Dear 2006 FRC Inspector,
Welcome to the 2006 *FIRST* Robotics Competition and

THANK YOU VERY MUCH!!!

Your contribution to our program is greatly appreciated. We hope that you'll really enjoy being involved in the inspection process and interacting with the many spectacular student/mentor teams.

In addition to offering a sincere "thank you", this document provides a brief overview of the inspection process and schedule. Also, there are a couple of reference attachments included that you will probably want to keep with you while performing inspections.

Typical Schedule

Wednesday PM – volunteer kick-off and initial training, assist with inspection area setup (scale(s), equipment, sizing box). Take the opportunity to get to know your Lead Inspector and familiarize yourself with the inspection area, equipment, checklist, training documents, pit area and sample kit of parts (KOP). Ask plenty of questions.

Thursday AM – calibrate the scale(s), last-minute and "on-the-job" training. If you've never inspected before, the Lead Inspector may have you train with a veteran inspector – this is an excellent way to get some experience. If you're lucky, a few teams may be ready for inspection by noon. Most teams won't be ready until 2PM or even later.

Thursday PM – inspections. Most inspections will occur between about 2 and 9PM and take about ½ hour each. Expect a bit of chaos but a lot of great interactions with the teams. Most teams will try to have their inspection performed between practice rounds. Your Lead Inspector may not allow teams to practice without either a full inspection or a preliminary screening for safety issues.

Friday AM – calibrate the scale(s), last-minute inspections before competitions. There are almost always a few stragglers. Every robot needs to be inspected before they can compete.

Friday PM and Saturday – competitions and teardown of the inspection area (after finals on Saturday). Not much for inspectors to do. An occasional re-inspection may occur. Your Lead Inspector may want you to perform random re-inspections.

Inspections

In a nutshell – the inspection process involves filling out a checklist for every robot (provided by *FIRST* to the Lead Inspectors) and placing a label ("Inspected by…") on the robot after passing inspection. That's about it.

In reality (and your Lead Inspector may have a slightly different procedure), the process is typically –

1) A team brings their robot to the dedicated inspection area for weight and size checks. The inspectors will "start" the checklist for the team and begin the process. At the inspection station, the robot will we weighed (robot (without battery and bumpers but with all possible mechanisms) and bumpers (separately from the robot)) and sized (in "starting configuration" and at all possible extensions of mechanisms). Your Lead Inspector may also want you to quickly scan the robot for any issues (sharp edges, components that can damage the field or balls) in order to allow the robot to begin practices (maybe even put the inspection "base" label on the robot but without signing and putting the "done" sticker over it).
2) When the team is ready to finish the inspection, they will approach the inspection area and request that an inspector follow them to their pit. Bring their checklist with you along with any additional reference material that you may need.
3) INSPECTION – Introduce yourself to the team and try to engage a student as your primary contact. Have her/him give you a quick summary of their robot's design. Ask plenty of questions – she/he will be very happy to tell you everything about their robot. Go through the checklist (sequentially should be fine). If their robot passes every check (some will not be applicable for all robots (e.g. pneumatics)), sign the checklist, place a "PASSED INSPECTION 2006" sticker on their robot, cover the sticker with a colored dot and sign/initial the dot (pre-numbered stickers (with team #) and colored dots (color varies by week) have been provided by *FIRST*). You may find a few issues with the robot, in which case you may have to return later after the team has a chance to correct the issue. Always return the completed checklist (with a copy of the team's bill of material) to the Lead Inspector or inspection area.

Questions?

If you have any questions, please don't hesitate to consult the Lead Inspector for the regional or a *FIRST* representative.

Remember –

1) Gracious Professionalism
2) SAFETY and EQUALITY - Although we continue to strive for perfectly objective inspection metrics, many checklist items will always be somewhat subjective. As long as the robot is SAFE (for humans, field, balls, other robots) and there are no components that give the team an unfair advantage, you should consider accepting marginal items (unless the team can easily correct the issue).
3) HAVE FUN!

Thanks again and GOOD LUCK!
Russ Beavis, Chief Inspector for *FIRST*

PS - Your Lead Inspector may have additional information for you. He/she may wish to use a process that is slightly different from the process described above. For example, many Lead Inspectors will require that the entire inspection process be performed at the inspection station instead of in the team's pit.

Attachments –

PLEASE READ – Inspection Checklist Details (to keep the checklist brief)

PLEASE READ (for last-minute rules interpretations) - Summary of GDC (Game Design Committee) Responses that Impact Inspection (from *FIRST*'s Q&A site)

What's New in 2006 – for veteran inspectors who want a summary of the key changes

Custom Cylinder Form – list of acceptable pneumatic actuators that may be used

Pneumatics Diagram – schematic for the required components and plumbing

Pneumatics Picture – picture of the components assembled as per diagram

Wiring Diagrams – schematics showing acceptable electrical wiring configurations

Wire Gauge Picture – picture comparing wiring of different sizes

Bumper Diagram – drawing showing bumper requirements

Parts Use Flowchart

Bicycle Flag Diagram

Additional Reference Info –

Another excellent document to include with the above reference material is the "KOP_Checklist_&_Photos" PDF on the *FIRST* website. The document contains a detailed list of all components in the KOP with photos included.

Inspection Checklist Details

Size: The robot must fit freely in sizing box (28" x 38" x 60"). The bumpers (if used) may be removed. The robot must be in its largest start-of-match configuration. The bicycle flag does not need to be installed. Any decorations that may be used on the robot must be present.

Weight: All potentially utilized mechanisms must be included with the robot while on the scale - including decorations and the 7.2V backup battery but excluding the bicycle flag and the Exide ES/EX18-12 battery & its Anderson Connector w/leads. The robot must weigh 120.0 lbs or less (no exceptions).

Bumper Weight: Bumpers must be 15.0 lbs or less and the bumper mass must be approximately distributed uniformly. No abnormally "heavy spots" and no 15 lb "short" bumpers (i.e. battering rams).

Extended Size and Shooter Mechanisms: The robot must fit within a virtual 60" cube at all times (with cube faces parallel and perpendicular to robot's longitudinal and latitudinal axes). The teams must demonstrate that, during any combination of actuations, no part of their robot (with the exception of the bicycle flag) extends beyond the virtual 60" cube. If the robot does not have well-defined symmetry axes (e.g. it's a round robot), the team must define a forward orientation so that one face of the virtual 60" cube can be aligned with the forward direction. In addition to the above size checks, if the robot design incorporates a shooter mechanism, the inspectors must confirm that no part of the shooter mechanism extends beyond the base of the robot (excluding bumpers) during any actuation. The shooter mechanism only includes components that directly contact the ball during or after providing a dynamic impulse – for example, a turret may be designed to swivel a shooter mechanism and components of the turret are permitted to extend beyond the robot base. While examining shooter mechanisms (if included in the design), inspectors should also confirm that there is a shield covering the shooter mechanism.

