Technical Construction Analysis: Electrathon America

Executive synthesis of design, manufacturing, and mechanical/electrical regulations for undergraduate engineering

This guide analytically summarizes the minimum design and construction requirements under the official **Electrathon America Regulations (Revision K)**. The regulatory framework prioritizes operational safety, competitive equity grounded in energy management, and structural soundness, serving as an engineering benchmark for university teams.

1. DIMENSIONS, GEOMETRY, AND STABILITY

Critical Parameter	Mechanical Specification
Wheel Configuration	3 or 4 wheels (Tricycle / Cycle-car). All wheels must actively carry load.
Track Width	Minimum **2 ft (60.96 cm)** center-to-center on at least one axle.
Maximum Width	Maximum **4 ft (121.92 cm)** with steering aligned straight ahead.
Maximum Length	Maximum **12 ft (365.76 cm)** from extreme front to extreme rear.
Minimum Ground Clearance	Must roll over a **1.5 in × 1.5 in (3.81 cm)** test block without contact.

The vehicle must demonstrate static and dynamic stability during banked turns and severe braking. Tilting mechanisms (*leaning vehicles*) are permitted provided they are mechanically actuated and feature a rigid locking system for driver entry and exit. Steering geometry must ensure a curb-to-curb turning diameter of less than **50 ft (15.24 m)**.

2. STRUCTURE, BODYWORK, AND COCKPIT

- **Structural Chassis:** Must provide a rigid perimeter cockpit protecting the driver against impacts from any direction. Closed-section tubular dimensions are not strictly prescribed, but structural integrity is subject to formal approval during technical scrutineering.
- **Floor Pan and Enclosure:** A solid, rigid floor pan is mandatory to prevent any contact between the driver and the pavement. The bodywork must enclose the driver's legs, feet, and sides up to shoulder height to protect the ribcage.
- **Material Restrictions:** Cardboard, paper, or materials that lose rigidity when wet are prohibited. Brittle or shatter-prone panels (such as Plexiglas or fragile acrylics) are strictly forbidden. The nose cone must feature a minimum tip radius of **3 in (7.62 cm)** to mitigate frontal impact severity.
- **Roll Bar:** Rigid safety structure capable of withstanding an inverted free-fall drop from **1 ft (30.48 cm)** with the driver seated inside. It must be rigidly triangulated with at least 3 chassis mounting points (or 4 supports if attached within 4 in of the top). When properly strapped in, the driver's helmet must remain entirely below the straight line drawn from the top of the roll bar to the highest rigid forward structural point of the chassis.

3. DYNAMIC SYSTEMS, WHEELS, AND BRAKES

- **Mandatory Braking:** Mechanical braking system acting on at least **two wheels on the same axle** (either both front or both rear wheels). Physical redundancy via **independent actuation cables** for each braked wheel is mandatory, even when converging on a single lever or pedal. Dynamic testing requires bringing the vehicle to a complete stop in a straight line from 25 mph (40.23 km/h) in under **40 ft (12.19 m)**.
- **Axle Sizing:** Double-supported axles (supported by bearings on both ends) must have a minimum diameter of **3/8 in (9.52 mm)**. Cantilevered axles or stub spindles (supported at one end only) require a minimum diameter of **1/2 in (12.7 mm)**, and their retaining nuts must be positively locked using safety wire or cotter pins; nylon-insert locknuts alone are not permitted.
- **Tires and Guards:** Standard pneumatic tires are required. The driver must be physically isolated by rigid guards to prevent accidental contact with tires or wheel spokes.

4. ELECTRICAL SYSTEM AND POWER MANAGEMENT

Propulsion must be purely electric. Motor power delivery must be controlled by an automatic return-to-zero throttle (**"dead man"** passive safety switch) that immediately cuts power upon release of the control input.

- **Chassis Isolation:** Under no circumstances may the metallic structural chassis be used as an electrical return path or ground conductor. The entire electrical system must remain completely floating.
- **Overcurrent Protection:** Every circuit branching from the battery pack must incorporate a fuse or thermal circuit breaker sized according to standard automotive wire gauge (AWG) ratings and mounted as close as possible to the battery source.

Wire Gauge (AWG)	Max Fuse Rating	Wire Gauge (AWG)	Max Fuse Rating
14 AWG	15 A	6 AWG	105 A
12 AWG	20 A	4 AWG	140 A
10 AWG	30 A	2 AWG	200 A
8 AWG	80 A	1/0 AWG	300 A

5. ENERGY STORAGE (BATTERIES)

RESTRICTED BATTERY CHEMISTRY: Standard Class limits energy storage exclusively to sealed **Lead-Acid batteries** that will not spill electrolyte if punctured, authorizing only commercially available, unmodified **Gel or AGM (Absorptive Glass Mat)** technologies.

- **Standard Class Weight Limit:** The combined weight of all onboard batteries (including instrumentation and control batteries) must not exceed **73 lb (33.11 kg)**. Vehicles are exempt from this weight cap if they use an exact pair (2 units) of approved commercial models: Optima YellowTop D35/D75/D25, RedTop SC25A/35A, Odyssey Genesis G42, MK 40, Exide Orbital, or Champion Vortex.
- **Advanced Battery Class:** Permits experimentation with high-energy-density chemistries under strict mass limits calibrated to cap energy around 1 kWh: **$LiFePO_4$: 29 lb (13.15 kg)**; **Lithium-Ion: 15 lb (6.80 kg)**; **NiMH: 41 lb (18.60 kg)**; **Silver-Zinc: 23 lb (10.43 kg)**.
- **In-Race Charging:** Battery swapping or external charging during a race is prohibited. Energy recovery is permitted solely via regenerative braking or bodywork-integrated solar panels in the Solar Class.

6. EMERGENCY MECHANISMS AND PASSIVE ERGONOMICS

- **Master Isolation Switch (Kill Switch):** Mechanical main disconnect switch installed directly in the primary positive cable between the battery pack and speed controller, rated above the motor's locked-rotor stall current.
- **Switch Accessibility:** Must be operable by the driver from the normal seated driving position without removing hands from the cockpit, and externally accessible to track officials. The exterior actuator must be clearly marked inside a **solid red equilateral triangle measuring at least 4 in (10.16 cm) per side** in high contrast against the bodywork.
- **Safety Harness:** Automotive **5-point safety harness** bolted to structural chassis members using structural-grade bolts, nuts, and washers, capable of supporting the suspended weight of the entire loaded vehicle with driver and batteries. Lap belt anchors must be positioned 3 in below the waist, and shoulder harness anchors 3 in below the shoulders.
- **Egress Test and Ballast:** The driver must demonstrate unaided self-extraction from the fully buckled vehicle in **20 seconds or less**. Minimum driver weight with full safety gear is **180 lb (81.64 kg)**; lighter drivers must securely bolt solid, non-liquid ballast to the chassis, removable for official weigh-in.