ROBOBATTLE

TECHNICAL REQUIREMENTS

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1. General requirements

1.1 Weight category limits

Combat robots are divided into two groups based on their weight category:

– Lightweight 0-29,9 kg;

– Heavyweight 30-55 kg.

If a combat robot qualifies as a walking or an autonomous robot, then the robot is given an extra 20% weight advantage.

1.2 Regulations of weight limits

A combat robot is weighed in a combat-ready configuration. The means of transport are removed before weighing. All of the following parts and materials need to stay in or on the robot:

– all liquids that are allowed according to this document;

– all gas and batteries that are allowed according to this document;

– all cosmetic elements;

– all additional systems, such as internet transmition, telemetry systems, etc; – cameras and audio systems.

While determining the weight of a combat robot, some parts are left out. These are as given:

– remote-controlled camera and/or audio systems that the organisers accept;

– devices used to transport the robot; – remote control.

1.3 The marginal rate of measurements

– a combat robot's measurements inside the starting position should be 1m x 1m x 1m ($1m^3$); – a robot does not need to be disassembled when being taken on or off the arena.

1.4 Materials used in the making

Due to there being many different materials which can be used to build a combat robot then, all of them will not be listed in this instruction. Overall most metals, plastics, elastomers and composites are allowed to be used, except for when a particular material is prohibited according to another point in this document or when the material is toxic or dangerous in any other way.

The use of the following materials is allowed, but with certain limits:

– lead (Pb). It cannot be on the surface of a combat robot unless it is covered. The robot has to be covered well enough so that the enemy cannot touch the surface in such a case;

– polystyrene, polyurethane and polyvinyl chloride. These can be used for isolation or to soften attacks only on the insides of a combat robot.

The following materials are prohibited from being used in combat robots due to them being toxic:

– beryllium;

– baron fibre;

– copper plated uranium;

– radioactive materials;

– asbestos;

– carbon or fibreglass bulk fibers (bound or woven);

– any type of metal powder;

– metal shavings or glass wool;

– degradable organic substance;

– reactive metals (such as lithium or sodium); – glass.

1.5 Energy system

The number of energy systems used on a combat robot is not limited, only if it follows the regulations and rules set for all other robots.

The following types of energy systems can be used in robots:

– electric motor

– pneumatics

– hydraulics

– mechanical systems

In certain situations, using other types of energy systems is alright. To be allowed to use another type, the user needs to contact the organisers.

1.6 Lights and sound

The use of lasers, lights and/or sound sources on a combat robot is limited by considering safety and practicality.

Suppose a fighter robot has an artificial light or sound source. Then there must be a safe method to turn off the light(s) or sound(s).

Class I lasers can be used without limit. Lasers lighter than that can hurt the eye; therefore, the following rules need to be followed:

– lasers that are up to class II and have a lower output capacity than 1mW can be used on combat robots. The frequency does not matter;

– class II lasers can only be used if they are placed firmly and point to the ground, not further than 1 meter from the edge of the combat robot, when it is in its combat-ready configuration.

Using lights on a combat robot is allowed considering they are not too bright; otherwise, they can disturb the competitors, referees and audience. Strobe lights with low brightness can be used on combat robots only if they do not disturb the competitors, referees or audience.

Using a sound source is allowed, but the sound coming from the robot cannot be over a hundred and ten decibels (110 dB) and not go beyond 3 meters from the robot in any direction.

1.7 Special solutions

Unique solutions not mentioned in these general requirements must be coordinated with the organisers before the event.

2. Configurations for different combat robots

2.1 Multi-robot

A multi-robot is a combat robot that is made out of two or more separate parts that compete in unison as a single combat robot. The number of elements is not limited, but they do need to follow the requirements.

When defining the weight category for the multi-robot, all the parts are weighed together.

If a multi-robot has an autonomous part, it must follow the guidelines for autonomous combat robots. NB! Not every part of a multi-robot needs to be autonomous.

2.2 Walking combat robots

A combat robot that does not use any wheel type of movement (such as tracks or tires) can be qualified as a walking robot and get a 20% weight advantage.

2.3 Jumpy/jumping combat robot

The use of a jumpy or a jumping robot is allowed. A combat robot's jumping height can not go past 1 meter. It is measured from the ground to a robot's bottom at the jump's apex. The maximum height of a combat robot's hop can be up to 2 meters, measured from the part that flies out before and after the jump.