Bicycle Flag:

1) the robot must include a contiguous 12" long x ½" ID PVC tube to accept the flag
2) the robot's PVC tube must be capped at its "bottom"
3) the robot's PVC tube must remain approximately vertical at all times and cannot be articulated or actuated
4) when the 3' bicycle flag is installed in the tube, the height of the top of the flag cannot exceed 72"
5) the top must ALWAYS be at least 12" higher than any other component on the robot, even under ALL extensions of robot mechanisms
6) the robot's PVC tube cannot be attached to a bumper
7) the robot's PVC tube cannot be longer than 12"
8) tape cannot be used to cap the bottom of the tube
9) the tube cannot be machined in order to reduce mass

Bill of Material: All teams must provide a detailed cost estimate for their robot that describes the costs associated with every non-KOP component (except for the following excluded items - non-functional decorations, fasteners, adhesives, lubricants, spare parts, Victors and Spikes, parts at driver station).

1) Hardcopy printouts of the Bill of Material are preferred but simply displaying the list on a computer is acceptable.
2) The total cost of non-kit parts cannot exceed $3500 with no individual component over $400 and no individual COTS electrical component over $200.
3) All components must be readily available such that ALL teams could, theoretically, acquire the identical part at the quoted cost and within a reasonable delivery time if so desired.
4) Costs for components that have been salvaged from previous years' robots must not include depreciation.
5) All parts purchased from IFI (i.e. not in the kit) must be included in the bill of material except for additional Victor 884 Speed Controllers and Spike Relay Modules.

Foreign Teams: Teams from outside the U.S. may request exemptions for some parts due to availability (e.g. metric vs. English). If the team is foreign and has successfully petitioned *FIRST* for an exemption, attach a confirmation letter (typically email response from *FIRST*) to this worksheet.

Safety and Wedges: No sharp protrusions (approximately 1 square inch minimum), no sharp edges, no entanglement risks, no wedge-shaped robot bases. The robot base can have wedge-shaped segments close to the ground but there must be provisions for minimizing interaction with other robots. For example, the wedge could be noticeably retracted within the robot's perimeter or the wedge could have a cover that's intended to provide first contact with other robots yet allow balls to easily contact the wedge.

Shooter Mechanisms and Shields: If the robot includes a shooter mechanism, there must be a shield covering the mechanism. In particular, all rotating and thrusting components must be protected from human access from all directions other than the "outlet" of the shooter. A good metric to employ – use a ¾" dowel to try and contact any moving component within the shooter mechanism.

Energy Sources: No energy sources are permitted other than a single Exide ES/EX18-12 battery, 7.2V backup battery, compressed air supplied by the Thomas compressor (either on or off the robot) and stored within the pneumatics (all components from the kit), dropping of robot's center of gravity and "safe" deformation of robot components (e.g. springs). No flywheels. Teams may use additional batteries to provide power for decorations but the batteries and circuitry must be completely isolated (electrically) from the robot control circuitry. In addition, the Exide battery must be securely attached within the robot.

Logos: Must prominently display school name and either primary sponsor logo or name.

Team Number: Must be displayed on all 4 sides at approximately 90 degree angles, numbers must be at least 4" high and have minimum stroke width of ¾", must be clearly visible (i.e. sharp contrast to attached surface).

Alliance Color LED: The Alliance Color LED is not required but is highly recommended. If present, it should be clearly visible while standing in front of the robot while in starting configuration.

Interference Mechanisms: Robot cannot include devices or decorations that may interfere with the vision systems of other robots

Decorations: Cannot affect outcome of match, cannot broadcast using wireless communication without clearance from *FIRST* Engineering, cannot employ 900MHz cameras, cannot use electrical power unless drawn from Exide 12V battery via either 20A or 30A circuit breaker

Ball Visibility and Access: If the team plans on pre-loading their robot with balls before the beginning of a match, it is required that the pre-loaded balls be visible for counting. Opaque shooter mechanisms are acceptable as long as the team does not plan on beginning a match with balls in the opaque region. In addition, balls remaining in the robot at the end of match must be removable without powering-up the robot. Please confirm that balls remaining in shooter mechanisms can be safely removed from the robot at the end of a match (and without robot power).

Acceptable Mechanical Parts: All parts that are used on the robot must be either from the kit of parts (or identical to a part in the kit) and/or be acceptable as per Parts Use Flowchart (rule R46).

Specifically Prohibited Mechanical Parts:

1) mechanisms from previous years' robots (this is essentially impossible to inspect but it is a rule that we need to try to enforce)
2) traction devices that may damage the field - no metal, adhesive or velco acting as an anchor or providing traction
3) any ball-contacting mechanism that may damage the surface of the balls (e.g. sandpaper)
4) adhesive-backed tape except Velcro and double-sided foam for attaching components
5) reflective tape except in small quantities for optical sensing and labels
6) electrical tape used for any objective other than insulation
7) lubricants that may drip onto the field or contact the balls
8) hydraulic components
9) components considered "hazardous" as per MSDS
10) unsafe additional parts

Chemical Modifications: The kit of parts components cannot be chemically modified except - metal may be heat-treated, anodized or plated and rope may have ends singed to prevent unraveling.

Motor Modifications: Modifications to mounting brackets, output shafts, electrical leads and modifications to/removal of Fisher-Price and Globe motor gearboxes are the only permissible alterations to the kit motors. The gear, tensioner and threaded stud from the end of the big CIM motor (the mini-bike motor) can be removed. Motors CANNOT be modified in order to reduce mass or improve airflow or in any way that could reduce the mechanical integrity of the device. It's OK to add material such as heat exchangers and fins, drill a couple of new mounting holes and alter the output shaft (and pre-attached mechanisms such as the above-mentioned gearboxes) – nothing else.

Bumpers: If the robot design incorporates bumpers, the bumpers must satisfy the following requirements –

1) must utilize a pair of stacked "pool noodles" (2.5" OD) on a ¾" thick x 5" tall plywood mounting surface and covered with a tough, smooth cloth (1000 denier Cordura Plus is recommended)
2) must be removable for inspection
3) cannot add more than 3.5" to each side of the robot with only "pool noodles" and cloth extending beyond 1" from the bumper mounting surface
4) when mounted on the robot, must be between 2.5" and 8.5" from the floor
5) cannot include any sections with abnormally large linear mass density (i.e. no short, heavy bumper segments), bumpers should be no heavier than 3 oz per inch of length
6) bumpers cannot be held in place using Velcro-style fasteners

Acceptable Electrical Parts: All parts that are used on the robot must be either from the kit of parts (or identical to a part in the kit) and/or be acceptable as per Parts Use Flowchart (rule R46). The following is a sample list of acceptable additional parts that may be used.

