are clamps or brackets
- Consider using something other than a Clippard tank if you require a lot of air



**Bracket for Plastic Air Tank
(am-2008)**



**0.89 Gallon Aluminum Tank
(Lowriderdepot.com)**

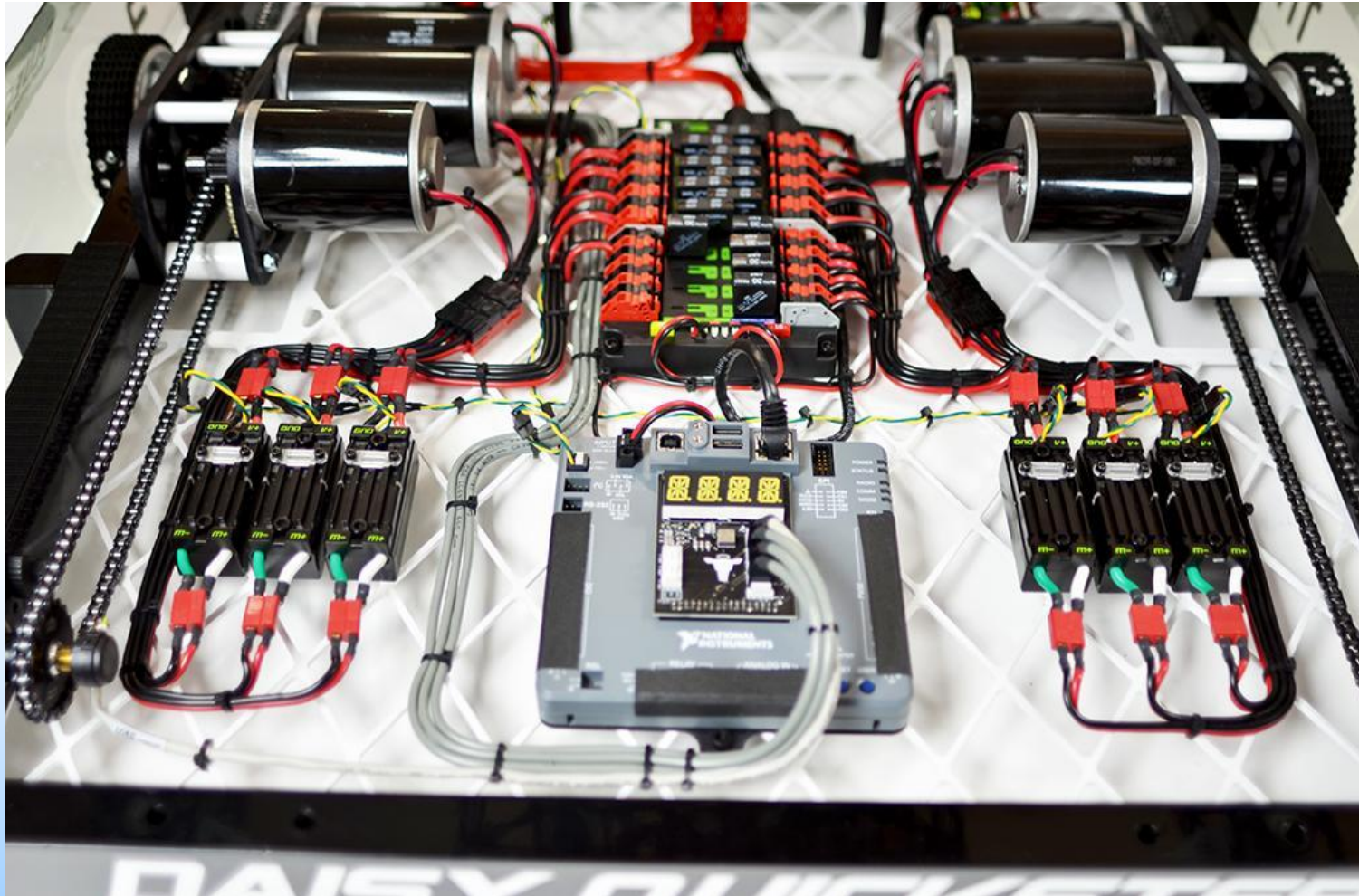
Mechanical Recommendations

- Clip your cable ties as short as you can get them
- Run your hands over every part of the robot and file down accordingly
- Ensure your battery is secure but easy to remove
 - Constrained in every direction
 - Minimal movement
- Properly secure pneumatic storage
 - COTS solutions are preferred
 - Clamping is better than cable ties
 - If the storage tank can move it will undergo scrutiny