2.4 Autonomous combat robots and parts

An autonomous combat robot is a robot that is not controlled by remote control. An autonomous combat robot gets a weight advantage of 20%. A combat robot is allowed to use autonomous combat robots or autonomous parts, provided that:

- All autonomous actions can be stopped or cancelled with a remote control device
- If the remote control device fails, all things autonomous in the arena stop their movement.

3. Remote control

3.1 Controlling a combat robot

A combat robot's every move and use of weapons must be controlled and predictable. All primary control and communications with the combat robot's defence mechanisms must happen through radio communications. Transmitting with the help of light waves (such as infrared), sound, and wires are forbidden.

Controlling speed through binary controls (in/out) is not recommended, although it is allowed. For all movements happening on the ground, it is strongly suggested to use proportionate speed control. Proportional, discrete and binary controls are authorised to be used to move a weapon.

3.2 Radio communications equipment offered in trade

For controlling a combat robot, devices found in consumer commerce can be used. These are allowed to be used by the Estonian law on specific frequencies.

Every combat robot's remote control system must have a reliable defence mechanism. It should stop all movements and weapons in a safe method and configuration in case the transmitter's signal breaks.

3.3 Controlling a combat robot

Many different users can control combat robots. There is no limit to how many manual remote controls can one have. It only applies if the radio frequencies used are allowed by the law.

Two different radio-controlled channels can manage an ordinary radio-controlled combat robot. A radio-controlled multirobot can be controlled by a maximum of three separate radio-controlled channels.

4. Safety of a combat robot

4.1 Safety of a combat robot

A combat robot must be built not to harm anyone or anything around it at any time unless it is fighting or being tested.

In addition, a combat robot has to be activated or deactivated in a reasonably short time so that the dangers from the process are minimal to the activators or deactivators and everyone around it.

4.2 Spinning parts

If a combat robot has spinning parts, then, while spinning, it needs to be shown that the traction turns off when a remote control transmitter shuts down.

A combat robot needs to be constructed in a way that when the traction is turned off in the spinning part then, it stops within one minute.

5.Electric energy

5.1 Combat robot's electrical systems

Usually, a combat robot has two general types of electrical systems (primary and secondary).

Primary electrical systems are used to move a robot and to directly or indirectly start a weapon's system. Primary electrical systems are characterised by their strong use of electrical power.

Mainly all combat robots have a low voltage secondary electrical system to start remote control receivers. Be it thus that this system's energy usage is low. If the secondary electrical system has a power failure, it will cut communications.

5.2 Voltage limits

Standard voltage limits apply to the electrical systems of a combat robot. It depends on whether the voltage is obtained from a direct current (DC) or an alternating current (AC).

A combat robot's direct current's rated voltage is limited to 48 volts. The maximum allowed voltage for a direct current is measured while the electrical systems are active from whichever highest potential point to the point with the lowest potential is 50 V.

The maximum/minimal alternating current voltage measured when the electrical systems were active is –80/+80 V. The voltmeter's readings cannot be more than 50 V rms.

5.3 Allowed types of betteries

Only the given types of batteries can be used in combat robots:

– Lead batteries, considering that they are of the closed type and with the following properties:
1. the battery can be used in any position, even backwards;
2. “absorbed” or “stabilised” electrolytes are being used in the battery;
3. the battery is leakage proof;
4. is missing a way to check or add battery acid.

– Ni-Cad batteries offered in commerce can be used;
– Ni-MH batteries offered in commerce can be used;
– Li-Po batteries offered in commerce can be used;
– Liitiummetallakud on keelatud. Li-Ion batteries offered in commerce can be used.

Lithium metal batteries are forbidden from use.

If you want to confirm whether a specific batterie model is allowed to be used, contact the event organisers.

5.4 Battery installation

For safety reasons, the batteries need to be correctly installed and protected.

All batteries need to be fixed so they do not get loose when getting hit from different sides, even from the top (in case the combat robot spirals over) with a force of five times the weight of the battery.

To fix primary energy type batteries such as Ni-Cad, Ni-MH or Li-Ion, isolated metal strips or clamps or other materials which handle moderate heat need to be used. Plastic bandages can not be used to attach such batteries.