1) additional Hitec HS-322HD or HS-322S servos (no limit except cost)
2) Victor 884 Speed Controllers (any year, no limit except cost)
3) Spike Relay Modules (any year, no limit except cost)
4) 1 additional 4-slot Maxi-style Fuse Block
5) 2005 CB/Distribution Panel (can be used in place of the Maxi-style Fuse Block and ATC fuse panels supplied in the kit, does not need to be included in bill of materials)
6) up to 2 additional small CIMs (FR801-001)
7) either Exide EX18-12 or ES18-12 battery
8) any 7.2V backup battery pack similar to the kit component
9) previous years' kit parts as long as they follow all other rules and are acceptable as per Parts Use Flowchart
10) 2005 RC can be used but only if it's been upgraded by IFI to 2006 RC equivalence
11) 2005 OI can be used but only if a 2006 model cannot be acquired and integrated

Specifically Prohibited Electrical Parts:

1) Victor 883 or 885 Speed Controllers
2) Batteries and Motors different from/in addition to kit of parts components (except for additional servos and CIMs mentioned above). "Motors" includes similar devices for converting electrical energy into mechanical motion or force such as electromagnetic solenoid actuators (solenoids for pneumatic control are treated separately, refer to following items in the checklist).
3) 2005 and older IFI RC, OI and modem (with only two exceptions – 2005 OIs can be used if a 2006 model cannot be acquired and integrated, 2005 RCs can be used if IFI has performed an upgrade to the part for equivalence to a 2006 RC (IFI places a label on all upgraded 2005 RCs))
4) electrical tape used for any objective other than insulation
5) components considered "hazardous" as per MSDS
6) unsafe additional parts
7) circuit breakers other than 20A, 30A and 40A auto-resetting Snap Action brand circuit breakers (as in the kit of parts)
8) Any component that is not COTS or assembled from COTS (custom circuit boards and wiring assemblies for attaching the COTS items are acceptable)

Wire Size and Color Rules:

1) must use appropriate colors for power distribution (red/white/brown for positive; black/blue for negative)
2) #6 AWG wire minimum from battery (+ and -) to Anderson Disconnect and to main circuit breaker and to distribute power to all circuit breaker and fuse panels attached to the main circuit breaker (CB/Distribution Panel from 2005 kit of parts or ATC Fuse Panels and Maxi-style Fuse Blocks from 2006 kit of parts)
3) #12 AWG wire min for all circuits protected by 40A Circuit Breaker
4) #14 AWG wire min for all circuits protected by 30A Circuit Breaker
5) #18 AWG wire min for all circuits protected by 20A Circuit Breaker
6) #24 AWG wire minimum for connecting sensors, Vision System, small muffin fans, LEDs or PWM signals to the Robot Controller
7) Ribbon cable smaller than #24 AWG may be used to connect to the 9 pin ports on the RC
8) wire pre-installed on motors and cables supplied for the pneumatics valves and the camera module are exempt from the above rules - these cables can be shortened but replacement or extension wires must obey the above minimums

Sensor Outputs: Sensor outputs can only be wired to Robot Controller Analog Inputs, Digital I/O, TTL Serial, Program Port, or Custom Circuit boards. No series connections between Spike/Victor outputs and their attached loads are permitted **except** low-impedance current sensors connected in series with load being monitored.

Custom Circuits: Custom Circuits may connect to the Robot Controller's Analog Input, Digital I/O, TTL Serial, PWM, Relay or Program Ports. In addition, custom circuits may connect to Branch Circuit breaker outputs, Speed Controller or Relay Module outputs or

any kit or COTS sensors. Custom Circuits may NOT interfere with other robots, directly affect any output devices (e.g. generate PWM inputs for the Victor 884), be used for wireless communication or connect to the Radio or Tether Ports on the RC.

Acceptable Pneumatic Parts: All parts that are used on the robot must be either from the kit of parts (or identical to a part in the kit) and/or be acceptable as per Parts Use Flowchart (rule R46). The following is a sample list of acceptable additional parts that may be used.

1) previous years' kit parts as long as they follow all other rules and are acceptable as per Parts Use Flowchart
2) solenoid pneumatics valves, cylinders, regulators and fittings (no limit except cost, must be rated for 125PSI, all pneumatics actuators must be identical to those listed on the Pneumatics Components Order form
3) pressure sensors (no limit except cost, must be rated for pressure at mounting point)
4) "vacuum generators" (no limit except cost, must be driven by motor from the kit of parts)
5) pneumatic shocks (no limit except cost)

Specifically Prohibited Pneumatic Parts:

1) components considered "hazardous" as per MSDS
2) unsafe additional parts
3) hydraulic components
4) air tanks different from or in addition to the 2 supplied in the kit
5) air compressor or pressure relief valve different from or in addition to the quantities supplied in the kit

Pneumatics Operational Test: If the robot design includes pneumatics, confirm that the pressure in the air storage tanks (i.e. at compressor output) does not exceed 120PSIG and that the "working" pressure does not exceed 60PSIG (output of the Norgren adjustable regulator and any additional downstream regulators). Also confirm that the manually operated vent valve and the Nason pressure switch function as required. After the pneumatics system has reached a steady-state condition, operating the vent valve must release the air in the tanks and cause tank pressure to drop. Also, the compressor should turn on to attempt re-pressurization.

Summary of Game Design Committee Responses to Rules Questions from Teams (responses which may impact the inspection, considering all GDC responses as of February 13th, 2005)

1) team numbers can be located on the bumpers (if used)
2) (rule G13) if using a container on the robot for balls loaded prior to autonomous mode, the balls must be clearly visible for counting by referees before the start of the match (may want to consider whether the balls are visible in any orientation, e.g. if all balls are loaded "black-side up" will they be clearly visible?)
3) warn teams about use of green paint and non-green LEDs, they may be asked to modify their robot if a the paint/LEDs interfere with a team's vision system
4) pre-attached motor wires don't have to be removed in order to obey wire size rules (but wires added to the pre-attached wires must obey the size rules)
5) copper wire only - no aluminum
6) 10 deg bumpers (all bumper faces, if bumpers are used, must be within 10 degs of vertical)
7) the bicycle flag holder on the robot must be a contiguous piece of PVC tube that is 12" long with ½" inner diameter
8) no lasers or laser pointers
9) no mechanisms that can force the robot (minus any balls in possession) to be over 60" tall while on floor
10) if the robot is not rectangular, make sure that the team identifies a "front" surface in order to identify whether the Alliance Color LED is properly located and to define the 60" cube for determining whether any part of the robot extends beyond the maximum permissible volume while competing
11) bumpers can be actuated but must stay in the allotted bumper volume
12) bumpers can be segmented
13) bumper decorations are OK (all colors are OK)
14) applying 12V to the Gear Tooth Sensor (GTS) using a PWM cable connected to a 20A circuit breaker is not OK (as per wire size rules which dictate 18AWG conductors attached to 20A breakers), teams should place a "custom circuit" (with a fuse) between the 20A breaker and ground stud and the GTS in order to provide a transition for the requisite 18AWG conductors to 24AWG (or bigger) conductors to apply power to the GTS
15) slip rings are OK for transferring electrical power and signals through rotational unions, please confirm that the slip rings are rated for the expected current and attached circuit breaker
16) connectors (e.g. between motors and victors and breakers) are OK, please confirm that the connectors are rated for the expected current and attached circuit breaker
17) bumper mounting bolts don't have to be in the center - just make sure the bumpers don't flop outside of 10 degs from vertical
18) no lubricants can touch ball
19) must wire the cooling fans for the victor speed controllers (must be wired to the +12V and GND connections)
20) ground returns can be handled in "any way" (i.e. either to terminal blocks or ground studs), just make sure that ground conductors have the proper size
21) bumpers don't have to cover all edges of robot