Mechanical Recommendations

- If ballast is used, it must be in compliance with the rules
 - No additional batteries
 - Must not pose a threat to personnel, field, or other robots
 - No exposed lead (uncoated dive weights)
 - Avoid containers of loose fasteners or ballast
- Ballast must be secured to the robot
 - Containers of loose material will undergo particular scrutiny

Electrical Inspection



Electrical Inspection

- **Breaker visibility is extremely important**
 - Robots have escaped the field
 - Imagine you're a stranger with seconds to disable a robot
 - Can you find the breaker?
 - Can you disable it?
- **Design for access and provide plenty of signage**
 - Labeling not required but **highly** recommended
 - Ask a total stranger to turn off your robot and see what they do
- **Consider potential for other robots and game pieces to disable breakers**

Electrical Inspection

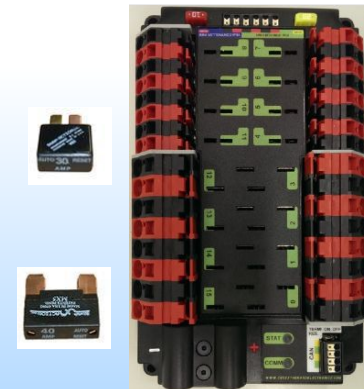
- **Robot Radio**

- Make it a priority to get the radio programmed immediately
- Mount the radio high and away from metal
 - Avoid clamping the radio (cable ties)
 - Use adhesive hook-and-loop tape
- Radios power has been a source of issues
 - Secure connections with tape or adhesive
 - Consider Power Over Ethernet (POE)
 - Can use both POE and plug



- **Power Distribution Panel**

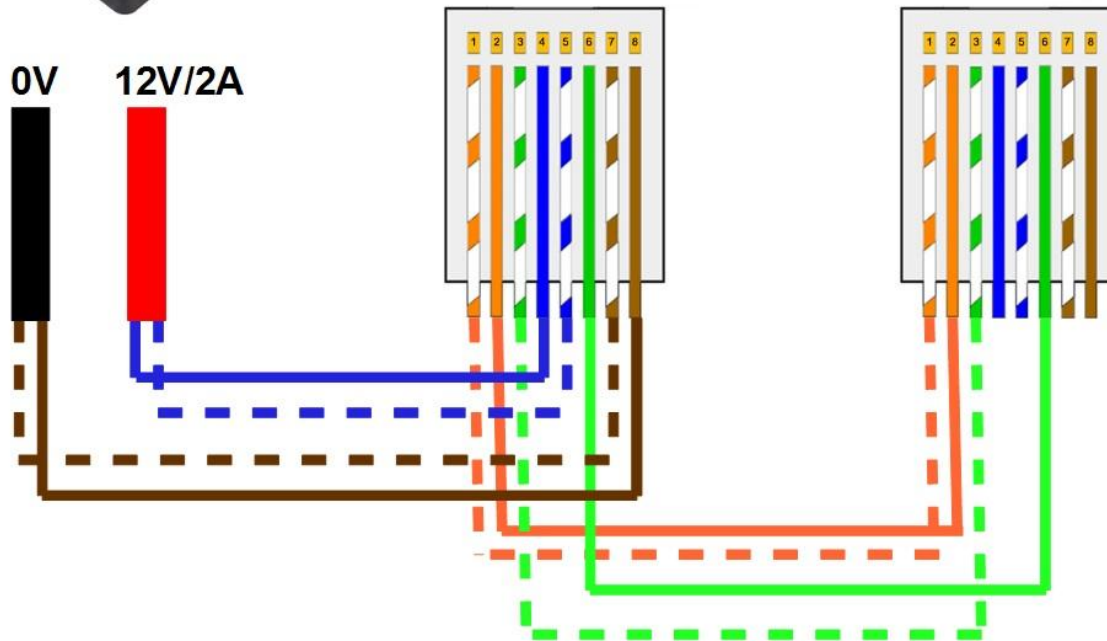
- Must be visible for inspection
- Accessibility is key for good design



