



Spaceport America Cup

Intercollegiate Rocket Engineering Competition
GPS Tracking Requirement and Recommendations

Table of Contents

SECTION	PAGE
1.0 INTRODUCTION	3
1.1 BACKGROUND	3
1.2 PURPOSE AND SCOPE	3
1.3 CONVENTION AND NOTATION	4
2.0 GPS TRACKING REQUIREMENT	5
2.1 WHO DOES THIS APPLY TO?	5
2.2 COTS AND SRAD GPS SOLUTIONS	5
2.2.1 COTS GPS TRACKERS	5
2.2.2 SRAD GPS TRACKING SYSTEMS	6
2.4 FCC HAM LICENSING	6
2.5 ASSIGNMENT OF FREQUENCY	6
2.6 REPORTS, SAFETY INSPECTIONS AND FINAL RANGE CHECKOUT	7
2.6.1 REPORTS	7
2.6.2 SAFETY INSPECTIONS	7
2.6.3 FINAL RANGE CHECKOUT	7
2.7 MCC COORDINATION WITH TRACKING	7

1.0 INTRODUCTION

The Experimental Sounding Rocket Association (ESRA) and the New Mexico Spaceport Authority (aka Spaceport America; NMSA) have partnered to host and support the Spaceport America Cup (SA Cup), a week-long series of events which will set the background and provide structure for the world's largest university rocket engineering competition. This new host-event continues the Intercollegiate Rocket Engineering Competition's (IREC) legacy of inspiring student design teams from across the country and around the world.

1.1 BACKGROUND

The continued growth of the IREC has required multiple changes in policy and procedures over the years to ensure high levels of safety, efficiency and participant satisfaction. To continue supporting the growing numbers of participating teams, ESRA has identified a critical area which has been causing delays in team launch processing. This specific area relates to the numbers of teams attempting to recover their rockets and the amount of time each team requires to recover their rocket.

In 2019, an informal study was done to determine average recovery times of rockets. The end result of the data analysis showed a very clear separation between teams utilizing GPS tracking and those who do not. Teams without GPS tracking or with problems with their GPS tracking hardware/software were utilizing 3-4 times more time trying to recover their rockets.

ESRA has determined that it will now be a requirement that all participating teams will begin utilizing GPS tracking solutions on every rocket project to expedite rocket recovery. In addition, the GPS tracking solution **must be compatible with the Mission Command Center (MCC) receivers and it's 30' antenna array.**

1.2 PURPOSE AND SCOPE

This document defines the minimum GPS Tracking criteria ESRA expects IREC teams to meet before launching at the SA Cup. The event organizers use these criteria to promote flight safety and expedite rocket recovery. **Failure to meet the requirements stated in this document provides may negatively impact a team's score and may lead to a failed safety review and grounding of your rocket.**

1.3 CONVENTION AND NOTATION

The following definitions differentiate between requirements and other statements. The degree to which a team satisfies the spirit and intent of these statements will guide the competition officials' decisions on a project's overall score in the IREC and flight status at the SA Cup.

GPS: Global Positioning System is a radio navigation system that allows land, sea, and airborne users to determine their exact location, velocity, and time 24 hours a day, in all weather conditions, anywhere in the world.

Telemetry: The collection of measurements or other data at remote or inaccessible points and their automatic transmission to receiving equipment for monitoring.

RF: Radio frequency is the oscillation rate of an alternating electric current or voltage or of a magnetic, electric or electromagnetic field or mechanical system in the frequency range from around 20 kHz to around 300 GHz

Frequency: A specific and fixed numeric frequency within a given band.

Frequency Hopping/Spread Spectrum: A technology that varies the transmit and receive frequency of the system..

FCC: Federal Communications Commission - The FCC is an independent agency of the United States government created by statute to regulate interstate communications by radio, television, wire, satellite, and cable

Transmitter: A piece of equipment used to generate and transmit electromagnetic waves carrying messages or signals, especially those of radio or television.

Receiver: a piece of equipment used to receive and collect electromagnetic waves carrying messages or signals, especially those of radio or television.

HAM: Amateur Radio (ham radio) works with the FCC to create and implement a series of certification levels for individuals which allow the use of specific frequency bands and signal strengths based on their certification level. Certification levels include Technician, General and Extra.

COTS: Commercial Off the Shelf – A purchased complete solution (entirely) from a tested and approved rocketry vendor

SRAD: Student Researched and Designed – A solution designed, developed and tested by the student teams

APRS: Automatic Packet Reporting System (APRS) is an amateur radio-based system for real time digital communications of information of immediate value in the local area.

Data can include object Global Positioning System (GPS) coordinates, weather station telemetry, text messages, announcements, queries, and other telemetry.

MCC: The Mission Control Center is a central point for rocket recovery operations at the Spaceport America Cup. Rocket recovery teams are assigned communications and tracking backpacks before they depart to recover their rockets.

2.0 GPS TRACKING REQUIREMENT

2.1 WHO DOES THIS APPLY TO?

For the 2020 Spaceport America Cup and all future IREC events, **all** rockets will be required to have an approved GPS tracking solution on their rockets. Teams will be required to prove their tracking solutions are functioning during the final safety checks before proceeding to the launch pads.

2.2 FREQUENCY MANAGEMENT

The MCC will begin coordinating the assignment of frequencies to teams in the months leading up to the Cup. This will ensure each team has a frequency that does not conflict with any other team. With that said, teams should still be able to quickly change frequencies on their transmitting and receiving stations if needed. Teams will test their transmitter in coordination with the MCC prior to launch to ensure the MCC is receiving GPS telemetry.