Plastic bandages can attach secondary energy battery packs to a radio receiver.

Due to all primary electrical systems using Ni-Cad, Ni-MH and Li-Ion batteries, they heat up when working. Because of this, all pneumatic system parts need to be isolated.

To avoid batteries accidentally short-circuiting, they need to be placed as such:

– different battery elements that make up a battery need to be correctly put together and isolated so that no element gets short-circuited;
– all naked battery terminals need to be covered with electrical insulation. The insulation needs to be applied so that nothing can get through it, and it can not be easily brushed off;
– Batteries need to be placed so that they are under the body of the combat robot, thoughtfully placed.

5.5 Electric capacitors

In a primary electrical system, it is allowed to use capacitors to store the energy. At the same time, electrolyte-type capacitors need to be attached so that they are thoughtfully protected and placed firmly inside of the combat robot’s body.

5.6 Electric circuits

A combat robot’s primary and secondary electric circuit must follow generally accepted electrical engineering practices. Some specific requirements are as follows:

All naked battery terminals and wire tips in a primary electric circuit must be covered with electrical insulation. The insulation needs to be applied so that nothing can get through it, and it can not be easily brushed off.

Secondary electric circuits need to be insulated in the same way.

All electric wires need to be attached or leaned to the chassis of the combat robot using cable connectors and/or clamps.

5.7 Turning off the electricity

All combat robots with a primary electrical system need to have a method to shut down the system completely. Every primary electrical system needs to have a button that can shut down the system that follows all the following requirements:

- the switch needs to be wholly mechanical and directly connect or disconnect the electric circuit without using other electrical components;
- the switch needs to be a closed type where a potential electric arc only appears inside of the button;
- the switch needs to directly turn off the electric current in the batteries of the primary electrical system. Turning it off indirectly is forbidden (with the use of a relay or contractor);
- the switch needs to be placed as close to the batteries as possible;
- in case a primary energy battery is connected to the conductive chassis. The switch must be placed, so the power is interrupted between the battery and the chassis.

Instead of the actual head switch, a removable one can be used if it follows all the requirements for the head switch.

All head switches need to be placed so that they are in a place where they can be turned off and on so that the one switching it on or off doesn't get hurt by the robot's weapon system or any part that is powered by an energy source.

Using a unique tool to gain access to the head switch is allowed only if all the head switches can be turned on or off with the same tool.

6. Fuel powered engines

Fuel-powered engines are forbidden due to the event being held indoors.

7. Pneumatic systems

7.1 Pneumatics overview

Pneumatic systems involve storing, using and controlling compressed gasses that operate actuators.

Incorrectly designed and built pneumocystis can be very dangerous. Additionally, damage taken during a fight can make every pneumatic system dangerous.

7.2 Limits of compressed gasses

There are set limits for using gasses in pneumatic systems for combat robots. The following gasses are allowed to be stored or used in a combat robot:

– nitrogen (N2), only in a compressed state;
– air (21% O2, 78% N2), only in a compressed state, oxygenated air is forbidden from use;
– carbon dioxide (CO2) can be stored in a liquified or gaseous state only if the pneumatic system is constructed so that using liquified CO2 in the system is safe.

The maximum pneumatic pressure allowed to be stored in a combat robot at all times is 175 bar.

Limits for the total volume of gasses inside a combat robot or multi-robot are limited. The limits are dependent on the gas that is being used:

– lightweight 300 litres N2/0,5 kg CO2
– heavyweight 1200 litres N2 / 3kg CO2

To ensure or increase the robot's pneumatic pressure, a pneumatic pump (compressor) can be used. It is allowed only if:

- there is a safety valve for each compressor, the nominal value of which corresponds to at least 120% of the pressure of gas leaving the compressor
- each compressor has a rated pressure equal to or greater than the opening pressure of the compressor relief valve.

All pneumatic pressure vessels need to be commercially available products. The use of self-made or modified pressure vessels is prohibited.

7.3 Pneumatic components

It is strongly suggested to use pneumatic components with standard indicators. Due to the high risk of modification, using custom-made or modified pneumatic components is not supported. If a custom-made or self-modified pneumatic component is used in the combat robot's pneumatic system, the competitor is asked to show:

– a data sheet and/or calculations proving that the component is of sound construction;

– the component functions reliably and safely during a safety/engineering inspection.