Electrical Inspection

Diagram of PoE with respect to R63

(pigtail not shown)



Electrical Inspection

- A CUSTOM CIRCUIT is any electrical COMPONENT of the ROBOT other than motors, pneumatic solenoids, roboRIO, PDP, PCM, VRM, RSL, 120A breaker, motor controllers, relay modules, wireless bridge, or batteries.
 - Any active electrical item that is not an actuator or core Control System item
 - CUSTOM CIRCUITS shall not produce voltages exceeding 24V
 - Can't directly alter power pathways
 - High impedance voltage monitoring or low impedance current monitoring acceptable
 - Can't directly control motor controllers or relays
- Can be connected to the CAN bus
 - CUSTOM CIRCUITS shall not interfere with, alter, or block communications among the roboRIO, PDP, PCM, and motor controllers
- All remote cameras that broadcast a signal (e.g., use WiFi) used have to be pre-approved by FIRST

Electrical Recommendations

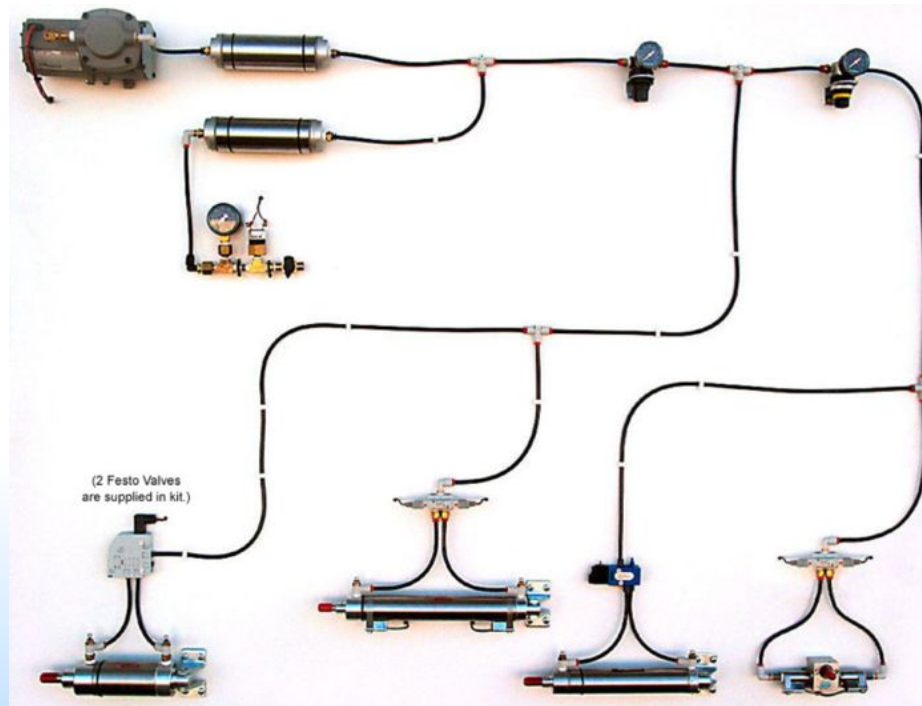
- The best thing you can do is have clean, well-labeled wiring
 - Easy inspections
 - Easy troubleshooting
- Use quality connectors such as Anderson Powerpole
- Consider using larger gauge wire
 - 10 gauge for motors
 - “Easy-ID Low Voltage Cable”
 - 4 gauge for battery
 - “Ultra-Flexible Battery Wire”
- Pull on every connection and verify nothing is loose
- Consider using perforated sheets for electrical mounting
 - “High-Strength PVC Plastic Perforated Sheets”
- Consider investing in a hydraulic crimper



Electrical Recommendations

- Avoid making assumptions when it comes to motors, solenoids, or custom circuits
 - Use the FRC Q&A System
 - Feel free to contact me ahead of time for additional clarification
 - Pre-inspections are great for this
- A good example is “automotive motors”
 - Will require evidence that the motor is actually for automotive use
- Avoid using any kind of clamping action to secure your radio
 - This can cause the radio to have intermittent connectivity due to how the antenna is located inside the casing.
 - One solution that seems to work well is to use sticky-backed hook/loop tape such as 3M Dual Lock.
- Examine the location of your circuit breaker and think about what is the potential risk of a field element (or another robot) accidentally turning your robot off.