22) no 2005 IFI RCs, OIs or modems are allowed (with one exception - see below)
23) a 2005 IFI RC can be used if it's been upgraded by IFI to be equivalent to a 2006 IFI RC (IFI places a label on upgraded 2005 RCs to indicate the rework)
24) the gears in the standard transmission can be lightened
25) no electromagnetic actuators (tachometers or similar electromagnetic sensors are OK) other than kit motors, Hitec servos, pneumatic valves, decorations, kit compressor (i.e. no solenoids or brakes or electromagnets)
26) the CMUcam2 camera module is allowed to drive servos connected to its own bracket
27) multiple CMUcam2 modules are allowed (but there's only 1 TTL port on the RC)
28) Any pneumatics actuators (cylinders and rotary actuators) must be ordered from the Custom Cylinder Form found on www.bimba.com for the *FIRST* teams
29) teams can use any combination of (up to) two 4-slot Maxi-style fuse blocks + 2005 CB/Distribution panel + ATC panels (one 6-position and one 12-position, both included in the KOP)
30) the robot can't release pressurized air into anything except pneumatics cylinders and rotary actuators from the Custom Cylinder Form
31) can't use a motor as a tachometer unless it's a kit motor
32) no driver station parts can be attached to the acrylic on field's alliance station
33) no stored rotational energy (flywheels), teams can obviously use spinning devices in their robot (drive wheels, gears, launcher parts, etc, motors) but the energy in the rotating components must be supplied by the on-board 12V battery and not imparted by another energy source prior to the match
34) no custom-built pneumatic systems (except vacuum generators using kit motors)
35) it is OK to remove the gear, tensioner and threaded stud from end of big CIM motor
36) pneumatic rotary unions are legal, make sure that they are rated for the pressure at the union
37) robot mechanisms (except for shooter mechanisms) can extend over and beyond bumpers
38) (rule S03) a "shooter mechanism" is any mechanism that is designed to eject a ball, it includes any part that delivers the final impulse or touches the ball after impulse
39) (rule S02) "shooter mechanisms" have a 12m/s muzzle velocity limit (rule S02), we will not be inspecting for muzzle velocity but there will be an apparatus at each regional for spot-checking at the request of game officials
40) (rule S03) the "shooter mechanism" must remain inside robot starting dimensions (not just 28" x 38" but whatever the robot's designed size minus bumpers) and be shielded to avoid contact with other robots (rules S01 and S03)
41) for bumpers, hexagonal pool noodles are an acceptable equivalent to round pool noodles
42) the Hitec HS-322S and HS-322HD servos are considered to be equivalent
43) important emphasis – shooter mechanisms must be shielded and balls must be retrievable from shooter mechanisms without powering-up the robot (for end-of-match)

44) bicycle flags must ALWAYS be at least 12” above the highest part of a robot (i.e. not just at the start of the match but under all extensions)
45) tape cannot be used to cap the end of the 12” PVC bicycle flag tube
46) decorations, if using electrical power, can only derive power from the Exide 12V robot battery (via either 20A or 30A breaker)
47) If the robot uses an off-robot compressor for pre-charging the pneumatic tanks on the robot (either 1 or 2 Clippard Instrument tanks), the team must use the KOP Thomas air compressor through a 20A breaker and Spike Relay Module (with fuse replaced by 20A Snap Action breaker if desired). The team is not required to use the Robot Controller and/or Nason Pressure Switch and/or circuit breaker panels to control the process.

What's New in 2006

1) bumpers, if used, must be identical to the approved design (with few exceptions)
2) only 2006 model OI and RC components can be used (unless they are 2005 parts that have been upgraded by IFI)
3) pre-coiled pneumatic tubing has been included in the KOP
4) a pair of large "mini-bike" CIM motors have been included in the KOP (only 2 of the smaller CIM motors (from last year) are in the KOP but teams can purchase and use 2 additional small CIM motors)
5) the coast/brake headers on the Victor Speed Controllers can be driven by the RC
6) teams can use any lug for battery connection as long as the connections are secure
7) the 2005 CB/Distribution Panel was not included in the KOP for 2006 but teams are permitted to use it either instead of or in addition to the new panels in the KOP - a 4-position Maxi Block (one in the KOP and one may be purchased separately) for holding 40A breakers and 6- and 12-position ATC fuse panels (one each in the KOP)
8) decorations, if using electrical power, can only derive power from the Exide 12V robot battery (via either 20A or 30A breaker)
9) **shooter and hopper requirements –** Shooter mechanisms must be shielded for safety. If the team plans on pre-loading their robot with balls before the beginning of a match, it is required that the pre-loaded balls be visible for counting. Opaque shooter mechanisms are acceptable as long as the team does not plan on beginning a match with balls in the opaque region. In addition, balls remaining in the robot at the end of match must be removable without powering-up the robot. Please confirm that balls remaining in shooter mechanisms can be safely removed from the robot at the end of a match (and without robot power).
10) If the robot uses an off-robot compressor for pre-charging the pneumatic tanks on the robot (either 1 or 2 Clippard Instrument tanks), the team must use the KOP Thomas air compressor through a 20A breaker and Spike Relay Module (with fuse replaced by 20A Snap Action breaker if desired). The team is required to use the Robot Controller and Nason Pressure Switch to control the process.

Custom Cylinder Form

(from www.bimba.com, this is from the *FIRST*-specific "free cylinder" section)

