

2019 Robot and Inspection Rules Summary as of 15 Feb (TU12)	
10.1	Overview
COMPONENT: part in most basic configuration	
MECHANISM: assembly of COMPONENTS with specific function	
COTS: standard (non custom order) item available to all teams, unmodified, obsolete OK	
VENDOR: Tax ID; not a FIRST team; ship COTS ≤5 days; maintains stock; products available to all teams;	
FABRICATED ITEM: COMPONENT or MECHANISM altered...*	
10.2	General Robot Design
R1	FRAME PERIMETER: in bumper zone; fixed non-articulated structural; excl minor prot. ≤ ¼"
R2	STARTING CONFIGURATION ≤ FRAME PERIMETER (excludes bumpers & minor protrusions)
R3	FP ≤ 120 inches, Starting height ≤ 48"
R4	Max extension: 30" beyond FP
R5	Robot weight ≤ 125 lb (excl bumpers, battery w/ <12" cable)
10.3	Safety & Damage Prevention
R6	not designed to shoot H PANEL > 3' past FP (G6)
R7	"71 rule": limits damaging traction devices *
R8	No hazards from protrusions or exposed surfaces
R9	General hazmat, safety & interference rule *
R10	No power to remove game pieces or robot
R11	Lubricants: internal only
10.4	Budget Constraints and Fabrication Schedule
R12	BOM ≤ \$5500, excludes ≤\$5/part & 2019 KoP
R13	Individual part ≤ \$500
R14	BOM uses Fair Market Value: COTS: VENDOR price, else mat'ls & non-team labor. Cap kickoff/FC items at \$500.
R15	No physical elements before kickoff. Exceptions: operator console; bumpers; battery assemblies; single COTS electrical + wires modified, connectors, shaft, gear, pulley, filter capacitor
R16	software/designs before kickoff must be public
R17	Bag ROBOT by Feb 19 2259 CST, excl. withholding, except'ns to R15, COTS
R18	up to 3 bags, separate tags & entries, one form
R19	Re-seal if attending another event
R20	Hands-off times and exceptions & limitations *
R21	Robot access times for 2 day events *
R22	Unbag at competition only after lock-up form approval and pits open
R23	WITHHOLDING ALLOWANCE ≤ 30 lb *
10.5	Bumper Rules
R24	Cover corners to 6 in; curves are corners
R25	In BUMPER ZONE (0-7.5") except per G23 (HAB)*
R26	BUMPERS non-articulated rel to FP
R27	Quick/easy installation & removal for inspection
R28	Red/Blue; no markings except: R29, hook & loop or snaps on hard parts, white FIRST logo
R29	numbers: visible all sides; Arabic num 4+" tall; ½"+stroke; white or w. outline; not around sharp corners; no subst. logos or icons for numerals
R30	Bumper set, incl fasteners & structures ≤ 15 lb
R31	Bumpers must be constructed as follows: a ¾" nom x 4.5-5.5" plywood or robust wood b no hard parts >1" beyond FP c pair of 2.5" (nominal) round, petal, hex pool noodles, solid or cored. No mods or deforms except end cuts; All same in a bumper set; soft fasteners inside OK, but mind cross-section d Rugged smooth solid color cloth on ext. surfaces* e,f metal angle/bracket may secure cloth & segments g attach rigidly to FP *
R32	Fill the cornerjoints with pool noodle
R33	FP backing: ½" @ ends; gaps ≤ ¼" deep, ≤8" wide

10.6	Motors & Actuators
R34	Only motors permitted (any quantity) List of Motors * (overview in R37 rows 1 to 3) solenoid, ≤1" stroke, ≤10W cont at 12V. hard drive motors or fans in kickoff/FIRST Choice; or part of controller or COTS computing vibration & focus motors in COTS computing PWM COTS servos with a retail cost < \$75 Motors integral to COTS sensor One R86 compliant compressor to compress air
R35	No motor mods except Mounting brackets & output shaft Leads trimmed, connected, or spliced remove Denso motor window locking pins conn. housings on KOP auto for connections Servos as specified by the manufacturer Dynamo wiring harness as doc'd by FIRST* Minimal labeling: purpose, connectivity, performance...