Pneumatics Inspection



- **Minimum Components**

- Pressure gauge to show the “stored” air pressure (≤ 120 psi)
- Pressure gauge to show the “working” air pressure (≤ 60 psi)
- A Pressure Relief Valve calibrated to release at 125 psi as close to compressor as possible
 - Prefer a rigid connection to compressor
- A Pressure Switch connected to the Pneumatics Control Module and calibrated (≤ 120 psi)
- A Vent Plug Valve that vents the stored air to atmosphere
 - Should be easily accessible
 - Must vent “high side” of system to atmosphere
- Pressure Relieving Regulator to relieve back-pressure from devices and maintain a 60 psi “working” pressure

Pneumatics Inspection

- **No modifications to components except:**

- Remove mounting pin from cylinder
- Wiring modified to connect to control system
- Do not paint or tape over components

- **Compressor**

- Any type allowed if meet specs
 - Teams need to show documentation
 - KOP compressor is actually undersized
 - 0.88 cfm vs 1.10 cfm limit
- Only one can be used
 - Can be off-board



- Must still be controlled by robot

- Minimal pneumatics must still be on robot

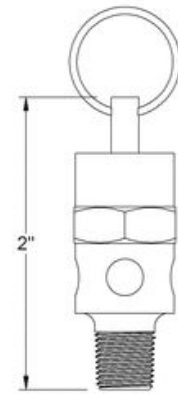
- **Pneumatic Solenoid Valves**

- Non-KOP Solenoid valves are **restricted to 1/8” NPT** port diameters
 - Teams need to provide documentation
- If solenoid valves rated below 125 psi are used, an additional pressure relief valve must be added to the “working” pressure circuit and set to a lower pressure than valve rating
- Only one solenoid per pneumatic actuator
- Controlled by Spike relay or NI 9472 Digital Output module



Pneumatics Recommendation

- **Perform your own pneumatics check**
 - Check the high pressure gauge shows ≤ 120 psi
 - Check the working pressure gauge shows ≤ 60 psi
 - Compressor should stop at 120 psi or less
 - Check operation of pneumatics relief valve
 - Short the leads of the switch
 - Make sure relief valve relieves at no more than 125 psi
 - Static pressure relief valve (right) superior option
- **Treat pneumatics like an electrical system**
 - Cleanly lay out and label your tubing
 - The easier it is to inspect, the easier it is to troubleshoot
 - Simplify as much as possible (the tank on the right is equivalent to 6 Clippard tanks)
- **Ensure your gauges, regulators, dump valve, relief valve, and switch are easily accessible**
- **The AndyMark 1.1CFM compressor can get hot enough to melt tubing.**



**Pressure Relief Valve
(McMaster-Carr 48435K714)**

White Clippard P/N: AVT-PP-41



Not Allowed !!

Follow-On Inspections

- Have inspectors re-certify all changes to the Robot, with the exception of:
 - Adding/removing fasteners or labeling
 - Changes to code
 - Replacement of components and mechanisms with identical units
 - Additions, removals, or reconfigurations of robot with previously inspected subsets of mechanisms
- When in doubt, ask.

Disputes

- Unfortunately there will be disagreements.
- If you disagree with the ruling of an inspector, please contact the LRI (or the RI may do so)
 - RIs are responsible for inspecting robots
 - LRIs are responsible for customer service
- If you disagree with the LRI, you have the right to escalate the dispute to the SRI (me)
 - The LRI will contact me directly
- If you disagree with me, you have the right to request that I contact Al Skierkiewicz, FRC Chief Robot Inspector
 - I will coordinate with Al and get a final ruling
 - This is not likely to be a fast process
- If you disagree with Al, too bad.

Design Recommendations

- Do not assume the field is perfectly engineered
 - Broken ropes in 2016
 - Field elements getting damaged or bent during play
 - It may be the field's fault, but it's still your problem
- A simple robot that works perfectly is better than a complicated robot that can't be trusted
- Design your robot as if everyone is out to destroy you
 - Emphasize ruggedness and survivability
 - Design for reliability and repair



Questions?

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