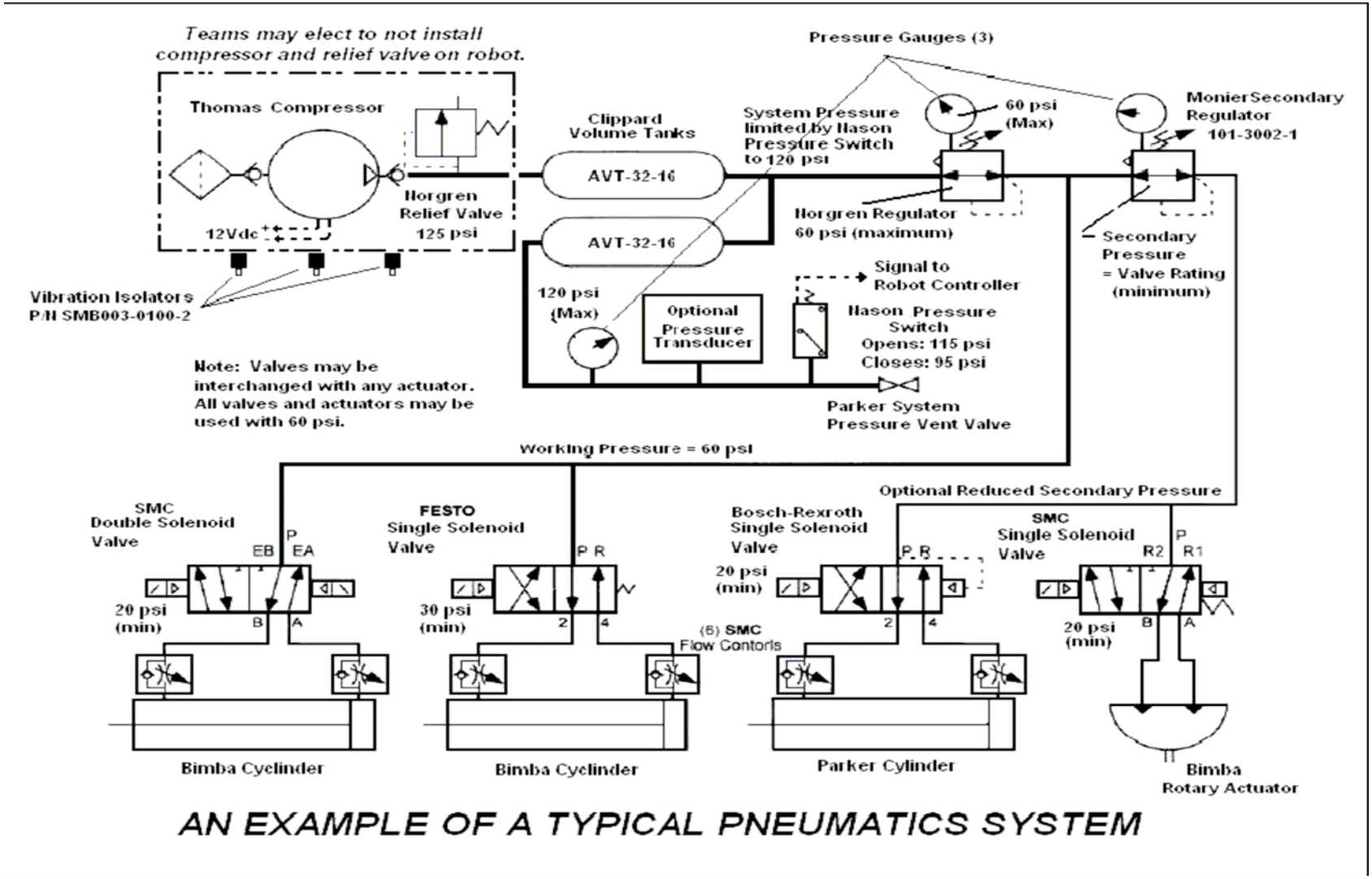
Teams are allowed to procure up to 3 cylinders and 1 rotary actuator for free. Additional cylinders and actuators are allowed (unlimited quantity) but the costs must be included in the team's bill of material.

The following table lists the only valid air cylinder configurations. Air cylinder part numbers must be M-XXYY-ZZ.
-"M" is optional (specifies whether magnetic position sensors are included)
- XX represents bore, must be either 04 (for ¾" bore), 17 (for 1.5" bore) or 31 (for 2" bore)
- ZZ represents mounting option, must be DP (for ¾" and 1.5" bores) or DXP (for 2" bore)
- YY represents stroke length, must be a value from the table below

Bore (XX)	Valid Stroke Lengths (YY, in inches)
-04 (3/4" bore)	0.5, 1, 1.5, 2, 2.5, 3, 4, 5, 6, 8, 10
-17 (1.5" bore)	0.5, 1, 1.5, 2, 2.5, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 24
-31 (2" bore)	0.5, 1, 1.5, 2, 2.5, 3, 4, 5, 6, 7, 8, 9, 10, 12, 24

Rotary actuators must also be from Bimba. There are only 2 acceptable part numbers.
- PT-017090
- PT-017090-M

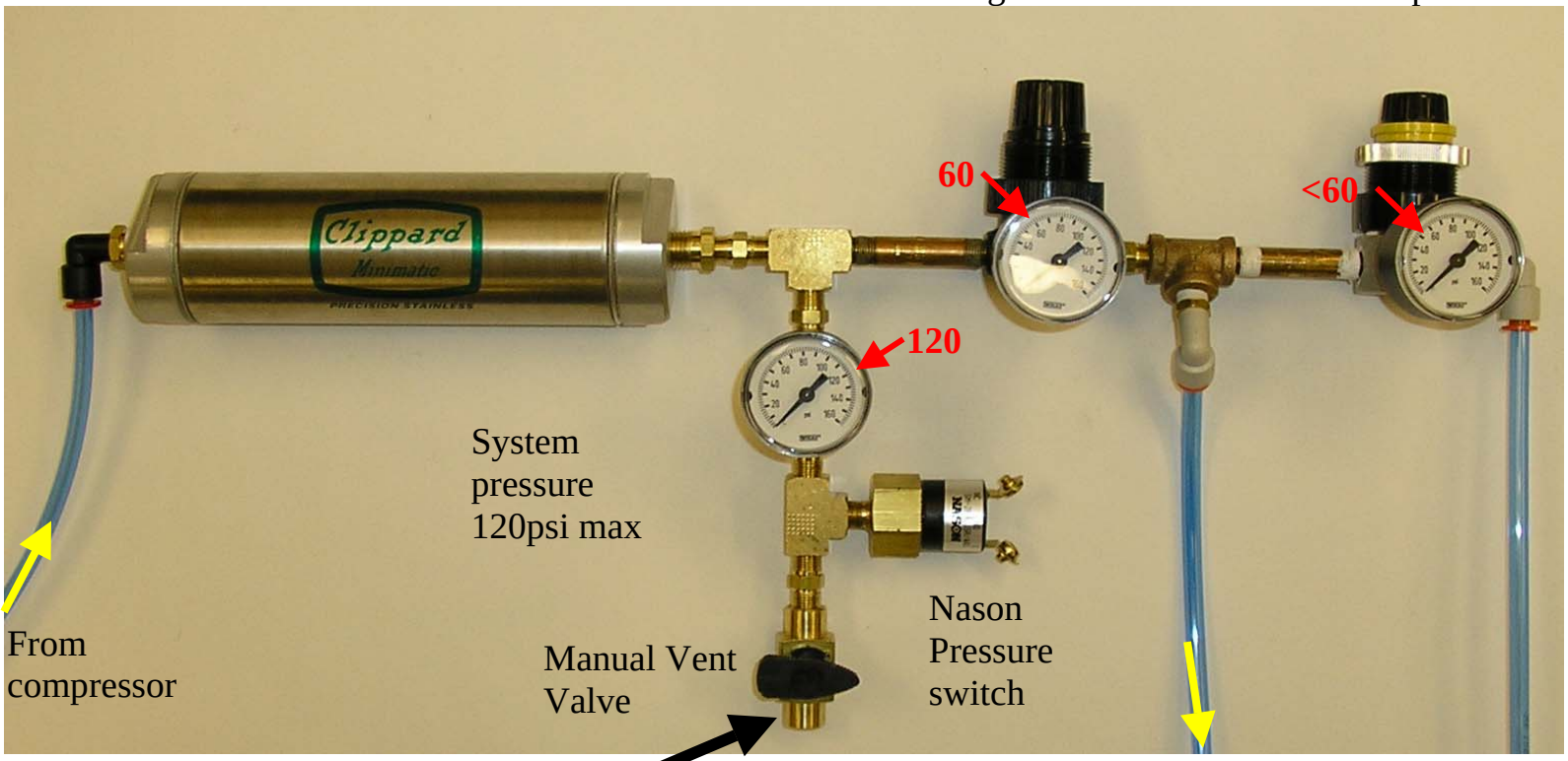
Pneumatics Diagram – If the robot uses pneumatics, the setup must be similar to the following.