- Students may have multiple GPS Tracking solutions within their rocket. One of these solutions must meet the requirements highlighted in this document.
- All transmitting devices on the rocket must be documented in your interim and final reports. Frequencies for all devices must be coordinated with MCC.
- Any team that is transmitting on a frequency not assigned to them will be penalized.

2.3 COTS AND SRAD GPS SOLUTIONS

2.3.1 APPROVED COTS GPS TRACKERS

Approved COTS GPS solutions for high power rocketry are easy to use and available for a few hundred dollars.

Approved COTS Solutions

Vendor	Product		Website
Altus Metrum	TeleGPS, TeleMega, etc	70cm, APRS	Click Here
Big Red Bee	Beeline GPS	70cm, APRS	Click Here
Featherweight	Featherweight GPS	900MHz	Click Here

GPS Trackers have a multitude of options:

- Frequency Ranges –
 - 900MHz – Does not require a HAM license, good option for international teams who cannot acquire necessary certifications. MCC has a very limited number of 900MHz receivers so you may experience delays launching if you utilize this frequency range.
 - 70cm – To avoid significant delays in potentially launching, teams should utilize 70cm/APRS systems for their GPS tracking systems. Requires a HAM license, or a similar international licensing.
- Student teams may have MULTIPLE GPS Tracking solutions. Teams with multiple stages or deployables are encouraged to use the Big Red Bee 70cm GPS units in each of the rocket stages and/or deployables. The Big Red Bee 70cm GPS unit has built in GPS timeslot capability.
- **APRS Support IS HIGHLY RECOMMENDED for ALL TRACKERS.**

2.3.2 SRAD GPS TRACKING SYSTEMS

SRAD GPS solutions are approved but require significant additional documentation and testing.

Here are additional requirements for SRAD developed GPS Tracking systems

- Must be able to easily and rapidly change frequency within the bandwidth you are assigned by the MCC.
- Frequency Hopping/Spread Spectrum transmitters are not permitted.

- APRS protocol is required for SRAD GPS Tracking. The protocol utilizes 1200baud AFSK and the APRS packet format. See <http://www.aprs.org/doc/APRS101.PDF>
 - Transmit rep must be set to 2sec. Transmissions on the same frequency from different stages(transmitters) must be shifted using GPS timeslotting.
- Solution must be thoroughly and successfully tested out to:
 - For 10k' flights - 2 miles (line of sight on the ground).
 - For 30k' or higher flights - 3 miles (line of sight on the ground).

2.4 FCC HAM LICENSING

Teams are HIGHLY recommended to work towards getting their HAM license (or similar for International teams). The 70cm APRS GPS Tracking solutions require a minimum of the primary user to be licensed at the Technician level or higher. Again, this certification is relatively easy to attain and looks great to future employers.

- Teams outside of the US should make every attempt to get licensed in their own region where possible.
- Most countries have reciprocal HAM licensing with the US. If you have a HAM license from outside of the US, make sure to bring a copy of the license printed in English with you.
- All others, make sure you know your callsign and are using it on your tracking solution.

2.5 ASSIGNMENT OF FREQUENCY

All teams will be assigned a frequency by Davinci personnel (MCC staff) prior to arriving in Las Cruces. Failure to utilize this assigned frequency will cause significant delays in approving your project for flight and may cause your rocket to be grounded. Assignments will be provided to the teams via HeroX messaging and web forms. The MCC will maintain the team database of frequencies in order to ensure teams do not conflict with other team's frequencies.

Again, Frequency Hopping/Spread Spectrum transmitters do not meet the requirement. They are not able to be received by the MCC.

Teams are organized by Team number and frequency. The team must have a fixed frequency and comply with the COTS or SRAD requirements.

2.6 REPORTS, SAFETY INSPECTIONS AND FINAL RANGE CHECKOUT

2.6.1 REPORTS

GPS tracking systems information, including configuration, testing and HAM certifications should be included in interim and final reports. Videos of GPS Tracking testing should be included on your social media feeds and links in your final report.

2.6.2 SAFETY INSPECTIONS

This information, configurations and system will be reviewed on each of the interim reports and will be physically inspected during the RANGE SAFETY CHECKOUT at the Tuesday conference session. Inspectors will ensure:

- Team is utilizing their assigned frequency
- All teams should label their rockets with team name, number and GPS frequency. This label should be duplicated on each part of the rocket which could separate either as designed or accidentally.
- Members have appropriate HAM licensing (if needed)
- Transmitter and receivers are properly prepared.

2.6.3 FINAL GPS TRACKING SYSTEMS CHECKOUT

At the pads, teams will be instructed by the pad managers to turn on all electronics and confirm flight systems and GPS tracking systems are functioning properly. The team must be able to communicate with their receiving station and confirm that GPS signals are acquired and functioning properly. Pad managers will then call in the pad assignments and confirm that the MCC is receiving GPS telemetry successfully. **Teams who cannot confirm GPS Tracking signal either through their team receivers or through the MCC will not be allowed to launch.**

2.7 MCC COORDINATION WITH TRACKING

The MCC has a large 30' radio tower with antenna arrays and stronger receivers. This system will be able to pick up signals at a significant further distance than handheld antennas.

Teams attempting to recover their rocket who cannot lock onto its location should contact the MCC via their recovery backpack radio. They should then provide Team Identification Number. The MCC will provide the most recent updated coordinates received.

2.8 **INTERNATIONAL TEAMS WHO CANNOT SECURE A HAM LICENSE**

Many international teams have confirmed that they will be unable to secure appropriate licensing for a HAM frequency. Teams needing an exception like this should

- Attempt to utilize a 900MHz Featherweight GPS tracking system
- Post their request on the HeroX GPS Tracking forums. Davinci staff are monitoring this forum and will work with you to find a workable resolution.