R36	Except servos, fans & integral motors, each actuator controlled by one of: MC (Motor Controllers): DMC 60[c]; Jaguar (PWM); Dynamo integrated; SD540; Spark; Spark MAX; Talon; Talon SRX; Victor 884, 888, SP, or SPX.* RM (Relay Modules): Spike; Automation Direct* PC (Pneumatics controllers): PCM
R37	Power regulator to load map. UNO, 1 load/reg 1/MC: CIM; AM 9015 RS775 Pro; BAG; mini-CIM; Banebots; RedLine; NEO 2/MC or 1/RM: KOP Auto; AM PG; Snow Blower; NeverRest Integrated controller only: Nidec Dynamo RM or PC: Compressor multi/RM or 1/PC: pneumatic solenoid valves multi/MC or RM, or 1/PC: solenoids or CC CC (CUSTOM CIRCUIT): electrical COMPONENT except motor, elec. or pneum. solenoid, roboRIO, PDP, PCM, VRM, RSL, 120A breaker, MC, RM, radio, battery
R38	Servos connect to ONE of: RIO PWM, Spartan Sensor PWM, or REV Servo module
10.7	Power Distribution
	Apply for event, not just FIELD/MATCHES
R39	Battery is robot's only electrical energy source: Non-spill SLA, 12V, 17-18.2Ah, rectangular 7.1"x3"x6.6"; 11-14.5#; nut/bolt terminals
R40	COTS computing & I/O may be powered by integral or 100Wh USB batteries 2.5A max/port. Musts: secured, COTS cables, mfg recc charging
R41	Battery chargers need installed SB connector
R42	Battery chargers only used at ≤ 6A charging
R43	R39 & R40 only batteries on robot, period
R44	Secure the battery, including rolls & inversions
R45	All mains connections fully insulated at all times
R46	Only non-elec energy: compressed air per R86 & R87; change robot CoG; deformation (springs); closed-loop gas shocks; air filled wheels
R47	Mains circuit: 1 battery, 1pr SB conn., 1 120A breaker*, 1 PDP, connected with 6+ AWG copper wire only, no add'l devices or mods, per fig 10-9
R48	Circuits powered from ONE PDP WAGO pair (except R53 & R55)
R49	Isolate electricals from ROBOT frame (>3kΩ)
R50	ONE main breaker, quickly & safely accessible
R51	PDP, wiring, breakers: easily visible (inspection)
R52	CC may not produce voltages > 24V
R53	RIO power ONLY from designated PDP terminals
R54	Radio power ONLY from 12V 2A VRM output
R55	Radio's VRM powered by designated PDP terminals. 1 PCM is only other load there
R56	PDP: One WAGO, one wire.
R57	Only PDP breakers are Snap Action: VB3-A series F57 terminals; MX5-A or MX5-L series, ≤40A
R58	Fuses in PDP: mini-automotive rated as marked.
R59	One breaker one circuit. Breaker values: ≤40A: (MC CC 40A AD relay), 1ea ≤20A: Fans, no limit; (Spike 25A AD relay), 1 ea ≤ 10A: 12A AD Relay, 1 ea 20A: PCM w/comp., 1 ea; VRM and/or PCM without compressor, 3 total

R60	All circuits: insulated copper wire sized at least: 12 AWG: 31-40A protected circuit 14 AWG: 21-30A protected circuit 18 AWG: 6-20A; PDP->(VRM, PCM->compressor) 22 AWG: ≤5A; PDP->RIO 24 AWG: VRM 2A circuits 26 AWG: RIO PWM port outputs 28 AWG: SIGNAL LEVEL (≤1A draw and source) [Examples*] May be non-copper. Exempt: wires recommended/attached by mfg
R61	Connectors, slip rings, etc.: protected as rated
R62	Non-signal level, constant polarity wiring shall be color coded the entire length as follows: Pos: red, yellow, white, brown, black w/stripes Neg: black, blue Exempt: orig attached to devices, POE ethernet
R63	Custom circuits may not directly alter power*
10.8	Control, Command, & Signals System
R64	One RoboRIO, image version ≤ FRC_2019_v14
R65	One OM5P-AN or OM5P-AC radio, cfg for event
R66	RIO ethernet => "18-24vPOE" port on radio. Network switch allowed but discouraged.
R67	Robot-> console comms is limited to 4Mb/s and to specific network ports*
R68	Configure RIO, DS, & radio as directed*
R69	All signals must be Console -> Arena -> ROBOT
R70	No wireless to/from robot except per R65 & R69
R71	Mount radio so diagnostic lights are visible
R72	1 or 2 RSLs, visible 3' away, RIO RSL+ terminal to both La and Lb, RIO RSL-terminal to RSL center
R73	No mods to DS SW, RIO, PDP, PCM, VRM, RSL, breaker, MCs, RMs, radio, or batteries except: User programmable code on RIO Calibration of motor controllers per manuals Fans on motor controllers from their power Spike relay ==> compressor may have breaker Wires, cables, signal connected as provided Fasteners, including adhesives OK Thermal interface material/paste ok Labels ok Jumpers may be moved. Jaguars: custom limit switch circuit OK Mfg supplied firmware updates OK Wires on MCs cut, stripped, connectorized Devices repaired (not improved) Talon SRX data port cover removed Tape may be applied to AI plate inside radio
R74	Except designated 12V input, no 12V power, RM, or MC outputs shall be connected to the RIO
R75	Every power controller connected properly*
R76	Motors controlled via MXP must be controlled via PWM pins, passive conductors to extend same, or an approved ACTIVE DEVICE: : Kauai Labs navX MXP; RCAL MXP daughterboard; REV RIOduino; REV Digit Board; WCP Spartan Sensor Board; Huskie 2.0 board.