Pneumatics Picture – picture of the components assembled as per diagram (only 1 tank shown, 2 may be used)

Norgren Regulator
60psi max
Working Pressure

Optional Monier
secondary Regulator
less than 60psi

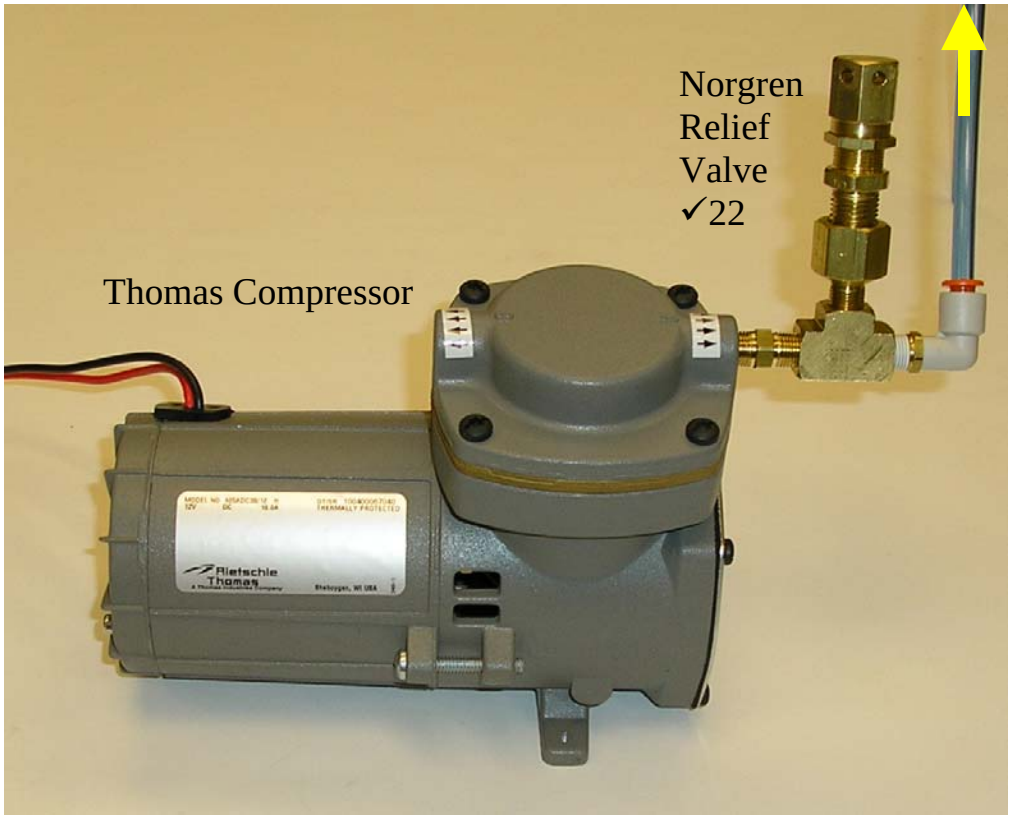


This valve must be visible & accessible.
Inspector will check function of this valve.

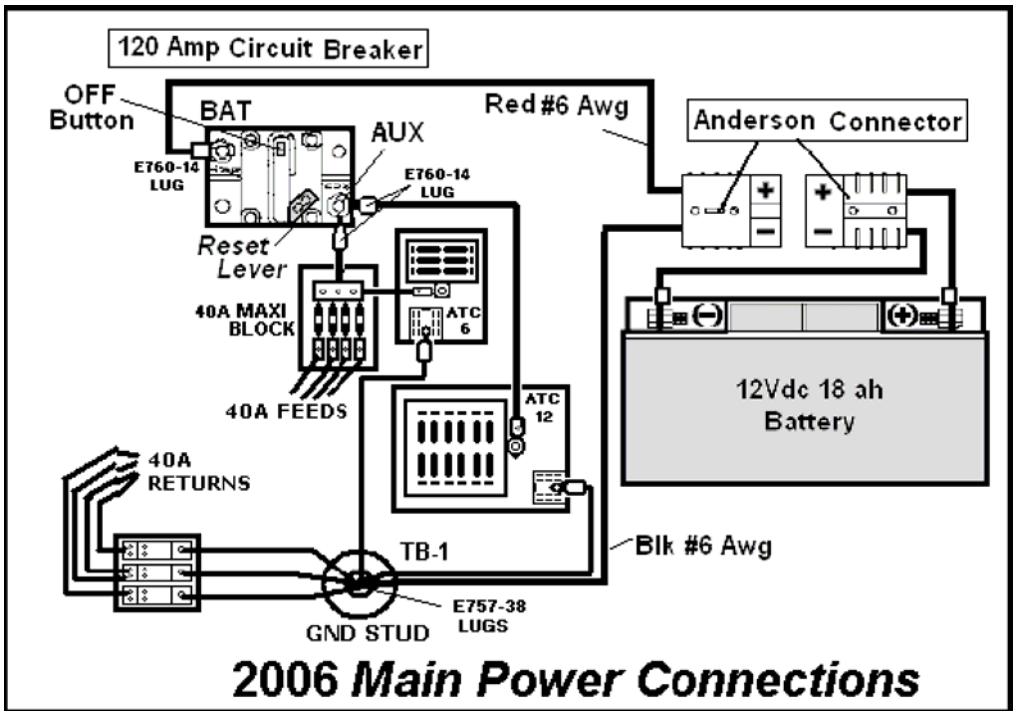
Pneumatics Picture – picture of the compressor assembled as per diagram (may be on or off the robot)