7.4 Installation and assembly of components

Minimum requirements apply to the installation and assembly of pneumatic components. They aim to mitigate the effects of solid inertial forces and weapons damage in combat.

None of the pressure vessels of the pneumatic system must be directly visible from outside of the combat robot.

All pneumatic components must be insulated from heat sources. Such sources include, among others, electric motors and certain types of batteries.

8. Hydraulic systems

8.1 Hydraulics overview

Hydraulic systems involve pressurising and controlling fluids that operate linear and rotary actuators. A hydraulic system contains fluids under very high pressure, so a system that is not correctly designed and built can be dangerous. In addition, injuries sustained during combat can render any hydraulic system unsafe.

8.2 Requirements for hydraulic systems

The maximum hydraulic pressure used in a combat robot is 350 bar. If an accumulator or another hydraulic pressure tank is used anywhere in this system, the pressure in the tank must not exceed 175 bar.

The entire hydraulic pressure of the combat robot must be produced by one or more hydraulic pumps located on the robot, powered by an electric motor.

Hydraulic fluids must be stored in a hydraulic tank where the pressure does not exceed 2,5 bar.

There is no specific limit to the amount of hydraulic fluid stored in the tank. To keep the arena as clean as possible, a minimum amount of liquid should be kept in the container, which is sufficient for an adequately functioning hydraulic system.

8.3 Hydraulic system components

It is strongly recommended to use standard hydraulic components with common characteristics. Specific custom components are permitted with some restrictions.

All hydraulic accumulators and boosers must be commercially available products. The use of self-made or modified accumulators and boosters is strictly prohibited.

9. Combat robots weapons

9.1 Weapon construction

When the combat robot is not currently in a state of combat or being tested, the robot's weapon system must be completely secure and safe for all people and objects in the vicinity of the combat robot.

9.2 Means of rendering harmless

A combat robot may not use devices designed to paralyse the opposing robot's mechanics without causing direct damage. Disarming means substances or materials used to knock one or more mechanisms of another combat robot out of line. Means of rendering harmless are considered to be:

- all types of nets;
- fishing line, string, rope, etc.;
- non-metallic chain or cord;
- ball bearings or glass balls;
- tape coated with glue
- metal shavings or wool

9.3 Throwing weapons

Each projectile must be connected to the combat robot's structure by a non-elastic shackle. The shackle must be strong enough to hold the projectile without damaging the bond even after multiple firings. The length of the shackle, measured from the attachment point on the combat robot to the end of the throwing weapon, must be less than 2 meters.

9.4 Prohibited weapons

It is prohibited to use the following weapons:

The use of electricity or electric fields as a weapon is prohibited. It also includes the following:

– stun guns and livestock stunners;
– means of jamming radio signals;
electromagnetic pulse.

No liquids may be used as a weapon or inside of it. It also includes the following:

- water and other liquids;

- liquefied gases;
- chemicals or corrosive substances
- foaming liquids;
- adhesives.

Explosives or flammable substances may not be used as a weapon inside the weapon. It also includes the following:

- class C weapons as defined in the gun law;
- gunpowder and cartridge fuses;
- military explosives;
- sodium azide.

Flammable liquids must not be used as a weapon or directly inside. It also includes the following:

- gasoline, alcohol, ether, etc.;
- propane, butane, acetylene, etc.

It is forbidden to use weapons which disturb the field vision of the opposing team's operator. It also includes the following:

- intentionally created thick smoke;
- light or laser beams directed at the operator.

It is forbidden to use weapons that damage the opponent by manipulating the temperature. Other things that are prohibited:

- plasma torches;

- liquefied gases.

10. Combat robot appearance

10.1 Appearance

The exterior design of the combat robot must show the competition as an aggressive yet “clean” (fair) sport. Therefore, the appearance of the combat robot must meet the following requirements:

– the exterior of the combat robot must not contain words, images or sketches that are not suitable for television;

– the exterior of the combat robot must not have words, images or sketches that are not suitable for children;

– the design and external surfaces of the combat robot must not contain words, images or sketches that attack or insult religious organisations, different races or nationalities, etc.; – all advertising on combat robots must be in good taste.