R77	Each CAN MC must be controlled from the RIO, passed via PWM (per R75) or CAN, but not both.
R78	Each PCM controlled from the RIO via CAN.
R79	The PDP CAN must be connected to the RIO
R80	CAN may have extra non-interfering devices
10.9	Pneumatic System
	Apply for event, not just FIELD/MATCHES
R81	Pneumatic parts: forbidden unless permitted
R82	Pneumatic items: COTS and (rated for 125 psi, or downstream of regulator & rated for 70psi)
R83	original, unaltered except: cut tubing; wiring modified for interface; assembly using pre-existing threads/brackets/fittings; removing mounting pin (but not cylinder); labeling.

R84	The only pneumatic items permitted: a KoP-equi vent plug valves b KoP-equi pressure relief valves; c Solenoid valves 1/8" (3mm) NPT, BSPP, BSPT diameter, or 1/4" OD tubing connectors d pneumatic tubing, 1/4" max OD e transducers, gauges, flow control valves, manifolds, and connection fittings f check & quick exhaust valves meeting R93a g Relieving shutoff valves (3-way exhausting) h regulators adjusted to 60 psi or less i cylinders, linear and rotary actuators j storage tanks, except white clippard tanks k One compressor, R86 compliant l Debris or coalescing (water) filters, m Venturi valves (high pressure is subject to pneumaticrules, vacuum side is exempt)
R85	If pneumatic used, following are required: One (1) FRC-legal compressor (per R86) Relief valve (R84-b) via rigid fittings to compressor Nason pressure switch SM-2B-115/R443 at least on pressure vent plug Stored pressure gauge, upstream of primary reg Working pressure gauge, downstream of regulator Working pressure regulator
	<p>The diagram illustrates a pneumatic system. On the left, a compressor is connected to a pressure relief valve. The line then goes to an air storage tank. From the tank, a line goes to a pressure vent plug. Another line from the tank goes to a pressure switch. A line from the pressure switch goes to a working pressure regulator. Finally, a line from the regulator goes to a working pressure gauge. Labels include: Compressor, Pressure Relief Valve, Air Storage Tank, Pressure Vent Plug, "Stored" Pressure Gauge, Air to "working" components (cylinders, etc.), "Working" Pressure Regulator, and "Working" Pressure Gauge.</p>
R86	ONE onboard compressor, 1.1 cfm.
R87	Stored air ≤ 120 psi. None stored offboard.
R88	One primary adj. relieving regulator ≤ 60 psi.
R89	Only compressor, relief, p. switch, vent plug, gauge, tanks, tubing, p. transducer, filters, fittings on high pressure side
R90	Gauges easily visible on high and low sides
R91	Relief valve: hard fittings to compressor output
R92	Nason p. switch SM-2B-115/R443; high side, wired to PCM or to RIO programmed for shutoff
R93	Vent plug: vent all air pressure & be accessible
R94	Don't plumb solenoid valve outputs together
10.10	Operator Console
R95	NI Driver Station rev 19.0 or newer
R96	must include diagnostic graphic display visible for inspection and match
R97	Driver station: direct connect to FMS (no switch) using proded cable. Ethernet port accessible.
R98	≤ 60" long, ≤14" deep or worn/held, ≤78" from floor, no attachment except loop tape & ethernet
R99	No wireless comms except FMS
R100	No hazmat, unsafe conditions, or interference
11	Inspection & Eligibility Rules
	LRI final authority
	May practice uninsp. FTA may pull if unsafe
	BYPASS/DISBLE by FTA, LRI or Head Ref*
I1	Built by team to play DDS*
I2	Get inspected before playing a qual match
I3	Present all mechanisms, configurations, and decorations at inspection. Subsets OK*
I4	Reinspect for any change except: fasteners, labeling, code, identical COTS or MECHANISM replacement, subsetting
I5	Present BOM at inspection. R12 for details
I6	Inspect power off, vented, & unsprung except as necessary
I7	student team member for any inspection efforts