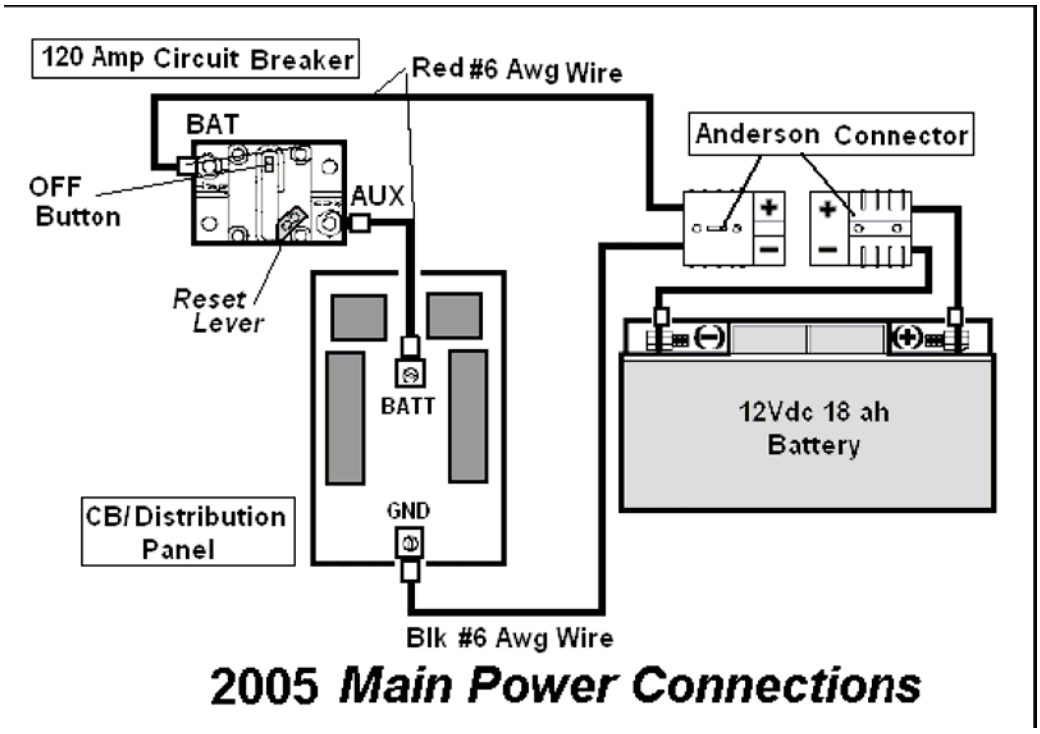
This compressor should be used to charge the pneumatic system. It can be mounted on the Robot or be used in the pits to charge the Clippard Volume tank(s).

The Norgren relief valve should be mounted on the compressor in either case.



Wiring Diagram – schematic showing acceptable electrical wiring configuration
**Note that this is simply an example of a possible configuration. The 2005 CB/Distribution Panel can be used in place of or in addition to the Maxi blocks and Circuit Breaker Panels shown.





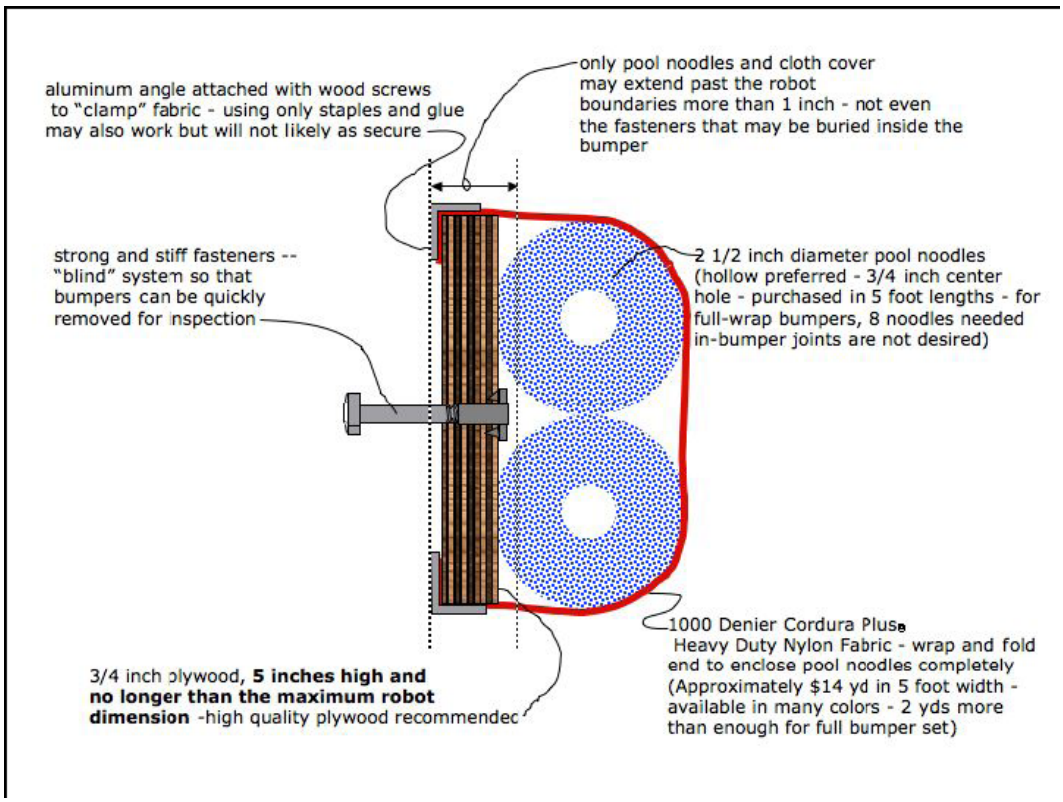

MAIN DC POWER COMPONENTS
1. 12V Exide battery ES18-12
2. Buss 120A Circuit Breaker
3. ATC Fuse Panel 6 position
4. ATC Fuse Panel 12 position
5. Maxi Style Fuse Block 4 pos.
6. Stud w/Nut - TB-1 GND post
EXIDE
TECHNOLOGIES
1
2
3
4
5
6

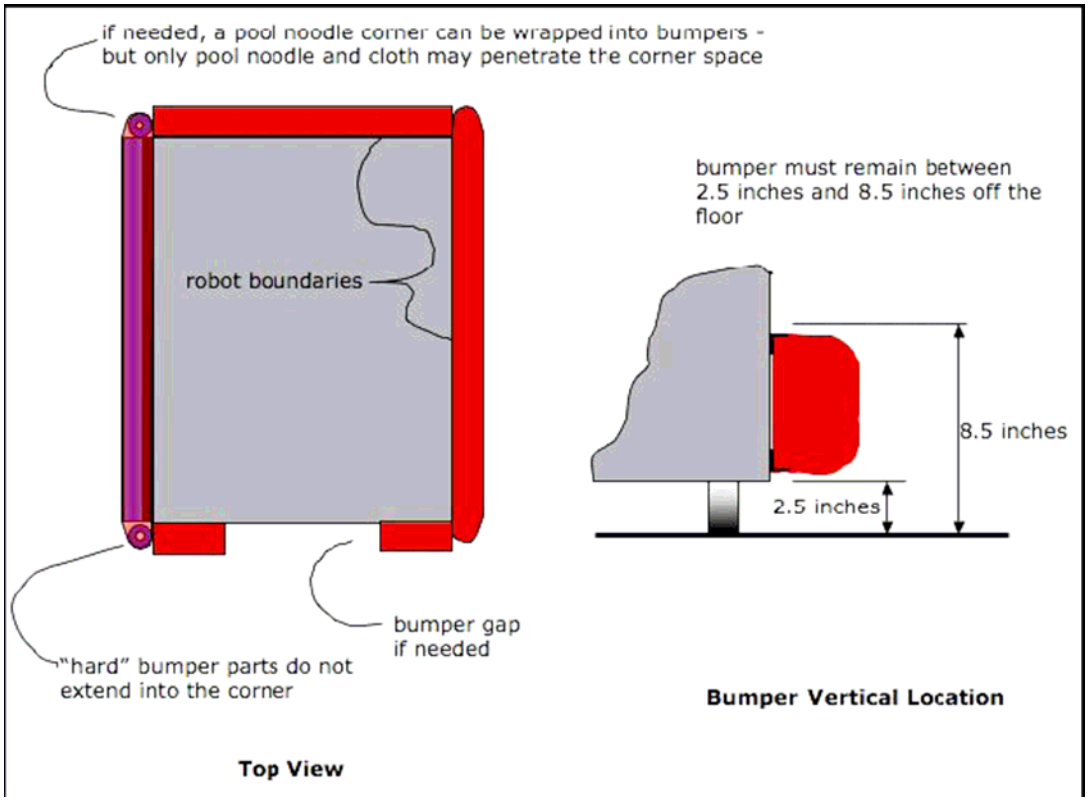
Wire Gauge Picture – picture comparing wiring of different sizes

Wire Gauges (AWG) = 6 12 14 18 24 ribbon 32

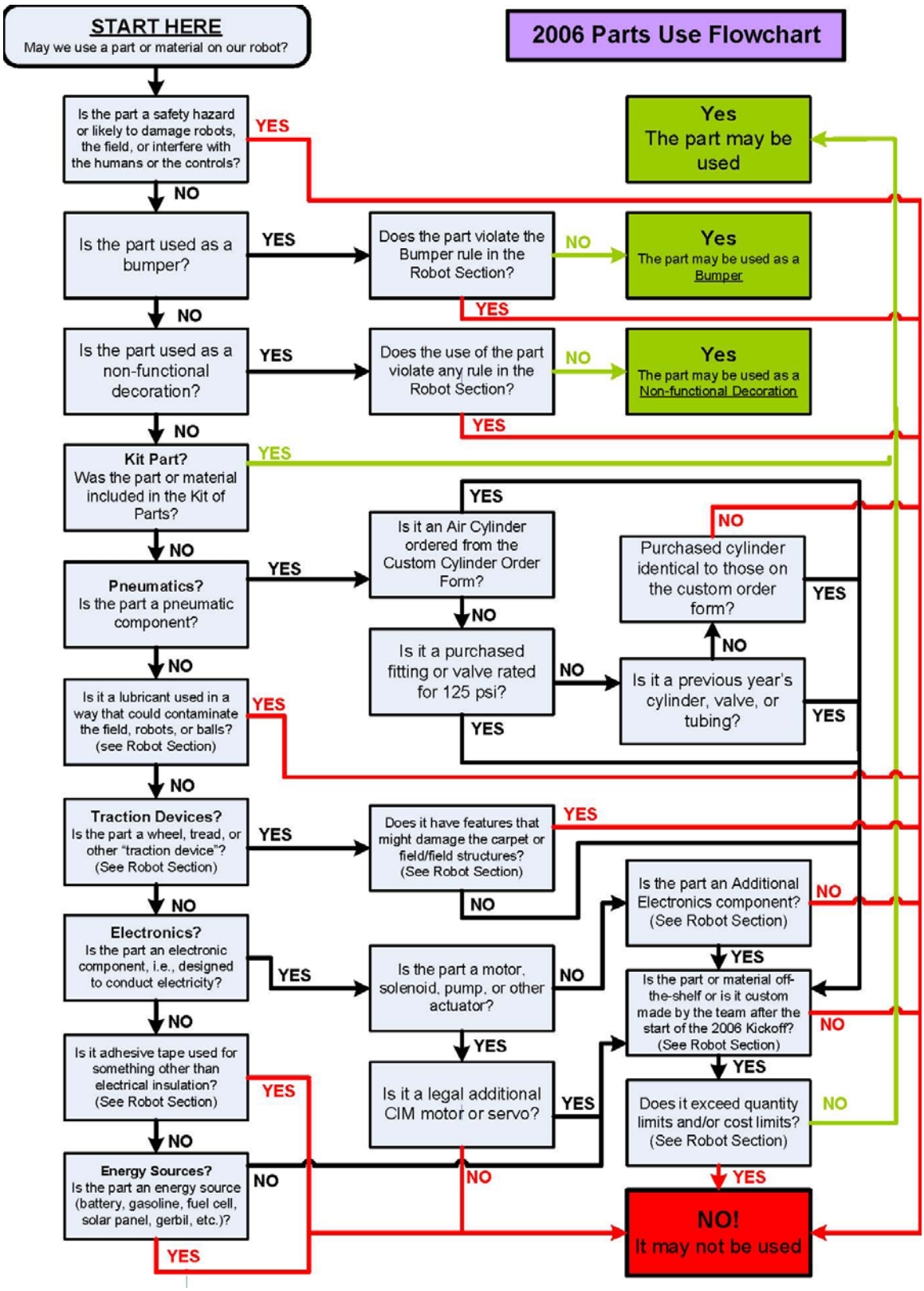
6 AWG (or larger diameter) must be used in battery-to-circuit breaker path
12 AWG (or larger diameter) must be used in circuits connected to 40A breaker, 14 (or larger) with 30A circuits and 18 (or larger) with 20A circuits
24 AWG or larger may be used for sensors, vision system, muffin fans, LEDs and PWM control signals
Ribbon cables with individual conductors smaller than 24AWG may be used to connect to the 9 pin ports on the Robot Controller
**EXCEPTIONS – Cables that are included in the kit and intended to power kit parts (eg solenoid valves and cameras) and cables attached to motors do NOT have to obey the above rules. The exempt cables may be shortened (motor cables cannot be disconnected directly at the motor windings) but extensions/replacements MUST obey the rules.

Bumper Diagram – drawing showing bumper requirements



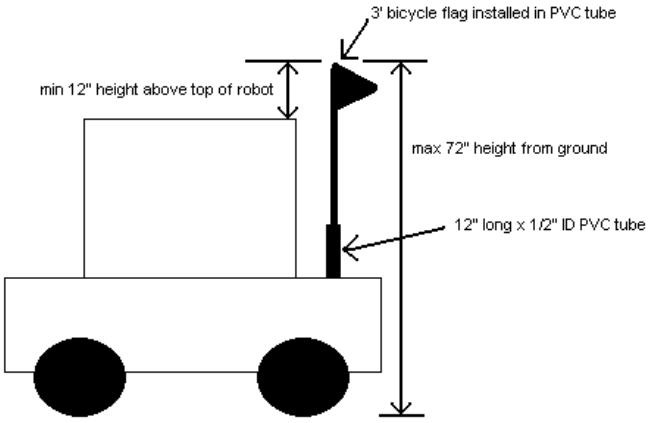


Parts Use Flowchart (rule R46)



Bicycle Flag

• the robot must include a contiguous 12” long x ½” ID PVC tube to accept the flag (**with no attempts at weight reduction**)
• the robot’s PVC tube must be capped at its “bottom” (tape is not allowed)
• the robot’s PVC tube must remain approximately vertical at all times and cannot be articulated or actuated
• when the 3’ bicycle flag is installed in the tube, the height of the top of the flag cannot exceed 72”
• the top of the flag must ALWAYS be at least 12” higher than any other component on the robot (even given any extension of the robot)
• the robot’s PVC tube cannot be attached to a bumper
• the robot’s PVC tube cannot be longer than 12”



flag can be translated along axes parallel to ground but cannot chage height or tilt

cannot be attached to bumper

flag must remain vertical